Lecture Notes in Information Systems and Organisation 69

Gregory Prastacos
Nancy Pouloudi *Editors*

Leading and Managing in the Digital Era

Shaping the Future of Work and Business Education

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Preface

Digital technologies, such as the Internet of things (IoT), artificial intelligence (AI), machine learning, robotics, blockchain, and virtual and augmented reality, are leaving a lasting impact on the way we work, live, and communicate. These rapidly emerging technologies are radically transforming areas of cognitive and physical work, enhancing efficiency, and creating new opportunities and new challenges. As a result, management roles are evolving in constantly renewed directions. In this digital era, managers work alongside intelligent machines that perform many cognitive tasks hitherto performed exclusively by humans.

In June 2023, at the inaugural International Conference on Leading and Managing in the Digital Era (LMDE) in Athens and Syros, Greece, we opened up a debate engaging researchers as well as academic and industry leaders on the potential of digital technologies today and their impact on business, leadership, the future of work, and business education. The conference research presentations and debates showed that a new set of skills and a new style of leadership are required, where digital savviness is essential, together with an increased focus on collaboration, transparency, entrepreneurship, diversity, and inclusion.

Additionally, as the development of digital technologies converges with the trajectories of deepening environmental problems and increasing sociopolitical turbulence, risk awareness, and risk management become top priorities. This results in new ethical challenges as business needs to pursue sustainability and responsibility. Decision-makers here often find themselves in unchartered waters, making stronger collaboration of industry and academia imperative.

The digital era therefore carries a combination of hype, challenges, misconceptions, and uncertainty. These are documented in research and experienced in business practice and societal relations. It is not surprising that "VUCA," an acronym for volatility, uncertainty, complexity, and ambiguity, has been trendy for more than a decade. The more technology develops and the more challenging the transparency and predictability of the impact of technology-enabled and technology-led decision making, the greater the challenges for the way we work, live, and communicate. Artificial intelligence and generative AI in particular accentuate these challenges further. How can we prepare for and address these challenges? Can research contribute?

The organization of the LMDE conference and the present book were driven by our observation that our understanding of the digital era is fragmented. We study the digital era within silos of different disciplines, typically focusing on a specific technology, a specific sector, a specific local, or a regional context, as we are restricted by resources as well as the need for a manageable scope. Our research is also often restricted by the choice of particular research paradigms and methods. As a result, we cannot break the vicious cycle of a fragmented, limited, and inefficient engagement with the potential of the digital era.

This book, with selected papers from the LMDE conference and invited contributions, aspires to inspire a new interdisciplinary direction in research by bringing together complementary and occasionally conflicting accounts of what it means to be leading, managing, and learning in the digital era. The reader will find innovative contributions that explore how digital technologies and the business and societal context that these influence, shape the "digital era" in different parts of the world. We have deliberately invited and included contributions that bring to the fore the diversity of relevant contexts, disciplines, theories, and methodologies. Studied together, the chapters in this volume showcase the impact of digital technologies on business, on business schools, and on research. What are the key messages?

First, it is clear that the digital transformation of business is at the top of the agenda of every CEO. New technologies enable better and faster dissemination of information, vast improvement in operations, upgrades in customer experience, business model innovations, and significantly improved decision making. New skills and mindsets are needed to be competitive and to match the emerging new roles when traditional leadership and management roles are disappearing. At the same time, the opportunities for digital disruption fuel a trend toward start-ups and entrepreneurial activities.

Second, to produce graduates that meet the skill demands of newly digital employers, business schools are urgently revising and retooling existing programs and curricula by infusing more technology and creating new programs that address the changing needs. High-profile international projects, such as the MaCuDE project (www.macude.org), sponsored by AACSB International, systematically address the efforts of business schools to revise their curricula, while HR managers seek to attract digitally savvy candidates that also possess a set of meta-skills that have been identified as critical for success in the digital era.

Third, the digital era and the transformation of the workplace create significant opportunities and expectations for impactful research. Academic journals increasingly publish papers on the applications of digital technologies on business, and research grants are pursued to examine the future of work, the changing roles of management, the new skills needed in the digital era, how curricula should change, and how modalities of delivery will change. Researchers need to set a broader, interdisciplinary agenda and explore innovative methods to respond to the challenges of the changing business and technological landscape.

To present these messages, the chapters in this book are organized in six parts. These cover six interrelated themes, drawing from different disciplines and research traditions at different levels of analysis. The First Part, **Governance in the Digital**

Era, sets the scene by reviewing the challenges that the digital era presents for policy-makers at national and global levels. This research is complemented by research at the organizational level in the Second Part, **Strategy and Entrepreneurship in the Digital Era**, that discusses strategic issues that organizations of different sizes and levels of digital maturity face. These two parts present the context within which an innovation space is created, contested, developed, and exploited. In the Third Part, **Innovation and Digital Transformation**, the book presents examples from different sectors, where AI and other innovative technologies are integrated in business. These innovative technologies transform business processes and stakeholder relations and impact business results as well as the experiences of workers, users, and consumers. The Fourth Part, **The Future of Work**, then focuses on the changing conditions of workspaces and their implications for human resource management and the future of work. The Fifth Part, **Leadership and Skills in the Digital Era**, explores the impact of this changing business and societal landscape and studies the leadership style and skills needed in these conditions. Finally, the Sixth Part, **Business Education in the Digital Era**, studies how such skills and leadership may be cultivated in business education and draws lessons for the future. The following paragraphs present the book contents in more detail.

Part One: Governance in the Digital Era, presents issues that are, or should be, at the forefront of decision making at a macro-level. These include boundary-spanning technologies as well as national and global policies. Digital platforms are representative of how technologies that span national and regulatory boundaries offer opportunities for new business models and innovative services. However, they are also limited by differences in regulatory regimes and can become harmful because of their potential for misinformation and the manipulation of their users. What is the role of governance in addressing these challenges? Viewed from a policy-making perspective, *Jelassi* discusses how the global guidelines developed recently by UNESCO can contribute to an ecosystem that promotes freedom of expression and reduces negative externalities. He argues that taking into account the multiple stakeholders involved and the high-risk situations that may be influenced by digital environments are critical success factors for effective regulation. Viewed from an academic perspective, *Clemons et al.* provide a provocative account of the unanticipated changes brought about by digital platforms, with substantive impact on the way communication, business, and society are viewed and shaped. These two different yet complementary perspectives of the first two chapters point to some of the dilemmas and challenges for regulators in the digital era: can trust be established, and if so, how? Would regulation become more stringent or more relaxed and under what circumstances? The two contributions provide some of the answers and challenge the reader to think about a broader set of questions pertinent to the long-term use of digital platforms. In the third chapter, *Koniakou et al.* explore how governments can leverage the potential of digital technologies for economic and social development. They propose a five-pillar framework that treats government as a key enabler of digital transformation, presenting relevant interventions in an integrated manner. *Bitros and Malliaris* complement the different perspectives on governance in the digital era by proposing a thought-provoking analogy with the ancient Athenian state to discuss whether money

can be privately produced. They review the changes in financial institutions brought about by digital currencies and debate how the state's responsibilities are likely to shift over time to accommodate developments in electronic money.

Part Two: Strategy and Entrepreneurship in the Digital Era reviews important strategic issues for companies. *Dessypri* reports on a thought-provoking panel on the integration of sustainability into business education from the LMDE conference. The chapter provides space for business leaders to present their appreciation of sustainability as well as the relevant contributions of digital technologies and big data. The chapter concludes with guidelines for integrating sustainability in business schools' curricula. *Bonini et al.* compare business angels and equity crowdfunding and thus elucidate the financial funding space for start-ups. *Doukidis et al.* report on surveys of small business from different market sectors before and after the pandemic, shedding light on the challenges and impact of the pandemic on this under-researched type of business. *Pereira et al* take up a broader set of challenges and risks that companies face and study the lessons reported in the literature on the ways in which businesses digitally transform their supply chains to respond to disruptions. *Bugliesi and Micelli* recognize the high demand of digital skills as one of the key challenges for businesses, especially SMEs, in the digital era. Drawing lessons from the Italian context, they advocate the convergence of higher vocational education with SMEs, facilitated by business schools. This part of the book starts and ends with chapters that explore the implications of business concerns for the future of business education. This acknowledges the aspiration of businesses to have access to talent and expertise that are relevant to their needs in the digital era but are also sensitive to other ethical concerns that promote good practice and sustainability.

Part Three: Innovation and Digital Transformation turns our attention to the ways in which various digital technologies transform business practices and operations in different sectors. The first two chapters in this part focus on digital twins and manufacturing. *Nyden and Bika* illustrate how digital twins and AI help a pharmaceutical company respond to regulatory and market pressures, balancing the need for faster clinical trials, streamlined drug development, and quality and safety for patients. *Farmakis et al.* present a practitioner-oriented framework for digital transformation and show how digital twins accelerate digital transformation in manufacturing with reference to four real-life production cases. The third chapter in this part, by *Vaidian et al.*, explores the critical role of experimentation environments for collaboration, knowledge transfer, and idea generation. Building on the experience of EU-funded projects and focusing on human–machine interaction in the digital era, this chapter accentuates the need for holistic and interdisciplinary approaches when thinking about the factory of the future. The chapter by *Koukopoulos et al.* draws our attention to a different domain, that of personal selling, and offers a review of the promising role and prerequisites for the use of AI, both from the academic and practitioner literature perspectives. *Osta et al.* also consider AI but in the very challenging healthcare domain, where users of technology and consumers of services are patients. The chapter draws on empirical data from 62 countries to explore the behavioral intention of these users toward chatbots. A common thread across all

chapters in this part is that the issue of trust and experience with technology is shown to be paramount, regardless of which sector is studied.

Part Four: The Future of Work presents the challenges of the digital era for workers and human resource (HR) managers alike. How can the evolving Metaverse workplace be safe and inclusive? This is the topic of the chapter by *Dimitriou et al.*, who stress the importance of the human resource function and the need for a new legal framework that corresponds to the ethical challenges and the new realities of the digital era. *Pavlakou* brings forward hope, as pivotal in training interventions. Focusing on the healthcare domain, where the use of digital technology can be an extra source of stress and anxiety for staff, she shows how increased hope and optimism have positive impact on goal-setting skills and problem-solving abilities, leading eventually to increased patient satisfaction. *Hanzis* studies team resilience in the hybrid corporate landscape, exploring through qualitative in-depth interviews how project teamwork has changed substantially since the pandemic and how the need for reliable technology and connections is complemented by virtual skills and social etiquette. *Papalexandris* addresses a novel challenge for human resource management and poses the question: can digitalization assist companies in supporting sustainability? The chapter shows this to be the case and presents relevant policies and practices grounded in longitudinal qualitative study with HR managers. The final chapter in this part, by *Konstantopoulou et al.* complements HR concerns by stressing the importance of a robust cybersecurity culture in organizations, supported by effective governance, as a shield against the growing risk of cyberattacks.

Part Five: Leadership and Skills in the Digital Era builds on the previous parts of the book and studies how new skills are needed in knowledge workers but, primarily, in leaders in the digital era. *Kokuryo et al.* set the scene in this part by bringing to our attention the importance of honor, altruistic thinking, and trust. The authors develop an ethical framework that draws from the Japanese cultural traditions as an alternative to Western business norms, arguing this constitutes an effective path to sustainability and societal cohesion. The following chapter, by *Alexopoulos et al.*, considers the changing role of leadership at the organizational level and focuses in particular on agile organizing. As agility is becoming a trend, not just in technology development but also in digital transformation, it is important to appreciate the importance of context curation and revisit contingency leadership theories. *Iordanoglou et al.* use the insights of business executives from the USA and Europe to consolidate the key skills needed in the digital era. They propose four categories of skills: digital competence, business acumen, leadership effectiveness, and personal effectiveness. They then proceed to make two curricular proposals: one on which courses contribute to these skills, and another on how these skills can be taught. *Kargas et al.* extend the discussion on digital transformation, by reviewing the skills and knowledge that define managers in the post-pandemic era. The research employs data from the European labor database and discusses why the need for lifelong training is more pronounced in the digital era. *Rodrigues et al.* also discuss the skills needed for responsible leadership in the digital age, focusing particularly on non-cognitive competencies and soft skills. Taken together, the chapters in this part use different empirical data and previous research to draw quite similar conclusions about the

need for soft skills on the one hand and attentive and ethical leadership on the other to cope with the challenges created by the digital era.

Part Six: Business Education in the Digital Era, provides reflections for the need to revise business school curricula (first two chapters) and pedagogical methods (last two chapters), given the challenges of the digital era and the opportunities provided by the integration of technology in teaching delivery following the pandemic. *Roese et al.* tackle the emerging roles of marketing professionals and argue for the need to see artificial intelligence as central in the education of the next generation. Omnichannel distribution, proximity marketing, and ethical considerations are identified as key challenges for future training in this field. *Tzouvanas and Zenios* reflect on the wide-ranging effects of climate change risks for business in the digital era and recommend a broad curriculum on climate for business education. They draw from their experience to propose a course on climate finance and argue for the need to critically consider regulatory initiatives in such educational endeavors. *Saad-Lessler and Ryan* review the pedagogical tools that were effective in supporting student learning following the pandemic. Student and faculty perspectives are compared, indicating good practices, that would be useful to preserve. *Talanti et al.* provide complementary empirical evidence from digital learning contexts. They report on the significance of social presence and teaching presence for student satisfaction, thus concluding that instructors in a digital learning environment have a great responsibility to select appropriate instructional methods and create the appropriate climate.

While we have structured the book around the six themes summarized above, our readers will notice that there is overlap in the topics treated within each part of the book. Looking closely at the content of the chapters it becomes obvious that this interrelation is inherent in the digital era. For example, one cannot discuss innovation without referring to the technologies that make this innovation interesting or challenging, the context (both organizational and regulatory) that can enable or hinder such innovation, as well as the people engaged in this innovation and the skills that they would need. Similarly, any discussion of the digital era regardless of the specific technology or unit of analysis needs to consider sustainability. Importantly, all the topics brought up in this book relate to the future of education, as the latter is closely related to the business models that are studied and the skills that are cultivated. Thus, we would encourage the interested reader to engage with multiple themes. This book has been created on the premise that in the digital era, we need to work more across disciplines and not be restricted by narrow thematic lenses. We are delighted that this message is reflected in all chapters of this book, and we appreciate the authors' effort to transcend disciplinary boundaries in order to respond to the challenge of thinking about leading and managing in the digital era.

The contributions in this volume were subject to a blind review process involving at least two reviewers per chapter. A second round of reviews was undertaken where necessary. We would like to take this opportunity to thank all the authors who submitted their work for consideration in this volume, providing extremely rich and stimulating contributions. We also thank the numerous reviewers (see the list of reviewers at the end of this volume) who supported our vision for an inter-disciplinary, boundary-spanning compilation of work on leading and managing in

the digital era. We also solicited and editorially reviewed three chapters to present important complementary perspectives on the digital era, related to governance at supra-national level (chapter by Jelassi), the role of technology for environmentally sustainable business and its implications for business education (chapter by Desypri, reporting on a related panel discussion at the LMDE conference, featuring business leaders from diverse industries and company profiles), and insights from innovative technology-enabled pharmaceutical research (chapter by Nyden and Bika). Finally, we would like to thank our host institutions, the Stevens Institute of Technology and the Athens University of Economics and Business that together with the Bodossaki Foundation organized the LMDE 2023 Conference. We are grateful to them and all sponsors of the conference as they paved the way for this book to materialize. We hope that you will enjoy reading the chapters and that they will inspire your vision for the future of research, business, and education in the digital era.

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Gregory Prastacos
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About the Editors

Gregory Prastacos, the LMDE Conference Co-General Chair, is Professor of Operations Research at the Stevens School of Business, where he also served as Dean (2012–24). He holds a Ph.D. in Operations Research and an M.S. and a B.S. in Computer Science, all from Columbia University. Prior to joining Stevens, he was the Rector at the Athens University of Economics and Business, and before that, he was on the faculty of the University of Pennsylvania's Wharton School. He has published extensively, and his papers have appeared in journals, such as *Management Science, Operations Research, Journal of Management, Journal of the Operational Research Society, Journal of Heuristics, Journal of Business Ethics* and more. His book on *Managerial Decision Making* has been translated in Chinese and published by Tsinghua University Press. His book on *Leadership Through the Classics* has been published by Springer. For his research, he has received a number of awards, including the Edelman Award by INFORMS. Dr. Prastacos is the founder and chair of AACSB's Digital Transformation Affinity Group and the principal investigator of the MaCuDE project (macude.org).

Nancy Pouloudi is Professor of Information Systems Management in the Department of Management Science and Technology at the Athens University of Economics and Business, Greece. She holds a Ph.D. in Information Systems from the London School of Economics. Her research focuses on organizational and social issues in IS adoption and implementation. She is President of the Association for Information Systems (AIS) for the academic year 2023–2024. She had previously served as Region 2 Representative on AIS Council (2010–2013) and regularly serves on the AIS Region 2 Board and the Executive Committee of the Mediterranean Conference on Information Systems (MCIS). She is Senior Editor of the *European Journal of Information Systems* and Member of the Editorial Boards of the *Journal of the AIS, Information and Management, IT for Development*, and *Health Policy and Technology*. Her service has been recognized by the 2016 AIS Sandra Slaughter Service Award and the 2020 AIS Technology Challenge Award.

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Governance in the Digital Era

Towards an Internet of Trust—UNESCO's Guidelines for the Governance of Digital Platforms

Tawfik Jelassi

Abstract Bad regulation and the different approaches taken by regulatory regimes across the world regarding the rules of the digital ecosystem have created problems for businesses that operate in the digital economy and want to work in many countries. Based on its decades-long work on freedom of expression, UNESCO developed global guidelines for the governance of digital platforms. They are intended to serve as a guidance with specific provisions for different actors, including governments, regulators, digital platform companies, civil society, and the media sector. The guidelines were developed between 2022 and 2023 through an inclusive multistakeholder approach. They emphasize the role of the different parties to create an enabling digital environment. They also offer provisions to be applied in high-risk situations such as during elections, conflicts and other crises. When fully implemented, the guidelines will empower relevant stakeholders to have a digital governance system that fosters freedom of expression while tackling negative externalities such as mis-/dis-information, hate speech and other harmful online content.

1 An Opportunity to Create a Vibrant Digital Ecosystem

The digital revolution we have experienced in recent decades can be compared to the vast opportunities created when Johannes Gutenberg and his associates invented the printing press in the fifteenth century. Human connections have been revolutionized; business has been transformed and the dissemination of information to the public has drastically changed.

The dynamics of the digital ecosystem are continuing at a rapid pace with the recent development of generative AI creating further opportunities and challenges. The question of how these technologies should be governed is a top priority for policy and law makers as well as business leaders across the world.

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This digital revolution creates multiple opportunities for individuals and businesses: the possibility for businesses to scale up beyond their borders, for new markets to open up, and for countries to participate in the digital economy and benefit from the digital transformation.

At the same time, the challenges are also numerous, including the spread of mis-/dis-information, which affects businesses in serious ways and leads to bad investments, loss of capital, and reputational attacks. The concentration of power and influence among big tech hegemoths would also worry businesses trying to develop themselves. Different countries and jurisdictions have dealt with the issue in different ways, which impact the competitiveness of businesses and raise their opportunity costs in new markets. Bad regulation also negatively impacts business, thus the need to do something about it and help chart a positive course of action.

After having advocated in 2021 the concept of "Information as a Public Good", calling among others for the transparency of digital platforms, and after having this concept endorsed by its 193 Member States, UNESCO initiated and launched in 2022 a global initiative on the governance of digital platforms, focusing on proactive measures for peace, dialogue, and understanding in the digital sphere. The approach used was rigorous, evidence-based and informed by eight decades of multilateral policymaking on freedom of expression as well as the protection and promotion of diverse cultural expressions. The first step in this approach was to commission a review of the state-of-the-art in the subject matter through an analysis of over 800 pieces of literature related to the governance of digital platforms (Berger et al., 2023). We then did a mapping of existing regulations and gathered insights from relevant stakeholders: governments, regional organizations, civil society, digital platforms' companies, whistleblowers, and tech journalists.

As a result of this research work, we found out that half of the 55 countries that had developed or were considering developing national legislations to address the online spread of harmful content, would likely or possibly limit freedom of expression and access to information (Mendel, 2023). There was therefore an opportunity to improve the digital ecosystem for individuals and businesses.

2 UNESCO's Mandate and Its Work on Internet Governance

Established in 1945, right after the second world war, UNESCO has the mandate to "contribute to peace and security by promoting collaboration among the nations through education, science and culture in order to further universal respect for justice, for the rule of law, and for the human rights and fundamental freedoms, which are affirmed for the peoples of the world, without distinction of race, sex, language or religion, by the Charter of the United Nations." Today, in a world profoundly shaped by technological progress, this mission holds greater relevance than ever before. Indeed, digital platforms have become a new front in the pursuit of peace.

Internet governance has a crucial importance for the development and application of digital technologies by governments, the private sector, civil society and the technical community. In their respective roles, stakeholders must adhere to shared principles, norms, rules and procedures that shape the evolution and use of the Internet. For UNESCO, Internet governance is a central issue because of Internet's contribution to enhancing the free flow of information and ideas, fostering sustainable human development, and building inclusive knowledge societies across the world.

UNESCO therefore advocates for an inclusive and transparent approach to Internet governance based on the principle of openness and encompassing freedom of expression, respect for human rights and privacy, universal access and technical interoperability. Ethics as well as cultural and linguistic diversity in cyberspace are other key issues to address. All of these elements are essential for UNESCO to fulfill its constitutional mandate as entrusted to it by its Member States, and to advance its work to make the digital space a level-playing field for all, leaving no one behind.

UNESCO and the Universal Declaration of Human Rights

UNESCO is the lead United Nations' agency to protect freedom of expression, which is a right codified in Article 19 of the Universal Declaration of Human Rights, whose 75th anniversary was commemorated on 10th December 2023. The freedom of expression right is further developed in articles 19 and 20 of the International Covenant on Civil and Political Rights and in General Comment no 34 of the Human Rights' Committee. It was further elaborated on based on existing jurisprudence. The right to freedom of expression in international human rights law is a multi-faceted right encompassing the freedom to communicate thoughts and to seek and receive information and ideas. However, in the digital age, this vital right faces significant challenges, including mis-/dis-information, hate speech and conspiracy theories.

To counter this online information harm, a patchwork of legislation and regulations has emerged across the world, without the existence of a unified regulatory guidance. Consequently, many countries have adopted regulatory measures, often detrimental to civic space, ranging from poorly-crafted regulations to extreme extra-legal measures such as Internet shutdowns.

Fostering an Internet of Trust

It is in this context and in full alignment with its constitutional mandate that UNESCO launched in May 2022 an initiative to develop global guidelines for the governance of digital platforms. The approach used was to engage as many stakeholders as possible to identify the best way forward. Through initial discussions, it was agreed that one of the main elements was to create a global and coherent framework for the governance of digital platforms. UNESCO had several ideas in mind, but was

determined to carry out an open and comprehensive consultative process to achieve the best possible outcome.

We followed a multi-stakeholder approach, involving UNESCO's Member States, digital platforms' companies, intergovernmental organizations, civil society, media, the academic community, as well as groups in situations of vulnerability and marginalization. We advocated for the governance of digital platforms that emphasizes transparency, the balance of institutionalized powers, openness, accessibility, and the promotion of cultural diversity. These Principles were also part of the multi-stakeholder approach initiated in 2005 during the World Summit on the Information Society (WSIS), and reaffirmed in 2015 by the UN General Assembly. It also resonates with UNESCO's commitment to the UN on the development of 'Our Common Agenda' policy brief "Global Digital Compact", and the UN Code of Conduct for information integrity on digital platforms. When fully implemented, the UNESCO guidelines will empower all relevant stakeholders to put in place a governance system that can foster freedom of expression while tackling negative externalities.

Among the principles steering the discussions from the outset was the importance for users and organizations of the rules that governments applied to big tech companies and their transparency in managing content. A key factor from the beginning was the responsibility of governments to maintain an enabling environment which would in turn positively impact business and the economy. There was also an early discussion on the principles needed for digital platforms' companies to carry out their responsibilities, and it was crucial for UNESCO to maintain a multistakeholder approach throughout the guidelines' development process. Also important was the view that the governance of digital platforms is not solely in the hands of either governments or the digital platforms' companies themselves but rather a major issue that impacts the whole of society. Only through these principles and actions as well as an appropriate process that we can create an Internet of Trust.

In February 2023, UNESCO held in its Paris headquarters a global conference entitled "Internet for Trust", bringing together over 4000 stakeholders to break down as many dialogue silos as possible. Prominent speakers from all corners of the world provided insights and perspectives on the way forward for the governance of the digital ecosystem. Participants in this conference included representatives of Member States, media, civil society, and digital platforms such as Meta, Google, TikTok, and Twitter/X.

To inform the discussions, UNESCO had provided a first draft of the guidelines and commissioned different research studies, including the identification and analysis of legislations already developed in 55 jurisdictions. A key finding here is that most of the existing legislations did not align with the above-mentioned principles. The "Internet for Trust" conference saw among its speakers Christopher Wylie, who was the whistleblower in the Cambridge Analytica scandal which revealed the tools that some digital platforms allowed for interfering with the electoral processes in established democracies. Wylie stated memorably during the discussions that there were more safety rules for a refrigerator or a toaster in any kitchen than for digital platforms that reach billions of people around the world and have direct consequences!

This conference was a major milestome in the process of the three global consultations conducted by UNESCO and generating over 10,000 comments from 134 countries, making this effort one of the largest consultations ever carried out by a United Nations' organization. On 6th November 2023, the UNESCO guidelines for the governance of digital platforms were unveiled and published in English, Spanish, Portuguese, Arabic, Russian, Chinese and French.

The release of the UNESCO (2023) Guidelines was complemented by an IPSOS (2023) survey on online disinformation and hate speech during election campaigns, involving over 8000 respondents across 16 countries holding elections in 2024. This survey reinforced UNESCO's view that there was a demand, and an urgent need, for such guidelines on how to govern the digital ecosystem in different regions of the world. UNESCO also released a video on YouTube explaining the guidelines and developed dedicated web pages focusing on the guidelines and their related consultations. Also, a communication campaign on UNESCO's social media was launched to raise awareness about the guidelines beyond the large community which had interacted with them during the open consultations.

3 Key Principles Underpinning UNESCO's Guidelines for the Governance of Digital Platforms

The "*Guidelines for the governance of digital platforms: Safeguarding freedom of expression and access to information through a multistakeholder approach*" are a testament of UNESCO's commitment to fostering inclusive participation and protecting freedom of expression, access to information and other human rights. The guidelines are not just a set of rules; they constitute a call for action to safeguard freedom of expression and access to information online within the framework of the governance of digital platforms. They establish a clear framework of responsibilities and roles for States, digital platforms' companies, intergovernmental organizations, civil society, the media, the academic community, the technical community and other stakeholders.

The guidelines constitute a framework which specifies the responsibility and role of each stakeholder. They advocate for a multi-stakeholder approach to the governance of digital platforms, emphasizing transparency, institutionalized checks and balances, openness, accessibility, diversification of skills, and the promotion of cultural diversity. Highlighting the importance of media and information literacy programs, the guidelines call for user empowerment and commitment from governments and technology companies. More specifically, they stipulate five principles to which platforms must comply:

1. Content moderation should no longer be reserved for developed countries or English speakers. We must ensure that content moderation and curation is reliable and effective, appropriate for the volume of content to be moderated, and carried out in all major languages spoken on the digital platform.

2. Digital platforms must integrate human rights' safeguards, carrying out regular due diligence and risk assessments. This includes proactive measures before elections and in response to conflicts or crises.
3. Digital platforms must be transparent by disclosing the processes used to moderate and curate content, including automated measures (Puddephat, 2021).
4. Digital platforms must provide information and tools to users, including their terms of use, in all major languages spoken in the countries where they operate. This should also extend to age-appropriate language for children, with due consideration for people with disabilities.
5. Digital platforms should adopt the principle of responsibility, integrating users' reporting and complaints' mechanisms into their operation.

Target users of the UNESCO guidelines include policy makers, regulators (media regulators, audio/visual regulators, telecommunications regulators and other relevant regulatory bodies), as well as other governance entities dealing with the implementation and evaluation of policies, codes of conduct or regulation, digital platforms' companies, and other stakeholders such as civil society, in their advocacy and accountability work. Media can also benefit from these guidelines in their ongoing efforts to hold powerful actors accountable.

An Enabling Environment

All stakeholders share responsibility for sustaining an enabling environment for freedom of expression and the right to information, while ensuring there is an open, safe and secure environment for users and non-users. The UNESCO guidelines outline a set of duties, responsibilities and roles for States, digital platforms' companies, intergovernmental organizations, civil society, media, academia, the technical community, and other stakeholders to enable the environment where freedom of expression and access to information are in the core of digital platforms' governance processes.

To create and sustain an enabling environment, States must respect, protect, and fulfil human rights in accordance with international human rights' standards. They must (1) avoid taking arbitrary or disproportionate measures to deal with online harms, (2) promote free, independent and pluralistic media, and (3) guarantee strong protections for journalists. States must refrain from imposing measures such as Internet shutdowns and moreover, independent regulators should be equipped with the necessary means to enforce international human rights' standards in the digital ecosystem.

When it comes to international organizations, they commit to supporting stakeholders through technical assistance, monitoring, and reporting of human rights' violations. Civil society, academia, and media act as important watchdogs, which monitor, evaluate and report on laws, policies, regulatory actions among others that impact human rights, as well as the behavior of the digital platforms. Also, digital

platforms' companies should be requested and able to manage and mitigate human rights' risks related to potential harmful content online. They should commit to align their design processes as well as content moderation and curation policies and practices to international human rights' standards.

The Role of Digital Platforms

Digital platforms should be transparent and accountable, and they should be able to give their users tools to engage critically with their products. In general, digital platforms should comply with five key principles:

1. Conduct human rights' due diligence.
2. Adhere to international human rights' standards including in platform design, content moderation, and content curation.
3. Be transparent.
4. Make available information accessible; and
5. Be accountable to relevant stakeholders.

Furthermore, the guidelines outline the importance for companies to evaluate risk in significant situations: first, prior to any important design changes, major policy decisions (including those related to the advertising system, if applicable), changes in operations, or new activity or relationship/partnership. Second, to protect the rights of all groups in situations of vulnerability and marginalization, including women and girls, as well as journalists, artists, human rights' defenders, and environmental defenders. Third, to protect the integrity of electoral processes. Fourth and last, to evaluate risk in significant situations in response to emergencies, crises, conflicts, or important changes in the operating environment.

Five Over-Arching Principles for the Governance of Digital Platforms

- Platforms' content curation and moderation policies and processes should be transparent.
- Checks and balances should be formally institutionalized.
- Governance processes should be open and accessible to all stakeholders including vulnerable and marginalized groups.
- Diverse expertise should be a common feature of all regulatory arrangements.
- Governance should protect and promote cultural diversity.

The guidelines call for regulatory arrangements to be effective, sustainable, and to ensure independent oversight. Also regulation should be developed through open, transparent, and evidence-based processes.

Furthermore, the UNESCO guidelines emphasize the importance of media and information literacy (MIL) programs to empower users, promote cultural diversity, social inclusion, and global citizenship as well as reduce the 'participation gap' between citizens who engage in the creation and critical use of media and information content and those who do not. Finally, MIL programs should promote gender equality and women's empowerment as well as provide opportunities for participation by groups in situations of vulnerability and marginalization.

The UNESCO Guidelines Will:

- Encourage and contribute to the development of global multistakeholder networks and common spaces to debate and share good practices about digital platforms' governance, gathering different visions and a broad spectrum of perspectives.
- Serve as a tool for all relevant stakeholders to advocate for human rights-based regulation and to hold governments and digital platforms accountable.
- Advance evidence-based and human rights-based policy approaches.
- Encourage as much worldwide convergence as possible in platform governance policies to avoid Internet fragmentation.

4 Next Steps for an "Internet of Trust"

While the launch of the guidelines marks a significant milestone of UNESCO's work on fostering freedom of expression in the digital ecosystem for the benefit of people and organizations, our commitment must persist. We are currently continuing our effort, amplifying awareness about the guidelines as well as their purpose and use, and monitoring their implementation. The latter is being done through multiple initiatives:

1. UNESCO is supporting the establishment of a 'Network of networks' comprising regulatory authorities, electoral management bodies, and epistemic communities. This collaborative effort is designed to facilitate the exchange of best practices, and to monitor and assess the effective implementation of the guidelines on the national, regional, and global levels. This meta-network was created on the basis of a "Statement of the networks of media and online safety regulators" issued during the UNESCO global conference "Internet for Trust" in February 2023. The first in-person meeting of this network took place on 18–19 June 2024 in Croatia.
2. UNESCO is supporting the creation of a knowledge network—a platform for think-tanks and research centers worldwide. This network will analyze the implementation of the guidelines and offer policy advice and strategies to follow.

3. Carrying out a number of pilot implementations of the guidelines in a select set of UNESCO Member States across the world, including countries in the Global South. These implementations will start during the second half of 2024 and be led by national regulatory authorioties in cooperation with UNESCO.
4. We are working on several other strands of implementation, which are intended to move forward important aspects of the governance of digital platforms.

5 Conclusion

As described in this chapter, the objective of the UNESCO guidelines for the governance of digital platforms is to create a global and coherent framework for the digital ecosystem whereby each important stakeholder has a clear set of duties and responsibilities. The private sector and business community will benefit from operating in a trustworthy online space. Independent and transparent regulation, aligned with human rights' law, will create an enabling environment for users' online exchanges and transactions. Mis-/dis-information will be properly addressed through an effective content moderation and curation. For the digital platforms themselves, it will be beneficial to have global regulatory principles accepted by all parties, since it is almost impossible for them to abide by the numerous different regulatory regimes existing today across the world. Their transactions' costs would go down and the opportunities for a stronger usage of their tools, systems and services would increase.

The UNESCO guidelines represent a call for action to preserve freedom of expression and access to information on digital platforms, and each of us holds some responsibility for preserving these valuable rights. We need to engage with our communities and make our voices heard to achieve a positive change.

As we embark on this journey to safeguard our digital future, we need to join forces to protect human rights online and ensure an open, safe, and trustworthy digital space for all. I hope we can all mobilize to make these guidelines a reality in the digital space. If we succeed in this endeavor, together we will be able to pave the way towards an "Internet of Trust".

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Increased Technological Capability and the Future of Platform Regulation: New Forms of Relaxation or New Forms of Restriction

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Abstract Rapid technological change leads to discontinuous change in business, the evolution of new business models, and the disappearance of entire industries, just as rapid environmental change leads to the evolution of new species and the extinction of others. Rapid change in business models leads to new sources of power and new forms of abuse of power, which in turn leads to the need for new forms of regulation. While increased regulatory restriction may be necessary to deal with new forms of abuse, regulatory relaxation may be necessary to allow the pursuit of new opportunities and the provision of new services. Some business models may require both: sharing economy platforms produce value for their users and should be encouraged, while creating harmful externalities that need to be controlled.

1 Introduction

The digital transformation of our personal lives has created new business models, with new services and new forms of interaction. No matter how digital transformation is defined, these new business models may create new risks for consumers and thus may require new forms of regulation (Clemons et al., 2022a, 2022b, 2022c; Haugen, 2023). Likewise, innovations in commercial practices have created new business models with new sources of power and new forms of abuse of that power, which

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may require new forms of regulation (Clemons, 2018). Digital innovations have also created new business opportunities with new services. Pursuing these new opportunities and offering new services may justify regulatory relaxation. We propose areas for increased regulatory restriction as well as areas for regulatory relaxation. We draw heavily on existing research on information systems (e.g., Clemons, 2018) and technology regulation (e.g., Savin, 2018).

Waves of regulatory changes and the creation of numerous new regulatory agencies accompanied the industrial revolution. Between 1880 and 1930, the US alone created the Interstate Commerce Commission, the Food and Drug Administration, the Federal Trade Commission, and the Radio Commission, passed the first antimonopoly legislation, and agreed the Kingsbury Commitment to limit the power of America's Bell System's monopoly in telecommunications. The history of Britain, France, and Germany is similar.

Digital transformation is as dramatic as the industrial transformation that occurred between 1880 and 1930. Some existing regulations developed in response to the changes resulting from earlier waves of technology-enabled business transformation may still be applicable and indeed may still be adequate. However, new sources of monopoly power may require new forms of antimonopoly protection. New forms of abuse of consumers and of consumer manipulation may require changes to marketing law and to the regulation of advertising. When social media replaces traditional journalism as a source of information, platforms cease to be solely sources of entertainment and become mechanisms for the potential manipulation of citizens. Whether or not these new forms of manipulation were intended by the social media entrepreneurs, resulted from opportunities seized by legitimate businesses, or the result of hostile action by agents of foreign powers is in some sense irrelevant; new forms of abusive manipulation are clearly important elements of unfair advertising and deliberate disinformation (Wylie, 2019; Trzaskowski, 2023). Both forms of manipulation involve a reduction in individuals' ability to take informed action, which is both a loss of agency and a loss of human dignity. When consumers are manipulated, they make suboptimal purchases, pay too much, do not buy what they actually want or need, or both. But when citizens are manipulated, then democracy itself is at risk: societal polarization increases, voters make poor choices, extremism flourishes, violent terrorist groups recruit more effectively, and societies may become ungovernable (Clemons & Waran, 2019; Trzaskowski, 2021, 2022).

Historically, the law strives for predictability based on formal legal codes and historical jurisprudence (Hay, 1991). To the extent that the law preserves that status quo, it may also protect existing power structures and limit innovation. This predictability is essential for business planning and for fair and equitable enforcement of the law. However, we are now experiencing rapid change in online business models, which will lead to rapid regulatory changes to address abuses and encourage innovation, and which will reduce predictability. The EU's current move towards risk-based compliance embraces legal and technological uncertainty, again at the expense of reduced predictability.

We explore examples where regulatory change is justified and where it is not. A complex new balance is required to achieve the greatest societal value from

technological innovation, and this balance involves both regulatory relaxation and increased regulatory restriction. New technologies gave rise to digital optimists, who initially believed that transparency would eliminate most forms of consumer abuse; shoppers would instantly know about poor-quality products or abusive pricing, and would shift their purchases to better, safer, or less expensive alternatives. Many MIS scholars believed that Platform as a Service, Software as a Service, and Outsourcing would lead to easy and nearly costless market entry and market exit, making almost all markets contestable (Baumol et al., 1983). Contestability, combined with price transparency, would make monopoly power and monopoly profits impossible. This misplaced confidence led to the misplaced belief that markets would automatically correct all abuses.

Legislators and regulatory organizations in both the US and the EU need to understand the costs and benefits of new platform businesses, in order to create the best regulatory balance for society. Finally, executives need to understand the future of regulatory change to anticipate both the creation and the elimination of business opportunities. We seek to provide guidance on how regulations should be updated to reflect the power, benefits, and harm created by new business models.

Sometimes, regulations need to be more restrictive. Regulation needs to be reconsidered in all instances where technological progress has made existing regulation obsolete, or when existing regulation has been superseded by business models that it cannot control. Marketing law, the Food and Drug Administration (FDA), and the Federal Trade Commission (FTC) in the US were designed to help consumers deal with changes in information asymmetry. The industrialization of food production, for example, meant that consumers no longer knew much about what went into the food they purchased, and as industrialization increased, lack of knowledge affected consumers in a wide range of products and services. When platforms and online sellers can analyze every move you make and every click you take, they know far more about you than you know about them, and informed manipulation and informed opportunistic pricing both become far easier for online sellers. Consumers know less, and suppliers know more than before. Regulation and consumer protection laws designed to reduce information asymmetry are no longer adequate, when manufacturers and regulators have new sources of information that were not previously available to them. Optimists hoped that full transparency and community-generated content would provide consumers with adequate new sources of information, like users' product reviews and seller ratings would provide sufficient new sources of information for consumers, but these sources of information have been less useful than were initially expected (He et al., 2022). Consumer protection needs to be strengthened to address this change in relative information asymmetry.

Likewise, sometimes regulations need to be made less restrictive. New online business models create new forms of value for consumers, some of which may be blocked by existing regulations. Ride-hailing platforms and home-sharing platforms offer consumers great convenience, and there are environmental benefits when resource sharing improves resource utilization. Mashups, gaming mods, and technology-enabled artistic transformation can create numerous new opportunities by reusing protected works in novel ways, but may be blocked by the current form of copyright

restrictions. The need for new forms of regulation does not always imply the need for stricter regulation.

Our methodology looks at business models and all the parties that they affect, both users and others who may be affected indirectly by externalities. We start by examining the widest set of new online business models, to see which create new sources of power. We then determine the list of affected stakeholders affected by each platform, which may include customers, competitors, suppliers, or members of the greater community. We next explore actual current and potential future sources of harm to these stakeholders, as well as benefits. Some problems may be addressed by the marketplace, and some problems may already have solutions.

We next ask two sets of questions:

- When do these new online businesses clearly create harm? Who is harmed, and how? How would regulation help? Do traditional forms of regulation offer necessary relief?
- When are there clearly valuable opportunities that are not being realized, and when are these benefits blocked by overly restrictive regulations? How should regulation be relaxed to allow these benefits to be captured? Who benefits from the change and who is harmed? When the proposed regulatory change involves revoking a right that has previously been granted, such as a patent or copyright, what compensations are appropriate, and what transition path could possibly lead to the new regulatory environment?

2 Review of Online Business Models and Their Sources of Power

In the next section, we examine five new online business models. Some of them, like online retailing gateways, existed previously but have gained far greater significance. Others, like online aggregator platforms for the sharing economy, are new. For each of the five business models, we describe the model, explain its source of power, explain its revenue model, and explore opportunities to create value or to abuse power and create new forms of abuse. We will then provide one or more examples of how companies that have deployed this business model have been able to abuse that power.

Gateways and Mandatory Participation Third-Party Payer Systems

Mandatory Participation Third-Party Payer Systems (MP3PPs) that function as gateways may be the most interesting and prevalent businesses on the net, the most popular with consumers, and among the most problematic for regulators (Clemons,

2018). In these businesses, the platform operator (Party 2) provides a gateway system that allows its users who are buyers (Party 1) to interact more easily with retailers and service providers who are sellers (Party 3). These platforms allow users to locate a large array of potential sellers, and to compare their offerings on the basis of quality, price, and match with the users' individual requirements. The platforms may provide numerous other services, like recommendations, user-generated quality reviews, and safe and easy payment mechanisms. Over time, Party 1 begins to encompass all users, because the platform is so valuable to them, and over time, users become dependent upon the platforms for an increasing share of their interactions with sellers. Consequently, over time, Party 3 becomes dependent upon the platform as well, not because it truly needs the platform to perform its services, but because it needs the platform in order to reach its users. The platform creates an environment in which sellers cannot easily survive without the platform.

At this point in the evolution of MP3PP platforms, platform operators can begin to charge Party 3 sellers for participation on the platform, and as long as buyers value the platform, sellers have no choice; if buyers participate, then sellers must participate as well. Moreover, the platform appears to be "free-er than free" (Clemons, 2018) to Party 1 users; not only do they not need to pay for service, they actually receive services that they value. But the platforms are not free for Party 3 sellers. Over time, platform operators have learned that, in theory, they can demand the full marginal value of the sale from Party 3! In practice, Party 2 has learned to moderate its demands, to avoid causing sellers to go bankrupt, to avoid unwanted regulatory attention, or to avoid driving those sellers powerful enough to bypass the platform to decide it is economically desirable to do so (Clemons, 2018).

Moreover, this is a business model where competition does not drive down the prices that platforms charge for their services, because reducing charges to Party 3 is irrelevant to users. Bing is less expensive for its sellers than Google, but Google still enjoys a vastly greater market share among users. Indeed, mandatory participation gateways represent a unique market structure, in which competition among platforms actually can drive up prices that platforms charge to Party 3. Assume two platforms, as was the case when Sabre and Apollo competed as travel agent computerized reservations systems. If Party 1 buyers "single home," that is, use only one platform or another but not both (Rochet & Tirole, 2006), then both Sabre and Apollo will increase the prices they charge airlines, in order to increase the payments they are able to make to travel agents to encourage usage. Raising prices charged to airlines for essential services did not make Sabre or Apollo less attractive to its travel agency users; rather, raising prices allowed Sabre and Apollo to compete for market share by increasing the benefits that they provided to those users. Moreover, on at least one occasion, each of the platforms Sabre and Apollo suspended a competitor airline, driving the airline into bankruptcy (Clemons, 2018). While this single exclusion did not reduce either platform's attractiveness to travel agencies, it was catastrophic for each of the airlines involved, and was instrumental in airlines developing the understanding of just how powerless they were to resist the platforms' charges. These bankruptcies were also observed by the airline industry's regulators and were the basis

of the computer reservation systems (CRSs) being declared essential facilities and regulated (Copeland & McKenney, 1988).

This business model is an odd hybrid. It is not quite a monopoly, but it has monopoly power as a set of "parallel monopolies." It should be subject to monopoly regulation to limit platform operators' ability to charge sellers, although, as we have seen from the experience of Sabre and Apollo, increasing competition does not ensure reduction of these prices. However, each of these parallel monopolies can be used as the basis of a platform envelopment strategy, discussed next, and platform envelopment does indeed allow the platform operator to create additional, secondary monopolies. MP3PPs existed in the past; computerized travel agent reservation systems are perhaps the best-known examples (Copeland & McKenney, 1988). However, the increasing importance of platforms means that their form of abuse is now more prevalent, and regulation is now more important.

Platform Envelopment

Each application added to a platform creates value for users, and in general creates superadditive value; that is, the value of a platform and all of its applications is considerably greater than the sum of the values of the individual parts. VisiCalc was essential to the initial success of the original Apple computer; neither an Apple computer nor VisiCalc software would have had much value alone. At early stages in a platform's development, it attracts software developers, because the value of each application greatly increases the value of the platform, and developers are attracted because their apps are of little or no value without a platform on which to run them.

Once a platform has achieved the necessary scope and the necessary portfolio of apps, it can begin to implement a *platform envelopment strategy* (Parker et al., 2016). If most users single home, use only iOS, for example, then the platform operator can gain monopoly power, and can evade market forces in its development and promotion of its own applications portfolio. Google's abuse of its control over Android, and the restrictions imposed by its Mobile Applications Distribution Agreement (MADA) (Google, 2010), formed the basis of The EU Competition Commission's multi-billion Euro penalty imposed on Google (European Commission, 2018; Ray, 2022). The MADA enabled Google to force all manufacturers whose phones ran under Android to act in accordance with Google's strategy for apps on their phones. This gave Google near-monopoly control over apps in areas that provided Google with essential sources of information. We return to the discussion of MADA below.

Social Media

Social media platforms have created a lot of controversy because of their potentail to spread deliberate and divisive disinformation, deceptive advertising, and political

campaigns that may manipulate and deceive consumers and voters. Thus, as described below, regulators, social critics, and academic researchers acknowledge that there are fundamentally differences between historical mass-produced disinformation and the fully informed, customized, and tailored disinformation campaigns that can be employed to manipulate users today. Indeed, the disinformation campaigns enabled by social media have been described as an existential threat to democracy; see, for example, the acceptance speech for the 2021 Nobel Peace Prize (Ressa, 2023). New regulation of advertising was required in the waves of regulation that followed the rise of massive industrial companies after the 1980s.

It should be obvious that the need for additional regulation of any innovative product or service cannot be interpreted as a rejection of the innovation or a call to revert to the status quo before the introduction of the innovation. For example, those of us who relied on social media to deal with the pandemic are not advocating for the elimination of social media. Calls for safer products and services, whether in medicine, food, transportation, or online services must never be interpreted as Luddite rejections of the services, their benefits, or the dedication of their entrepreneurs. Rearranging the message of Mark Antony, we have come neither to bury social media nor to praise it, but it is often the case the harm that innovations create is the subject of calls for regulation.

Social media platforms began as mechanisms for users to assess each other and to communicate with each other. For commercial reasons that are well-understood, many have evolved into *Trojan Horses*, which we all willingly invite into our homes, before we discover that they are actually tools for the manipulation of voters and consumers (Trzaskowski, 2021). These businesses are not abusive in the same sense that MP3PPs and platform envelopment business models are abusive. Their abuse is not a result of monopoly power, either directly or indirectly, and abuse does not involve overcharging. Rather, their abuse is based on monetizing individuals' fears and areas of ignorance by enabling interested parties to manipulate users' behavior. As we now know, the revenues available from enabling manipulation are far greater than the revenues that can be earned by charging users fixed monthly fees for participation in social media platforms (Swisher, 2018). It does not matter if social media platforms initially planned to use dark patterns to manipulate consumers (Trzaskowski, 2023) or to enable disinformation campaigns to manipulate elections (Wylie, 2019), just as it does not matter if oil companies expected petroleum consumption to contribute to climate change (McCarthy, 2023) And Facebook and X executives are aware of the use of their platform for disinformation programs in politics, climate change, and anti-vaccination campaigns and have been reluctant to reduce their use.

There seems to be evidence that the use of platforms to implement disinformation campaigns does not exploit design flaws or security flaws in the platforms; rather, the platforms appear to have been designed to facilitate implementation of disinformation campaigns. The co-founder of the website Recode, Kara Swisher (Swisher, 2018), argues that Cambridge Analytica did not have to hack Facebook, but could go in through the front door and exploit its internal mechanism and advertiser tools to achieve its objectives (Johnson & Vercoe, 2020). The former business director of

Cambridge Analytica, Brittany Kaiser, provides complementary details supporting Wylie's work describing the abuses that occurred at Cambridge Analytica (Kaiser, 2019; Wylie, 2019).

Commercially, recommender systems use their detailed knowledge of their users to recommend books and movies that users may enjoy. When they propose products at the exact time that a consumer is thinking about a purchase, they can often make sales with recommendations that are not optimal, causing users to pay too much or to obtain a product that is not the best available match with their preferences.

Data-intensive targeting can be used to manipulate users into reading misleading content, which has been placed as part of a marketing campaign, or worse, as part of a paid disinformation campaign, what others have called the *digital microphone*. What makes these campaigns so powerfully effective is their ability to prepare content designed for each user segment's vulnerabilities, and then to direct this content where it will have the largest impact (Clemons & Waran, 2019). When social media directs users to alternative truths from paid disinformation campaigns, the harm is enormous. Effective implementation of misleading recommender systems or successful disinformation systems requires personal information, but this does not mean that users are paying for free services with information. Users are paying for these services by sacrificing their agency and freedom of choice. Commercially, they are paying by making inappropriate purchases. In political areas, users are paying through societal polarization, increased recruiting for extremist and terrorist positions, and a loss of their human dignity (Trzaskowski, 2021).

Aggregators for the Sharing Economy

Aggregators for the sharing economy are harmful in ways that are different from the abuse of the business models discussed above. They often do not exercise monopoly power, and unlike MP3PPs, they add value for both buyers and sellers. Their harm originates because they produce externalities, which may harm a wide range of stakeholders, especially those who are not users of the platforms.

Turning luxury apartments into Airbnb rentals is surely economically efficient: if the owner of the apartment can increase rental revenues, and if the Airbnb renter is willing to pay more for weekly rentals than any tenant would pay for a long-term lease, then we have surely achieved allocative efficiency. Beyond the economic efficiency, the sharing economy can also be beneficial for the green economy. Cars dispatched as needed produce less pollution than cruising taxis. Shared use of physical goods can result in less manufacturing and more effective use of expensive physical resources. But there are inevitably externalities. Hotels may be harmed economically by new and unanticipated competition. Cities may be harmed by the unanticipated reduction in taxes raised by hotels. Entire neighborhoods can be changed, as permanent residents are driven out by the higher prices that tourists are willing to pay for short stays in desirable properties; this is especially true in the old historical centers of European cities (Barker, 2020; Mead, 2019).

Economists have long known that markets do not resolve the problems of externalities (Coase, 1960; Cornes & Sandler, 1986). The externalities produced by the sharing economy can indeed be viewed as its "Dark Side" (Mosaad et al., 2023). Since those harmed are neither creators of the products and services that cause harm nor users of them, neither buyer nor seller behavior is altered by the externalities. Without control from market forces, only regulation or altruism will limit the harm. Regulation of externalities is a truly "wicked problem" (Rittel & Webber, 1973), in the sense that there is no algorithmic solution that will balance the interests of various stakeholders. However, just as zoning regulations have been widely adopted to limit the externalities within cities, even though this reduces existing property rights, some form of regulation will eventually emerge for sharing economy platforms to balance the many benefits they offer against the harm that they cause to existing property owners. This remains a "wicked problem," due to multiple stakeholders with competing objectives, the absence of a single objective function, and the known inability to produce optimal solutions involving tradeoffs among different individual utility functions.

Creative and Artistic Reuse of Protected Artistic Content

Copyright law, like all law, exists to balance the interests of competing parties, in order to benefit society (Calabresi & Melamed, 1972). Copyright law protects the creators' profits from supplying innovation, by limiting competition, but in doing so it restricts society's access to those innovations by allowing the holders of copyright protection to earn near-monopoly profits from their innovations. Society and its regulators have sought to balance society's interest in the supply of innovation and society's interest in access to innovation, keeping protections long enough to reward innovators and ensure the supply of innovation, but no longer than necessary, in order to facilitate less-expensive access to that innovation (Clemons et al., 2022a, 2022b, 2022c).

Technology makes the creative reuse of artistic works easier. It is easier to create playlists and mashups, of course. Image manipulation is easier because it is easy to use Photoshop to transform images and it is easy to use advanced technologies to create animation from live actors, as was done with the Avatar movies. However, some forms of reuse may be mostly parasitic and add little creative value, and other forms of reuse may harm the reputation of the original innovators and the value of their creative works. Although it is tautologically true that ease of creative value-adding reuse should, in general, move the balance of optimal design of copyright to one with reduced protections, it is not immediately clear which protections should be reduced, or by how much, or how the owner of protected IP should be compensated. The case of Andy Warhol Foundation *v.* Goldsmith et al. decided on May 18, 2023, by the US Supreme Court (Docket no. 19-2420) demonstrated just how much of artistic reuse remains unregulated and how much is not yet resolved.

3 Why We Need More Regulation Than We Expected

In the end, our initially optimistic views may have been wrong. We explore the reasons for the optimistic belief that the Internet would create frictionless, perfect markets, without the need of regulation. And we explore how creative development of profitable business models, more powerful than they anticipated, proved that optimism misplaced.

Unlimited Interoperability

Digital platforms appeared to offer unlimited interoperability, which would make platform envelopment strategies impossible. With normal software engineering practices, platforms would be built with stable, well-defined application interfaces, which would allow independent application developers to add apps to the platform. Platform envelopment strategies, like those that resulted in the Department of Justice's anti-trust litigation, would now be impossible.

Microsoft's destruction of Netscape and WordPerfect, replacing them with Internet Explorer and Word, was at the heart of the Department of Justice's litigation against Microsoft. This was done in part by constantly changing the APIs, and even by having Windows delete Netscape, illustrating the power of deliberately restricting a platform's interoperability. More recently, Android's MADA specified which of Google's own apps had to be pre-installed and which had to be pre-installed on the home page. It also specified which competitors' apps could not be pre-installed. Hardware vendors who did not comply risked having all of their machines banned from Google's app store, greatly reducing the value of their phones. These modern forms of platform envelopment were not envisioned by digital optimists.

Reduced Barriers to Entry

Digital optimists believed that more markets would become fully contestable (Baumol et al., 1983) as barriers to entry were reduced. Cloud computing and Computing-as-a-Service meant that companies would not face massive startup costs to enter a market, nor would it be expensive to exit. Likewise, these meant that companies could succeed without the need for scale to match their existing competitors already in the market. Additionally, Software-as-a-Service meant that even small companies would be able to contract for services on an as-needed basis, without the massive costs associated with developing their own software for all application areas. Moreover, perfect transparency and perfect search meant that companies with better products and services could easily be found, and meant that larger companies with larger advertising budgets would not automatically dominate.

And yet, despite all of these factors, the digital optimists were wrong. Even with the nearly unlimited resources of Microsoft behind it, Bing continues to border on irrelevance. When Amazon was one of several online booksellers, competing against Barnes and Noble and Borders, among others, its emergence as the dominant online retailer was hardly assured (Easter & Dave, 2017; Milliot, 2011). The launch of Prime was a brilliant move contributing to Amazon's ultimate domination: once millions of users had paid for their annual Prime membership, they had little interest in competitors' online services and no desire to pay for multiple enhanced online membership services. Amazon's current market power is evidenced by the changes announced in Prime services: membership fees have increased, Prime membership no longer provides access to streaming video without advertisements and Prime membership no longer provides free delivery from Whole Foods. Prime membership no longer provides free access to the Washington Post, and the discounted subscription rate for Prime members has recently tripled (Battle, 2023; Owen, 2022). Dramatic increase in prices, simultaneous with reductions in quality of service, are strongly suggestive of monopoly power and the absence of effective competition. Moreover, as active life control interfaces like Alexa allow us to order from Amazon and Whole Foods, and as smart homes, controlled by Alexa and Google Nest, gain in power, smaller retailers are becoming less visible and less relevant (Clemons et al., 2023). The number of market participants is decreasing, rather than increasing, in a wide range of industries.

Full Market Transparency

Many information systems professionals, including MIS faculty, believed that the Internet would bring zero-cost search to all consumers. This would result in all of us effortlessly finding the right product or the right service for our needs, at the best price. Manipulation of consumers, as had been possible with the old travel agent airline reservations systems, would vanish. We would all find the flight we wanted at the price we wanted.

And yet, as Google's founders noted even before the creation of Google Search, the insidious problem with search was that users did not know what they were searching for. It was not necessary to offer them an ideal product; it was only necessary to offer them a *good enough* product. That led to the development of profit-maximizing auctions for keywords. Companies were even forced to pay for their own name as a search keyword, ensuring that traditional advertising would not be sufficient to ensure that a company was found. Even if Marriott advertised so that users searched for Marriott, Google might return a competitor in its list of results, or a third-party booking service, if Marriott did not bid enough for the rights to use its own name (Clemons, 2018).

Fake reviews of products and services are a problem in every market, around the world. Paid reviewers create fake reviews to inflate the apparent quality of a product or service (He et al., 2022; Luca & Servas, 2016) or to damage the reputation of

competitors' offerings (Li et al., 2023; Sahut et al., 2024). Academic researchers have contributed to the problem, studying the most effective way for Facebook to manipulate the content of paid "fake likes" of recommendations from one Facebook user to a friend, and using an understanding of personalities to maximize the effectiveness of recommendations and the likelihood that the recipient will be influenced (Dhelim et al., 2022).

Full Access to All Information Relevant to Citizens

Digital optimists expected that the proliferation of news sources would make the power of any single false source of information irrelevant. The Fairness Doctrine, created when there were at most two or three sources of television news in any metropolitan area, ensured that all points of view would have equal access to audiences, but the proliferation of cable and Internet news sources made the Fairness Doctrine appear to be irrelevant, and Fox News was created as a response (Cook, 2011). Fake news and disinformation have become problems globally, despite our hope that full transparency would make online lying impossible. Fox News' record-setting settlement with Dominion Voting Systems demonstrates just how persistent broadcast disinformation can be, after the end of the Fairness Doctrine for broadcast television (Thompson, 2023).

The rise of social media as the principal source of news for a significant portion of Americans (Walker & Matsa, 2021) represents what may be an even more significant problem than disinformation on television. Social media platforms like Facebook do not pretend to be providers of accurate information; they are entertainment companies. They use personal information on every user to enable the crafting of stories designed to maximize engagement, and they have discovered that engagement is correlated with fear and rage. They likewise use personal information to target stories to readers who will resonate with them, further maximizing societal polarization (Ressa, 2023). Digital optimists never envisioned this as a possibility.

Reduced Importance of Scale

The combination of outsourcing and costless interoperability among systems providers was expected to eliminate the advantages of large corporations, as firms "moved to the market" and replaced internal operations with market-based transactions. For example, telecommunications analysts expected that after the deregulation of telephony and the breakup of the Bell monopoly, there would be at least two cell service providers in each state, one associated with entities previously part of the Bell System and the other a new entrant. And yet, costless interoperability did not occur. Cellular telephony requires massive national scale and ubiquitous geographic

coverage, and we have only three major cellular service providers in the US: AT&T, Verizon, and T-Mobile.

Likewise, contracting did not replace internal production and vertical integration in all sectors of information services. Content producers do not contract to provide content through cable companies providing bundles of services. Netflix and Amazon Prime now produce their own content, and Disney and MGM now provide their own content distribution. A household interested in movies may find itself subscribing to four or five movie services, just as a household interested in music may find itself subscribing to Amazon Prime as well as more specialized services like live streaming jazz from Lincoln Center or streaming opera from the Met. The move to the market did not occur.

Reduced Importance of Scope

Digital optimists anticipated the elimination of transactional friction. With transaction costs going to zero, there would be no need to buy everything from the same vendor. Servicing the entire long tail of products and services would lose its importance. Consumers and businesses would purchase products from the widest array of suppliers, getting the best price on each from a portfolio of vendors, and giants like Amazon would not have emerged. Any consortium of sellers or software providers would be fully as attractive as Google or Amazon appear to be today.

Clearly, this did not emerge as expected. There are only two effective app stores. Apple iOS and Google Android dominate cellular services, not just the market for cellular operating systems. Smaller booksellers and smaller retailers cannot compete online with giants like Amazon, and smart homes and digital assistants powered by Amazon and Google may eventually threaten even traditional giant retailers like Walmart (Schreieck et al., 2019).

Need for Continued Regulation

Each of these beliefs caused digital optimists to believe that the need for regulation would be reduced in an online world. And as we have seen, in all of these areas, markets did not evolve as the optimists expected. Regulation needs to be more extensive than anticipated, and in some areas like platform envelopment and mandatory participation third-party payer systems, perhaps more extensive than they are currently. Additionally, consumers need more protection from manipulation and unfair marketing practices, enabled by detailed individual profiling. Consumers need protection from first-degree (perfect) price discrimination, likewise enabled by detailed profiling of each consumer. Citizens need protection from informed crafting and targeting of fake news.

Finally, rapid advances in artificial intelligence create entirely new classes of threats. These threats are emerging so rapidly that even regulators are not sure what to permit implementors to do, what to require them to do, and what to ban, resulting in a situation where implementors are required to implement *risk-based compliance.* That is, implementors need to predict all of the threats that their systems might encounter. Next, for each potential future threat, they need to analyze the severity of the risk that the threat might create. Presumably, the analysis of the severity of a risk should consider both the magnitude of the problem a faulty system could cause and the probability of that problem actually occurring. This involves analyzing the threats, and the implementor's potential responsibility, for problems that have not yet been encountered. This is far more complex even than it initially appears. The global market crash of 1987 was caused, in large measure, by program trading programs inappropriately labeled *portfolio insurance.* While each system, acting in isolation, would have done as its designers intended, when they all executed simultaneously, they protected no one and instead caused an unprecedented crash caused by program trading. We believe that the risk was self-evident after the fact; it was not anticipated either by implementors or by regulators.

We have discussed elsewhere, at the 2024 Hawaii International Conference on System Sciences, the impossibility of assessing all future risks, even were implementors committed to performing it to the best of their ability. How many oil company engineers or electrical generation utility engineers in the late 1890s could have anticipated the severity of climate change that would result within a century from the burning of fossil fuels? If the impacts of AI are comparable, and if, as expected, they arise faster than the problems of the industrial revolution, can AI systems implementors really be expected to anticipate them and manage them effectively, even if they act in good faith and with the best of intentions?, There will be a clear need for entirely new forms of regulation (Roose, 2023), but this is beyond the scope of this paper.

4 Areas for Regulatory Relaxation

We see three areas where regulatory relaxation would be valuable to society, and no doubt there are others.

The first is *value-creating artistic reuse* of material that enjoys copyright protection, combining and transforming the protected works to create new artistic contributions. Technology has made the transformation and reuse of artistic materials easier, which means that restrictions on reuse now impose greater restrictions than before on the supply of new creative works. Reperformance, taking a work performed by a gifted musician during a time of limited technological fidelity, and reperforming it to create a higher fidelity version than was possible at the time of the original performance, is merely a single example of this. Whatever balance between supply of and access to innovation that was previously optimal now must be reassessed, and protections enjoyed by protected artistic works almost certainly need to be reduced.

We provide significant additional guidance, ensuring that the owner of copyright is not harmed, and ensuring appropriate payments are made for the reuse of protected material (Clemons et al., 2022a, 2022b, 2022c). We note that our recommendations apply only to artistic works, and not to technological works like software products, where there may be compelling commercial reasons for maintaining or even extending protections.

A second area is to make more extensive use of sharing economy platforms, with the additional services and improved resource utilization that they offer.

A third reason for regulatory relaxation is to allow cooperation in the development of European platforms by firms that might otherwise be viewed as competitors. As we have seen, scale and scope remain significant sources of competitive advantage, and indeed, in some instances, the power conferred by scale or scope may be insurmountable. Amazon offers unbeatable convenience because it offers a single source for almost all consumer purchases. Amazon's Alexa provides a smart digital assistant, what we call an active life control interface (Clemons et al., 2022a, 2022b, 2022c), which enables a home shopper to access anything Amazon sells, plus access to a wide range of music that Alexa can play on demand. Smart appliances, smart homes, and autonomous vehicles will all need access to at least one of the dominant American platforms, Alexa, Siri, or Google Android. No single European retailer, appliance manufacturer, automobile company, or media company can compete individually.

If European regulators want a domestic EU competitor to these dominant American platforms, they will have to encourage a degree of cooperation that would previously have been unthinkable. It may be necessary to let *all* retailers and *all* manufacturers collaborate to develop a platform with the greatest possible scope of offerings. The resulting scope would enable this platform to be as attractive to European households as the existing American platforms. As a result of this cooperation, the EU would have a single platform, rather than many, but it would have a viable platform, rather than many irrelevant platforms. It is necessary for regulators to allow cooperation, resulting in a single platform rather than many, in order to increase successful platforms from zero to one. We call this the Cooperation Paradox (Clemons et al., 2022a, 2022b, 2022c).

5 Conclusions

This paper makes three modest contributions. First, it introduces the concept that regulatory relaxation may be justified in cases where technology creates new opportunities. We see three principal areas for regulatory relaxation. One area for regulatory relaxation is permitting greater use of Uber and Airbnb, and other sharing platforms, where the environmental benefits and the value to users can offset the disruptions caused by introducing sharing into a local economy of community. The other areas for regulatory relaxation are permitting more extensive use of protected artistic works in creative works derived from them or permitting reuse to achieve reduced environmental impact. We summarize these recommendations in Table 1.

Table 1 Types of platform business models and reasons for increased regulatory restrictions or for regulatory relaxation

	Reasons for more restrictions	Reasons for more relaxation
Gateways and MP3PPs	New form of monopoly power	–
Platdform envelopment	New form of monopoly power	Superadditive value for consumers
Social media	New form of abuse of individuals, new forms of societal harm	–
Aggregators in the sharing economy	New form of harmful externalities	More efficient resource utilization, value to consumers
Creative reuse of protected artistic works	–	New creative works in a range of artistic domains
Coopperation within and across industries, to achieve scale and scope	–	EU platforms, especially active life control interfaces, need scale and scope to compete effectively with American giants like Alexa and Google

Its second contribution is an examination of principal online business models and their sources of power, as well as the potential for new forms of abuse of power. Our third contribution is based on the examination, and it is a classification of areas where greater regulatory restriction appears to be justified.

The principal limitation of this paper is shared with all research that examines a large collection of businesses, in diverse areas, in numerous countries, and attempts to draw inferences from these examples. We do not know if our dataset is complete; there can be business models that we have not examined, or that have not emerged yet, that will represent new sources of power and new abuses of power or will create new opportunities. In the first case, there may be a new form of regulatory restrictions that we missed, while in the second case, there may be new opportunities for regulatory relaxation that we likewise missed. This is exacerbated by the tight length restriction, which prevents us from providing more detail on the analyses.

Additionally, implementing any regulatory change is quite difficult and the difficulties vary across legal jurisdictions as well as across business areas. Since most online platforms are based in the US, limiting the power of Google or the abuses of Facebook may be much more difficult in the US than in the EU. All jurisdictions have some form of limitations on monopoly power, but in most of the West, attempts to limit the societal harm of social media platforms and their role in disinformation campaigns are made more difficult because of firm commitments to free speech.

There are several areas where our team of computer science and information systems faculty, working with law faculty, will continue our research efforts.

- Mathematical modeling of the impact of increased regulation on different parties is always useful.

- Likewise, the benefits of relaxing restrictions on cooperation among industry competitors should be amenable to modeling. Regulators might permit cooperation within an industry to create an EU competitor to dominant American platforms like Amazon / Alexa, Apple / Siri, and Google's smart assistants, but economic models will be essential before regulators can be convinced to encourage what might appear to be collusion.
- We are currently modeling the most effective mechanisms for controlling fake news and disinformation campaigns.
- We are currently working on mechanisms, like extensions to consumer protection law, to deal with the manipulation of consumers' purchases, unfair trade practices, and first-degree (perfect) price discrimination.

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Proposing a 5-pillar Model for a National Digital Strategy

Vasiliki Koniakou, Georgios Doukidis, Vasiliki Zarogianni, and Yiannis Mourtos

Abstract As governments around the world are in the midst of a historic and highly challenging process of shifting away from traditional methods of operation, seeking to modernize and digitalize their processes, so as to fully leverage the potential of digital technology for economic and social development, this article aims to offer a five-pillar model for a national digital strategy for digital transformation on a country level. It builds upon a different way of framing the role of the state in digital transformation, perceived as a facilitator of change, instead of a mere provider of services to be digitalized. Whereas literature tends to focus on verticals such as e-commerce, or legislative and policy frameworks that are either too narrow or too abstract, the proposed strategy includes a set of horizontal and vertical interventions in an integrated manner. The aim is to offer incentives and support to private initiatives critical for the digital transformation of different aspects of the national economy, as well as developing an ecosystem of innovative new digitally based entrepreneurship. It also contains measures to build a competitive and extrovert IT sector, as well as to attract foreign direct investment from international ICT companies.

1 Introduction

During the last two decades, governments around the world have been engaged in the historic and highly challenging process of shifting away from traditional methods of operation, seeking to modernize and digitalize their processes (Jonathan, 2020). The swift advancement of digital technologies and the ubiquitous presence of the Internet have induced large-scale transformations in government and the public sector (Kokkinakos et al., 2016). Additionally, the emergence of new technologies like Artificial Intelligence (AI), blockchain, Internet of Things (IoT), and robotics is

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further pushing governments and public administration to quickly adapt and change their traditional ways of operating (Agostino et al., 2021; Gascó, 2003).

Simultaneously, the COVID-19 pandemic has had a significant impact on the digital transformation of governments around the world (Agostino et al., 2021). The sudden need for social distancing and remote work has accelerated the pace of digital transformation in many areas, giving new impetus to the relevant state initiatives (Gabryelczyk, 2020). Yet, regardless of the extensive global focus, digital transformation is a rather fragmented field of research and practice. Particularly regarding the digital transformation of the state, the literature is still rather underdeveloped, while there is still no widely established definition (Kraus et al., 2021; Reis et al., 2018), nor a single strategy (Chanias et al., 2019; Matt et al., 2015). Hence, what exactly the digital transformation of the state and the public sector means, entails, and requires remains an open question.

Although there is extensive literature exploring the drivers and barriers to the digital transformation of the state and wider public sector (Jonathan, 2020; Mergel et al., 2019), so far research and practice tend to disproportionally focus on e-government (Savoldelli et al., 2014). This way, digital transformation on a state level is primarily identified as e-government, denoting the introduction of digital technologies aimed at improving the efficiency and effectiveness of government operations (Huang & Karduck, 2017; Mergel et al., 2019). Additionally, the topic is rarely addressed from a strategic point of view (Ismail et al., 2017), as part of a larger national action plan that aims at accelerating the progress and development of the country or improving the national economy, making the scope of the existing frameworks rather narrow (Huang & Karduck, 2017; Tekic & Koroteev, 2019). At the same time, the widespread use of digital technologies and the fast digitization of daily life have resulted in significant changes to socio-economic and political aspects, which call for a broader understanding of digital transformation in the context of the state, and a more comprehensive approach to digital strategies for the public sector, the economy, and society (Mergel et al., 2019; Vial, 2019).

This paper aims to contribute to the literature on the digital transformation of the state, by proposing a new model for a digital transformation strategy at the level of the state. Whereas admittedly the digitalization of public services is critical for the digital transformation of the state, through this paper we argue that so far the focus of the existing frameworks has been relatively limited (Huang & Karduck, 2017; Tekic & Koroteev, 2019), while contemporary world calls for a more holistic approach. Embracing the central role the state has historically played before technological, social, economic, and other developments (Hanna, 2018; Kooiman, 2003), the paper argues for the pivotal role the state may have in promoting the transformation of key sectors in the national economy and society. Moreover, it suggests that since the transformation of the economy and the public sector are closely related and can be mutually reinforcing (Bonina & Cordella, 2009), they ought to be jointly considered as part of a comprehensive digital transformation strategy for a country, aligned with the national development strategy (Hanna, 2018). Stemming from this observation, it offers a comprehensive and multi-layered proposal for a national digital strategy that builds upon five distinct but interconnected pillars.

The paper starts by proposing a different way of understanding digital transformation in the context of the state, suggesting a more holistic approach that perceives the state not as a mere provider of services that need to be digitalized, but as a facilitator of digital transformation. Our view is in line with the models suggested by the United Nations (UN) the European Union (EU) and the Organisation for Economic Co-operation and Development (OECD). Championing the idea that strategy and not technologies drive digital transformation (Kane et al., 2015), it highlights the necessity for policies that support the transformation of the economy as an integral part of the national digital strategy of the state. The proposed strategy includes a combination of horizontal and vertical interventions as well as structural changes aimed at the digitalization of the economy and society at large. Although some countries already follow a similar approach in drafting their national strategies, the discussion in academia is still lagging. Thus, this article also hopes to bring the discussion on national digital strategies back into the academic limelight. Additionally, exploring the digital transformation of the state from a strategic point of view would arguably enhance not only academic literature but also aid policy-makers by shedding light on the key interventions required.

The remainder of the paper is structured as follows: First, in Sect. 2 we set the background of our study, addressing the concepts of digital transformation of the state/public sector and national digital strategy. Thereafter, in Sect. 3 we present the vision and the details of our suggested five-pillar national digital strategy. Finally, Sect. 4 offers our closing remarks and insights on further research.

2 Digital Transformation of the State and National Digital Strategies

Digital Transformation of Public Services, and E-government

Already since the late 1980s, researchers have highlighted the promises and opportunities of the Information and Communication Technology (ICT) revolution for the state (Doukidis & Giannakos, 1988; Doukidis & Smithson, 1995). Progressively, the transformative powers of ICT technologies for the state became identified with the digitalization of the provision of public services, denoting a wide range of initiatives and strategies aimed at leveraging technology to enhance the efficiency, accessibility, and effectiveness of public services, summarized in the term "e-government" (Davison et al., 2005; Mergel et al., 2019). The concept first emerged in the 1990s, as a key component of the management covenant called the "New Public Administration" and was eagerly promoted by US Vice President Al Gore (Almarabeh & AbuAli, 2010). In a nutshell, it entails the introduction of digital technologies in the public sector, the digitalization of the operations of public institutions, and the transition from paper-based to digital-based systems to deliver public services and facilitate communication with the citizens, accompanied by a wide range of infrastructural

and administrative changes in public administration (Cordella & Tempini, 2015; Matt et al., 2015; Tan & Crompvoets, 2022). Thus, at the level of the state, digital transformation became largely identified as the introduction of digital technologies and Internet-based services aimed at improving the efficiency and effectiveness of government operations, as well as enhancing transparency and citizen engagement (Huang & Karduck, 2017; Meijer & Bekkers, 2015; Mergel et al., 2019).

During the last three decades almost all governments around the world, at different paces and through a variety of initiatives and strategies, have designed and implemented digital transformation plans under the e-government label. The first initiatives emerged in the early 1980s as attempts to formulate legislation related to information technology (Doukidis & Giannakos, 1988). In Europe, the "e-Estonia" program aimed at promoting the extensive digitalization of the Estonian public administration is a commonplace example, yet the digital transformation of the public sector has been high on the agenda of several other European countries. For example, in 2010 the government in the United Kingdom launched its "Digital by Default" initiative, aiming to digitalize its public services, make it easier for citizens to access government services and information online, and simplify the process of interacting with government agencies (Al-Muwil et al., 2019; Cabinet Office, 2012). Similarly, throughout the years, different Italian governments have tried a wide range of options to digitally transform the public sector. In 2016, hoping to accelerate the process, the Italian government introduced a large number of e-government projects and appointed a special team (the "digital transformation team") to implement the "Digital Agenda 2016–2019" (Battisti, 2020). The public sector in Germany has also undergone various attempts aimed at the digital transformation of the state. In 2018 the German government initiated a comprehensive reform of its public service delivery, intending to digitize all 575 public services by 2022 (Mergel, 2021). Finally, Greece has also initiated a wide-ranged digital transformation plan, since early 2020, aimed at transforming both the public sector and the national economy (OECD, 2022).

As the concept was gaining prominence in the global public policy arena, international organizations, such as the UN the EU and the OECD, proposed a variety of frameworks and metrics to promote, assess and evaluate the advancement in the digital capabilities of public administration and society. Some of the most well-known frameworks for transforming government through technology include the EU's "eGovernment Action Plan 2016–2020," the US's "Digital Government Strategy," and China's "Internet Plus Government Services" policy. Simultaneously, the two most prominent indexes for digital transformation at a country level, namely the "Digital Economy and Society Index" (DESI) by the EU, and the "E-Government Development Index" (EGDI) by the UN, assess the progress focusing not only on the integration of new technologies but also considering the process of digital transformation with the national economy, as well as including further citizens-centric perspectives. Although some of the frameworks bear the title "strategy" they hardly include the characteristics of a comprehensive, detailed, and holistic strategic plan, that includes interventions that go beyond a specific domain. Most of them are primarily focused on the digitalization of the provision of specific public services,

and policies to achieve the most optimal use of ICT to bring the citizens closer to the public administration. This narrow focus on e-government frames digital transformation as the mere transition from analogue to the digital provision of public services (Savoldelli et al., 2014). Such a limited scope restricts the role of the state in the digital era and deprives the state of the opportunity to innovate on a larger scale, serving as an enabler of the digital transformation of the country as a whole (Hanna, 2018).

National Digital Strategy, and the Digital Transformation of the Country

Another term that emerged with urgency in the public policy agenda migrating from the business world around the mid-2010s, is "national digital strategy". Briefly, national digital strategies are the sum of government initiatives designed to promote a government's top digital policy priorities and goals and to guide a country's economic and societal transformation through digital means. Such strategies constitute comprehensive frameworks, premised on a holistic approach, and a set of multiple overarching objectives that focus on the entire digital landscape of the country. They aim at facilitating digital transformation on a large scale, making the most of the opportunities the advent of technologies may offer to the national economy and society. Common objectives of these strategies include becoming a leader in digital advancements, promoting digital innovation, boosting productivity and economic growth, and improving overall well-being by reducing digital disparities and promoting social inclusion. The specifics, content, and priorities of national digital strategies can differ significantly between countries, and there is an ongoing debate about what should be included in such a strategy and how it should be managed (Mancini et al., 2022).

Whereas digital transformation strategies for the state, focus primarily on improving the efficiency and effectiveness of the public sector by leveraging digital technologies, a national digital strategy looks at the overall digital landscape of the country, considering factors such as economic, environmental, and social impact. Nonetheless, as OECD observes, up until here, most countries have rather focused digital strategies, that target a specific sector, policy, or technology, such as infrastructure development, broadband expansion, artificial intelligence (AI), the Internet of Things (IoT), digital security, and digital skills (Mancini et al., 2022). Such narrowly focused plans do not amount to a national digital strategy. On the other hand, some countries have broader national plans or strategies. Although these plans often serve a coordination function and may also address digital policy issues, they typically engage with them only as one among many other policy areas.

As governments globally strive to design their national digital strategies, researchers, as well as international and intergovernmental organizations have offered several guidelines and models. The EU Commission, for example, has published "The Digital Decade Policy Programme" (DDPP), a sum of objectives and targets for 2030,

which will guide the digital transformation of the EU Member States. Maintaining the strong commitment of the Union to human rights online and the human-centric approach, the DDPP is built upon four-key pillars, namely Digital Skills, Digital Transformation of businesses, Secure and sustainable digital infrastructures with an emphasis on access, and Digitalization of public services (EU Commission, 2022). Similarly, the OECD Members have agreed on the "Going Digital Integrated Policy Framework", which identifies the most relevant policy domains to consider when preparing and designing a national digital strategy. The Framework highlights 38 policy domains across seven dimensions, namely Access, Use, Innovation, Jobs, Society, Trust, and Market Openness (OECD, 2020). Whereas they both serve as a useful point of departure, they remain rather abstract, serving mainly as principles rather than guidelines. Simultaneously, at an academic level, even though there is an emerging body of research on national digital strategies, engaging with design, implementation, and impact assessment, studying the factors that determine their success or failure and the respective roles of different stakeholders, they are mostly focused on narrow, sector-specific initiatives.

3 A Five-Pillar National Digital Strategy

Building upon a Holistic Approach and a Strategic Vision

As state-wide digital transformation is still unfolding, the need for a comprehensive strategy is hardly in question. What remains a question is how this strategy should be, what are the key components, and how it ought to be structured. Observing that targeted initiatives and small-scale reforms are not enough, Hanna argues that an effective national digital strategy is essentially comprised of a sum of interconnected components. Building upon a combination of qualitative and quantitative research, as well as studying policy-making trends, success stories and failures of national digital transformation plans (Hanna, 2020), he argues that a strategic plan for digital transformation on a country level should include initiatives focused on five key domains, namely on an affordable and competitive information infrastructure; a dynamic and innovative ICT industry; widespread ICT literacy premised on entrepreneurial culture, education and re-skilling of the national workforce; a well-planned investment program for ICT employment to modernize public sector; and a set of incentives to encourage the efficient utilization of ICT for private sector development, all of which within an enabling, supportive, and agile policy and institutional environment (Hanna, 1991, 1994, 2010, 2018). His analysis highlights the centrality of an approach that equally focuses on interventions aimed at enhancing infrastructure, supporting and maintaining a robust ICT industry, promoting digital literacy, entrepreneurial mindset and education while investing in the digitalization of the public sector, and promoting the penetration of ICT in the private sector. These

elements, jointly introduced along with an innovation-friendly institutional framework, allow the diffusion of digital technologies across all the central domains of the economy and society, taking the digital transformation of the state to the next level.

From this angle, a vigorous and innovative digital economy constitutes both a key priority and an integral part of digital transformation. Hence, to encourage and support the transition of the national economy to the digital era, the state should promote the adaptation of new technologies, taking policy initiatives to encourage the digital transformation of businesses, particularly supporting Small and Medium Enterprises (SMEs). It is also critical to implement measures towards strengthening the broader ICT industry, supporting the creation of new, innovative products and services. From a similar point of view, along with strengthening the local technology business sector, it is crucial to also create the conditions necessary for attracting foreign ICT companies, while giving incentives for private or even foreign investments in national infrastructure. Initiatives that stimulate the diffusion of digital technologies in all sectors and industries should be combined with the promotion of digital skills and competencies, and the re-skilling of working personnel. Furthermore, it is significant to facilitate the development of new, innovative digital entrepreneurship with an international focus, utilizing the talents of start-ups, along with investment from venture capital funds, and financing from alternative sources combined with tax reliefs. Such steps essentially stimulate the adoption of digital technologies, promoting the multi-layer digital transformation of all the key sectors of the economy and society, in ways highly relevant to the broader development strategy of any given country.

Proposing Interventions on Five Strategic Domains

Taking Hanna's approach as a point of departure, we propose a national digital strategy that incorporates the previously discussed elements within a well-defined strategic vision premised on a holistic approach. Essentially, we combine e-government, as one of the pillars of the suggested model, with four more pillars, bringing together stricto sensu digital transformation of the state, with national digital strategy. The proposed model suggests a shift in the way we perceive and frame the digital transformation of the state, as well as the role the state may have within a national digital strategy. Whereas often the role of the state in the context of digital transformation is primarily defined in terms of e-government, we argue that the state can be a significant facilitator for the introduction of new digital technologies and systems in all aspects of socio-economic life, creating a virtuous cycle in which private and public sector digital transformation are complementary and mutually reinforcing. Hence, to make the most out of the opportunities that digital technologies offer, governments need to invest in a national digital strategy that goes beyond the digitalization of public service delivery and extends to the broader digital transformation of the country, the national economy, and society. Such a strategy builds upon a sum of feasible interventions organized into five pillars that combine different

aspects of the aforementioned elements. It also involves the design and application of a framework for the implementation of different initiatives that aim at promoting and enhancing the integration of digital technologies in various key sectors of the economy and society and the continuous growth of digital maturity.

The rationale for the five pillars is relatively simple. Our model seeks to mobilize all the key stakeholders and the necessary resources (financial, technological, and human), as well as engage all the value chain partners to support and promote digital transformation. Simultaneously, turning the formerly discussed key elements of a national digital strategy into objectives, our interventions are intended to attract and encourage investments in information infrastructure via multiple channels; support a robust and innovative ICT industry; promote the integration of digital technologies in various key sectors of the economy and society; support the penetration of ICT in both the public and the private sector; and promote digital skills, digital literacy and innovative entrepreneurial culture in the society. This way we tackle most of the key digital transformation-related challenges regarding access to digital technologies and services, enhancing and maintaining digital infrastructure, promoting digital skills and the digital economy, supporting the digitalization of SMEs and start-ups, and encouraging the diffusion of digital products and digital services (OECD, 2017) (Fig. 1).

Our proposition is in line with the aims and objectives of both the EU DDPP and the OECD Framework, as the changes we promote follow the same rationality. Nonetheless, instead of abstract principles and high-level guidelines, our framework offers a set of concrete interventions across four strategic domains, including the well-established dimension of e-governance. The interventions and policy initiatives are both vertical and horizontal, aimed at offering incentives and support to private initiatives critical for the digital transformation of different aspects of the national economy, as well as bringing the necessary organizational and administrative changes within the public sector, including policy initiatives. Apart from tax reliefs, financing

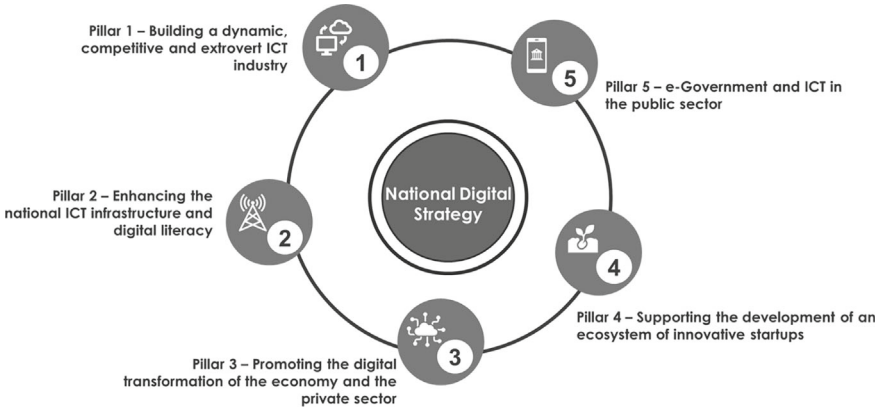

Fig. 1 Visualization of the five pillars plan

tools, subsidies, and offerings in the form of available facilities and infrastructure, our proposal suggests structural changes and policy initiatives and emphasizes the need to support and promote research for the development of new and innovative solutions, products, and services, as well as on education, digital training and the promotion of re-skilling and up-skilling. This way, our strategy combines all the key elements Hanna identified, organizing them in a way that allows them to be achieved from different angles, as the different pillars are essentially mutually reinforcing each other.

As how the interventions are exactly expressed and specified ultimately depends on the country in which the strategy will be implemented, here we offer a brief overview of the aim of each pillar and the objectives behind them. The following paragraphs summarize the five pillars.

Pillar 1: Building a Dynamic, Competitive, and Extrovert ICT Industry

This Pillar focuses on technology companies and companies within the broader ICT sector. It aims to encourage them to innovate and venture into the new era of digital entrepreneurship, while particularly supporting ICT companies to become the flagships of the national economy and a motor for the digital transformation of the country. The proposed interventions promote the development of new and innovative digital products, services, and processes within the wider ICT sector; encourage synergies between established businesses and Universities or other Research Institutions; support companies to acquire intellectual property rights and quality certifications for their products and services; and seek to enhance the connection and the exports to the international market. Moreover, the Pillar suggests the creation of innovation clusters within the ICT domain, and the establishment of an internal market for data, as a critical part of the knowledge economy and data-driven innovation.

Pillar 2: Enhancing the National ICT Infrastructure and Digital Literacy

The purpose of this Pillar is double. Firstly, it seeks to improve the national ICT infrastructure and secondly, it aims to contribute to the enhancement of digital skills and digital literacy among the population. To achieve these it provides a nexus of vertical and horizontal interventions intended to draw private investments in the national ICT infrastructure, focusing primarily on high-speed connectivity and novel, open high-speed spaces, such as Gigabit Hubs, as well as attract foreign ICT companies, R&D and Services Centers of ICT. Such companies and structures, apart from vital strategic investments for the digitalization of the economy constitute also significant enablers for the diffusion of digital technologies and digital services across every sector of the economy and society. To that end, we propose a set of regulatory initiatives aimed to secure wide access to ICT services, through a competitive market of service providers. Apart from offering monetary incentives, services and infrastructure-related inducements for foreign investments, this Pillar places a lot of

emphasis on the up-skilling and re-skilling of the working population. More specifically, it provides specific initiatives intended to structurally reform and upgrade the ICT-related curricula of the Higher Education Institutions (HEIs), along with targeted re-skilling and up-skilling programs for people who are already in the market.

Pillar 3: Promoting the Digital Transformation of the Economy and the Private Sector

This Pillar engages with the digital transformation of the private sector, seeking to ensure the effective utilization of ICT for the development of the private sector. It is also intended to make the digital transformation of the national economy deeper and wider, by looking at the smaller units of the economy which are often overlooked. When addressing the digital transformation of the private sector we tend to focus on large companies. Yet, in the context of the proposed digital national strategy, we place small and medium companies at the center. The Pillar includes interventions aimed at assisting SMEs to enhance their digital readiness by establishing their digital presence, acquiring the necessary digital tools to improve their processes and customer experience, creating digital promotion channels, and ultimately engaging in e-commerce. Focusing particularly on e-commerce, the Pillar proposes seven vertical interventions that collectively build a national e-commerce strategy on three levels, business to customer (B2C), business to business (B2B), and business to government (B2G). The underpinning objective of this strategy is not only to augment the digital maturity of businesses but also to elevate the quality of services, enhance transparency and restrain tax fraud and evasion. Furthermore, it engages with the digital transformation of the freelancer market, offering suggestions aimed at enhancing their digital maturity. Nevertheless, as no national digital strategy would be complete without addressing the digital transformation of large enterprises, the strategy also offers a concrete framework for the transformation of customer experience, business processes, and business model (Doukidis et al., 2020).

The Pillar also includes a set of interventions and proposed initiatives the state may take to enhance the digital transformation of other key sectors of the national economy. For example, these sectors could be agriculture, shipping, and tourism. The Pillar suggests a set of actions to be taken within a larger plan following the most recent trends in the international market and technological developments, while duly considering the specific requirements and characteristics of each sector. Apart from digital transformation per se, the purpose here is to also promote research and technological innovation within these sectors, through the establishment of distinct Research and Innovation Hubs for each sector aimed to develop and test technological solutions while playing a central role in technology and know-how transfer. Finally, as often legislation and policymaking about new technologies are rather reactive, the proposed strategy suggests a selectively proactive approach. It offers a number of proposed interventions on how cutting-edge new technologies, such as blockchain and other Distributed Ledger Technology (DLT) applications, cryptocurrencies, and FinTech solutions should be regulated, along with some suggestions as to how they

could be applied to promote and further advance digital transformation. The rationale behind the proposed regulatory initiatives urges the state to seek ways to use new and emerging technologies for the modernization of the public sector and the benefit of the state and citizens.

Pillar 4: Supporting the Development of an Ecosystem of Innovative Startups

The fourth Pillar focuses on start-up entrepreneurship, particularly this branch that engages with new technologies, digital services, and innovative products. The purposes here are multiple. First of all, the Pillar offers various alternatives aimed at assisting start-ups to grow, attract investments, and gain access to financing options and opportunities that will allow them to mature, and further develop their products and services. Simultaneously, it promotes the synergies between the start-up ecosystem and the academic and research community, highlighting the significant role of University Technology Transfer Offices (TTOs) in facilitating the transfer of innovative solutions to the market. Moreover, seeking to promote innovation and foster not only the diffusion but also the development of new and innovative digital technologies in the country, the proposed strategy offers a roadmap for establishing Innovation Clusters with the active participation and cooperation of the government, established businesses, investors and funds, universities, and the start-up ecosystem. The proposed interventions allow the establishment of a vibrant start-up ecosystem, focused on experimenting and developing novel digital solutions, products, and services that advance the digital transformation of the market and everyday life, while turning research results into actual products, bringing innovation to practice. Additionally, through the Innovation Clusters, the start-up ecosystem is also expected to act as a catalyst for the digital transformation of other sectors and actors of the economy.

Pillar 5: E-government and ICT in the Public Sector

Finally, our last pillar encompasses e-government and the further introduction of ICT in the broader public sector. E-government denotes the introduction of digital technologies in the public sector, aimed at digitalizing the public sector processes and services, to improve the efficiency and effectiveness of government operations (Huang & Karduck, 2017; Mergel et al., 2019), and enable citizens, companies and organisations to interact with government and the public sector remotely and more easily, making the interaction with government and the public sector more accessible. As already discussed, e-government has been the central point and the key objective of most of the most prominent national digital strategies, and digital transformation frameworks for the state. Apart from the digitalization of traditional government processes, the automation of administrative tasks, and the provision of online services, we propose the introduction of cutting-edge technologies such as AI,

Machine Learning (ML), and Distributed Ledger Technology (DLT), combined with a comprehensive programme of digital re-skilling and up-skilling for employees in the public sector. Several countries have undertaken similar initiatives, with very positive outcomes (Delopoulos, 2015; Mikhaylova, 2019; von Lucke & Fitsilis, 2023).

4 Concluding Remarks

Digital transformation has turned from a buzzword to a pressing policy objective during the last decades, making digital strategies for the transformation of the state and the wider public sector highly required. Yet, referring to the state, digital transformation remains a relatively elusive term (Mergel et al., 2019). So far literature tends to disproportionally focus on only one of the multiple aspects of this multifaceted phenomenon, namely e-governance, while what exactly a digital national strategy entails is only partially addressed. Literature usually engages with drivers and obstacles for digital transformation, particularly addressing e-governance, while most roadmaps for digital strategies remain at a rather abstract level (Ismail et al., 2017; Stoletov, 2022). Considering the need for further research into a holistic approach towards national digital strategies and the digital transformation of the state, our proposed model stems from the idea that the transformation of the economy and the public sector are closely related and mutually reinforcing (Bonina & Cordella, 2009). Additionally, in the context of digital transformation and a national digital strategy the state ought to be viewed not only as a provider of services but also as an enabler of change and transformation in the digital era. Hence, embracing the digital transformation of the state as a complex process that requires a wide array of changes, policy initiatives, and investments, our proposed strategy builds upon these necessary components, organized into five pillars, which aim to induce, encourage, and support the digital transformation of the national economy and society. Our proposal builds upon the remarks of Nagy K. Hanna on the necessity for a holistic approach to digital transformation on a state level, and expands upon the models recently proposed by the EU and the OECD.

The proposed framework is hardly the end of this research. First and foremost, further comparative research is required to assess the potential impact, as well as the effectiveness of the proposed model, also in comparison to existing ones. The effectiveness could also be evaluated using DESI as a premise, seeking to identify the different metrics of DESI that the proposed model affects. Moreover, using our framework as a point of departure, further research ought to examine what type of multipliers these interventions create for the national economy, what effects they may have on Gross Domestic Product (GDP) and how the overall digital economy may develop through these and/or similar interventions. Additionally, using metrics such as DESI and EGDI as a point of reference for the country's progress, research should also explore how these strategies ought to be adopted. Taking a step further, it would be worth studying how such individual national digital strategies could

fit within broader supranational and intergovernmental strategies, such as the EU digital agenda 2030, and/or foreign agreements. Finally, as digitalization and digital transformation may also challenge the traditional foundations of the state and the democratic polity, it would be crucial to meticulously study what, if any, negative implications such strategies may have for democracy and human rights, and how such implications can be mitigated.

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Central Bank Digital Currencies: Key Concerns Accommodated in a Model of Classical Athenian Descent

G. C. Bitros and A. G. Malliaris

Abstract We identify the main pros and cons that drive the interest of central banks to issue digital currencies, we discuss the key issues that such currencies raise, and we propose a model that allows them to issue digital currencies in a way that we consider best from a technical, historical, and political economy perspective. Although it seems remote, envisioning a future where money is privately produced, akin to classical Athens, it is not beyond the realms of possibility. In this scenario, the "common" good, embodied in the principles of democracy, free markets, and individual freedoms, could be supported by constraining the state's role in monetary policy. The state's responsibilities would focus primarily on ensuring competition, alongside tackling illicit activities and preventing tax evasion. However, until then, governments are likely to adopt hybrid systems consisting of two nodes: One that provides for a state-operated digital mint, supplying electronic money on a voluntary basis, and another rich in private digital currencies, all circulating in parallel and in competition.

1 Introduction

The last 30 years, digital technologies, such as the internet, artificial intelligence, machine learning, robotics, and virtual and augmented reality have revolutionized our ordinary lives. This technological upheaval started by replacing physical mailing by e-mails, moved to phones and texting, doing shopping online, searching efficiently online with the brilliant Google search engines, using electronic forms, books, and then during the pandemic, doing most of our work from home. At the same time, while digital technologies were rapidly expanding, the United States (US) and many

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other economies experienced a major Global Financial Crisis, followed by an unusually slow recovery, and then a pandemic that lasted about 3 years. During this period, digital technologies like Zoom and Teams facilitated online teaching and teleconferencing and working from home, all reducing the spread of Covid-19 and further encouraging the growth of digital economies. Thus, today, in addition to individuals, families, schools and churches, universities, firms, and local and state governments, who have experienced the impacts of these changes, we witness in many ways the interest of central banks to explore the implications of digital technologies in the fronts of money and the conduct of monetary policy. In this context, our purpose here is to identify the confluence of forces that drive these changes, to discuss certain fundamental issues associated with the so-called Central Bank Digital Currency (CBDC), and to consider policy responses that may be appropriate looking forward.

The prospect of such a currency raises many questions, ranging, e.g., from technological and economic, to political, ethical, and even constitutional. Here we shall place the emphasis on those that have attracted the biggest attention in the economics literature. However, before proceeding, it is important to understand a key development that has to do with the vast opportunities digital technologies have created for the production and distribution of private currencies.

In the past, as documented by Brunnermeier et al. (2019) and others, unbacked private paper currencies generally failed because they lacked the advantages of public currencies. However, in the last fifteen years the national and international expansion of e-commerce has led to a spectacular increase in the demand for electronic payments, as well as to a significant decline in the use of cash. In turn, these two trends have motivated technology-driven start-ups ("Fintech") and large e-commerce and social media platforms ("BigTech") to enter increasingly into the financial markets which have been dominated traditionally by banks and credit card companies. It is not surprising, therefore, that central banks are keenly interested in the implications that these developments may hold for their ability to conduct effectively monetary policy and carry out their micro-prudential tasks, as well as the advantages that a Central Bank Digital Currency (CBDC) may offer in preserving and even strengthening their status in the monetary system.

The rest of the paper is organized as follows: In Sect. 2 we focus on the possible reasons why central banks may wish to venture into issuing their own digital currencies. From the literature on the economics of CBDC it turns out that, aside from fending off competition from private digital currencies, central banks may have a wide range of motivations for doing so, including gaining firmer control of the money supply or simplifying micro-prudential policies. In Sect. 3 we comment on a few key political and economic issues that may deter the adoption of CBDCs, such as considerations that have to do with an increase of the state's reach into the private lives of individuals, thus raising questions whether this development would benefit democracy and the free way of life and creating a complex landscape for the future of digital monetary systems. In Sect. 4 we examine how the monetary system may evolve to accommodate in a balanced way the interests of governments to serve the "common good" and those of the dispersed public. To accomplish this objective, we outline the foundational elements of a model centered on digital currencies, taking

inspiration from the institutional frameworks utilized by the Athenians during the classical era. This approach leverages the potent influence of monetary systems for the benefit of their city-state. The paper concludes with a comprehensive summary of our findings and offers a set of final observations and remarks.

2 Main Drivers for a US CBDC[1]

Assuming the interest central banks show in the CBDCs is serious, it is not clear to us why they may wish to replace the current vastly digitized public currencies, nor what new arrangements they might need to put in place for them to succeed. At present, perhaps there is a delay clearing up their views because of the lack of hard evidence regarding the net balance of potential benefits and risks. We believe that central banks have strong incentives to proceed with issuing a CBDC, but at the same time face strong impulses to postpone because of political economy considerations. The objective in this section is to explain the main incentives that may drive the interest of central banks to introduce this kind of currencies.

Advances in the Efficiency and Stability of the Monetary System

Drawing on the accumulated evidence, Bitros (2015) concluded that key to the errors of the Federal Open Market Committee (henceforth, "the Fed" or the "US central bank") and the federal fiscal authorities (henceforth the "US Government" or just the "State") that led to the 2008 financial crisis was the Fed's failure to tame the risk-taking activities of commercial banks. This failure was not conjectural. It was due to the moral hazard that the Fed's standing as lender of last resort embedded in the decision making of commercial banks. To warn the latter about their risk-taking dispositions, it is true that the Fed together with the fiscal authorities left Lehman Brothers to go bankrupt. But shortly thereafter, they conceded that the structure of the banking sector is dominated by banks "too big to fail" and their warning was

[1] In early 2020, about 35 countries were exploring the potential of digital currencies to be issued by central banks or the private sector. Covid-19 interrupted these explorations. In late 2023, central banks in over 130 countries representing 98% of global GDP showed interest in investigating digital currencies. Clearly, the question of country focus was a problem, and we chose to concentrate on the United States. One may reasonably argue that, for instance, the Eurozone would be a better choice because, not only is it much more advanced in terms of development of a digital currency, but in the Fall of 2023 the European Central Bank (ECB) outlined a two-years trial phase that has some common characteristics as well as some major differences from the CBDC we propose. The reasons for our choice are, first, that the US dollar is the preeminent world currency, and secondly, that we hold a better knowledge of the US monetary system. However, the fundamentals of our analysis and conclusions remain invariant with respect to this choice.

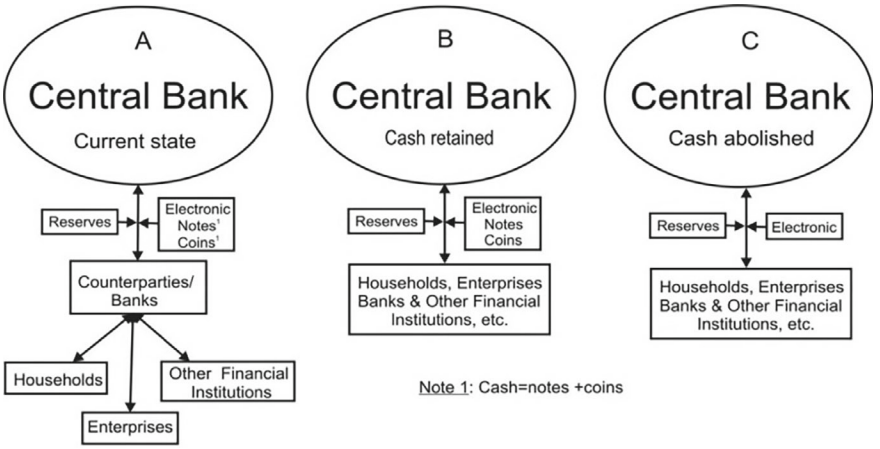

Fig. 1 Possible evolution of the monetary system

lost. For, as long as the managements of systemic banks are bent on maximizing profits for themselves and their shareholders, they will always find ways to thwart the limits set by regulatory controls. Hence, since in the established banking system the problem of moral hazard is inherent, the frequency and the severity of financial crises may be expected to increase.

Allowing for this undesirable prospect, the Fed has two CBDC reform options. As shown in Fig. 1, from the current state of the monetary system (Exhibit A) the Fed may introduce a CBDC account for all citizens to use along with cash for payment and deposit purposes (Exhibit B) or do the same but abolishing cash altogether (Exhibit C). Either of these reforms would eliminate the moral hazard problem mentioned above, enhance Fed's control over the money supply, and hence improve on the transmission of monetary policy, simplify micro-prudential policies, reduce the current fragility of the banking system, and in general increase the efficiency of the monetary system. Given that either of these reforms would lead to the famous 100% reserve scheme, the gains in efficiency according to Benes and Kumhof (2012) might be as much as 10% of GDP, whereas "steady state inflation can drop to zero without posing problems for the conduct of monetary policy".

Protection of Fed's Monopoly Power

Fiat currency, whether backed or unbacked, serves three functions. It is a unit of account, a means of payments, and a store of value. Not long ago, the Fed had legal monopoly over all three attributes or services of the US dollar. However, more recently, a plethora of private digital currencies entered the market offering various bundles of these services to a satisfactory extent. In turn, this trend gave impetus to a

growing body of literature arguing that these currencies erode the monopoly power, independence, or even "sovereignty" of the Fed, thus inhibiting its ability to conduct monetary policy effectively.[2]

The beginning of this trend started in 2009 with Bitcoin. Since then, the number of cryptocurrencies has grown into the thousands. However, for the time being, the challenge to the dominance of public money does not come from these currencies. It comes from the prospects that were created when in 2019 Facebook Inc. announced their plans to introduce a digital currency called Libra. According to the provisions described in their First White Paper,[3] this currency was designed to be a simple global currency and financial infrastructure empowering billions of people, based on a secure, scalable, and reliable blockchain, backed by a reserve of assets designed to give it intrinsic value, and governed by an independent Libra Association tasked with evolving the ecosystem.

This project is still pending, due to deliberations of the US Congress. In addition, a year later, Facebook Inc. made efforts to launch this currency in Switzerland under the name Diem, which also remains under review by the pertinent Swiss authorities. From these reactions, one can conclude that governments will contest all attempts that may undermine the monopoly power of central banks over national currencies. However, as analyzed by Brunnermeier et al. (2019), there are now indications that "BigTech" corporations have started slowly to "bundle" the traditional three functions of currencies, as well as "re-bundle" them by adding more services, growing their own digital currencies, and thus challenging severely the monopoly power of central banks over national currencies.[4] Drawing on these trends, it is then quite likely that the Fed is pressured into issuing its own digital currency, first, as a means to fend off potential competition from the private digital currencies that may emerge along the lines of the Libra project, and secondly, to preserve its monopoly over the conduct of monetary policies.

Restoration of Citizens' Trust in the Public Currency

Central banks in Western type economies have always been tasked by governments to manage paper currencies, so as to achieve "stability" in the general price level. The

[2] Indeed, there are now certain experts whose arguments transcend the concept of the central bank's "independence under the law" and go as far as to side with the shaky notion of central bank "sovereignty". For example, see Ahnert, et al. (2022).

[3] See https://coinrivet.com/facebooks-libra-white-paper-in-full/

[4] Meta experienced strong opposition from politicians and policymakers who were concerned that Libra could give Meta too much control over the US monetary system. Moreover, as of the present, it is also true that most private attempts at launching digital currencies on a large scale have been paused or cancelled altogether. But as long as the fight between "big governments" and "big-to-fail-banks" on the one hand, and the technology empowered "big-tech" corporations rages on, on the other, the fate of privately produced large scale digital currencies has not been sealed, at least not yet in our view.

overwhelming evidence is that they have not honored this obligation. For example, consider the criticism that Ricardo (1809: III, 21–22) addressed to the Bank of England for the way it managed the quantity of banknotes. If he lived in the US in the post 1971 period, would he hold a better view of Fed's currency management? We believe that he would not, because in the 52 years since then, the US dollar has lost over 85% of its value.

Now, transferring value through inflation from diligent savers to huge borrowers like the US government cannot be a legitimate policy objective of the Fed. Yet the data show that this is the outcome of the adopted policies. "Price stability" has been redefined to apply at a longer-run target inflation rate of 2%, thus allowing creeping inflation almost by design. A possible excuse that this has been happening for the sake of combating unemployment due to "sticky" wages, though might sound it is for the "common good," is actually not, because those who benefit are not the ones who bear the costs. As a result, citizens lose trust in the public currency, and look elsewhere for alternatives to protect the purchasing power of their assets. The data show that in 2021 the number of cryptocurrencies had grown to over 6000, thus indicating that the trust of citizens has dropped, and the Fed confronts a herculean task to win back their trust in the public currency.[5]

Hence, switching to a CBDC can be viewed as an opportunity for a new beginning aimed at price stability, in which case, Fed's interest in this reform would be grounded on sound logic. Additionally, since a CBDC offered directly to citizens may enhance the transparency of the monetary system, the Fed has an extra incentive to adopt the reform as a way of repairing its credibility.

Abatement of Monetary Policies from Ethical Lapses[6]

From economic analysis we know that inflation distorts the informational content of prices (see, e.g., (Friedman, 1977) thus leading to misallocation of resources; it biases the distribution of national income in favor of the younger and against the older; and not the least, as we said earlier, it transfers purchasing power from savers to borrowers. Aside from giving rise to a mistrust for monetary policies, these effects raise also significant ethical issues. One example is the adverse impact of inflation on the most vulnerable part of society, that is, the people in retirement who have no working options and their resources are limited. As a result, the poverty and inequality that they fuel undermine democracy and the rule of law. Another example is the acquiescence of the Fed to the huge indebtedness of the US Government. The accumulated debt is future taxes, which are unethical because they will burden

[5] Besides, when economists of the professional status of Kotlikoff and Leamer (2009) call for a radical reform of the banking system to restore trust, it goes without saying that currently its structure is suspect in its core.

[6] Renowned libertarian economists have looked into the moral foundations of the fractional reserve system, and they have found it wanting.

future generations that are not around to enjoy the benefits from spending or protest by voting. Last is the example of the "large-to-fail" banks. The realization that the Fed allowed a few banks to become invincibly large and thus render taxpayers ultimate insurers of their survival has detrimental moral implications.

To conclude, introducing a CBDC, and thus moving to a 100% reserve monetary system, may be accompanied by several advantages. In particular, while "monopoly" considerations may be part of the Fed's interest to introduce a CBDC, there are several other benefits associated with this initiative including:

- **Enhanced Financial System Efficiency**: A CBDC in an increasingly digital global economy could streamline payment systems, making transactions faster, more efficient, and potentially more secure.
- **Financial Inclusion**: CBDCs have the potential to improve financial inclusion by providing access to financial services for individuals who are currently unbanked or underbanked, particularly in remote or underserved areas.
- **Stability and Control**: As private digital and cryptocurrencies are gaining popularity, a CBDC allows the central bank to maintain a degree of control over the monetary system, ensuring stability and mitigating risks.
- **Counteracting Cryptocurrencies**: A CBDC could be a strategic response to the challenges posed by the rise of cryptocurrencies, by offering a digital currency that is regulated and backed by the central bank.
- **Innovation and Modernization**: Adopting a CBDC is part of modernizing the financial system, keeping pace with technological advancements and evolving consumer preferences towards digital transactions.
- **International Competitiveness**: As other countries develop their own CBDCs, not engaging in similar explorations could potentially put the US at a disadvantage in the future global financial landscape.
- **Policy Implementation**: A CBDC could provide new tools for the implementation of monetary and fiscal policy, potentially making it easier to distribute funds directly to citizens or implement policy changes more rapidly.
- **Security and Counterfeit Reduction**: Digital currencies can reduce the risk of counterfeiting and improve the overall security of the monetary system.
- **Data and Analytics**: A CBDC could provide valuable data on money flows and economic activity, which can be used to make more informed policy decisions.

However, the gains from these sources may not be adequate to sway Fed's Board of Governors toward a US CBDC.

3 Main Drivers Against a US CBDC

The Fed is "free" and "independent" to act for the sake of the "common good", but within the limits set in the law by the US Congress, which has the constitutional prerogative over the US dollar. In addition, the Fed will have to confront various operational and political impediments that may deter the introduction of a US CBDC.

Here we turn to the main of them. Moreover, there are several other reasons against the implementation of CBDC in the US including:

- **Privacy Concerns**: A CBDC could potentially allow the government to monitor individual financial transactions in real-time. This raises significant privacy issues, as the government could have access to detailed information about people's spending habits.
- **Cybersecurity Risks**: The introduction of a CBDC would create a new target for cyber-attacks. If not properly secured, a CBDC system could be vulnerable to hacking, data breaches, and other cybersecurity threats, potentially jeopardizing the financial security of individuals and institutions.
- **Impact on Monetary Policy**: The introduction of a CBDC might complicate the Federal Reserve's ability to conduct monetary policy. For example, if a CBDC provides a very safe and liquid place to store money, it might lead to greater sensitivity of money demand to changes in interest rates.
- **Technological Challenges**: Implementing a CBDC requires sophisticated technology infrastructure. The challenges of developing, testing, and securely operating such a system are significant and could pose risks if not managed carefully.
- **Economic Exclusion**: While a CBDC could increase financial inclusion for some, it might exclude others, especially those without access to the necessary technology or those who are less technologically literate.
- **International Implications**: The introduction of a CBDC could have implications for international finance, affecting exchange rates, cross-border transactions, and global financial stability.
- **Risk of Bank Runs**: In times of financial stress, the public might rapidly convert their deposits at commercial banks into CBDCs, potentially leading to bank runs.

A Colossal Undertaking at Equally Significant Social Costs

Berentsen and Schär (2018, 99–103) argue in favor of CBDC on two grounds. The first is the negative view they take on the future of cash. For them, while cash provides many advantages, its end might be near. The second ground is their claims that a CBDC: (a) increases the stability of the financial system; (b) simplifies monetary policy and makes it more transparent; and (c) requires low administrative effort. However, one could argue against the last argument primarily for the following two reasons.

The first reason is that, upon introducing the CBDC, the Fed will have to set up and manage a new system for payments and deposits purposes. This implies that it would have to hire and employ thousands of employees with all the hardware, software, and administrative skills to establish and operate a huge organization, a colossal undertaking, indeed. Would the efficiencies that would result from the introduction of the CBDC compensate for the cost for their services? If the benefits are anywhere

near those reported by Benes and Kumhof (2012) and mentioned earlier, our view is that the setup and operating costs render this reform unwarranted.

The second reason leads us to the same assessment. For, it is not unlikely that under the new monetary regime the banks lose deposits, and the Fed is obliged to re-invest its excess reserves with them. But in this event, the central bank from *lender of last resort* would turn into *lender for all occasions* and the controllable moral hazard problem that it faces currently might become uncontrollable, since under the CBDC the central bank would assume huge reputational risks.

However, aside from its highly uncertain benefits on economic grounds, the proposed reform depends also, and certainly more critically, on the following political and institutional considerations.

The Risks to Citizen "Privacy"

Relevant in this regard are the troubling insights that the authorities may gain into the private lives of citizens. For example, since all transactions will be virtual, it may be possible that the Fed turns the US dollar into a virtual currency transferred via permissioned ledgers or pseudo-blockchains. This in turn would facilitate real-time tracking of transactions, where all those with poor credit records might be excluded, tax authorities might have access to private records, etc. In short, the US CBDC could equip the government and regulatory bodies with advanced forensic tools.

This development would offer unparalleled and potentially enticing opportunities to gather detailed insights into the spending patterns and social behaviors of citizens, a scenario that raises the possibility that the US CBDC could become synonymous with comprehensive financial surveillance. In this case, and to protect individual freedoms, its introduction only on a voluntary basis and with secure institutional guarantees for citizens' privacy might render it palatable. Even then, depending on the circumstances, the lack of trust may lead the CBDC to failure. To corroborate this possibility, it suffices to mention the debacle that the central bank of Ecuador suffered when in 2014 it introduced electronic money and enabled citizens to undertake transactions through their mobile phones directly from their accounts with the central bank. As explained in greater detail by White (2018), despite its apparent convenience, the citizens refused to embrace the central bank electronic money so much so that the government of Ecuador was forced in 2017 to decommission it.

The Limits to Fed's Independence

By Article 1, Sect. 8, of the US Constitution, the authority "to coin Money" and to "regulate the Value thereof" is assigned to the US Congress. Drawing on this authorization, in the *Federal Reserve Reform Act of 1977*, the latter mandated that:

> The Board of Governors of the Federal Reserve System and the Federal Open Market Committee shall maintain long run growth of the monetary and credit aggregates commensurate with the economy's long run potential to increase production, to effectively promote the goals of maximum employment, stable prices, and moderate long-term interest rates.

One year later, in Sect. 108 of the *1978 Full Employment and Balanced Growth Act,* the US Congress repeated the same wording, albeit with the important qualification that:

> … the Board of Governors shall include an explanation of the reasons for any revisions to or deviations from such objectives and plans.

From these provisions it follows that, if the Fed decides to proceed with the reform, irrespective of the degree of its "independence", it will have to obtain authorization from the US Congress, where, depending on the political circumstances, the outcome may be uncertain. Hence, as long as the US Congress is concerned and the political parties are as polarized as they currently are, even if the Fed wished to push ahead with this reform, it might not be able to do so unless the issue of citizen "privacy" is resolved to the satisfaction of a respectable majority in the US Congress.

Despite potential benefits, based on the preceding considerations, some people think that a CBDC, voluntary or mandatory, with or without cash, is a bad idea. But money is too important for the "common" good and the question of the state's involvement in market economies where money is produced privately remains open. For this reason, the aim of the next section is to elucidate why the time-tested monetary systems of classical Athens could provide an exemplary model for guiding necessary reforms in Western democracies. This is particularly relevant in addressing the challenges posed by digital currencies, as these ancient arrangements have proven successful over centuries and may offer valuable insights for modern financial adaptations.

4 Prospects Looking Forward

Money in ancient Athens was produced and traded like any other commodity. But due to its strategic importance for keeping Persians at bay, holding the sea lanes open for securing the necessary imports of cereals, strengthening social bonding, and other reasons, the state, with the acquiescence and support of the *Assembly*, had been empowered with several mandates over the currency whose enforcement resulted in an economic environment in which money functioned as in a free banking system, and where the state:

(a) Determined the unit of account called drachma and linked it to silver;
(b) Retained the exclusive right to cutting silver drachma coins of various denominations;
(c) Operated a mint, which was open to cutting drachma coins on demand for anybody who brought in silver bullion;

(d) Enforced legal and administrative mechanisms to defend the currency's integrity in the domestic and international markets; and
(e) Carried out all its transactions in this currency, thus turning the drachma into the dominant currency in the Eastern Mediterranean and beyond.

Moreover, in addition to the evidence that drachma coins circulated in Athens in parallel and in competition to foreign currencies, which rendered the state's drachma cutting monopoly contestable, the government was in the hands of citizens themselves, who had all the interests to maintain the currency's integrity. As for the deposit and loans markets, they were regulated as all other non-foodstuff related activities.

Drawing on the Athenian model of the monetary system, we have put together the one depicted in Fig. 2. The inner circle shows the domestic economy, whereas the outer circle shows the international economy. The well-known giant corporations Amazon, Apple, Facebook, etc. operate their own private digital currency networks and as is the case their operations spread domestically and internationally. Observe that the model provides also for a state digital mint, and at the center there is the banking sector.

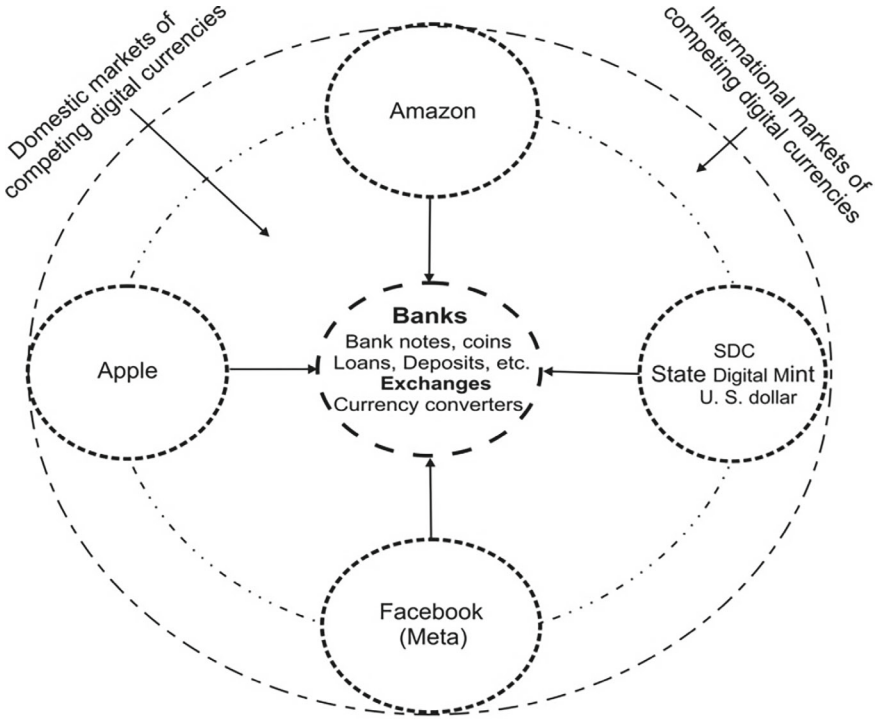

Fig. 2 Open distributed network of private and state digital currencies in the U. S

The perspective adopted in this discussion acknowledges that while it may seem remote, it's not implausible to envision a future akin to ancient Athens, where private entities produce money. In such a scenario, the broader "common" good, underpinned by the core tenets of democracy, free markets, and individual liberties, would be upheld by restricting the state's role in monetary matters to specific responsibilities. However, until then, confronted with the challenges of private digital currencies, governments in contemporary democracies are likely to adopt hybrid systems consisting of two nodes: One that provides for a state-operated digital mint, supplying State Digital Currency (SDC) on a voluntary basis, and another rich in private digital currencies, all circulating in parallel and in competition with each other.

In such a setup, if the government settles all its transactions with the public in its own electronic money and, say, Libra (LB) coins, the following could happen: (a) the SDC and the LB means of payment could turn into reserve currencies; (b) the demand for them could create strong incentives for financial institutions to supply them in price stability preserving quantities; (c) financial institutions could be free to issue notes in these as well as in any other currency, without government imposed convertibility obligations; (d) in the absence of a lender of last resort, citizens and financial institutions could assume the responsibility for the maintenance of political and economic freedoms; and (e) while the government would not issue a mandatory electronic currency (since this could undermine democracy and citizen sovereignty), it could issue a voluntary one under conditions that would preserve its value and the state would retain all prerogatives to enact and enforce rules and regulations for keeping all markets open to competition, and to combat tax evasion and illicit activities.

5 Summary of Findings and Concluding Remarks

Whether the Fed or any other central bank decides to issue a CBDC depends on the balance of benefits and risks as assessed by its own decision-making centers and the supervising state authorities. So, it is of great interest to know the intellectual climate that prevails on this subject within central banks. One accessible channel is the official and unofficial discussion papers that are published by central banks all over the world. From the Fed's Board of Governors of the Federal Reserve System (2022) publication, one is impressed with the tentativeness of the prevailing views and assessments on both sides of the balance. Assuming, first, that there are no detailed plans rendering potential benefits firmer and brighter than the risks, and secondly, that the issue of citizen "privacy" is not resolved, the gestation period of a US CBDC may be expected to be long, unless unexpected developments in the front of "BigTech" digital currencies precipitate some reaction from the Fed or the US Congress.

Over three decades ago, while assessing the models of free banking found in the literature, Friedman, Schwartz (1986, 43) concluded that in the past the emergence of privately produced currencies failed to take roots because almost invariably

governments intervened on various pretexts. At that time, not enough was known from which to piece together a model of money and banking in classical Athens. Hence, they were justified in invoking the lack of a historical precedent as a condition for the possibility of "privately produced viable money without government" to ever emerge. In the meantime, as argued in Bitros (2021) and Bitros et al. (2021), circumstances changed as new research has expanded vastly our knowledge about the Athenian society and economy in that period. As a result, it has become possible to revisit the issue in search also for insights regarding the current challenges that emanate from the advent of digital currencies. The key discovery from this research is that the use of the silver standard in classical Athens provides a robust historical example to model the structure of a contemporary hybrid monetary system. This modern system would encompass a government-operated, voluntary digital currency alongside private digital currencies. These different forms of currency would coexist, circulating simultaneously and competitively. While in the context of the conceptual model sketched in Fig. 2 governments in Western type democracies are envisioned to abstain from issuing a mandatory digital currency, in order to safeguard the anonymity of citizens, and hence their civil liberties, governments retain and should exercise all prerogatives under the law to control abuses of competition in private markets, and to combat tax evasion and other illicit activities.

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Strategy and Entrepreneurship in the Digital Era

Harnessing New Technology for Environmentally Sustainable Business: Trends for the Future of Business Education

Athina Dessypri

Abstract Sustainability is one of the top items in every CEO's agenda and, is fast becoming an essential element of business education. Given that sustainability awareness and efforts are led by academia and civil society and influences industry, a mixed panel discussion composed of industry leaders, academics and civil society participants was organized in the LMDE Conference, to address the question "How can sustainability be effectively integrated into business education." To better position the problem that business schools are facing, the panel discussion first addressed three important related topics: (a) to what degree are business operations interconnected with environmental considerations, and therefore how do environmental strategies affect other business units (e.g., operations or finance), or other strategic issues (e.g., innovation or strategic change); (b) what is the business case for sustainability, i.e., how innovations around sustainability bring value and contribute to the financial performance of the firm; and (c) how technology and the abundance of data today (sensors, IoT) can help in effectively addressing the sustainability objectives. Having addressed these issues and having established the strategic importance of sustainability in a firm, the panel developed guidelines and presented some case studies that could be followed by business schools in order to build their capacity in integrating sustainability into their curricula.

1 Introduction

Bodossaki Foundation's vision is a society of equal opportunities for all: Education and Environment are two of our four focus areas which also include Health and Civil Society. We thus appreciate the importance and impact of the LMDE Conference on business education and consequently on future business executives. Society needs business leaders to be educated and introduced to frameworks that help them navigate in in an increasingly complex world, and make them able to cope with emerging

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environmental, social, and ethical challenges. From their position as managers and decision-makers they play an extremely important role for the world and the planet.

As Chair of the Board of Trustees of Bodossaki Foundation I was asked by the Conference Chairs, Professor Gregory Prastacos Dean of the School of Business at Stevens Institute of Technology and Professor Dimitrios Bourantonis Rector of Athens University of Economics and Business to organize this session, and I like to warmly thank them for inviting Bodossaki Foundation to co-organize this conference and organize the specific session. I would also like to express my gratitude to the panel participants who accepted our invitation and so generously shared their knowledge, expert opinions and experience.

This paper reports on the topics debated in the panel "Harnessing New Technology for Environmentally Sustainable Business: Trends for the Future of Business Education" that I chaired at the LMDE Conference in June 2023. The paper is organized as follows: In Sect. 2 a brief background is introduced, enhanced by key references that relate to the topics of interest. Sections 3–6 deal with the main topics of the session: Sect. 3 presents the environmental interdependencies facing corporations, Sect. 4 discusses the technology and the power of data to address these issues, and Sect. 5 introduces an imperative for business schools to develop the knowledge, skills and mindset for the future leader. Section 6 presents the implications for business schools and how they can build related capacity, including examples of already evolving good practices. Finally, Sect. 7 includes a summary of the contributions and outlooks for the future.

2 Background and Key Literature

The topic of sustainability has become one of the top items in every CEO's agenda and, as such, it is fast becoming an essential element of business education, where the objective is to prepare leaders for tomorrow's firms and society. However, the question many business school leaders are facing is: How can sustainability be effectively integrated into business education? How can we make sure that our education succeeds in providing, in addition to the knowledge about the technical and economic issues related to sustainability, the broader context, mentality and mindset for a future leader to address these complex issues in a continuously changing business and technological landscape?

To answer these questions, the panel discussion of the LMDE Conference first addressed three important related topics:

(a) understand how environmental considerations affect other operations of a business (e.g., operations or finance), or other strategic issues (e.g., innovation or strategic change);
(b) understand what the business case for sustainability is, i.e., how innovations around sustainability bring value and contribute to the financial performance of the firm; and

(c) how technology and the abundance of data today (sensors, IoT) can help in effectively addressing the sustainability objectives.

Concerning **environmental interdependencies facing corporations**, the importance of considering environmental impact of business operations increases continuously. This includes evaluating the reciprocity between what companies take from nature, how they transform resources, what they make as products and services, and what they return to nature from the use and the end of life of their outputs (Golgeci et al., 2021; Klein et al., 2022). Concerning the impact to internal operations, environmental considerations affect production, operations and logistics decisions among others, and therefore have a direct impact on the finances of the firm.

In addition, the United Nations Sustainability Goals, the Paris Agreement, the recent COP 28 in UAE and other regulatory mechanisms put institutional pressure on all industries to reduce the carbon footprint, reach Net Zero and minimize all negative secondary effects that come from their business including ethical considerations such as hazardous jobs, child labor and any other forms of social exploitation. In parallel, consumer pressure for green products, environmentally sustainable and ethical value chains, and transparency in all operations are market drivers for sustainable business transformation. These developments are increasingly becoming key drivers for innovation, strategic change, and exploration of new technologies at all levels of business activity (Hosta & Zabkar, 2021; Stern & Valero, 2021; Yadav et al., 2023). This is addressed in Sect. 3 of this paper.

The **business case for sustainability and nature**, i.e., strategically connecting corporate goals and environmental sustainability is an imperative for making the sustainability transformation a reality. Innovations must earn their keep by creating value for users, customers and society, but also by returning value to the innovating organizations so they can keep innovating (Keeley et al., 2013). Innovating ourselves to the next industrial revolution of sustainable enterprises and an economic reality that connects industry, society and the environment, as coined by Senge and Carstedt (2001), has today, finally, become priority one for most CEOs and boards of directors. Building business cases for sustainability, where sustainability and financial performance go hand-in-hand is frequently discussed and exemplified in the literature (Cote, 2021). The triple bottom line, described as the Three Ps, People, Planet, and Profit, emphasizes this interconnection (Slaper & Hall, 2011). More specifically, related to greenhouse gas emission reduction goals and Net Zero, the European Environmental Agency predicts that the implementation of the European Green Deal demands global investments of more than 500 billion Euros per year between 2021 and 2030, thus creating huge potentials for job creation and development of new sustainable technology businesses (Speck, 2023). This is addressed in Sect. 4 of this paper.

Exploring **new technologies and harnessing the power of data** is one of the means to reach the broad array of sustainability goals that companies are striving for. The abundance of data today, through technologies like sensors or Internet of Things (IoT) is a reality that companies can rely on. Data and technology can significantly accelerate process optimization, energy efficiency, design and development

of circular products and services, and access to and analysis of critical market and operations data on the route sustainability (Close et al, 2021). However, one must be ware of over-faith in the miracles of technology, e.g., when policy-makers pledge for carbon-capture and expansion of nuclear energy to move away from fossils, although the one is still in its infancy (Dziejarski et al., 2013) and the other requires huge investments and come with significant risks of a different nature (CFSS, 2023). Moreover, decision-makers must consider the entirety of technology value chains and related systems. For example, all electricity is not clean, and digitization and electrification rely on rare material and minerals, some of them considered 'conflict minerals', which are complex to source and dispose of in an ethical and sustainable way (Turel et al., 2021). This is addressed in Sect. 4 of this paper.

Related to the above key considerations a number of additional considerations come into play. For example, a common question is: Why should business care about nature in the first place and how can we help them achieve the necessary transformations? What is the experience of companies like NatCap, represented by one of the panelists, in advising companies on understanding and measuring their environmental interdependencies and then employing preventive and mitigating practices? This consideration is addressed in Sect. 3.

A second important consideration is the monitoring of the impact of human or corporate activities on biodiversity: Is it needed, and why? How does it work? How do we envisage this being used, and how can it contribute towards achieving our environmental goals? What is the experience of labs, like SEED in ETH Zurich, represented here by one of the panelists, in developing methodologies that can measure the impact human/corporate activities have on biodiversity at any place on the planet? Can tools like those that SEED is developing be used to implement public policy or corporate strategy? How? Are any of these tools addressing accounting for nature? Is it Open-Source? These are all important considerations that will have an increasingly important role with the growth of technology and are addressed in Sect. 4.

A related consideration has to do with the role and the experience of consulting firms, like BCG, a leading global strategic consulting firm represented in this panel. Questions like: What is your stand on the issues we discuss? Do your clients see the need to understand their environmental interdependencies? Do they incorporate them in their strategy? Do they see the risks? and other related questions are very relevant here. This consideration is addressed in Sect. 5.

Finally, an important consideration is what should Business Schools do to prepare tomorrow's leaders for the challenges and the opportunities they will be facing. What initiatives do leading Business Schools like INSEAD do to address the topic of environmental leadership? What are some of the related skills that present and future business leaders need to develop? Is there a need for formal education around sustainability? Are there any good practices we can share? Are there any pitfalls that should be avoided? Are there success stories we can study and learn from? These questions are addressed in Sect. 6 where guidelines and success stories are provided.

The following sections analyze the topics above.

3 Interdependencies: The Business Case for Sustainability and Nature[1]

Businesses have a significant impact on nature, and even the most routine practices in our current economic system might have catastrophic consequences. Whether it is pollution, land use change, resource consumption, or the introduction of alien species—current economic practices are driving catastrophic biodiversity loss and exhausting our natural capital at an unsustainable rate.

While impacts on nature may sound familiar, business dependency on nature is less discussed. Farmers, for instance, rely on nature to provide them with freshwater for irrigation, highlighting the interconnectedness between business operations and natural resources. This dependency on nature extends beyond agriculture to industries like forestry, fishing, aquaculture, construction, utilities, and the food industry. In fact, a much-cited World Economic Forum report 'Nature Risk Rising' (WEF, 2020) suggests that over half of the world's GDP is moderately or highly dependent on nature and its services.

These impacts and dependencies on nature pose physical risks to businesses. Substantial coffee plantations, for example, are at risk of extinction due to climate change, disease, and deforestation. The potential loss of coffee varieties would destabilize the global coffee market, affecting the livelihoods of many smallholder farmers. Similarly, invasive species already cause annual losses of up to 16% in rice, wheat, and maize production, valued at $96 billion.

As consumers and investors become more aware of the nature crisis, businesses face increasing reputational risks that arise from their impacts on nature. Regulatory pressure is also increasing, with globally agreed frameworks and regulations being implemented to enable companies to live up to the promises of the Global Biodiversity Framework agreed at COP15 and report on their nature-related risks and opportunities.

Businesses have the power to make a positive impact on nature. McKinsey's recent 'Nature in the Balance' report (Aminetzah et al., 2022) suggests a range of specific actions taken by businesses could address planetary boundaries such as forest cover loss, freshwater consumption, nutrient pollution, and biodiversity loss. These actions include switching to regenerative agriculture, reducing food waste, and implementing sustainable delivery models. Agriculture, in particular, has significant potential to address projected overages or gaps in various planetary boundaries by 2050. Levers such as regenerative agriculture, agroforestry, water-efficient agriculture techniques, and manure management can contribute to mitigating these challenges while providing economic benefits. Widespread adoption of regenerative agriculture practices alone could mitigate a significant portion of the projected gaps in biodiversity, freshwater consumption, and nutrient pollution while reducing operational costs.

[1] This section is largely based on the presentation of Sebastian Leape, CEO, NatCap.

Despite the increasing awareness of the importance of nature, most companies are yet to take meaningful steps on nature and remain focused primarily on the climate agenda. Companies often report being fully stretched on executing on their climate pledges and unable to find bandwidth to engage on the nature agenda. But that is a mistake. Climate and nature are inextricably linked: they share common drivers resulting from the direct exploitation of land and have the same solutions in the form of changing how land is used to protect and restore nature. You cannot win on climate without addressing nature.

Companies are taking note, with leaders like Kering and Unilever demonstrating commitments to protect and regenerate land, forests, oceans, and agricultural crops while implementing sustainable sourcing and reducing their environmental impact. We are seeing a noticeable trend among the most engaged companies moving on from merely certifying supply chains towards embedding nature more holistically into business decision making.

To make a change, all businesses can learn from industry leaders. First, they need to measure the impacts and dependencies on nature in their operations, portfolio, or supply chain. Second, they should identify activities that can reduce their impact on nature while improving company performance. Third, setting targets aligned with frameworks like the Science Based Targets Network (SBTN, sciencebasedtargetnetwork.org) and utilizing science. Finally, they should report on progress against targets and exposure to nature related risk in line with emerging voluntary frameworks including SBTN and the Taskforce on Nature-related Financial Disclosures (TNFD, tnfd.global) to provide full transparency with stakeholders. Winning on nature is a big challenge, but we have no option but to tackle it at pace.

4 Harnessing the Power of Data[2]

The global economy is, and always has been, 100% dependent on nature. Recognizing that our current ecological trajectory is leading us on a path to massive extinction, major financial and policy actors are now moving to quantify, measure, and value biodiversity at scale.

Trillions of dollars and global commitments are pouring in to promote the recovery of nature. Biodiversity data methods and markets are rapidly developing, driven by growing financial and regulatory demands including TNFD, COP15 commitments and related standards. Growing needs are supported by rapid developments in the data supply side, from satellite to bioacoustics, e-DNA, supply chain analytics and distributed data networks through personal and public sources.

However, simply creating a flow of data about nature's component parts is insufficient to effectively measure and understand biodiversity; it rather depends on how those components are analyzed. Accounting in the wrong way can do more harm than

[2] This section is largely based on the presentation of Alexa Firmenich, Co-Director SEED, Crowther Lab, ETH Zurich.

good. Decades of research has shown that true value of nature lies in its complexity, not in individual components such as carbon, water, or species. We therefore need a comprehensive and standardized measure of biodiversity that reflects nature's actual complexity across scales. Otherwise, markets are poised to repeat the mistakes of the past, optimizing and propagating certain aspects of nature that each actor, industry, or sector values, over the integrity of the whole.

The Crowther Lab of ETH Zurich is an innovative ecology and data science lab within one of the world's most prestigious technology universities. We are developing the world's first biodiversity index that accounts for all scales of life's complexity at a genetic, species and ecosystem level, for every location on the planet, and its change over time. This uniquely provides a measure of the health of biodiversity relative to how it would be if subjected to only minimal human disturbance, using ground-sourced data and machine learning to provide an overarching measure of the health of nature.

SEED will provide a powerful, high-integrity basis for the analysis of nature-related risks and opportunities by the financial and wider business community, and across specialist markets such as biodiversity credit markets. Our goal is to bring greater accountability and transparency to nature markets, and catalyze the $500 billion per annum that has been committed towards regenerating biodiversity and the 1.6 billion communities who live and work in natural ecosystems.

5 An Imperative for Business Education[3]

Business education should equip the next generation of business leaders with the skills they need to steer companies successfully in the future. Climate is already, and will be even more so, a major driver of how corporate strategy will evolve. Recognizing the implications of climate and sustainability on an organization and steering it into the future will be critical to managing the associated risks successfully but also identifying and capturing emerging opportunities. Afterall, as with all major disruptions, climate change and sustainability will also create new opportunities for those who seek them out.

Adaptive strategy has already been part for business education for some time. This approach to corporate strategy has been necessary as trends like globalization and technological evolution have monitoring for signals and adjusting our strategy far more frequently than in the past. The climate challenge, however, is different in a number of ways that requires a more targeted approach:

- Climate and sustainability brings a number of highly impactful changes in tandem such as technological advances, regulatory changes, supply chain disruptions, macro-economic turmoil etc.

[3] This section is largely based on the presentation of Chryssos Kavounides, Managing Director and Partner Athens, Boston Consulting Group.

- All sectors and all geographies are affected but each in different dimensions and at different scale or speeds.
- There are distinct elements to consider from sustainability targets and immediate regulatory and cost considerations to longer term business risk, operational risk, pre-empting adaptation actions and building long-term resilience, understanding and catering for social acceptance and the implication on the brand.
- A deep dependance on technological solutions to both understand the solutions and make informed strategic choices means deeper expertise, new capabilities and a need for partnering.
- The implications for business on the collection, interpretation, reporting and sharing of data is in itself a significant undertaking.

Future leaders will need a set of new or enhanced skills to dela with this challenge and business education needs to equip them with the foundations and the mindset to build upon those, including:

1. Understanding all the different ways a business can be affected from immediate impact to is fundamental business model due to cost, regulation, or reputation issues to a range of different risks that will emerge as a result of climate change (physical, supply chain, macro)
2. Developing a deep understanding of the different risks an organization faces as a result of climate change and how to consider the impact on different sectors and geographies.
3. Building a "learning organization" to continuously understand better the option space and solutions available to adjust the business model (including processes, and infrastructure), identify new emerging business opportunities, and develop effective adaptation roadmaps.
4. Building and participating in partnerships and ecosystems to accelerate learning, build capabilities and adopt new emerging technologies (e.g. envirotec) and deploying shared investments for transition and adaptation.
5. Embed resilience as a top strategic priority in organizations alongside growth and profitability.

6 Discussion—Building Capacity in Business Schools[4]

Incorporating sustainability into business school curricula is essential for preparing future business leaders to address the environmental, social, and ethical challenges of the modern world. Here are some strategies that business schools can use to build their capacity in integrating sustainability into their curricula:

[4] This section is largely based on the presentation of André Hoffmann, Vice-Chairman of the Board of Directors, Roche Holding LTD.

1. Collaborate with experts: Business schools can partner with sustainability-focused organizations, experts, and practitioners to develop and enhance their curricula. These partnerships can provide access to real-world case studies, guest lectures, and collaborative research opportunities.
2. Create dedicated sustainability courses: Develop dedicated courses focused on sustainability, such as sustainable business strategies, environmental economics etc. These courses can cover topics like sustainable development, renewable energy, ethical supply chain management, and impact investing.
3. Infuse sustainability into core courses: Integrate sustainability concepts into core business courses, such as finance, marketing, operations, and strategy. For example, incorporate discussions on sustainable finance, green marketing, sustainable operations management, and the integration of sustainability into business strategy.
4. Offer experiential learning opportunities: Provide students with hands-on experiences through internships, projects, and field studies focused on sustainability. This allows them to apply their knowledge to real-world sustainability challenges and develop practical skills.
5. Establish research centers and initiatives: Create dedicated research centers or initiatives focused on sustainability within the business school. These centers can support faculty research, organize conferences and seminars, and provide resources for students interested in sustainability.

Here are some examples of success stories:

1. Student demand and involvement: Respond to student demand for sustainability education by offering specialized courses, concentrations, and degree programs. The Haas School of Business at the University of California, Berkeley introduced a Sustainability Certificate program that allows MBA students to develop expertise in sustainable business practices and engage in experiential learning.
2. Partnerships with sustainability-focused organizations: Collaborate with organizations that specialize in sustainability, such as NGOs, sustainability think tanks, and corporate sustainability departments. The INSEAD Business School in France partnered with the World Wildlife Fund (WWF) to create the INSEAD-WWF Sustainability Leadership Program, which provides executive education on sustainability and leadership to business professionals.
3. Integration of sustainability into experiential learning: Incorporate sustainability-focused projects, internships, and consulting opportunities into the curriculum to give students hands-on experience with real-world sustainability challenges. The University of Exeter Business School in the UK offers an MBA program with a focus on sustainable leadership, which includes a consultancy project where students work with organizations to develop sustainability strategies.

7 Conclusions—A Call for Action

The discussion's key take aways could be summarized as follows:

Integral Nature of Sustainability: The imperative need for businesses to incorporate environmental considerations into their operations is now unquestioning. Regulatory mandates, escalating insurance costs, and the tangible effects of biodiversity declining and shifting climate conditions underscore the inextricable link between profitability and environmental costs. Moreover, sustainability, in its broadest sense, encompasses not only environmental considerations but also corporate sustainability and concerns for social justice.

Interdisciplinary Nature of Sustainability: The panel's lively discussions underscored that sustainability involves all aspects of business education. From supply chain strategies to accounting, finance, marketing, and risk management, sustainability is a horizontal issue. More crucially, it extends into the realm of corporate strategy and mission, necessitating a comprehensive understanding and integration into the core of business fields.

Leadership in the Sustainability Landscape: The rise of a fresh generation of young executives championing the sustainability cause is apparent. Businesses now require leaders capable of navigating the intricacies of sustainability as both a risk and an opportunity. As sustainability remains a dynamic and evolving field, these leaders must possess the foresight to anticipate and address challenges, paving the way for a business landscape that is not only profitable but also environmentally and socially responsible.

Urgency for Business Schools: The imperative for business education to align with the evolving landscape is clear. Business schools need to acknowledge that sustainability has evolved from being an elective choice to becoming an essential and widespread element that transcends all areas of business education. As young executives champion the sustainability cause, business schools must be at the forefront, shaping the curriculum to equip future leaders with the essential skills and mindset needed to tackle the complex interplay of environmental, social, and ethical challenges.

Collaborative Leadership: Recognizing the vast and interconnected nature of sustainability, business schools are urged to collaborate independently or form knowledge networks. This collaborative approach ensures the sharing of resources, knowledge, and best practices, fostering a collective effort to propel business education into the forefront of sustainability leadership.

In conclusion, the discussions underscore the urgency for businesses and educational institutions to collaborate harmoniously. The path forward necessitates the incorporation of environmental considerations into the essence of business operations, strategy, and education. The timing is apt for a comprehensive transformation where profitability is not at odds with sustainability but is intrinsically tied to it. As the business landscape evolves, both businesses and business schools are asked to embrace the challenges and opportunities that sustainability presents, ensuring a future where economic prosperity is synonymous with environmental and social responsibility.

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Navigating the Start-Up Financing Funding Gap: Comparing Business Angels and Crowdfunding

Stefano Bonini, Vincenzo Capizzi, and Francesca Tenca

Abstract This study presents empirical comparisons of fundraising outcomes for entrepreneurial ventures supported by business angels and crowd investors. Utilizing a comprehensive multi-year dataset derived from repeated annual surveys within the business angel (BA) and equity crowdfunding (ECF) markets in Italy, our findings reveal that, despite investing in comparable start-ups, ECF-backed ventures secure lower capital amounts than BA-backed ones. Moreover, ECF-backed start-ups acquire a smaller proportion of capital. These outcomes imply that equity crowdfunding and business angels are not perfect substitutes but rather function as different financial channels for inherently heterogeneous start-ups characterized by distinct funding requirements.

1 Introduction

In the dynamic landscape of entrepreneurial finance, two prominent actors have emerged as catalysts for start-up funding, i.e., business angels and crowdfunding platforms. As the global economy continues to evolve, traditional avenues for raising external equity capital have given way to innovative funding mechanisms that bridge the gap between entrepreneurs and potential investors. Among the different channels of start-up funding, this paper delves into the relationship between business angels and crowd investors, shedding light on their role in mitigating the start-up funding gap.

Business angels are high-net-worth individuals that engage in individual investments in entrepreneurial ventures and small and medium-sized companies. Recognized for their pivotal role in start-up financing, business angels' relevance is well-established in the literature (e.g., Mason & Harrison, 2000; Sohl, 2012). Notably,

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the total capital invested by business angels is comparable to venture capital investments on an overall basis. However, due to the smaller deal sizes, the number of transactions and the diversity of participants are considerably higher. Thus, business angels play a pivotal role in fostering the growth of nascent entrepreneurial ventures. These individuals bring not only financial capital to the table but also invaluable expertise, industry connections, and mentorship for entrepreneurs. Their involvement often extends beyond their financial contribution, positioning them as strategic partners invested in the long-term success of the start-ups they support. Moreover, the business angel market has experienced a very strong acceleration recently with the creation of angel networks and groups (Capizzi et al., 2010; Mason & Botelho, 2016; Mason et al., 2013).

On the other hand, equity crowdfunding has emerged as a source of democratizing access to capital for entrepreneurs. By leveraging online platforms, equity crowdfunding allows founders to reach a broad and geographically dispersed pool of investors, collectively referred to as the crowd (Bessière et al., 2020; Bonini & Capizzi, 2019; Hornuf et al., 2018). This inclusive approach to fundraising helps entrepreneurs, who may face challenges accessing traditional funding sources. In greater detail, the creation and management of a crowdfunding campaign typically occur through an online platform, where investments are made. These campaigns typically set a specific fundraising target and outline the designated use of the funds. A concise presentation video pitch delineating the start-up's features and value proposition, along with a brief project description or teaser, is commonly employed to present the project's objectives.

In addition, participants in a crowdfunding campaign, often engage in platform interactions, leveraging collective knowledge for financing decisions based on the "wisdom of the crowd". Rooted in the belief that the diversity and collective problem-solving capacity of the crowd lead to superior solutions compared to individual opinions and expertise, this concept underscores the effectiveness of collective input. Crowd investors also contribute feedback and suggestions to the campaign's proponents, transforming crowdfunding into a valuable tool for market testing, providing insights into the level of interest in new ideas and products.

While business angels and crowdfunding platforms operate independently, their interaction in the entrepreneurial ecosystem is becoming increasingly relevant (Wang et al., 2019). This paper seeks to explore the interplay of these financing channels, examining how they complement each other and collectively address the financing gap faced by start-ups. By understanding the dynamics between business angels and equity crowdfunding, we can gain insights into the evolving landscape of entrepreneurial finance and contribute to the development of strategies that enhance the success of start-ups. Our objective is to contribute fresh insights to these research topics through an examination of the fundraising outcomes for entrepreneurial ventures supported by either of these two financing sources. Leveraging a comprehensive, multi-year dataset derived from recurring annual surveys conducted in both the angel and equity crowdfunding market in Italy, we present comparative findings on the fundraising outcomes of start-ups backed by business angels and crowd investors, separately.

In many prior studies, research on multiple financing sources centers around cases involving co-investments among various start-up ecosystem actors. This approach aims to explore the behaviors of different economic players when investing together or sequentially (for some examples see Brown et al., 2018; Petit & Wirtz, 2022; Hornuf & Schmitt, 2016; Hornuf & Schwienbacher, 2016 and for instances of co-investments between business angels and crowd investors, and Goldfarb et al., 2013; Witlbank and Boeker, 2007 for co-investments between business angels and venture capitalists). Some studies also compare distinct financing sources, with examples including Ibrahim (2008), Lindsay and Stein (2020), Chemmanur et al. (2021), and Hellman et al. (2021), all of which analyze the dynamics between business angels and venture capitalists. In a notable study, Hellman et al. (2021) empirically investigate the interactions between business angels and venture capitalists, discerning complement and substitute relationships between the two investor types and between investor- and company-led interactions. Their findings suggest that business angels and venture capitalists function as substitutes, with this relationship influenced by specific company characteristics within a sample of Canadian start-ups. This implies the existence of two distinct funding channels with minimal transitions between them. Chemmanur et al. (2021) offer partial support for this initial result by linking the financing sequence to venture performance. Specifically, they discover that start-ups receiving venture capital financing in the first round and continuing to receive venture capital financing in subsequent rounds, along with those securing angel financing in the first round and venture capital financing in subsequent rounds, have a higher likelihood of a successful exit compared to those with other financing sequences (e.g., VC-Angel or Angel-Angel).

Nevertheless, prior research has rarely concentrated solely on the comparison between business angels and crowd investors. One noteworthy exception is the research conducted by Wang et al. (2019), which delves into the dynamics of how business angels and crowd investors interact on crowdfunding platforms. According to the authors, crowd investors play a complementary role to business angels in larger campaigns but emerge as the primary investor type in funding smaller campaigns that fail to generate sufficient interest from business angels.

With venture capitalists increasingly directing their attention towards later stages of venture financing, business angels and equity crowdfunding emerge as the two most critical sources of finance for early-stage ventures. Given that they contend within the same segment, comprehending the distinctions in their behavior becomes pivotal, ultimately shedding light on the impact these differences may have on funded ventures over time.

The remainder of the paper is structured as follows. Section 2 presents a focus on the start-up financial ecosystem. Section 3 presents the sample and the methodology of the study. Section 4 reports the results. Section 5 concludes and paves the way for future research directions.

2 The Start-Up Financial Ecosystem

Each financial system experiences a certain level of allocative inefficiency, leading to a gap commonly known as the "primary funding gap" between the demand for financial resources from start-ups and the supply of early-stage equity capital (Hall & Lerner, 2010; Landström & Mason, 2016; Mason & Harrison, 2000). Venture capital has been the predominant source of early-stage finance since its inception after World War II, following internal financing such as seed money from entrepreneurs and the family and friends financing (Bruton et al., 2005; Kaplan & Lerner, 2017). This dominance stems from the unique operational and investment practices, as well as expertise in the screening process (Chemmanur et al., 2011; Cumming, 2006), monitoring of contractual provisions (Cumming & Johan, 2013; Kaplan & Stromberg, 2003), implementation of the staged investing mechanism and syndication of investments (Filatotchev et al., 2006; Tian, 2011).

Nevertheless, despite the ongoing significance of the venture capital industry, a noticeable shift has occurred in the past decade with the increasing importance of alternative sources of early-stage funding. This shift is significantly reshaping the start-up ecosystem, carrying implications for entrepreneurs and policy makers (Bruton et al., 2015; Bellavitis et al., 2017). These alternative funding sources encompass various players, including incubators, accelerators, science and technology parks, university-affiliated seed funds, corporate funds, business angels, including angel groups, business angel networks, and angel investment funds. Additionally, equity- and reward-based crowdfunding platforms contribute to this diversification (Capizzi & Carluccio, 2016; Hornuf & Schwienbacher, 2016). Business angels and crowdfunding are specifically oriented towards providing financial support to seed and early-stage start-ups. Therefore, they address the financial requirements of companies that find themselves in comparable stages of the start-up lifecycle. In essence, these funding sources are particularly relevant for meeting the financial needs of start-ups during their initial and early developmental phases.

Finally, complementing the start-up ecosystem are non-equity financing investors, including banks, government and regional development agencies, as well as other entities providing expert services to entrepreneurs and investors. These include investment banks, gatekeepers, foundations, non-profit organizations, governments, universities, and research centers (Busenitz et al., 2003; Isenberg, 2010).

Each of these players exhibits distinct risk-return profiles, investment approaches and practices. This diversity poses a significant challenge for scholars, practitioners, and policymakers alike, as they strive to develop a coherent and well-structured start-up financing path that takes into consideration the peculiarities of these new actors (Hellmann et al., 2021). In this paper, we focus on two financial channels that represent major alternative to venture capital that have become established over the last years, i.e., business angels and equity crowdfunding.

3 Data

Data availability and reliability have been acknowledged as persistent challenges in studies focusing on angels and crowdfunding within the existing literature (Bonini et al., 2018; Cumming & Zhang, 2019; Landström & Mason, 2016; Lerner et al., 2018; Lindsay & Stein, 2020). In addition, the definition of business angels and the criteria for their accredited investor status undergo variations globally, introducing complexities in conducting comparative analyses across countries. This paper addresses these challenges by utilizing two exclusive sources of information for angel investments and equity crowdfunding campaigns. These sources enable an accurate identification of companies, the compilation of extensive investment and financial data, ongoing tracking, and the identification of follow-on funding. Information on business angel investments is sourced from the Italian Business Angel Network (IBAN), the national trade association for angels and angel groups / networks, through their annual surveys. IBAN conducts a thorough survey each year through a four-step sequential mixed mode (Snjikers et al., 2013), ensuring data reliability. The data, with a long time series and consistent collection methodology, have been previously used in the business angel literature (see Bonini et al., 2018; Bonini et al., 2019).

Equity crowdfunding campaign data are sourced from Crowdinvesting Observatory of Politecnico of Milan that collects data from all equity crowdfunding offerings on regulated equity crowdfunding platforms in Italy. The observatory gathers comprehensive information for each campaign, including the pitch, the term sheet, issuers' accounting data and statutes, and start-ups' management team. For successful offerings, the full list of investors is retrieved from regulatory filings. Under Italian regulation, companies are mandated to disclose their shareholders and their share of equity ownership, allowing to compute the number and identity of investors participating in the funding round by comparing ownership structures before and after the campaign. These data offer the advantage of analyzing the entire population of equity crowdfunding campaigns in Italy, mitigating the selection issues often encountered in studies relying on data from a single platform.

Sample

Our sample includes 3,231 unique investments, performed by 2,076 unique investors in 402 unique companies. Table 1 reports some sample summary statistics. The total number of funding rounds is 438. The number of funding rounds is greater than the number of companies which reflects that a few companies receive funding multiple times. This appears to be the case for angel-backed companies only, for which we observe 369 unique deals on 333 unique companies. Looking at unique investors, the sample includes 146 angels and 1,930 crowd-investors. Business angels on average invest in 3 transactions in our sample as captured by the number of unique investments (443). Perhaps more surprisingly, also investors participating to

Table 1 Sample distribution

	Full sample	Business angels		Crowdfunding	
Unique investments	3,231	443	(13.8%)	2,784	(86.2%)
Unique investors	2,076	146	(7.1%)	1,930	(92.9%)
Unique companies	402	333	(82.8%)	69	(17.2%)
Unique funding rounds	438	369	(84.2%)	69	(15.8%)

Table 2 Dependent variables distribution by sample

	Full sample	Business Angels	Crowdfunding
Invested capital (Mean (SD) EUR/000)	193 (559)	206 (583)	
Top (bottom) decile by target (EUR/000)	368 (15)	750 (8)	368 (15)
Share acquired (Mean (SD) %)	0.14 (0.18)	0.16 (0.18)	0.05 (0.07)
To p(bottom) decile by target (%)	0.28 (0.01)	0.44 (0.03)	0.016 (0.005)

crowdfunding offerings exhibit some consistency as measured by the roughly 1.5 times larger number of their unique investments.

Table 2 shows our main dependent variables. These are the total *Invested Capital* in the business angel or equity crowdfunding deal and the *Share Acquired* by angel or crowd investors in the focal deal. On average, BA-backed deals receive more capital (206,000€) compared to ECF-backed transactions (67,000€), and the difference is statistically significant. Interestingly, the share acquired by business angels is more than three times (16%) than the share acquired by crowd investors (5%). Moreover, BA-backed deals achieve significantly higher pre-money valuations. Companies seem also somehow different in terms of observable characteristics, such as the pre-investment company revenues, which are almost half for BA-backed companies compared to ECF companies.

Estimation Procedure and Variables

We will now conduct a detailed analysis of the distinctions between companies that obtained financing from business angels and equity crowdfunding to investigate the different behaviors of business angels and crowd investors. This examination aims to discern whether and how the invested amount and the ownership stake acquired are contingent upon specific observable factors associated with entrepreneurial ventures. We perform a series of OLS regressions, where the dependent variable, *Fundraising outcome*, is alternatively the natural logarithm of total amount of funds raised (i.e., *Invested Amount*) per company or the percentage acquired by the investors participating in the deal (i.e., *Share Acquired*).

$$Fundraising\ outcome_i = \beta_1 Fundraising\ type_i + \gamma_s \sum Controls_{s,i} + Industry_i + Year_t + \varepsilon_i ,$$

where the main independent variable is the *Fundraising type*$_{\mathrm{i}}$, an indicator variable taking the value of 1 for equity crowdfunding deals and 0 for business angel deals for venture i. *Controls*$_{\mathrm{s,i}}$ include a number of covariates relating to deal-level and industry-level characteristics. The first group include: *Pre-money valuation*, a variable capturing the pre-money valuation of the firm; *Pre-investment revenues*, a variable capturing venture's revenues in the last fiscal year prior to the external equity round; and the *Number of co-investors* participating in the focal financing round. As for industry characteristics, we include the price to book value ratio (i.e., *Industry P/BV*) for the industry in which the venture operates, and the *Industry CAPEX/Sales ratio*, measured as the ratio of total capital asset expenditures on the industry revenues. We finally include industry (i.e., a series of dummy variables for the industry in which the venture operates captured by the NACE Rev. 2 two-digit code) and year fixed effects.

4 Results

Table 3 shows the results, including deal-level and industry-level controls. All models (except univariate ones) include industry and time fixed effects. Columns 1–3 report the results for the dependent variable *Invested Capital* (log), while columns 4–6 report the results for the dependent variable *Share Acquired*.

Fundraising type is negative and statistically significant across all models ($p < 0.001$). This confirms that ECF-backed companies raise less capital than BA-backed ones and crowd investors acquire a smaller percentage of capital than business angels. As for control variables, we find that *Pre-money valuation* and *Pre-investment revenues* are positively related to the capital invested. Instead, *Pre-money valuation* is negatively correlated with the *Share acquired* by investors. As expected, a higher number of co-investors is associated to higher capital collected and a larger percentage of capital acquired. These findings suggest that equity crowdfunding and business angel respond to different financial needs of start-ups, as demonstrated by the lower capital need and, consequently, lower share acquired by crowd investors. In this regard, the two typologies of investors may respond to different needs and be directed to different types of start-ups and serve, to some extent, as parallel sources of funding for nascent businesses in their initial stages of venture development.

Table 3 Fundraising outcome and deal characteristics

	Log invested capital			Acquired share		
	(1)	(2)	(3)	(1)	(2)	(3)
Fundraising type	−0.763** (0.295)	−2.789*** (0.634)	−2.736*** (0.645)	−0.099*** (0.016)	−0.329*** (0.081)	−0.336*** (0.083)
Pre-money valuation		0.556*** (0.068)	0.554*** (0.067)		−0.033*** (0.009)	−0.033*** (0.009)
Pre-investment revenues		0.121** (0.058)	0.118** (0.059)		0.009 (0.006)	0.009 (0.006)
Number of investors		1.000*** (0.180)	0.981*** (0.184)		0.068*** (0.025)	0.069*** (0.025)
Industry P/BV			0.000			0.000
			0.000			0.000
Industry CAPEX/Sales			2.591 (1.982)			0.043 (0.270)
Constant	10.907*** (0.082)	2.757*** (0.942)	2.725*** (0.930)	0.155*** (0.010)	0.486*** (0.130)	0.496*** (0.134)
Time F.E	NO	YES	YES	NO	YES	YES
Industry F.E	NO	YES	YES	NO	YES	YES
$_R2$	0.02	0.50	0.50	0.02	0.28	0.29
N	388	231	231	388	231	231

The table reports results for two sets of OLS regressions where the dependent variable is alternatively the natural logarithm of total amount of funds raised per company or the percentage acquired. For both BA and ECF deals we aggregate the dependent variables at the deal level. The main explanatory variable is a dummy taking the value of 1 for ECF campaigns and 0 for BA-backed deals. Deal-level and industry-level covariates are included. All models except univariate ones include time and industry fixed effects. Huber-White heteroskedasticity-consistent standard errors are reported in parentheses and are clustered at the year level. ***, **, * indicate significance at the 1, 5, and 10% level respectively

5 Conclusions and Future Research Directions

In this study, we examined potential distinctions among start-ups and fundraising outcomes for companies receiving their initial financing from either business angels or crowd investors. Utilizing two distinct proprietary databases of BA-backed and equity crowdfunding ventures, our findings reveal that ECF-backed companies secure less capital compared to BA-backed start-ups, with crowd investors obtaining a smaller proportion of capital than business angels. This indicates divergent investment outcomes and behaviors among investors.

Our results support the notion that crowd investors and business angels, despite ostensibly addressing similar needs in the start-up financial ecosystem, may serve as distinct financial channels. These channels identify companies with unobservable but different characteristics. Furthermore, our study contributes to the existing literature on business angels and equity crowdfunding by highlighting the interactions between different investor types (Wang et al., 2019). In contrast to prior contributions primarily analyzing co-investment practices or the sequential investment patterns of companies financed by various capital providers (e.g., Hellman et al., 2021, Butticè et al., 2020), we propose the existence of distinct characteristics in ventures supported by either business angels or crowd investors.

This study suggests different avenues of future research. Firstly, our comparison of business angels and equity crowdfunding investors has assumed homogeneity in the features of business angels, for instance in the level of monitoring or active involvement in their portfolio companies. Nevertheless, it is well-established that angels increasingly form groups and networks, leading to variations in investment practices. The exploration of how different forms of cooperation among angels impact the fundraising process of companies remains an open question with intriguing implications.

Secondly, while our results are intended to be applicable on a global scale, variations in regulation and investment cultures could lead to idiosyncratic outcomes in different contexts. Therefore, future work can extend our findings to other geographical regions and institutional contexts, providing a more comprehensive understanding of the nuanced impact of different financing sources.

Thirdly, our data structure precludes the testing of whether the funding source itself may determine the outcome and subsequent fundraising. Consequently, our focus was on documenting the presence of systematic differences in fundraising outcomes of start-ups funded by either business angels or crowd investors. Future research, leveraging novel and enriched datasets, may delve deeper into the causal relationships at play.

Finally, this study compares two distinct samples of companies financed by business angels and crowd investors, where business angels and the crowd are considered independently. Subsequent research could explore interaction effects between business angels and crowd investors, investigating their joint participation in crowdfunding deals and unraveling the complexities that may arise from such collaborative approach.

In conclusion, our study sheds light on the fundraising outcomes of business angels and crowd investors taking into account their distinctive characteristics in financing start-ups. The observed divergence in investment outcomes supports the notion that these two financing sources, while seemingly addressing similar needs in the startup financial ecosystem, operate as distinct channels for start-ups, showcasing nuanced differences.

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The Digital Readiness of Small Businesses at Times of Crisis: The Case of COVID-19

Georgios Doukidis, Timoleon Farmakis, and Katerina Fraidaki

Abstract In the digital transformation era, businesses' acquisition of competitive advantage is linked to the use of digital technologies as it is associated with various benefits and opportunities. At the same time, the challenges and disruptions that arose during the COVID-19 period affected the operation of businesses and highlighted the value and agility these technologies offer for resilience and business continuity. To this end, digitalisation has been imperative for all businesses. In particular, these fundamental disruptions profoundly impacted small businesses' survival. Small businesses have distinct characteristics that differentiate them from larger businesses while being crucial to the European and global economy. Although there has been extensive research on the relationship between digital technologies, their advantages for businesses, and their strategic significance for established firms and big SMEs, further research is needed to examine the impact of digital technologies in the context of small businesses. To this end, this study investigates the leveraging of digital technologies and digital readiness of small businesses in all market sectors (commerce, manufacturing, professionals-scientists, tourism-food, services, and construction-building companies) and its effect on business benefits and response to COVID-19 problems, identifying challenges. A survey was conducted in Greece examining 500 small businesses. This paper compares the results with similar surveys conducted in the summer of 2019 and 2020, giving a unique opportunity to examine the COVID-19 effect.

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1 Introduction

The Utilisation of Digital Technologies by Small Businesses

Various studies examine digital technologies in the context of small businesses, even from the early 90 s (Doukidis et al., 1994). A study by Lopez-Nicolas and Soto-Acosta (2010) explored how ICT (Information and Communication Technology) impacts organisational learning, while Giotopoulos et al. (2017) examined the drivers of ICT adoption in Greece, where most companies are small. ICT technologies can benefit small businesses by increasing productivity, efficiency, decision-making, competitiveness and reducing costs (Barba-Sánchez, 2007). For instance, small businesses' adoption of cloud computing is associated with many benefits, such as cost reduction, reliability, security, privacy, productivity, and collaboration (Gupta et al., 2013). In addition, small businesses utilising Big Data Analytics positively impact financial and market performance, improving the quality and efficiency of work, lowering costs, and attracting new sales (Maroufkhani et al., 2020).

Despite various research examining the connection between digital technologies (DTs), their beneficial effects on businesses and their strategic role (Dehning & Zmud, 2003), little is known about the adoption rate of DTs and their contribution to micro and small business benefits, prioritising the main challenges. Small businesses have some particular characteristics, such as limited human and non-human resources, high risk in dealing with uncertainty, centralised decision-making, unformal processes and limited skills (Doukidis et al., 1996). To this end, their particularities and liabilities should be considered (Freeman et al., 1983).

Also, existing digital maturity models either apply to large or medium-sized enterprises or have a more sectoral or specific technology orientation, leaving a gap for small businesses. For example, the Digital Readiness assessment models proposed by Garzoni et al. (2020) and Pirola et al. (2019) are dedicated to assessing the maturity of manufacturing SMEs. The need for more research that sheds light on the digitalisation of small companies due to their vulnerabilities is also highlighted in recent Digital Transformation (DX) literature (Kraus et al., 2022). The digital technologies relevant in DX literature refer mainly to the SMACIT acronym, including Social, Mobile, Analytics, Cloud, Internet of Things and platforms (Vial, 2019).

Small Businesses, the COVID-19 Effect and Digital Technologies

During the COVID-19 period, small businesses faced some fundamental challenges such as limited financial resources, lack of technical knowledge, more stringent requirements from credit organisations, reduction of revenues, decrease in sales, lack of awareness for aid initiatives, staff reduction, temporary shutdown, supply chain and mobility issues and limited digital resources (Klein & Todesco, 2021).

Bartik et al. (2020) shed light on the effects of COVID-19 on small enterprises, analysing responses from 5,800 firms. The results show that small businesses faced severe financial problems and a lack of financial support, with 43% of the sample temporarily closed and stating that the employment rate has dropped by 40%.

Papadopoulos et al. (2020) report that small businesses leverage digital technologies (DTs) to ensure survival while dealing with extreme disruptions such as COVID-19. In addition, a survey in Italy (Roffia & Mola, 2022) reveals that COVID-19 disruption enhanced the awareness of the strategic importance of ICT and increased the intention to adopt ERP systems in small businesses. Although literature recognises the value of DTs in such extreme situations, there is limited knowledge of how much small business owners/managers used digital technologies during COVID-19. To this end, examining to what extent small businesses used DTs to address COVID-19 challenges and took lessons from results for future risks is crucial. Based on the above-mentioned analysis, this study addresses the following research questions.

a. What is the use of DTs by small businesses for (a) digital presence and communication, (b) digital transactions and promotion, (c) digital infrastructure and (d) managerial information systems for resource management?
b. What are the main perceived business benefits of digital technologies for small businesses, and what are the barriers to their use and implementation to be addressed and solved?
c. To what extent do small businesses utilise digital technologies/services in addressing the problems arising in small businesses from the Covid crisis?
d. What is the digital readiness for small businesses in Greece, and how does it affect business benefits and the response to COVID-19 problems?

These questions examine the extent to which small businesses use digital technologies to improve their daily operations, the primary perceived benefits and challenges, how these technologies were utilised to overcome the COVID-19 problems, and finally, the role digital maturity/readiness plays in resilience and competitiveness.

2 Survey Description: The Case Study of Greece

Small businesses play a crucial role in the Greek economy. Micro (1–10 employees) and Small enterprises (11–50 employees) are the backbone of the Greek economy, covering more than 99% of the total number of enterprises in Greece (~730,000 enterprises) and 75% of the private sector workforce. However, due to their low productivity and limited resources, they participate to a limited extent in exports and the national economy (only 20% of the gross national product) (SEV and EY, 2017). The fact that the majority of the Greek economy is composed of small businesses and the need for Information Systems research is also supported by academic literature (Avgerou & Doukidis, 1993). Due to its vulnerabilities, small businesses are essential for the Greek, European, and global economies (Ayyagari et al., 2007). It is, therefore, necessary to support (among other things) their investments in digital technologies

to increase productivity, focus on customer support, manage the enterprise more efficiently and improve their competitive position.

The quantitative survey "Digital Readiness of Small Businesses in Greece—2022", presented in this article, analyses the use of digital technologies of enterprises employing 1 to 50 employees in all market sectors (trade, manufacturing, professionals-scientists, tourism-food, services, construction-building companies, other) towards responding the above-mentioned research questions.

The survey, conducted by the E-Business Research Center (ELTRUN) of AUEB on behalf of COSMOTE, the leading telecommunications company in Greece, was carried out in March–May 2022, using the method of telephone interviews while similar surveys were conducted in 2019 and 2020. During the interview, researchers gathered all data through a structured questionnaire. A total of 500 businesses nationwide were interviewed. To enhance the reliability and validity of the findings, this study used a triangulation approach, utilising both quantitative and qualitative data from interviews and the active participation of different researchers during the data collecting and analysis phase. The data was analysed using descriptive statistics to extract valuable insights for further investigation. The summary results presented in this section relate to the four research questions.

3 Results and Discussion

The Utilisation of Digital Systems and Infrastructure by Small Businesses

Based on the survey results, we observe high rates of technology use, with an increase from 2020 for digital presence and digital communication. In particular, 78% have a website (up from 70% in 2020), 63% have a call centre (up from 52%), 66% use alternative digital communications for in-house (up from 60%) and 42% for out-of-house (from 52%), and finally 62% use video conferencing tools (up from 39%). The leading communication solutions are Viber (57% inside and 27% outside), Messenger (36% inside and 13%outside) and WhatsApp (15% inside and 11% outside), while the dominant video conferencing tools are Zoom (59%), Skype (46%), Microsoft Teams (41%), Team Viewer (13%) and Cisco Webex (11%).

Furthermore, there is a significant upward trend in 2022 (compared to 2020) in digital transactions, promotion and sales. In particular, 24% have an e-shop (up from 17% in 2020), 48% use digital campaigns as a promotional tool (up from 36%), and finally, social media is an important communication and promotion tool for 59% of small businesses (up from 62%). 68% of small businesses are satisfied with their e-shops, while 26% with an e-shop make more than 25% of their total sales online.

The leading social media platforms used are Facebook (95%), Instagram (with a significant increase from 49 to 65%), LinkedIn (15%), and Twitter (9%). Nakara et al. (2012) report that social media is a crucial and valuable tool for small businesses.

Those who do not just utilise it as a trendy term and nimbly incorporate it into their tactics are more likely to succeed. Moreover, the leading digital promotion platforms are Google Search (68%), GDN (63%), Facebook Ads (57%) and Instagram (39%). The use of technology in marketing is critical to the survival of small enterprises (Alford & Page, 2015). It is essential to be noted that there is an increase in the use of experts for building and supporting technology solutions. In particular, the percentage of small businesses where an expert professional created the website (from 65 to 77%) and supported them in their organised digital campaigns (from 17 to 33%) increased. However, there is still a high percentage of digital campaigns implemented by owners (13%) or by friends (19%) on a do-it-yourself approach, as reported by Ritz et al. (2019).

The use of managerial information systems is recorded as an essential operating infrastructure for most businesses, as 42% use ERP systems (43% in 2020), 37% use CRM systems (39% in 2020), and 22% of SMEs have both systems. There appears to be a state of stagnation in the adoption and implementation of information systems to manage resources effectively. Information systems such as ERP are critical components for small businesses; however, their integration is challenging due to their particularities (Malhotra & Temponi, 2010). At the same time, small businesses under COVID-19 faced financial issues (Bartik et al., 2020), resulting in a limited capacity for high investments in relevant systems. The use of IoT technologies is minimal (only by 4% of SMEs). At the same time, 48% are aware of the term data analytics, but only 25% use it, mainly for web/Google analytics. Even though emerging technologies offer a variety of business benefits, their adoption rate is slower than that of commonly used information systems (Akpan et al., 2021). In particular, there are basic implementations in Big Data analytics, and only a few established firms harness their full potential (Mikalef et al., 2019).

Digital infrastructure is another topic of great interest. Small businesses still consider digital security a significant issue, with 86% using a relevant technology solution (up from 78% in 2020) but mainly limited to device antivirus. The significance of digital security for small businesses is highlighted by (Rahman & Lackey, 2013). Servers are widespread and are utilised by 63% of businesses (up from 53% in 2020), while cloud infrastructure is utilised by 23% of businesses (up from 22%). Adopting cloud infrastructure is associated with augmented business performance for small businesses (Attaran & Woods, 2019). Furthermore, public digital services are universal and at a high level of satisfaction. 94% of businesses use public digital services (and 89% use their banks' digital services for payments), and 78% are satisfied with their use. The primary public services they use are gov.gr (88%), Ergani (85%), Taxis (78%), idika.gr (74%) and MyData (42%). The findings mentioned above are concentrated in Fig. 1 and categorised into the four pillars of digital systems use indicated above.

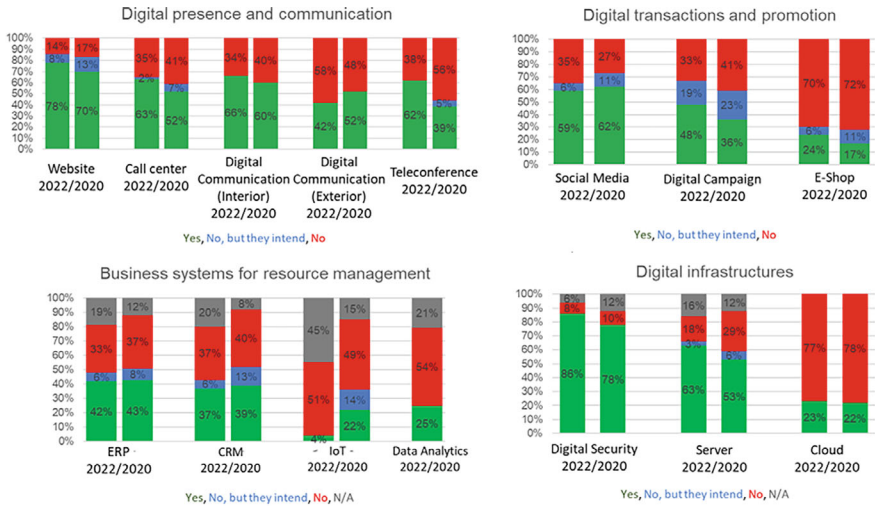

Fig. 1 Digital systems use is categorised into the four pillars of digital systems use (2020 vs 2022)

Perceived Business Benefits and Problems to Be Addressed

The benefits of ICT technologies are well documented in the literature regarding firms and bigger SMEs (Barba-Sánchez, 2007). Results indicate that digital technologies (DTs) also offer many benefits to small businesses. Small businesses have recorded significant business benefits (communication, planning, relationships, resource control) by using DTs, with the more digitally mature ones having a relative advantage. Specifically, 75% of small businesses cited more effective communication, 67% better business planning, 64% better customer relationship management, 62% better control of resources, 55% better decision making and 54% increased competitiveness among the benefits of leveraging technologies. Small businesses have also recorded significant quantitative benefits, such as cost reduction (59%) and sales growth (64%). Of the 64% of small businesses that reported a satisfactory increase in sales from using DTs, 29% saw increases of more than 20%. Similarly, of the 59% of small businesses that reported satisfactory cost reductions from using DTs, 16% found more than 20% reductions. Technology combinations are particularly essential in the context of digital transformation (Vial, 2019). Small businesses combining complementary innovatively digital technologies/systems (ERP & CRM, eShop and digital campaign) reported that they gained more business benefits. Across almost all business benefits, small businesses utilising combined technologies recorded higher favourable benefits rates than companies using only one or none of these technologies.

Lack of awareness, financial resources, support, and skills are the main barriers for using and utilising DTs. 47% of small businesses report a lack of awareness of technologies as a significant barrier for using technologies, 45% limited financial

resources for the necessary investments, 41% insufficient support from technology suppliers, and 39% lack of technical skills. 50% of small businesses lack digital skills, but only 30% report that they attend relevant training programmes to upgrade their digital skills. These results are in line with Ghobakhloo et al. (2011), who report that "*Lack of required resources (knowledge, skills, financial, managerial)*" is an essential factor for Information Systems adoption in small and medium-sized businesses.

The Utilisation of Digital Technologies in the COVID-19 Period by Small Businesses

COVID-19 negatively affected 53% of small businesses, and only 21% fully returned to their pre-COVID-19 operating state. The COVID-19 era affected businesses negatively in a variety of ways, with the main problems being health (53% of small businesses reported health compliance as a significant negative impact from Covid), financial (42% reported reduced sales), commercial (40% reported problems in customer communication), logistics (37% reported product delivery bottlenecks) and transactional (33% reported problems dealing with the government). Klein and Todesco (2021) also report various challenges, such as decreases in sales and revenues and supply chain and health restrictions.

74% of businesses have used DTs to overcome COVID-19-related problems, and 68% will continue to use them in the future. In particular, 52% used digital tools for more teleworking, 88% organised more teleconferences, and 66% carried out more digital promotions. Small and medium-sized businesses can use their limited resources better by leveraging digital tools like the Internet and communication platforms (e.g., WhatsApp, ZOOM, Skype) (Caballero-Morales, 2021). Finally, 75% reported increased e-shop traffic for those who had an online store, and 51% reported increased phone orders. At the same time, small businesses combining these technologies used them more effectively to cope with COVID-19 problems. For example, while 32% of small businesses in the total sample used the technologies to overcome problems in small businesses with ERP and CRM systems, the vale rose to 48%. According to (Roffia & Mola, 2022), COVID-19 disruption raised awareness of the strategic value of ICT and improved the intention of small businesses to implement digital systems. Figure 2 depicts small businesses' use of digital systems to overcome COVID-19 problems.

In crises and disasters, small enterprises commonly deal with challenges and liquidity issues; however, new opportunities also open up for them. Small businesses that follow innovative, proactive approaches showing an entrepreneurial orientation are more likely to overcome those problems and increase their performance (Eggers, 2020). Small businesses must find creative ways to transform barriers into opportunities and maintain operations in the long term (Thukral, 2021). Also, precautionary saving is essential for small businesses to increase survival chances in such disruptive

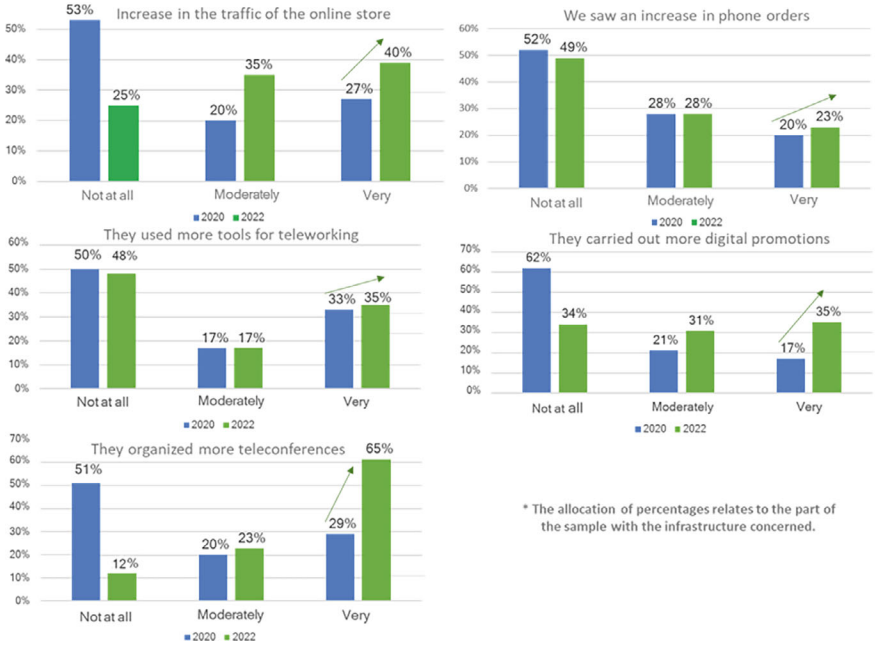

Fig. 2 Small businesses have used digital technologies to overcome COVID-19-related problems

crises (Cowling et al., 2020). Based on the data of this survey, companies with higher degrees of digital skills were affected less by COVID-19.

The Digital Readiness of Small Businesses and Its Effect on Business Benefits and the Response to COVID-19 Problems

To measure the Digital Readiness of small businesses, we created an Index (DRI) that captures the degree of digital maturity of small businesses based on the use of ten central digital systems and infrastructures in terms of (a) digital presence and communication (website, digital communication), (b) digital transactions and promotion (social media, digital campaigns, e-shop), (c) digital infrastructure (digital security, Cloud) and (d) information systems for resource management (ERP, CRM, IoT or data analytics). Depending on their score (how many of the ten technologies/systems they use), small businesses are divided into five groups (Elementary: Score 1–2), (Basic: Score 3–4), (Medium: Score 5–6), (Advanced: Score 7–9) and (Ideal: Score 10). This index follows the integration of the digital technology pillar of the DESI (2022) Index. It has been designed through iterative focus groups with experts from academia and industry to better suit the small business context.

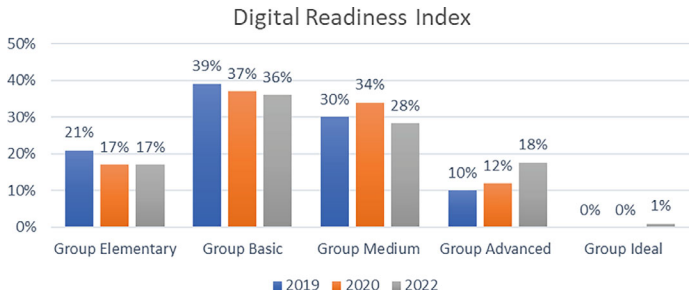

Fig. 3 Allocation of companies based on the digital readiness index

53% of small businesses are in the initial stages of digital readiness (Elementary and Basic), using only one to four of the above digital systems/infrastructure. Also, 28% are at the medium stage (Medium) with five or six digital systems/infrastructures.

19% of small businesses are already in the advanced stages of digital readiness, and there is progress with an increase (10%) in the average Digital Readiness Index (DRI) compared to 2020. The percentages of small businesses in advanced stages of digital maturity (Advanced and Ideal with seven to ten of the above digital systems/technologies) increased from 12% in 2020 to 18% in 2022. The average DRI also increased from 4.06 in 2020 to 4.47 in 2022. The increase in the DRI due to the COVID-19 disruption is documented in the literature, as many small businesses have followed the digitisation path to overcome challenges (Priyono et al., 2020). Figure 3 conceptualises the allocation of companies based on the Digital Readiness Index.

Digital readiness seems to be influenced by the size of companies and the sector. Larger companies (with 11–50 employees) have higher digital readiness than smaller companies. For example, 44% of the sample of small businesses with more than ten employees and, only 21% of the sample of small businesses with 2–5 employees and 18% with one employee are in the advanced stage of digital maturity. The sector with the highest digital readiness is services (with an average of 6.15), followed by tourism (4.73), trade (4.68) and manufacturing (4.44).

Small businesses' digital skills also seem to influence their digital readiness positively (Fig. 4). Digitally mature companies (advanced level) report that 67% of employees have the necessary digital skills, and 55% attend training programmes to upgrade their digital skills continuously. The corresponding percentages for small businesses in the early stages of digital readiness are very low. For example, in the elementary group, the percentages are 29% and 18%, respectively, while in the basic group, they are 46% and 21%, respectively, as illustrated in Fig. 4. Employees' digital skills and capabilities positively influence small businesses growth and innovation performance (Scuotto et al., 2021). This evidence explains why more digitally advanced businesses also have more digitally educated employees.

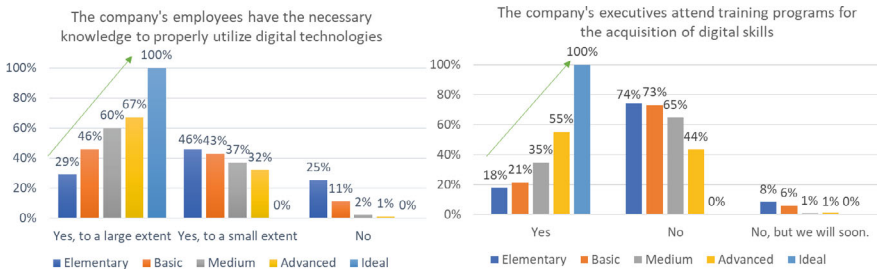

Fig. 4 The digital skills of small businesses positively influence their digital readiness

The Digital Readiness Index seems to positively influence the achieved business benefits since, for all benefits, an average increase is recorded for each category of companies with higher digital readiness (i.e. in ascending order of importance: elementary, basic, medium, advanced) as depicted in Fig. 5.

Finally, digitally mature small businesses utilised digital technologies to a greater extent to overcome COVID-19-related problems (Fig. 6). The digitally mature companies have returned much easier to standard conditions (e.g. in the advanced group, 24% have fully returned to the pro-COVID-19 era) than the other less mature companies (e.g. in the elementary group, 15% have fully returned). Also, the more digitally ready companies were in a more favourable position as they could more

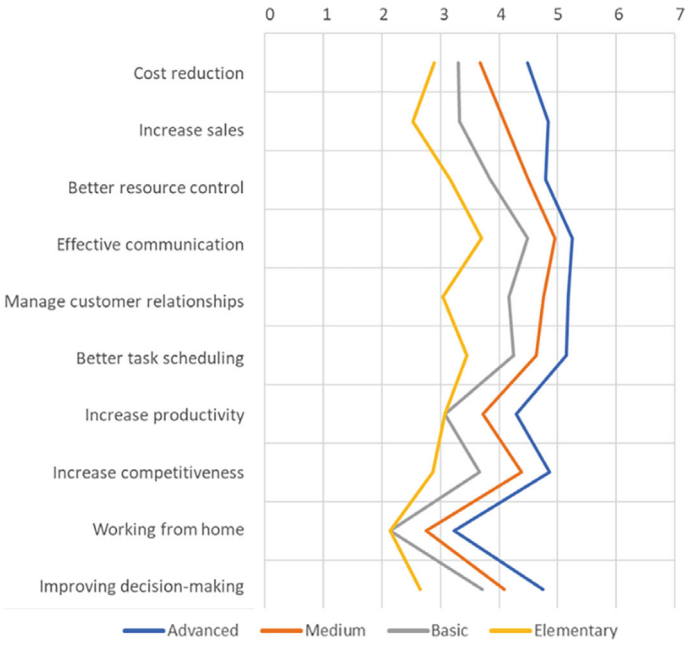

Fig. 5 The digital readiness index positively influences the achieved business benefits

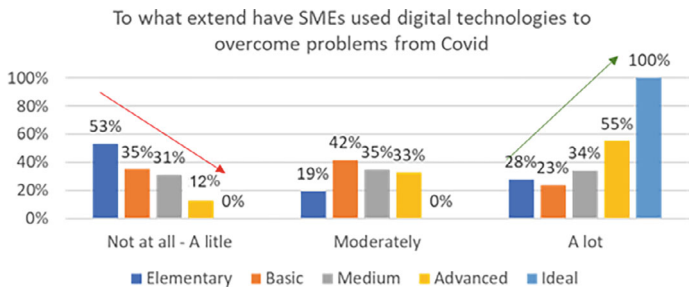

Fig. 6 Digitally mature small businesses utilised digital technologies to a greater extent to overcome COVID-19-related problems

easily use digital technologies to overcome related to COVID-19 problems (Priyono et al., 2020). For example, 55% of advanced companies leveraged technologies for this purpose and only 28% of companies in the elementary category.

4 Conclusion and Future Research

This study provides valuable theoretical perspectives and practical implications for the digitalisation of small enterprises. In particular, DTs have a high penetration for digital presence and communication and significant growth in e-commerce, teleconferencing and digital campaigns. There is also an increase in the utilisation of specialists for professional support for sites, digital campaigns, and CRM. Despite the strong interest in digital infrastructure, there is reported stagnation in the use of information systems for resource management (ERP and CRM systems). Digital security remains a critical parameter for small businesses.

Small businesses recorded significant organisational benefits, such as improved communication, planning, relationships, and resource control using technologies, while recorded specific quantitative benefits, such as cost reduction and sales growth. The innovative combination of technologies is vital. For example, businesses that combine ERP-CRM, Website-eShop, and eShop-Digital Campaigns seem to benefit more. Conversely, there are various barriers to adopting digital technologies, such as a lack of awareness of technologies, technical knowledge and staff training. The main barriers to using digital technology are a lack of technical information, professional support, and digital skills. Interestingly, while digital skills are lacking, only some businesses attend training programs.

COVID-19 negatively affected small businesses, as not all of them fully returned to their pre-COVID-19 mode of operations. In order to overcome problems, small businesses used digital technologies such as teleworking, videoconferencing, e-commerce and digital campaigns. As it occurs, digital technologies are beneficial in emergencies such as COVID-19 as digitally more mature companies and companies with higher degrees of digital skills are less affected, recover faster or gain a head

start. In addition, COVID-19 has changed consumer behaviour as small businesses reported increases in online shopping and increases in online payments.

Results indicate an increase in the average of the Digital Readiness Index (it is based on the use of ten well-known digital technologies/systems) compared to 2020. 19% of small businesses is already in the advanced stages of digital readiness, while still, 53% of small businesses are in the early stages. On top of that, the level of the digital readiness of businesses seems to be influenced by the sector, size and the skills of employees and managers. In particular, digital skills and training of employees and managers seem to positively impact companies' digital evolution and readiness. Digitally more mature small businesses have used digital technologies to overcome COVID-19 problems. To this end, small businesses that are digitally more mature or combine innovative digital technologies /systems (ERP & CRM, Eshop & Website) have reported more business benefits and coped better with problems.

The present research also highlights some meaningful opportunities for future research. Based on descriptive statistics, derive some research hypotheses, such as that the Digital Readiness Index positively impacts perceived benefits and resilience of companies. More advanced statistical techniques, such as SEM analysis, can further test these hypotheses. Also, identifying where/how critical organisational factors, such as digital organisational culture, affect small businesses' adoption and implementation of digital technologies is essential. Analysing also where/how digital technologies relate to other aspects of businesses, such as innovation, might be another future research direction. For example, examine how digital technologies help small businesses practice innovation in their products, processes or business model. Finally, despite the successful use of digital technologies in small businesses in difficult times such as COVID-19, it cannot be characterised as an organised digital transformation effort (Doukidis et al., 2020) since they do not have the long-term strategic orientation, appropriate resources, and capabilities for implementing transformation. As a result, the influence of digital transformation in the context of small business and bigger companies must be further researched.

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Digital Transformation and Complex Events in Organizations and Supply Chains

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Abstract This study examines the role of digital transformation on organizations and supply chains (SCs) to face complex events such as pandemics, wars, and environmental disasters. Digital transformation appears as a powerful tool to enable firms and SCs to face risks and respond to disruptions. Still, the literature fails to provide a deeper and more integrated understanding of the role of digital transformation, enabling organizations and SCs to face complex events. We employ a systematic literature review to address the research question approach and propose an original framework for analysis. We used the PRISMA approach to sift through a large number of documents from the Web of Science database and 2839 from the Scopus database. Organizations and SCs are seen to have accelerated the adoption of digital transformation and innovation in order to mitigate risk, increase resilience, and avoid economic collapse in the face of increased uncertainty due to external events such as COVID-19. This trend is continuing in the face of on-going major disruptions due to armed conflicts in the Ukraine and Palestine and, of course, the US-China geopolitical rift.

1 Introduction

Due to its novelty and uniqueness, COVID-19 has brought unprecedented challenges to organizations, especially supply chains (SCs) (Ivanov, 2020), which have experienced highly complex problems affecting the flow of production, manufacturing, distribution, services, and information, generating serious gaps in several network

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nodes (Queiroz et al., 2022). Considering the context of the pandemic and other critical events such as wars and climate emergencies, Fosso Wamba et al. (2021) have advocated digital transformation (DT) as a strategy for organizations to navigate through crises.

In this study, complex events refer to situations such as pandemics, wars, and environmental disasters, events that present a potential risk to individuals, organizations, and society, normally requiring urgent action to restore operations or new strategies for survival and adaptation to a totally new context (Fosso Wamba et al., 2021). These situations usually reveal the vulnerability of individuals, organizations, and SCs, exposing insufficiencies and lack of appropriate measures to minimize their negative consequences (Al-Dahash et al., 2016).

We examine the role of DT in organizations and supply chains (SCs) to face complex events. Complex events have become more frequent in recent decades, and their effects have been reaching organizations and SCs globally. DT is a powerful tool enabling enterprises and SCs to address risks and respond to disruptions more robustly (Queiroz & Wamba, 2022). However, the literature still fails to provide a deep and more integrated understanding of the role of DT in enabling global corporations to face complex events. Although literature related to DT has strived to offer solutions to organizations and society (Queiroz et al., 2022; Sarkis, 2020), there is still a lack of studies on the DT's role (Holmström et al., 2019) and how it can contribute to innovation in order to face little-known challenges, and, at the same time, improve crucial attributes such as flexibility, responsiveness, and performance (Fosso Wamba et al., 2021).

This study addresses this particular issue. Specifically, our analysis is guided by the following research question: How does DT enable organizations and SCs to face complex events? The study consists of a systematic literature review supporting the formation of a framework that indicates the main relationships between the context (exogenous factors), technology (DT), and motivation to adopt innovative technologies. This work can also shed light on management practice, helping decision-makers formulate company strategies and develop public policies encompassing management, coping, and recovery in the face of "highly disruptive" events. The framework developed herein can be used as a valuable tool to understand the role of digital transformation in organizations and chains, especially in facing crises and complex events.

The rest of this article is organized as follows: Section 2 presents the methodology and protocol adopted for the systematic literature review. Section 3 highlights the results and presents the conceptual framework. Finally, Section 4 concludes.

2 Methodology

We use the PRISMA approach (Moher et al., 2009) to map the reviewed literature drawn from two databases, Scopus and Web of Science, following earlier reviews (Stornelli et al., 2021; Thune & Mina, 2016). We map social science

publications addressing the topics of digital transformation (DT), innovation, and resilience, during the time period 2000–2022. The search was conducted considering the terms ("digital transformation*" AND "innovat*") OR ("digital technolog*" AND "innovat*") OR ("digital econom*" AND "innovat*") AND ("complexit*" OR "uncertaint*" OR "disrupt*" OR "dynamism*" OR "risk*") in titles, abstracts, or keywords of the articles. The search was restricted to documents published as scientific articles in English.

In the first phase of data collection, 4884 articles were selected—2045 from Web of Science and 2839 from the Scopus database. The data were imported into an Excel® spreadsheet for initial treatment. Duplicate works were identified in this first phase, leading to the exclusion of 296 (6.06%) articles and the reduction of the number of studies to 4588. The second phase consisted of selecting the articles published in journals on the ABS Academic Journal Guide (AJG) List, excluding journals classified as 1 (one) in the 2021 AJG. A full 3379 (73.65%) papers were eliminated, leaving a set of 1209 articles.

Continuing the PRISMA method, a third phase consisted of reading through the titles and abstracts of these papers in order to select those most aligned with the research interest meeting the three dimensions used by Stornelli et al. (2021), namely: (i) Contextual (e.g. crises, disruptions, complex events, environmental risks); (ii) Technological (digital transformation, innovation); and (iii) Analytical (e.g. response, adaptability, change, survivability, mitigation, risk mitigation, mitigation strategy). This third phase cleaning resulted in a sample of 68 articles (5.62%). In the fourth and final phase of treatment, a cross-sectional reading of the full text of the 68 articles resulted in a final set of 22 articles that were fully compatible with the topics of this research (Pittaway et al., 2004). From the 22 articles, 10 came from ABS 2 Journals, 10 from ABS 3 and 2 came from ABS 4 journals.

In subsequent steps, each of the 22 papers were uploaded into the QDA Miner software[1] for coding and analysis. These same data were also processed in the Excel spreadsheet. Coding was carried out focusing on categories defined a priori, related to the three analytical dimensions listed earlier in this section (contextual, technological and analytical), and categories linked to the type of industry researched, research objectives, methodological design, and unit of analysis.

The findings from the final sample of articles were synthesized following an approach common to other systematic reviews (e.g., Stornelli et al., 2021). Figure 1 summarizes the mapping process.

[1] QDA Miner is qualitative data analysis software developed by Provalis Research, used for analyzing textual data, such as interviews, open-ended survey responses, articles, social media content, and any other form of unstructured text.

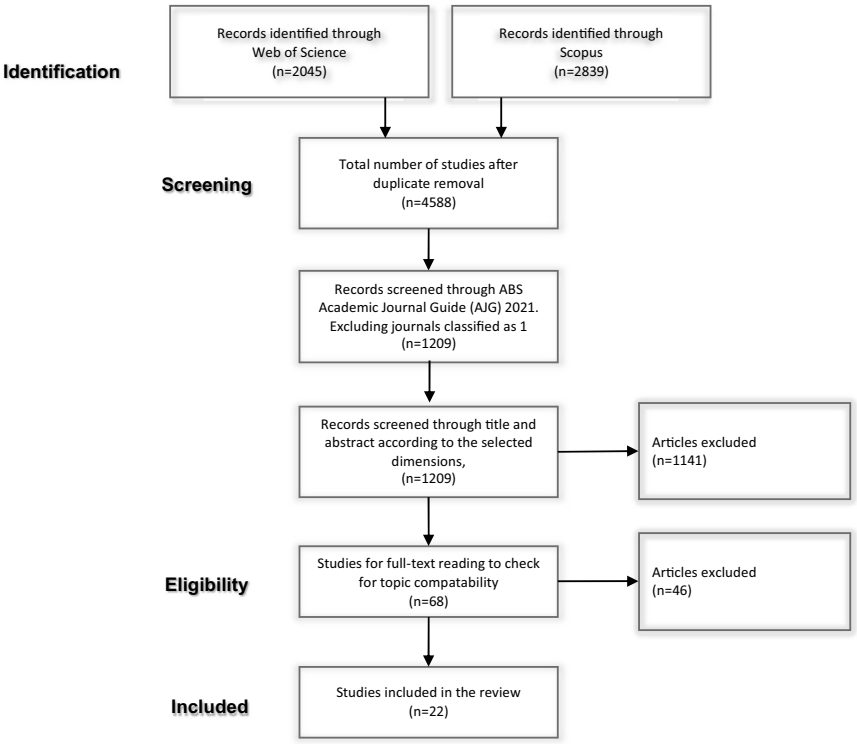

Fig. 1 PRISMA flowchart. *Source* Elaborated by the authors

3 Results and Discussion

The content analysis was developed with the help of the QDA Miner software and the Excel® spreadsheet.

Contextual Dimension (What Are Complex Events? How Are They Classified? What Are Their Characteristics?)

The examined studies show a predominance of connected complex events as a backdrop for the central discussions. The articles referred to external contextual factors that caused instability, interruption, or "breakdown" in the operations, activities, or processes of the organizations or supply chains (SCs). The mapping allowed us to classify the contexts into crises (13 articles), disruptions (3), complex events (3), and environmental risks (4 articles).

The contextual factor "**crises**" was related to situations of (i) dynamism and uncertainty in the SC caused by recent disruptions due to the pandemic and subsequent crises (Belhadi et al., 2021); (ii) COVID-19 lockdown in China (Jiang & Stylos, 2021; Ye et al., 2022); (iii) health crisis caused by the new coronavirus (COVID-19) (Ratten, 2021; Secundo et al., 2021; Soluk et al., 2021; Soto-Acosta, 2020; Vesci et al., 2021); (iv) reaction of Italian state museums to the closure of their buildings due to the COVID-19 pandemic (Agostino et al., 2020); (v) social distancing and minimal physical contact caused by the onset of COVID-19, which challenged and disrupted hospital practices (Gleiss et al., 2021; Oborn et al., 2021); and (vi) uncertain times [due to the COVID-19] (He et al., 2022).

The "crises" contextual factor in the literature was predominantly connected to the COVID-19 pandemic, arguing that it has caused an unprecedented global health crisis with severe socioeconomic consequences (Soto-Acosta, 2020) in organizations of all sizes and many sectors (Soluk et al., 2021). This disruption has required creative, flexible, and resilient responses from corporations (He et al., 2022), implying public policy and entrepreneurship initiatives around the globe (Ratten, 2021).

Regarding the contextual factor "**disruptions**," the articles discussed (i) a complex supply network affected by interruptions (Lohmer et al., 2020), (ii) disruptions in the diffusion of green products (Dev et al., 2021), and (iii) a high degree of likely disruption that challenges organizations and supply chains (Rauniyar et al., 2022).

The factor "**complex events**" dealt with (i) the continuity of the SC even during complex and emergency situations (Rauniyar et al., 2022), (ii) changes in people's behavior due to the restriction of movement and the lockdown policy that created "social distancing" (Trinugroho et al., 2022), and (iii) intractable social challenges such as climate change and sustainable development (George et al., 2021).

Finally, the contextual factor "**environmental risks**" referred to research addressing (i) cyber attacks—as the Internet of Things (IoT) became more widespread, further expanding the limits of networks, new windows of cyber threats opened everywhere (Boyson et al., 2022); (ii) natural disasters: crowdsourcing is not a new practice, but it is a concept that has gained substantial attention during recent disasters (Liu, 2014); (iii) "cultural overtourism," which causes substantial negative effects, burdening the local population, tourists, and the natural environment with overcrowding, vandalism, and pollution (Frey & Briviba, 2021); and (iv) business risks: commercial risks caused by the COVID-19 pandemic for small and medium-sized companies (Drydakis, 2022).

Technological Dimension (What Technologies? How Are They Applied?)

According to the reviewed literature, organizations and supply chains resort to technology to mitigate the disruptive effects caused by complex contextual events such as

various types of crises, disruptions, and environmental risks. This dynamic has been discussed through two main themes: (i) digital transformation and (ii) innovation.

Digital transformation is defined as the integration of various disruptive digital technologies such as blockchain, artificial intelligence, Internet of Things, cloud computing, big data and analytics, 3D printing, and augmented reality to transform existing services, organizational patterns, and business models (Jiang & Stylos, 2021; Rauniyar et al., 2022; Shankar et al., 2021). For example, Belhadi et al. (2021) pointed out that using artificial intelligence in supply chains led to increased organizational awareness about the importance of advanced information processing techniques.

Artificial intelligence allows small and medium-sized enterprises (SMEs) to increase their dynamic capabilities, leverage technology to meet new types of demand, move quickly to streamline business operations, increase efficiency, and reduce commercial risks (Drydakis, 2022). The unexpected COVID-19 pandemic caused an acceleration in digital transformation processes, encompassing not only the adoption of "dramatic" innovative technologies but also the increasing use of channels that almost everyone was already familiar with such as social media (Agostino et al., 2020; Gleiss et al., 2021; Soto-Acosta, 2020). It is understood that the intensity of transformation management equips an organization with transformative vision, governance, and culture, helping employees increase their capabilities when facing crises (He et al., 2022).

According to Arlbjørn et al. (2011, p. 8), **innovation** can be defined as a radical or progressive transformation in technology, process, or supply chain network that can be implemented to improve the creation of new value for the stakeholder. It includes all activities that aim to deal with environmental uncertainty by generating information processing and technological innovation to provide solutions to supply chain problems and identify new ways to improve processes (Rauniyar et al., 2022). The capacity for innovation consists of leveraging resources such as expertise, technology, and other types of knowledge to create new products, services, and processes (Ferreira et al., 2020; Hahn, 2020) or to withstand moments of rupture and vulnerability.

For instance, a variety of innovative initiatives underway have extensive organizational implications. Take the incorporation of blockchain technology which can be viewed most promising by allowing transparent, secure, and timely data exchange and automation through smart contracts (Lohmer et al., 2020; Rauniyar et al., 2022). The implementation of field sensors and real-time condition monitoring can serve as effective platforms for the diffusion of Internet of Things technology (Boyson et al., 2022). The use of the industry 4.0 architecture paradigm (Dev et al., 2021). The operationalization and integration of crowdsourcing into products and services (Liu, 2014). Cell phone and internet penetration, especially in underdeveloped countries, in order to substantially boost micro and small companies to use technology-based innovation (Trinugroho et al., 2022). Virtual reality, augmented reality, holograms and digital twins expected to be used to make cultural sites attractive to all types of tourists (Frey & Briviba, 2021). And the adoption of digital telemedicine technologies in hospitals (Oborn et al., 2021; Secundo et al., 2021).

Digital transformation and innovation are conceptually and empirically connected since, according to Rauniyar et al. (2022) and Herold et al. (2021), digital transformation is currently eliminating traditional barriers in organizations and supply chains that may impede innovation, thus heralding a new era in the management of corporations around the globe.

Implementing digital technologies allows for greater speed, quality, and precision of information and decision-making, contributing to highly effective management (Rauniyar et al., 2022). At the same time, innovation usually occurs at social, technological, organizational, and political interfaces (Liu, 2014). Digital transformation has been emerging as a tool to facilitate the building of resilience (Ye et al., 2022), to deal with the extraordinary pressure arising from events such as the COVID-19 pandemic (Vesci et al., 2021), and to provide foresight on improved political, economic and business practices (Ratten, 2021).

Table 1 lists the different types of technologies mentioned in our bibliographic sources.

How Has Technology Been Applied?

Technologies like those in Table 1 can be applied in different situations to mitigate and support the disruptive contexts analyzed in the examined articles. For example, potential application scenarios for blockchain technology in connection with supply chain risk management and supply chain disruptions were initially developed. Its influence on resilience strategies was examined to identify potential advantages and select the most promising approach (Lohmer et al., 2020).

Moreover, blockchain technology was said to offer new opportunities in the cyber world when combined with the Internet of Things due to the difficulties for hacking (decentralized nature and cryptographic algorithm). Smart contracts—made possible through blockchain—are currently considered one of the best solutions for mitigating supply chain risks. The immutable nature of blockchain eliminates intermediaries, reducing the risk of fraud, counterfeit products, and fraudulent acts and saving money. Blockchain can trigger significant improvements in transparency, accountability, trust, security, efficiency, and cost minimization, making it an ideal instrument for supply chain management in this digital era (Rauniyar et al., 2022).

Another example referred to the use of digital technologies to address climate change and drive sustainability. By digitizing institutions, these technology and business model innovations enable organizations to address governance gaps and enable new and existing markets to reduce "dead weight" losses and expand the socio-ecological surplus (George et al., 2021).

In the study by Secundo et al. (2021), a decision support system was developed based on an optimization model to help managers and service providers (physicians, hospital directors, and policymakers) support the allocation management of patient-specific devices. Furthermore, data suggests that digital healthcare solutions related to COVID-19 in Italy during the lockdown period included e-Health consultations, digital diagnostics, remote monitoring, and robot assistance (Secundo et al., 2021).

Table 1 Types of digital technologies in the context of digital transformation and innovation

#	Technologies	Author(S)
1	Blockchain technology (BCT)	(Lohmer et al., 2020; Rauniyar et al., 2022)
2	Artificial intelligence (IA)	(Belhadi et al., 2021; Drydakis, 2022)
3	Digitalization	(Belhadi et al., 2021)
4	Internet of Things (IoT), such as field sensors and real-time monitoring	(Boyson et al., 2022)
5	Industry 4.0 and additive manufacturing	(Dev et al., 2021)
6	Crowdsourcing and open street map	(Liu, 2014)
7	Digital technologies in the retail ecosystem	(Jiang & Stylos, 2021)
8	Cell phone; internet; digital financial technologies; Online sales	(Trinugroho et al., 2021)
9	Digital sustainability: blockchain; artificial intelligence; machine learning; big data analysis; technology and mobile applications; sensors and other IoT devices; and other telemetry tools such as satellites and drones	(George et al., 2021)
10	Innovation and digital technology: virtual reality, holograms and digital twins	(Frey & Briviba, 2021)
11	Internet of things (IoT) and other digital technologies (e.g., social media, cloud computing, big data analytics, and artificial intelligence)	(Secundo et al., 2021)
12	Digital platforms	(Soluk et al., 2021)
13	Social media	(Agostino et al., 2020)
14	Telemedicine: audiovisual technologies	(Oborn et al., 2021)
15	Digital innovation, digital technology and digital entrepreneurship, open service platform	(Ye et al., 2022)
16	Micro cloud computing, new robotics, fifth generation telecommunications (5G), Internet of Things (IoT), virtual reality (VR), augmented reality (AR) and mixed reality (MR) in retail	(Shankar et al., 2021)
17	Digital platforms; digital health; and platform economy (economic and social activity facilitated by digital platforms)	(Gleiss et al., 2021)

Source Elaborated by the authors

Agostino et al. (2020) mention that digital technologies, particularly the internet and social media, offer easy access to mass communication. Enhancing the possibilities for interaction with other people makes social media a potent tool to access cultural material (such as museums), especially in occasions of lockdowns and social distancing that we experienced recently. Frey and Briviba (2021) argue that physical,

cultural sites accurately reproduced by modern digital technology offer the possibility of creating a very similar impression as touring the original site, increasing the level of public acceptance. Such initiatives are already seen in various countries with Germany, France, and Italy serving as pioneers. Relatedly, Jiang and Stylos (2021) confirm the prominent role of the internet usage for work, convenience, and entertainment purposes in restrictive times of the pandemic based on in-depth interviews conducted with different service consumers in Europe.

Drydakis (2022), in turn, mentions the usefulness of artificial intelligence applications to: collect information related to customers' online purchasing history, types of online transactions, and digital presence; offer personalized shopping suggestions; reach the target audience online; offer immediate responses to customers; offer cash flow forecast; collect information about product assortments of other companies; combat fake product reviews; protect data, customer privacy and strengthen cybersecurity; provide legal services; recruitment and human resources (HR) activities.

Finally, Shankar et al. (2021) reflect that the manager's decisions about adopting technologies, especially in retail, depend entirely on execution. If implemented well, most technologies can be fruitful. Poor execution can have the opposite results. Examples of good technology implementations can be found in Hema's QR code, Specsaver's styling tool, Nike's quick store, Zara's self-checkout, Target's mobile wallet, Audi's virtual reality showroom, and the Sephora beauty center. In contrast, many retailers fail to implement customer relationship management systems. Often, this is due to a lack of vision, poor planning, and not putting the customer at the center, resulting in poor user adoption. The ability to use test storage to validate expectations and fine-tuning systems can be a viable path to improving success rates.

Analytical Dimension (Reasons and Motivations)

On the basis of the content analysis undertaken in the analytical dimension of the study, it was possible to map the different objectives and/or motivations—response, adaptability, change, survival, other risk mitigation strategy—through which digital transformation and innovation have been applied to enable organizations and supply chains to face complex events. Table 2 summarizes the set of objectives and motivations appearing in this collection of literature.

Organizational Results (Obtained with the Application of Technology)

The reviewed literature has provided some answers to address the research question posed herein—How does digital transformation enable organizations and supply

Table 2 Analytics dimension: objectives and motivations

Response	
1	Maximize the benefits of AI capabilities to drive sustained supply chain resilience (SCRES) and supply chain performance (SCP) (Belhadi et al., 2021)
2	Verify which were the reactions of the retail ecosystem to the COVID-19; (Jiang & Stylos, 2021)
3	Companies reacting to the COVID-19 pandemic (Soluk et al., 2021)
4	Telemedicine applied to minimize patient overload in hospitals (Oborn et al., 2021)
5	New ventures consciously organizing resources, driven by digital innovation, to improve resilience (Ye et al., 2022)
6	The role, drivers, and outcomes of technology adoption by buyers, retailers, employees, and suppliers in retail (Shankar et al., 2021
7	The dimensions of digital maturity influencing organizational resilience; how organizational resilience affects performance and employee optimism (He et al., 2022)
Adaptability	
1	The healthcare ecosystem facing the challenges posed by COVID-19 using the Internet of Things (IoT) combined with other digital technologies (Secundo et al., 2021)
2	Family businesses adapting to exogenous shocks, such as the COVID-19 pandemi (Soluk et al., 2021)
3	The type and quantity of content published by museums on their social media pages; the level of online engagement generated by their activity (Agostino et al., 2020)
4	Digital manufacturers participating in R&D processes to find solutions to problems created by an exogenous and unexpected health problem (Vesci et al., 2021)
5	Reflections on whether and how the COVID-19 outbreak accelerated digital transformation in organizations (Soto-Acosta, 2020)
Change	
1	Focus on the digital toolbox employed by pioneering organizations to propose a research agenda with new questions for entrepreneurship, business models, and ecosystems, as well as new ways of thinking about trust and institutional logic (George et al., 2021)
2	Innovation and risk-taking leading to productive political outcomes (Ratten, 2021
3	Multifaceted platforms disrupting conventional relationships and transforming value-creation structures in the healthcare market (Gleiss et al., 2021)
Risk mitigation	
1	The impact of blockchain technology on SC risk management and, in particular, SC resilience (Lohmer et al., 2020)
2	Strategies adopted by companies based on digital transformation enabled by blockchain to reduce SC (Rauniyar et al., 2022)
3	Use of technology for risk management against cyber attacks including illicit access to corporate networks for competitive espionage, financial and intellectual property theft, and interruption of operations (Boyson et al., 2022)
4	Mitigate negative externalities that affect cultural heritage, local populations, and the natural environment (Frey & Briviba, 2021

(continued)

Table 2 (continued)

Response	
5	Artificial Intelligence (AI) applications associated with reduced business risks for SMEs (Drydakis, 2022)
Mitigation strategy	
1	Speed of recovery and distributed production improving SC resilience to manage potential disruptions in the diffusion of green products (Dev et al., 2021)
2	Crowdsourcing to solve problems of information scarcity and overload during emergencies to potentially save lives and promote the reduction of risk of disasters (Liu, 2014)
3	Understanding of barriers to using digital technologies by micro and small businesses in Indonesia, which could improve productivity and efficiency (Trinugroho et al., 2021)

Source Elaborated by the authors

chains to face complex events?—based on the results obtained by organizations and supply chains that implemented transformative digital initiatives and/or innovative practices in business management.

Studies looking at artificial intelligence (AI) technology indicate that supply chains employing resources in information processing achieved sustained performance (Belhadi et al., 2021). Drydakis (2022) found that AI applications used to guide consumers online, provide cash flow forecasting, and facilitate HR activities were associated with reduced business risks caused by the COVID-19 pandemic in small and medium-sized businesses (SMEs). The study indicates that AI enables SMEs to increase their dynamic capabilities by leveraging technology to meet new types of demand, moving quickly to streamline business operations, increase efficiency, and thereby reduce their business risks (Drydakis, 2022).

Lohmer et al. (2020) show that the application of blockchain technology combined with collaboration within the supply chain, based on time-efficient processes, can substantially reduce the propagation of interruptions, the network recovery time, and total costs, thus contributing to increasing resilience in the chain and improving risk management. Studying crisis management, Jiang and Stylos (2021) observed the reactions of the retail ecosystem to the COVID-19 pandemic. Digital technologies were crucial to leveraging crisis management resources, influencing consumer purchasing behavior and online retail in general.

When considering complex events such as the recent COVID-19 pandemic, Trinugroho et al. (2022) found that more successful companies adopted digital technologies in their commercial activities, which made it possible to improve their productivity and efficiency. Agostino et al. (2020) showed that museums more than doubled the use of their social media during the coronavirus pandemic to overcome the effects of lockdowns and social distancing which generated a higher level of virtual engagement due to activities conducted digitally.

Finally, Vesci et al. (2021) gathered information on how the frugal approach to innovation suits an unexpected and extraordinary event like the COVID-19

pandemic. More specifically, the authors emphasize how frugal innovation principles can interact with agile manufacturer mindsets and enrich innovation strategies, providing effective solutions on a local scale but with potential global impact.

Proposed Framework

Based on the prior discussion, we propose an analytical framework indicating the main relationships connecting the three dimensions (contextual, technological, and analytical) regarding digital transformation in organizations and supply chains facing complex events (Fig. 2).

4 Conclusions

Organizations and supply chains have accelerated the adoption of digital transformation and innovation in order to mitigate risk, increase resilience, and avoid economic collapse in the face of increased uncertainty due to external events such as COVID-19. This trend is continuing in the face of on-going major disruptions due to armed conflicts in the Ukraine, Palestine, and, of course, the US-China geopolitical rift.

Technology, especially information and communication technologies, allows to improve resilience, manage information, and support decision-making during periods of uncertainty. Digital technologies potentially improve opportunities and risk analysis and expand the ability of organizations and supply chains to quickly diagnose disruptions and resolve their effects. Therefore, promoting a culture of innovation and digital transformation is critical in shaping the future of modern companies and value chains.

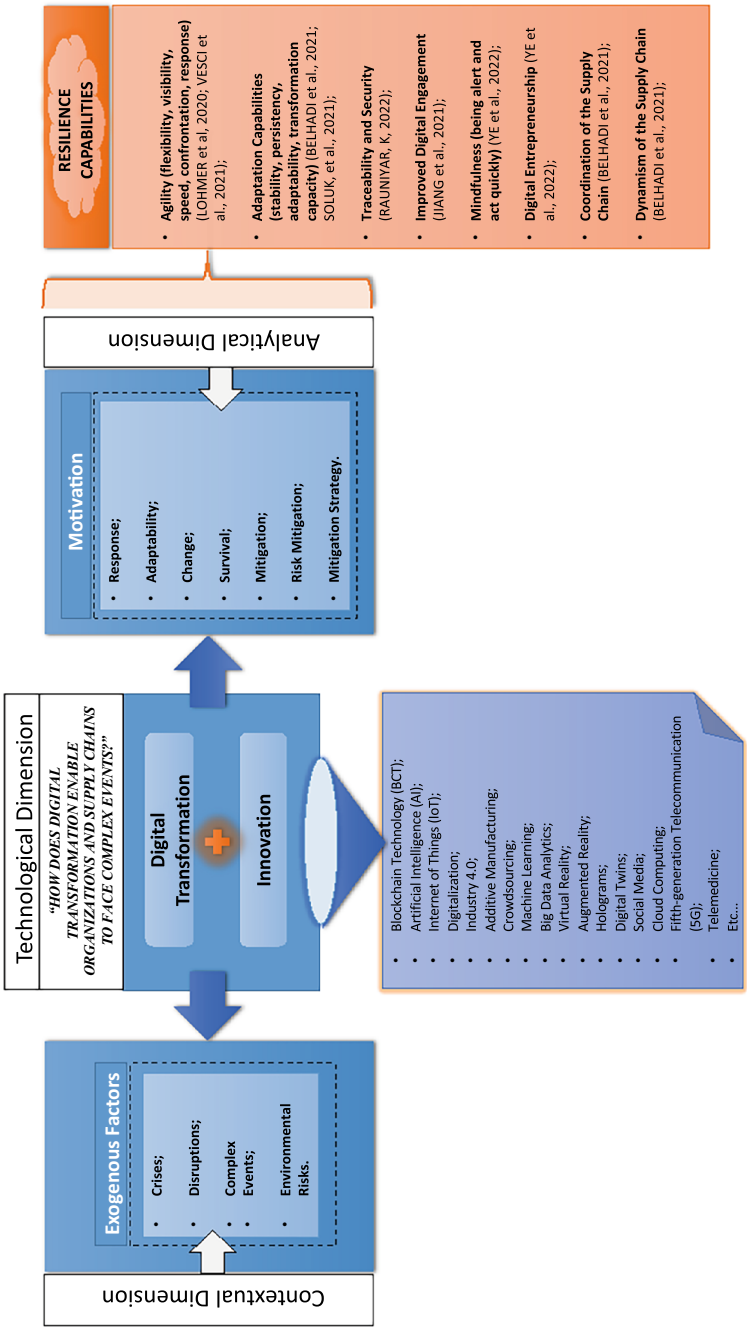

Fig. 2 Framework: digital transformation in the presence of complex events. *Source* Elaborated by the authors

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Fostering SMEs Digital Innovation Through Advanced Training and Design Thinking. Italy as a Case Study

Michele Bugliesi and Stefano Micelli

Abstract The mismatch between demand and availability of digital skills is one of the key challenges for entire industries in the digital era. The mismatch is particularly critical for SMEs, which most often lack both the critical mass to upskill their employees with in-house, corporate academies and the know-how to scout for start-ups to support their innovation journeys. In the present paper, we advocate a new role for business and executive schools to foster the convergence of higher vocational education and small and medium enterprises, favoring the diffusion of digital competences and enhance ecosystem competitiveness. We discuss the effectiveness of the approach with an analysis of the results of a two-year digital innovation project that has involved around one hundred companies and over four hundred students from fifteen tertiary vocational institutions across Italy.

1 Introduction

Digital skills have become critical for the productivity and competitiveness of both companies and workers. These skills include an understanding of information technology, the ability to develop digital solutions and an attitude to work collaboratively using technology. A well-established tradition of research has highlighted the correlation between knowledge and skills within organizations and the impact of digital savviness on labor productivity (see (Bettiol et al., 2022) for a recent contribution). On a related ground, the digital skill mismatch between demand and availability

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has been addressed both in the production and in the education systems worldwide (Brunello & Wruuck, 2021).

Companies have actively pursued the recruitment of technologically apt and responsible talents while investing in extensive training and retraining programs for their workforce. This dual investment aimed not only to increase company productivity but also to enhance career prospects for employees and bolster their resilience in the job market. Regrettably, this concerted effort has seen only partial success. Firms continue to encounter mounting challenges in attracting young talent and meeting their expectations, which nowadays encompass more than just competitive salaries and extend to job quality, professional advancement, work-life balance, and alignment of personal values with those of the company.

Universities and community colleges, in turn, have devoted significant efforts to craft new teaching methodologies to engage high-potential students and nurture their personal and professional advancement. From the wealth of experiments conducted worldwide, several pivotal factors emerge clearly as key for the creation of competitive innovation ecosystems: these include transitioning from passive to active learning, adopting innovation management tools to organize the learning process, establishing physical spaces and digital platforms to foster the collaboration between corporate entities and educational institutions.

Italy represents an interesting case of the skill mismatch of our present interest (Micelli, 2014, Altagamma, 2019). Both cultural and demographic reasons contribute to the problem: not only does the country have a longstanding tradition of undervaluing technological proficiency and scientific culture within its educational system, but also the rapid decline in birth rates and a limited presence of foreign workers has contributed to compound the issue significantly in the last decades. The consequent lack of digitally skilled young students has been particularly critical in the so called *Made-in-Italy* industries (food, fashion, furniture and mechanics) where an original mix of analogical know-how and digital savviness is crucial to achieve competitiveness (see (Bugliesi & Nardelli, 2023) for a general picture).

Recognized as a national public concern, the lack of digital skills has become the focus of a strategic agenda promoted by the Italian government, targeted at filling the digital gap and at promoting training and education on new technologies to favor the country's competitive development. Large corporations have embraced a related, independent agenda based on two complementary actions: on the one hand, they have involved business schools in the creation of in-house corporate academies to upskill and reskill their workforce; on the other hand, they have pursued a systematic scout for and acquisition of start-ups to support their course for innovation. Regrettably, while effective for large companies, these actions are not at the avail of SMEs, which too often lack the critical mass to respond to their own needs.

In this paper, we advocate a new role for business and executive schools to support the convergence of tertiary education and small and medium enterprises to favor the diffusion of digital competences and promote the competitiveness of local and regional ecosystems. We provide evidence of the effectiveness of the approach with an analysis of the results of Upskill 4.0, a two-year digital innovation project that

has involved around one hundred companies and over four hundred students from fifteen tertiary vocational schools across Italy.

The paper is organized as follows. We start in Sect. 2 with a sketch of the state of the art on digitalization in Italy and on existing approaches to open innovation and corporate training. In Sect. 3 we propose a new framework to respond to the digital skill mismatch between demand and offer that hinders innovation within SMEs. In Sect. 4 we report on the experience of the Upskill 4.0 project. We conclude in Sect. 5 with final remarks.

2 Background—Italy's State of the Art on Digitalization

The European Commission has been monitoring the digital progress of its member states since 2014 through the Digital Economy and Society Index (DESI) (cf. Russo, 2020), an annual report which includes country profiles intended to support the member states in identifying areas that need prioritized action in their digital strategies, thus helping them make informed policy decisions.

Looking at Italy through the DESI lens, the gap affecting the country with respect to the rest of the EU member states emerges very clearly, with Italy lagging far behind, in 19th position in the DESI 2022 composite index ranking. The ranking confirms the trend observed from the surveys of the last five years, during which the overall Italian performance shows constant improvement but at a rate that is not sufficient to narrow the gap from the EU average and from the majority of the benchmark countries.

A quick analysis of the different *key areas* of the index shows clearly that the country's critical weakness is in the area of human capital. Indeed, Italy ranks 25th out of 27 EU member states relative to this indicator and 27th out of 27 if we look at the sub-indicator measuring the percentage of people possessing at least basic digital skills.

The detailed analysis, in Table 1 below, shows further significant elements. Only 46% of the population aged 16–74 have at least basic digital skills (54% in the EU) and only 23% have digital skills above basic (26% in the EU). The percentage of ICT specialists in Italy is equal to 3.8% of total employment, still below EU average (4.5%), and only 1.4% of Italian graduates choose ICT disciplines, a figure well below EU's 3.9% average. Italy's performance is closer to the EU average for female ICT specialists, with a figure of 16% against an EU average of 19%. Finally, only 15% of Italian companies provide ICT training to their employees, five percentage points below EU average.

Equally worrisome evidence of Italy's digital lag is the distribution of the gap with respect to its Europeans peers over the various age groups, with a negative peak for younger generations and the 25–34 group in particular, affected by a difference of no less than 18 percentage points from EU average.

The picture emerging from the DESI surveys should come with little surprise, as Italy has been struggling with a deficiency of digital skills among firms, the

Table 1 Italy's human capital indicators

	Italy		EU	
1a1 at least basic digital skills % individuals	NA	NA	46% 2021	54% 2021
1a2 above basic digital skills % individuals	NA	NA	23% 2021	26% 2021
1a3 at least basic digital content creation skills % individuals	NA	NA	58% 2021	66% 2021
1b1 ICT specialists % individuals in employment aged 15–74	3.5% 2019	3.6% 2020	3.8% 2021	4.5% 2021
1b2 female ICT specialists % ICT specialists	15% 2019	16% 2020	16% 2021	19% 2021
1b3 enterprise providing ICT training % enterprises	19% 2019	15% 2020	15% 2020	20% 2020
1b4 ICT graduates % graduates	1.3% 2018	1.3% 2019	1.4% 2020	3.9% 2020

Source DESI 2022 Italy https://digital-strategy.ec.europa.eu/en/policies/desi-italy)

workforce, and even the student population for a long time without any adequate countermeasures being taken, either within businesses or by public policies. Only recently, the problem has become a national concern and a new drive to address it in the wake of the digital transformation era is finally emerging and showing first, encouraging effects.

Countering the Digital Gap—Corporate Strategies

Corporate strategies have revolved around two main directions: open innovation and corporate academies.

Open innovation represents nowadays an established trend among corporations willing to harness their R&D efforts. By collaborating with small, agile start-ups, companies tap into fresh ideas and solutions, gaining a comparative advantage over their competitors without compromising cost control. Joining forces with start-ups allows companies to pioneer new solutions and to gain access to talent, thus driving innovation at affordable and controlled costs and financial risks.

In the recent survey conducted in collaboration with Ipsos and INSEAD, Sopra Steria (2023) analyzes over 1,600 start-ups and corporate organizations, both public and private, across 10 European countries with the primary goal to assess the evolving landscape of corporate–start-up collaborations throughout Europe. The findings indicate a significant shift in the corporate landscape, with such collaborations becoming commonplace. An astounding 72% of the European corporations surveyed have embarked on open innovation projects in partnership with start-ups, with two-thirds of

the participants recognizing start-up collaboration as crucial or even mission-critical for their organization's strategic objectives.

Interestingly, in spite of its growing, but still immature startup ecosystem, Italy is among the countries that show most enthusiasm for open innovation, with 80% of the companies surveyed having activated a start-up collaboration, a trend that confirms PWC's Innovation Report on Italy (PWC 2018).

Corporate Academies are taking an increasingly crucial role as an organization model for knowledge management. Pioneered by the experience of General Motors and General Electric which began offering standardized in-house training programs about 100 years ago, Corporate Academies have long evolved into advanced education environments, often developed under the guidance of Business Schools, bringing together education, research, industry and external relations, acting as catalysts for innovation and growth of the company intellectual capital.

As shown by the recent Italian business association report (Assoknowledge, 2023)), Corporate Academies are becoming an established practice for corporations in Italy as well, and experience shows that companies adopting this practice have successfully attained improved competitive advantages and made valuable contributions to the overall growth of their entire value chain. While this endeavour represents a valuable step forward, we remark that it mainly involves large companies, which represent a tiny fraction of the enterprises operating in the country. Indeed, according to the Italian Institute of Statistics survey (ISTAT (2023)), out of the 1.577.034 enterprises (with employees) active in the country, 85% are small businesses with up to 9 employees. Interestingly, the Assoknowledge survey does not even take this pool into account in its analysis of innovation, as it only reports data referred to businesses with at least 10 employees, confirming, if need be, that even the basic innovation tools are not at the avail of most of the Italian entrepreneurial fabric of micro and small businesses.

Public Policies to Support Innovation Among SMEs

To counter this situation, various public policy actions have been devised over the past two decades. One of the first attempts to implement a new wave of innovation was the so-called Technological Districts initiative, launched in the early 2000s to create several centers of excellence for research and innovation leveraging university-industry collaborations and cooperation among enterprises. Along the same lines, *Industria 2015,* launched in 2006, targeted specific areas of the Italian manufacturing industry based on national strategic projects integrating manufacturing and services with the help of some key technologies.

A significant step forward came in 2016 with the *Industria 4.0* plan, meant to enhance productivity, efficiency, and innovation within Italian industries by leveraging technologies such as the Internet of Things (IoT), big data analytics, artificial intelligence (AI), and advanced manufacturing techniques. The plan revolved around two key pillars. On the one hand, an investment in research and development (R&D)

to foster innovation and technological advancements and to strengthen collaboration between academia, research institutions, and industry. On the other hand, a series of incentives and support measures to encourage businesses to invest in digital technologies based on tax credits for R&D activities, super-amortization for investments in Industry 4.0 technologies, and facilitated access to finance for digital transformation projects.

Despite the large number of incentives and opportunities made available by central and local governments, Italian small and medium-sized enterprises are still struggling to embrace the potential of digital technologies. According to OECD, an important percentage of Italian SMEs still ignore the very existence of the Competence Centers, of the so-called *Punti di Impresa Digitale* (PID) and of the Digital Innovation Hubs (Crupi, 2020) distributed across the country. Similarly, the use of training funds as a source of knowledge about training still appears to be limited.

To face the lack of information on existing instruments, in the framework of the Industry 4.0, the Ministry for Economic Development (MISE) has designed an 'Awareness' plan targeted at SMEs and aimed at zxinforming about the use and potential productive returns of new ICT technologies. Tailored demonstrations, informative sessions and discussions on the productive and enhancing potential of new technologies are at the core of the plan. By promoting a new learning culture, policies can contribute to the creation of an innovative ecosystem, based on stronger collaboration between public and private research organizations (OECD, 2019, 2022). As highlighted by business association analysts, linking with universities and tertiary technical education could prove to be particularly fruitful. At present, this connection is still underutilized. That said, its potential deserves to be considered and explored (Manfredi, 2023).

3 A New Approach for Tertiary Vocational Education

The *Industria 4,0* plan also recognized training and education as two fundamental tools to grow a digitally apt and technologically skilled workforce. Based on that, it promoted several initiatives targeted both at upskilling/reskilling the workforce fostering digital literacy, and at encouraging the integration of technology-related subjects into educational curricula. Right from the start, the focus has been on projects promoting the creation of professional profiles consistent with the use and exploitation of new technologies, especially in small and medium-sized enterprises.

The plan included a specific action on tertiary vocational training, based on an investment in the recently established *Istituti Tecnici Superiori* (ITS), a novelty within the Italian education landscape. Over the past decade, ITSs have developed a vocational alternative to the traditional university education, with two-year programs specifically aimed at equipping students with technical skills consistent with the demands by well-established firms within a territory. Currently, their offerings cover a variety of subjects, from energy to information and communication technologies, from mechanics to tourism. Enrolment in this first decade has grown significantly and

currently stands at about 10,000 new students per year; still a small number compared to the corresponding programs in Germany and France, but expected to double within the current decade thanks to the EU Next Generation Funding investment.

The *Industria 4.0* plan also supported a series of experimental initiatives to foster virtuous short-circuits between training and innovation coordinated by the Ministry of Education, University and Research (MIUR, today reorganized as MIM—the Ministry of Education and Merit). Among these, the *ITS 4.0* program, elaborated as a cooperation between MIUR and the Department of Management at Ca' Foscari University of Venice, aimed at making ITS students protagonists of active learning programs built around innovation management practices (www.its40.it).

The premise for the ITS 4.0 program is simple. Technology transfer based on the traditional linear innovation sequence (research and development, factory testing and, eventually, workforce training) ends up taking too long to ensure competitiveness in a time when innovation moves at a very fast pace. To speed up the process, the ITS 4.0 project brings together schools and enterprises to engage students, professors and the workforce in a cooperative effort to act as a collective innovation agent and respond to the enterprises' needs.

To achieve its expected outcomes, the program has experienced a pedagogic transition from discipline-based learning to problem-centered, challenge-based learning, an educational approach which involves presenting students with authentic and complex problems that require critical thinking, collaboration, and creativity. In challenge-based learning, students work in teams to investigate and analyze the problem, generate potential solutions, and develop action plans. They are encouraged to draw upon various disciplines and resources, to gather information, conduct experiments, and communicate their findings effectively. This approach promotes the development of skills such as critical thinking, problem solving, communication, collaboration, and self-directed learning. Facing complex challenges, ITS students gain creative confidence, self-reliance in their ability to innovate and transform the world around them (Kelley & Kelley, 2015).

The methodology adopted, *Design Thinking*, provides a structured approach to understanding and addressing complex problems that aligns well with the goals and processes of challenge-based learning. Articulated in clearly distinct steps, design thinking frames and streamlines the use of several existing tools (e.g., brainstorming) in a way that gives management a coherent and accountable framework. The methodology has proved effective as a tool for managing innovation processes in a variety of business sectors, from the design of technologies for health care to interfaces for online services. Design Thinking has been widely also at U.S. universities and community colleges to foster entrepreneurship and innovation (Kisker, 2021) (Fig. 1).

By incorporating design thinking into challenge-based learning, students develop a structured problem-solving mindset, empathy for end-users, creativity in generating solutions, and a willingness to iterate and improve. It helps them develop essential skills for addressing complex challenges, fosters innovation, and prepares them to tackle real-world problems effectively (Luka, 2020, Baden & Major, 2004, Razzouk & Shute, 2012, Welsh & Dehler, 2013).

Fig. 1 Design Thinking Process. Source: IDEO (https://www.ideou.com/blogs/inspiration/what-is-design-thinking)

Started with the ITS 4.0 initiative, the adoption of Design Thinking has had a significant impact on Italian tertiary vocational training. The ITSs that have begun to use this methodology on a routine basis have significantly transformed the way they manage their relationships with students and businesses. In general, students have appreciated the opportunity to get in direct contact with enterprises, to develop soft skills complementary to those traditionally developed within their traditional courses and have understood the potential of teamwork by recognizing the value of different skills. With respect to enterprises, ITSs have understood the potential of young students in fostering a digital culture within manufacturing enterprises and gained awareness in developing medium- and long-term innovation projects.

4 The Upskill 4.0 Project

Created in the wake of the successful ITS 4.0 initiative, Upskill 4.0 is a Ca' Foscari University spinoff, incorporated as a benefit company focused on promoting innovation for SMEs and craftsmanship by connecting firms and higher technical schools (ITS) to solve technological and innovation challenges.

As of 2023, Upskill 4.0 has managed more than one hundred innovation projects across the entire country, supporting companies operating in the main *Made-in-Italy* sectors: food, mechanics, fashion, furniture,... and more. The companies involved were selected through calls for expression of interest aimed at identifying candidates with established *know-how* in their industry sector and an adequate disposition towards technological innovation. On the education side, the projects involved Ca' Foscari University and fifteen ITSs nationwide, most of which specialized in digital

technologies. The projects were developed in batches involving a varying number of firms from different regions, each firm being engaged in a systematic sequence of steps synchronously with the other firms in the same batch:

- definition of the challenge with the firm's management;
- selection of the ITS student group and of the university researchers acting as tutors;
- execution of the Design Thinking innovation journey, through its six steps (cf. Fig. 3.1);
- presentation of project results at public final events.

We discuss three examples to help illustrate the nature of the projects and their impact for the involved SMEs.

In Verona, a renowned custom bicycle manufacturer sought assistance from Upskill 4.0 to enhance the steel tube welding process used in crafting their frames. The primary challenge in welding lies in the scarcity of skilled technicians adept at handling intricate operations on tubes of varying thickness. Novice technicians struggle to create high-quality frames and often abandon their work due to mounting frustration after repeated unsuccessful attempts. To address this issue, students from ITS Maker in Modena proposed a solution based on outfitting the welder with an augmented reality viewer. This innovative tool enables technicians to modulate the energy required at each stage of the welding process. Resembling techniques found in video gaming experiences, this solution preserves the artisanal nature of the craftsmanship while streamlining the process and fostering the integration of new professional profiles within the company.

A vivarium located in Canneto sull'Oglio, in the province of Mantua, sought ways to revamp its catalog to promote a better engagement with the interior design professional community. The students from ITS Fitstic in Bologna initiated discussions with industry experts, highlighting the importance of offering interior designers an image catalog encompassing the evolving aspect of the plants throughout the year. This includes considerations for their adaptability to specific terrains amidst the backdrop of climate change. Through renewed collaboration with the supply chain, the students developed a platform capable of showcasing a garden's seasonal appearances and assessing plant compatibility within a specific territorial context undergoing climatic shifts.

Engaged by a furniture manufacturer in Vicenza, Upskill 4.0 was tasked with conceptualizing furniture made from recycled materials utilizing existing machinery. The Students from ITS Malignani in Udine enthusiastically embraced the challenge from both creative and technical standpoints. Through a comprehensive evaluation of modern workspaces, they envisioned contemporary libraries and accessories tailored to their generation's preferences. Leveraging ongoing experiments in the Manzano chair district, they successfully crafted a collection of furniture using repurposed wood waste, aligning with the client company's existing equipment.

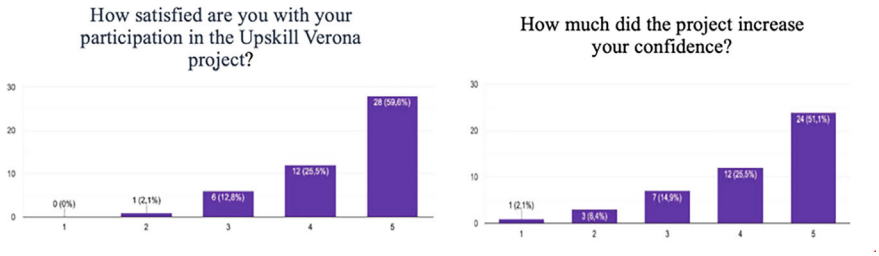

Fig. 2 Student evaluation: results processed from 49 completed questionnaires out of 150 sent to the students engaged in the Verona project in 2022 and 2023. The scale of values is from 1 to 5

Preliminary Evaluation and Findings

The impact of the Upskill 4.0 activities has been monitored in relation to both the learning outcomes and the technological progress.

Learning Outcomes

Although the number of completed projects and of students involved is still too limited to draw definitive conclusions, the questionnaires submitted to students and professors show a noticeable increase in engagement in the learning process and acquisition of relevant soft skills. From the first available elaborations, the students show that they develop a new ability to relate to the stakeholders in the enterprise, specific skills in defining complex problems, and a specific competence in presenting the results of their work.

The student evaluations are particularly interesting because they suggest new ways to motivate new enrolment toward tertiary technical education paths. For example, looking at the ratings by the students who participated in the projects carried out in the Verona region, one notices that not only is the level of satisfaction high but also that the participants' self-esteem benefits significantly from having experienced a collaborative methodology in a real-world context (Fig. 2).

Business Progress and Innovation

As for businesses, managers and entrepreneurs declare their appreciation, and recognize the value of innovation based on established methodologies. As a result of the disciplined interaction with students and researchers, they have had the opportunity not only to deal with digital technologies but also to test new market sectors, new business models and technological solutions as well as completely new languages and communication models.

Structured data from questionnaires submitted to entrepreneurs and managers are not yet available. Qualitative interviews, conducted on behalf of the banking foundation supporting the project, emphasize the importance of engaging with fresh and innovative perspectives and methodologies commonly employed by medium-sized and large enterprises. Though only a small fraction of the projects developed

by the working groups has actually been implemented, the overall evaluation of the process is nevertheless positive in the great majority of enterprises. The collective effort has ignited unprecedented dialogue among managers and entrepreneurs within the region and the results achieved by more proactive companies have inspired other firms, sparked knowledge sharing and promoted confidence in the potential of digital tools.

5 Conclusions

The outcomes of the Upskill 4.0 experience confirm the potential of problem-based, active learning in fostering innovation. By actively connecting schools, universities, and businesses, these teaching and learning models produce virtuous short-circuits which in turn provide talented students with opportunities to encounter and explore firms that frequently possess untapped potential. Moreover, they suggest a novel approach to developing policies aimed at nurturing digital innovation within small and medium-sized enterprises, enabling them to capitalize on significant technological opportunities. Indeed, the project has attracted growing attention from diverse associations representing manufacturing and service companies across the country, and motivated the proposal, currently being drafted, of a wider, nationwide initiative aimed at bolstering the competitiveness of small and medium-sized enterprises.

The social impact of the project is also paramount, as small businesses play a vital role both in metropolitan areas and in small towns, by providing opportunities for young individuals to form social bonds and showcase their skills, and by contributing to the resilience of a middle class long affected by the globalization trends of the last three decades.

Business schools and related institutions have a central role to play in both the economic and social domains. Economically, forging beneficial partnerships between advanced vocational training and small to medium-sized enterprises offers a pathway to reinforce sectors with untapped growth potential. By harnessing digital tools, traditional industries can venture into new markets and foster innovation in value creation. Socially, these connections strengthen the bonds within local communities, promoting the widespread dissemination of digital knowledge and fostering an informed and active citizenship.

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Innovation and Digital Transformation

New Medicines Design, Development and Commercialization in the Era of AI

Magnus Nydén and Dafni Bika

Abstract The escalating demand for innovative therapies and increasing chronic disease incidence pose significant challenges to the pharmaceutical industry. Regulatory bodies are prioritizing more cost-effective, sustainable solutions with greater transparency. In response, AstraZeneca is evolving its strategies to prioritize speed, sustainability, and cost-effectiveness, while maintaining quality and patient safety. We are leveraging advancements in data-centric science, digital twin technology, and AI, including generative AI, to expedite clinical trials and streamline drug development. Our digital transformation is rooted in a profound understanding of drug substance and product, clinical supply chain planning, and manufacturing. This shift is facilitated by data, novel business processes, and human skills. We are entering a new era of digital innovations, where our pharmaceutical development expertise is strengthened by tools like generative AI and deep understanding of various scientific disciplines. This paper provides an overview of our activities and methodology for digital innovations relevant to pharmaceutical technology and development. It delves into the Drug Development Holistic Digital Twin concept, aimed at transforming our work methods, productivity, and innovation, and concludes with an update on progress and future plans.

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1 Introduction

Addressing the Complex, Rare, and Chronic Diseases Conundrum

The contemporary healthcare landscape is labyrinthine in its complexity. An escalating prevalence of intricate, rare, and chronic diseases necessitates significant research investment for novel therapeutic discoveries. These conditions demand ingenious and innovative strategies, often requiring the development of entirely new therapeutic methodologies to effect meaningful change (Shemesh et al., 2021).

Take, for instance, chronic diseases such as cardiovascular disease, diabetes, and respiratory conditions. Given their persistent nature, long-term management strategies are essential for patients grappling with these daily challenges. Rare and complex diseases, on the other hand, represent the medical world's enigmatic puzzles, necessitating personalized, bespoke therapeutic approaches (Shemesh et al., 2021; Tan et al., 2010). However, the journey to effective treatment is fraught with difficulty. The unique nature of each disease complicates the discovery of efficacious drugs, a process consuming substantial time and resources, without considering the additional hurdles of clinical trials and regulatory compliance. The landscape is further diversified by the advent of synthetic molecules, advanced biologics, gene and cell therapies, and large, complex synthetic molecules, each with its own manufacturing intricacies (Shemesh et al., 2021; Tan et al., 2010).

Despite these formidable challenges, we remain resolute in our commitment to overcoming them. Our path forward is clear: relentless advancement, ceaseless creativity, and an unwavering patient-centric focus.

The Oncology Enigma

Oncology, a distinct discipline within the medical field, presents its unique set of challenges. Cancer is not a singular entity but a multifarious dilemma necessitating a comprehensive understanding of its underpinning molecular and cellular mechanisms (Shemesh et al., 2021).

The development of effective anti-cancer drugs, particularly for rare and aggressive varieties, resembles an expedition into uncharted territories. This journey mandates incessant research, perpetual innovation, and unwavering determination to uncover the next major breakthrough. Our R&D colleagues are indefatigable, leveraging their vast accrued knowledge while incorporating emerging techniques to enhance our fundamental understanding of the disease. This includes the application of AI-based methodologies to address cancer at its very core (Shemesh et al., 2021). The increasing demand for personalized oncology treatments further underscores the importance of understanding the underlying biological mechanisms and identifying

safe and effective drugs. Gene and cell therapies exemplify the trend towards named patient use manufacturing (Thakur et al., 2021; Brücher et al. 2014).

However, the oncology landscape does not accommodate a one-size-fits-all approach. Each patient and each cancer type necessitate specialized, custom-tailored treatments. With many forms of cancer posing life-threatening risks, the urgency for rapid drug development is palpable. This urgency extends beyond just drug discovery to include cost-effective strategies for transforming these drugs into viable patient treatments (Shemesh et al., 2021).

One example of accelerating Oncology Drug Discovery with AI is found in a recently announced partnership between AstraZeneca and Absci. The partnership is focused on leveraging Absci's "zero-shot" generative AI technology to fast-track the discovery of new cancer treatments. Combining AstraZeneca's oncology expertise with Absci's platform, the collaboration aims to refine antibody discovery, moving from AI-designed molecules to validated drug candidates in just six weeks.

Despite these immense challenges, the oncology field continues its rapid progression, fueled by innovations such as AI. Confronted with the formidable task of eradicating cancer as a cause of death, we remain undeterred, driven by our passion to provide patients with a beacon of hope for a healthier future.

Navigating Regulatory Challenges and Emphasizing Transparency

Regulatory authorities, such as the FDA, continue to raise the standards and adjust their expectations for pharmaceutical companies. The emphasis on transparency and data sharing is paramount, particularly about data submission processes and the safety and efficacy of novel drugs. Our responsibility is to provide the appropriate data, with an escalating focus on real-world evidence and structured data that prioritize patient experiences (Pharma IQ, 2022). We are tasked with demonstrating the functionality of these drugs in real-world scenarios, beyond the controlled conditions of a laboratory, and elucidating their effects on actual patients in their daily lives.

This shift in perspective holds transformative potential for pharmaceutical organizations. The focus is no longer solely about data generation, but rather on the creation of relevant, fair data and its proper management. It involves fostering an environment in which openness and accountability form the cornerstone of our operations.

Furthermore, some of the most influential regulatory bodies are forward-thinking in the digital age. For example, they acknowledge the potential of in-silico methods for predicting pharmaceutical outcomes. The FDA was an early adopter of this perspective, recognizing the transformative potential of these methods for the industry and benefiting patients (Pharma IQ, 2022). We have seen more acceptance of modelling and simulations and predictive studies data in stability and biopharmaceutics. In 2023 we have delivered significant productivity gains (tens of millions of

dollars) and lead time to launch reductions (more than 40 months) by Biopharmaceutics modeling that helps us remove the need for in vivo studies when changing formulations in development and predict food effects.

Technological Solutions: A Triad of Speed, Sustainability, and Cost-Effectiveness

In the face of escalating challenges, we persist, exploring cutting-edge technological solutions to address these issues proactively.

The pace of drug development is crucial, but speed should not compromise sustainability, cost-effectiveness, and, above all, patient safety. This is where 'digital twins' come into play.

Consider a virtual replica of a physical system—such as a simple tablet compression process, a complex chemical synthesis route, or even a business process like quality assurance. A Digital Twin for these processes or materials allows us to monitor and predict outcomes in real-time, optimizing future scenarios (Huang et al., 2021). This might involve hard sensor data from advanced material or process equipment, or soft data, such as supply and demand information to support supply decisions. It's akin to possessing a predictive tool that not only provides foresight into the future but also enables adjustments for improvement. This approach doesn't merely expedite drug development and ensure patient supply—it also enhances sustainability, quality, and cost-effectiveness.

As we navigate this evolving landscape, it's evident that the combination of digital twins and language models is more than a fleeting trend (Chen et al., 2020). It represents a transformative approach that may redefine the future of pharmaceutical innovation. This is the future we are stepping into—a future where technology and innovation synergize to create superior, safer, and more efficacious treatments for patients.

2 Methodology

Data: The Essential Fuel for Digital Twins

The potency of data-centric science and engineering approaches, commonly encapsulated under the broad term "AI", is well-established. AI methods place data at the core of discovery and design, utilizing high-quality datasets as the foundation for deriving insights, making predictions, and ultimately decisions (Chen et al., 2020; Brunton et al., 2019).

In the realm of drug development, we are increasingly generating data across several of our application domains, providing a rich resource for crafting digital

twins. The accuracy of a digital twin is intrinsically linked to the nature, quality, and volume of data. For instance, a digital twin of a drug development process would necessitate extensive data concerning the drug's chemical properties, manufacturing parameters, and the outcomes at various developmental stages (Girolami et al., 2020; Pan et al., 2022).

We ask three fundamental questions before assessing whether AI, particularly machine learning, can be used to identify patterns in data and thereby assist us in predicting output from input data. Those are:

1. Can we obtain the "right type" of data?
2. Can we obtain enough volume of that "right type" of data?
3. Can we obtain high enough quality of that "right type" of data?

The process always starts with "the right type of data". This question is answered by a subject matter expert. By deep mechanistic understanding, i.e., the chemistry, biology, process science or physics of the problem at hand, the subject matter expert can advise on the sensor technique to use. The questions about volume and quality are best assessed by subject matter experts working closely with machine learning experts. If the answer to all three is "yes" there is an opportunity to develop a neural net model trained by machine learning. If the answer is "yes" to #1 but the assessment is that we can measure data with volume or quality, enough we resort to mechanistic models to build our twins. For pharmaceutical development, because of the nature of the scientific problem and the often lack of large datasets we may have to resort to mechanistic models. Even in cases where the assessment is that we can answer "yes" to all three questions, our approach is always based on our mechanistic understanding and the underpinning models. This may then result in a hybrid modelling development approach.

However, for very complex scientific and engineering applications, a pure data-centric approach is often the only choice and hence data is crucial for constructing digital twins. Data is much like the foundation of a building, the more robust and reliable the data, the more impressive the resulting structure or twin.

For our ability to model a particular unit operation we focus on the three questions above. The next step is to connect unit operations in a workflow and a "control unit" to manage. This is where multimodal LLM's come in (more about this below) and the vital importance of structuring our data—"a data house in order", ultimately in the form of well-defined knowledge graphs—encompassing aspects such as Information Technology infrastructure, tools/software, foundational sensor data for automating data transfers, and more. Our focus on data transformation aims to harness the full potential of the data we generate dan identify any data gaps (Girolami et al., 2020; Pan et al., 2022).

Mechanistic Understanding: The Soul of Digital Twins

AI methods, such as machine learning, benefit from a mechanistic understanding of parametric relationships, or the underlying mathematical equations. By comprehending the fundamental principles and mechanisms, we can build models that are both more precise and reliable (Brunton et al., 2019). With these reliable models, we can perform simulations and iteratively refine these models using real or synthetic data towards a predictive model for the physical system. When this model consistently predicts accurately regardless of the input parameters, we have a digital twin of the physical system.

In the context of digital twins, a profound mechanistic understanding stems from years of accumulated fundamental knowledge by our scientists. It necessitates a deep comprehension of chemistry, biology, physics, and more to guide us towards developing new sensor systems to reveal "the soul" of the system/material/process under study (Novelli et al., 2022). This understanding is the foundation of a more precise and lifelike virtual representation. For example, understanding the mechanistic relationship between various parameters in a drug manufacturing process can aid in creating a digital twin that closely mirrors the physical process. The level of digital twin accuracy is vital for making reliable predictions and decisions (Brunton et al., 2019).

In essence, a mechanistic understanding of parametric relationships is akin to the fine-tuning of instruments in an orchestra. It refines the symphony produced by the data-centric approach and mathematical modeling (discussed more in the next section), ensuring the resulting digital twin is as accurate, predictive, and useful as possible. It is an integral piece of the puzzle that brings everything together harmoniously and heavily depends on the years of expertise accumulated by our scientists (Brunton et al., 2019).

Mathematical Models and Simulations: The Boundary Conditions of Digital Twins

A deep mechanistic understanding paves the way for the development of closed form mathematical models and the potential for using these models in simulations to predict outcomes given certain input parameters. Thus, the term "model" refers to the theoretical framework—hence "the boundary conditions of digital twins"—represented by mathematical closed form equations. It is a static representation of a system, while simulation is the dynamic implementation of the model over time. This dynamic nature allows for parameter exploration within the framework. Thus, models and simulations are inseparable and are key to unlocking the full potential of digital twins (Brunton et al., 2019).

Simulations mimic complex physical processes and systems, allowing us to adjust parameters and observe the resultant changes. In the context of digital twins, mechanistic models enable the creation of a virtual replica of physical processes/systems, providing a dynamic platform for experimentation and optimization. For instance, a mechanistic model forms the basis for simulating a drug manufacturing process, predicting the effects of changes in temperature, pressure, or chemical concentration. This predictive capability facilitates proactive problem-solving and decision-making, enhancing the pace and efficiency of the development process (Brunton et al., 2019; Pan et al., 2022).

In summary, for "well-behaved" or relatively simple physical processes/systems, closed form mathematical models and simulations act as the architect of digital twins by establishing a dynamic framework of meaning and utility. Their role in creating digital twins and, by extension, in pharmaceutical innovation, is indispensable.

However, there are physical processes/systems with such parametric complexity that a conventional closed form mathematical model is impossible to define. In these cases, mechanistic understanding and resulting mathematical models/simulations merge with data-centric techniques—AI, specifically machine learning—to usher in the next era of digital innovations (Brunton et al., 2019; Pan et al., 2022).

AI: The Rocket and Conductor of Digital Twins

In the present AI age, characterized by various machine learning techniques, we're witnessing the evolution of language models and, specifically the increasingly popular large language models (LLMs), and lately the development of multimodal input (e.g., images and video). These LLMs are emerging as new AI powerhouses, demonstrating unprecedented abilities to process, analyze, and "understand" complex data (Huang et al., 2021). As LLMs develop their multimodal input and output capabilities, they're anticipated to significantly enhance their cognitive abilities, thereby assisting humans in increasingly challenging tasks.

We already understand that machine learning is a valuable tool that supplements mathematical models, propelling them towards the creation of digital twins through training of the relevant data, especially for moderately complex systems/processes. We also recognize its potential for independently create digital twins of highly complex systems/processes by analyzing patterns in very large datasets (Brunton et al., 2019; Huang et al., 2021).

We envision a future where a well-trained and finely-tuned augmented multimodal LLM serves as the adhesive that integrates multiple digital twins into a cohesive framework—essentially, directing digital twins (see more in Sect. 5). In this sense, LLMs can be likened to the conductor of an orchestra, ensuring all disparate parts work harmoniously together to enhance the efficiency and effectiveness of an entire process, such as a pharmaceutical development process. As the conductor, it continuously updates and fine-tunes itself as more data becomes available, thereby improving its own performance (Brunton et al., 2019) (Fig. 1).

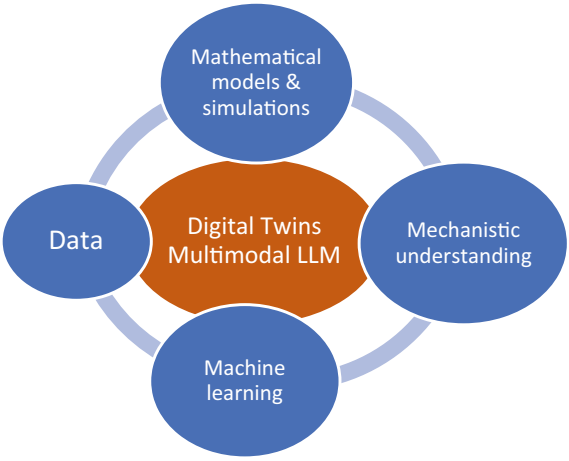

Fig. 1 Digital Twins are built on a foundation of data and mechanistic understanding translated into closed form mathematical models for simulations or into black box models developed by machine learning techniques. As LLM's develop we hypothesise that these models will play increasingly important roles as the conductor of different models

3 Case Studies: Digital Innovations in Action

Here we provide two concrete examples of work that aim toward creating digital twins, i.e., towards a proven predictive digital replica of the physical system/process. The focus is on specific projects in drug development where digital technologies have been utilized to accelerate drug development and improve patient outcomes.

Direct Compression versus Roller Compaction

Gavi et al. (2014) present a system model of a pharmaceutical tablet manufacturing process that connects the active pharmaceutical ingredient's (API) physical properties to the governing parameters of the product formulation process (Gavi et al., 2014). The authors contended that for the model to serve as a true twin of the actual system, it needed to address the following key questions:

- Which processing route is the most robust, considering the API material properties and dosage requirements?
- How do drug loading and tablet size influence the robustness of the manufacturing process?
- What process settings are necessary for a robust manufacturing route given the API material properties and drug loading requirements? (Fig. 2).

Specifically, they opted to compare the performance of Roller Compaction and Direct Compression technologies, aiming to predict which technology would be most suitable for a specific API. They then endeavored to define the governing equations for the relevant process steps and the chemical and material parameters related to those steps (Gavi et al., 2014). The subsequent step involved using the system models

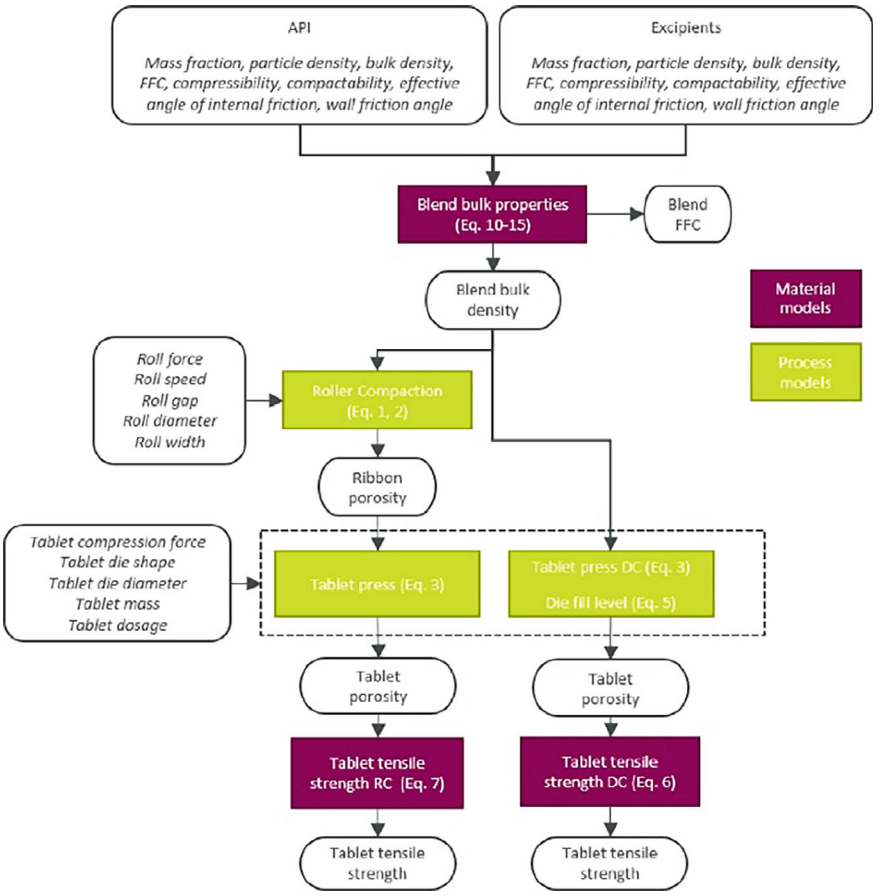

Fig. 2 Work by Reynolds et al. describing the multi-step and multi-parametric relationships in the Continuous direct compression (CDC) process

to generate process classification and design space maps computationally, with the objective of identifying a "parameter space" for robust pharmaceutical formulation and process decision-making.

Through conducting 6000 simulations across a range of process parameters and API properties, they discovered that the system model could indeed serve predictive purposes. Specifically, it could aid in selecting manufacturing technology for a certain API and support formulation and process design when, for instance, the API mass fraction was varied (Gavi et al., 2014). In conclusion, the underpinning mathematical model has shown strong predictive power, that with the training of real data over time is likely to lead to the development of a digital twin.

Predicting the Chemical Structure of Amorphous Structures

We would like to draw attention to a significant example from Cordova et al. (2021)—see Fig. 3. The authors amalgamated dynamic nuclear polarization-enhanced solid-state NMR, molecular dynamics simulations, and a machine learning method for chemical shifts (Cordova et al., 2021). This combination of methodologies enabled the prediction of disordered materials' structures, such as amorphous solids, in an extremely time-efficient and precise manner.

More specifically, they trained a machine-learning model on calculated chemical shifts (using a method called GIPAW Density Functional Theory) for 3546 different chemical structures from the Cambridge Structural Database (CSD) (Cordova et al., 2021). This machine learning model, known as ShiftML, can now predict chemical shifts for any molecular solid in mere seconds (compared to days or longer using standard DFT methods), paving the way for large-scale shift computations on extensive structures.

The authors effectively deciphered the structure of an amorphous material by integrating Machine Learning (ML), NMR, and Molecular Dynamics (MD) (Cordova et al., 2021). This was achieved by comparing experimental chemical shifts with predicted shifts from structures derived from the machine learning model's MD simulations. They claimed that this process could be conducted at-scale due to the highly efficient method developed. This research exemplifies the development of a mathematical model that illustrates the relationship between chemical parameters, represented by their chemical shifts, and the amorphous structure, a vital factor for oral product development. It's likely that a digital twin can be created with more extensive training on both experimental and theoretical data (Cordova et al., 2021).

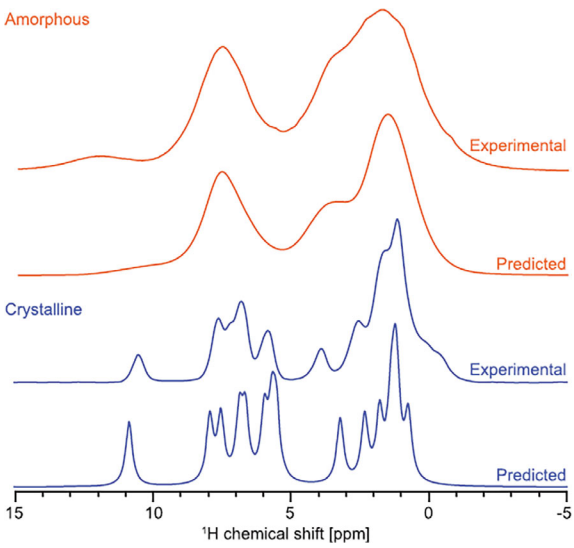

Fig. 3 Experimental and predicted NMR spectra using a combination of machine learning (ML) and molecular dynamics (MD) simulations allowing for predictive models for predicting performance of disordered materials

Synthetic Route Design—the Key to an Active Ingredient

In this example we focus on the synthetic route used to manufacture an active pharmaceutical ingredient (API). It is a key determinant for several long-term commercial metrics: cost of goods, sustainability (waste) and lead-time (manufacturing and development). Route Design is required for practically all development programmes to move from an initial discovery synthetic route (figure, top) to a commercially viable synthetic route (figure, bottom).

We use a lean process for performing Route Design, which comprises of 4 iterative steps:

(a) Invent synthetic routes to a target molecule.
(b) Predict and prioritise synthetic routes to explore in the laboratory.
(c) Execution of potential routes in the laboratory
(d) Decide on the longer-term synthetic route for clinical and commercial manufacture (Fig. 4).

As computational and AI capabilities improve, we supplement traditional, human innovation in synthetic route design to generate hundreds or even thousands of *potential* synthetic routes to an API for faster invention, prediction and prioritization. Traditionally, we would rely on the intuition and judgement of our synthetic chemists to select a handful of potential routes for laboratory execution. Our new approach uses

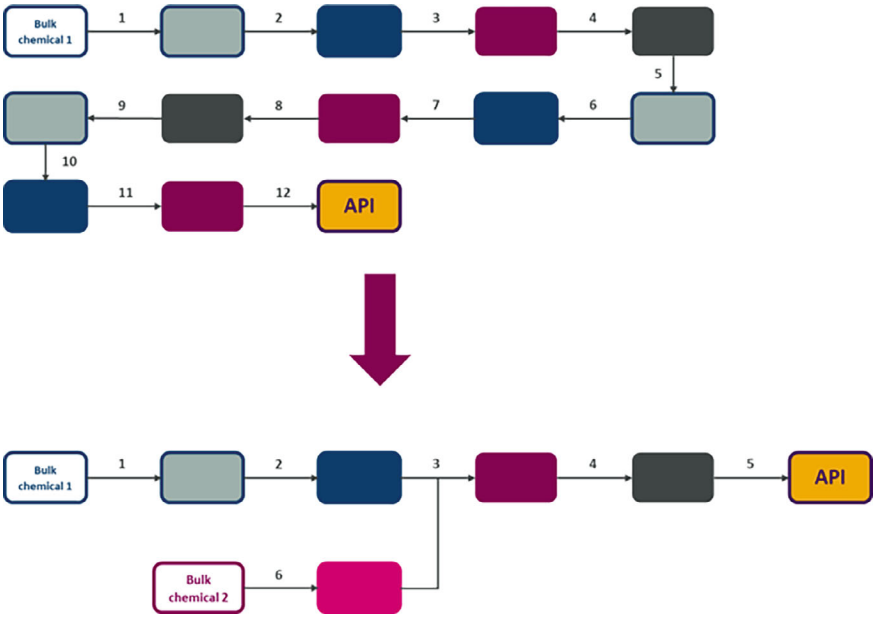

Fig. 4 Schematic example of route design at work, effectively reducing the number of synthetic steps in the manufacturing of our active pharmaceutical ingredients (APIs)

novel metrics based on graph and information theory to quantify the "complexity" inherent to each potential synthetic route. This complexity is then modelled against our internal portfolio of development and commercial compounds to provide estimates of cost and waste. This approach can be automated via the internal to AZ Route Manager tool, allowing thousands of potential synthetic routes to be modelled rapidly. The most promising synthetic routes can be highlighted and prioritized for laboratory investigation, reducing time to invention. This allows 1000 + ideas to turn into approximately 4 ideas for execution in the laboratory.

The prioritized ideas are executed experimentally using High-Throughput experimentation, continuous processing, or new synthetic pathways involving electrochemistry or photochemistry and traditional parallel automation equipment or even single flasks. The outcome is that some routes will have been shown to be viable, whilst others not. The 4 ideas will commonly reveal only 2 to be feasible. The demonstrated routes are compared to the existing route using Safety, Environment, Legal, Economics, Throughput and Cost criteria (Butters et al., 2006). This allows a weighting of each route against the criteria ultimately leading to selection of a route for clinical and commercial synthesis and supply.

This approach has allowed us to conduct our synthetic route design in a more focused way, affording a lead time reduction from 9–12 months down to 3–5 months for a typical project. We have used this approach on multiple projects to deliver cost-saving potential and with significant reduction in waste. Each of these approaches has also shortened synthetic length, offering shortening of supply chain lead-times, whilst reducing inventory costs.

4 The Impact of Language Models on Business Transformation

Language Models (LMs), including Large Language Models (LLMs) like OpenAI's GPT-4 and Google's inherently multimodal Gemini model, carry transformative capabilities, particularly for businesses with intricate supply chains (Chui et al., 2022; The Economist, 2023). LMs utilize Natural Language Processing (NLP) to comprehend, generate, and interpret human language, enabling a more sophisticated, human-like interaction with data. This capacity offers promise for various applications, ranging from customer service to decision support and knowledge management, extending further as their abilities evolve to understand and generate non-language outputs, thanks to multimodal data training.

In a business setting, LMs serve as an integral hub, amalgamating diverse digital twins into a unified, intelligent digital twin representing end-to-end business processes (Chui et al., 2022, The Economist, 2023). Processing and analyzing copious data from multiple sources, these models offer valuable insights, enhance communication, and improve supply chain coordination. For example, an LM could link a

digital twin of a manufacturing process with one representing logistics and distribution. By interpreting the language-based data generated across these processes, the LM can discern patterns, forecast outcomes, and propose optimizations, effectively creating an integrated intelligent model of the entire supply chain (Wiles et al., 2023).

Additionally, LMs can transcribe these insights into human-readable formats, making intricate data more accessible to decision-makers (Rotman et al., 2023). By presenting data as narratives or conversational responses, LMs facilitate data-driven decision-making across an organization's tiers. LMs can also adapt to real-time changes, learning from new data and feedback to refine their predictions and suggestions. This adaptability is critical in fluid business environments, where swift responses to changes can offer a competitive edge (Mazurek et al., 2023).

However, to fully harness LMs' potential, organizations must foster a digital mindset receptive to these advanced technologies. Leaders must comprehend LMs' capabilities and implications and motivate their teams to explore their potential. Employees, in turn, need to be receptive to learning about these models and integrating them into their workflows (Chui et al., 2022; Mazurek et al., 2023; Rotman et al., 2023; The Economist, 2023).

In conclusion, LMs hold the potential to overhaul business operations, especially in organizations with complex supply chains. They offer a pathway to integrate diverse digital twins into a comprehensive, intelligent model, boosting decision-making and efficiency. However, actualizing this potential necessitates a digital mindset that embraces innovation, continuous learning, and collaboration (Chui et al., 2022, Mazurek et al., 2023; Rotman et al., 2023; The Economist, 2023).

5 The Drug Development Holistic Digital Twin—The Next Era in Digital Innovation

The Holistic Digital Twin we aim to construct (see concept in Fig. 5) is anticipated to revolutionize our productivity and operational procedures. We envision it as an experimental platform for the entire organization, where we learn from our triumphs and failures and cultivate skills we currently lack. This endeavor is rooted in our foundational capabilities, augmented by Artificial Intelligence (AI). The figure provides a high-level overview of our proposed approach, illustrating various layers.

The cornerstone of this development lies in our business processes, such as standard product development, combined with well-managed data. This encompasses data from equipment sensors, actuators, analytical risk assessment, toxicity data, and others, each with a well-defined place in our business processes[10]. We aim to automate data transfer between equipment sensors and quality control tools, as well as manage the evolving performance of multimodal Large Language and Large Action models (Pan et al., 2022). By providing the appropriate contextual information to the Large Language Model (LLM), such as the location of certain data

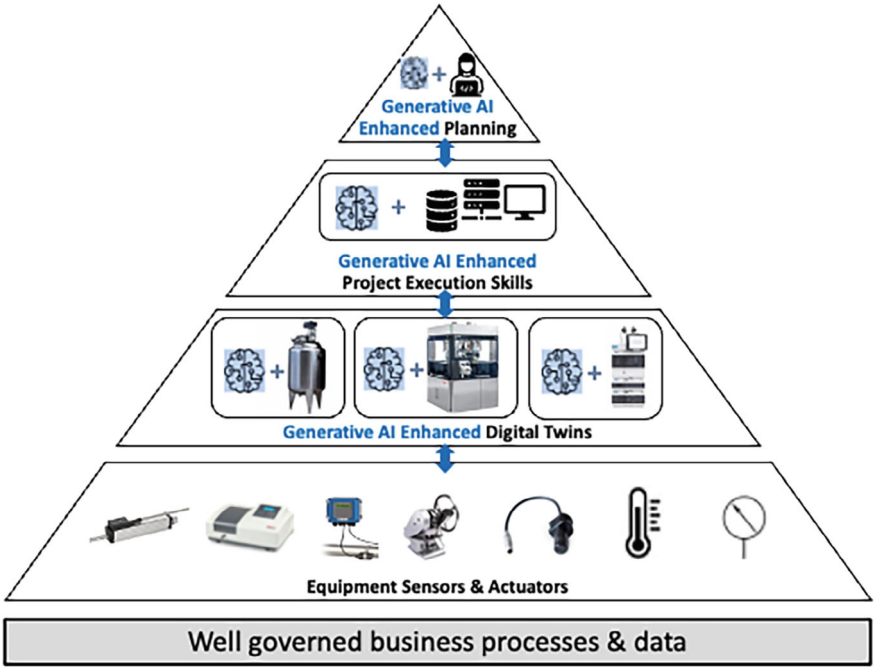

Fig. 5 Concept figure of a holistic digital twin of a pharmaceutical development function, re-drawn from Weirich et al. (2023). The different layers represent flow of data and information allowing automation across technical work as well as generation of reports, documents automated decision support at the top two layers. The holistic digital twin is founded on well governed business processes and data

within business processes, we aim to automate future tasks. These tasks include pre-filling risk assessment templates with predicted risks, proposing mitigation strategies, authoring and reviewing drafts, and more, all under proper human supervision and quality compliance measures.

A well-tuned LLM can be considered a "drug development brain", encompassing the cumulative knowledge from past submissions. It's akin to having immediate access to the collective knowledge of our AstraZeneca colleagues over the years. By connecting the LLM to external data, we can incorporate the best scientific knowledge from outside our organization. Hence, this "brain" could be further fine-tuned with external information, such as scientific papers and regulatory data (Fill et al., 2020).

A key feature of LLMs is their ability to work with relatively sparse data and identify patterns or parametric relationships. However, successful fine-tuning requires appropriate "prompting" of the LLM on how to comprehend, analyze, and generate new content from incoming data. This will be a critical aspect of AI augmentation. Lastly, we emphasize the necessity of data governance for successful automation and reduction of laborious tasks for lab staff, ultimately feeding the Generative AI-enhanced Digital Twin layer and the layers above.

In the layer above we predict the potential to use Generative AI for enhanced project simulation and forecasting, e.g.:

- Time line
- Resource and skills
- Viable routes towards the target commercial product
- Technical and regulatory risks
- Author plans, reports and regulatory submissions

And finally, in the top layer, a successfully deployed Generative AI enhanced Digital Twin will have capability to perform business scenario forecasting for:

- Overall resources
- Revenue
- Capital
- Carbon footprint

As an essential concluding remark, while constructing the Drug Development Holistic Digital Twin (DD HDT), we strive to ensure seamless integration with drug discovery and early formulation data. We will also establish a well-planned and smooth transition to our manufacturing sites for rapid and efficient deployment. This approach will facilitate further training of the mathematical models, thereby enhancing the precision and predictive capacity of the digital twins as they access a wealth of data from large-scale manufacturing.

6 Embracing the Digital Mindset: The Key to Successful Transformation

The advent of AI has already reshaped the business landscape, presenting both new opportunities and challenges. This shift necessitates a paradigm change in organizational culture and mindset, in leaders and the broader workforce. An effective digital transformation, especially when leveraging the power of AI, demands more than technological savviness; it requires a digital mindset rooted in adaptability, innovation, and continuous learning (Chui et al., 2022; Huang et al., 2021).

A digital mindset in an organization is characterized by an eagerness to embrace new technologies, a readiness to adapt to change, and a commitment to innovate—and as highlighted in this paper, a deep understanding of the potential with new AI technologies, LLMs in particular. This is challenging for most organizations because on the one hand it may be thought of as a new way of thinking about science and engineering. On the other hand, it can be seen as a natural extension of the science that Newton taught us some 350 years ago. It involves viewing digital technologies not as mere tools but as integral components of business strategy. AI, with its vast capabilities, exemplifies this shift. From predictive analytics to natural language processing, AI has the potential to transform various aspects of a business, making

it imperative for organizations to embed an AI-centric approach in their strategy and culture (Cordova et al., 2021).

For Drug Development leaders, a digital mindset involves championing this transformation. Leaders with a digital mindset foster an environment where innovation thrives, where calculated risks are encouraged, and where the adoption of new technologies is seen as an opportunity rather than a threat. They embrace AI's potential and understand its implications, thereby guiding their teams through the transformation process. They also recognize the importance of upskilling and reskilling, promoting continuous learning to ensure their teams can harness the full potential of AI (Chui et al., 2022).

For all, a digital mindset implies being open to learning and adapting to new technologies, including AI. It involves recognizing the value that AI brings to their roles and the organization at large. It also means being proactive in upskilling, continuously seeking opportunities to enhance their knowledge and skills in the digital realm.

Recognizing the transformative potential of artificial intelligence (AI) in drug development, AstraZeneca's Pharmaceutical Technology and Development (PT&D) function is proactively launching an upskilling initiative in partnership with an external provider. The senior leadership within PT&D has already undergone AI training, and the function is currently facilitating an AI ambassador program, specifically designed for proactive individuals eager to champion this advancement. This program aims to provide a comprehensive understanding of AI, with a particular emphasis on generative AI (GenAI), along with practical use cases for participants to apply post-training. Following the success of the ambassador program, a widespread AI education program will be rolled out to all PT&D employees, intended to showcase the technology's advantages and inspire all personnel to confidently navigate and contribute to the new era of AI-augmented drug discovery.

Moreover, a successful digital transformation necessitates a culture of collaboration and inclusivity. The power of AI lies in its ability to analyze and derive insights from analyzing patterns in vast amounts of data, a task that requires diverse perspectives and expertise. Therefore, fostering a collaborative culture where different skills and ideas are valued is crucial (Mazurek et al., 2023).

In conclusion, the digital transformation journey towards a Drug Development Holistic Digital Twin requires a comprehensive shift in mindset at all levels of an organization. It calls for a proactive approach to adopting new technologies, a commitment to continuous learning, and a culture that values innovation, collaboration, and diversity. By embracing this digital mindset, organizations can fully harness the power of AI, paving the way for a future of unparalleled growth and innovation.

7 Progress and Future Plans

We have already made considerable strides in our digital transformation. Several key process steps and chemically relevant materials now exist in a state that can be described as well-progressed towards becoming true digital twins (Chen et al., 2020). This advancement means that we can model, simulate, and sometimes even decipher parametric relationships from a first principles perspective, often assisted by data-centric (AI) approaches, to predict the outcome of a new "experiment" through in-silico models, and based on those carry out simulations to replace laboratory-based experiments in the future.

Reemphasizing our previous point, a successful Drug Development Holistic Digital Twin necessitates an organized "data house". This includes our IT infrastructure, digital tools, sensor systems, analytical lab equipment, business processes, and data that communicates the complex relationships in clinical manufacturing and supply chain. All data and systems that support our colleagues, whether in labs, pilot plants, or offices, must be readily accessible at the "push of a button". Moreover, the "data house" must constantly update itself as new data comes in, enabling the Drug Development Holistic Digital Twin, bolstered by AI augmentation, to continuously learn and enhance its predictive power (Chen et al., 2020, Spindler, 2021).

8 Conclusion

AI has already made its powerful presence felt globally. The advent of large language models and the Generative AI technology in late 2022 showed many the transformative potential of this technology. AI's application in drug discovery was recognized years ago as game changing. Now, as it rapidly matures, AI is starting to significantly enhance productivity in the drug discovery process, leading to the development of increasingly efficient and safe drugs and Active Pharmaceutical Ingredients (APIs) due to AI tools.

In pharmaceutical development, we embarked on our AI journey slightly later, due to the less apparent case for AI in this extraordinarily complex business segment. However, we now see the convergence of mature and emerging technologies as the foundation for transformative steps in productivity and fundamental understanding, the bedrock for long-term innovations and sustainability. We must deliver more medicines to patients, and faster. Drug Development (DD) can ill afford to be a bottleneck. Our patients deserve better!

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Dafni Bika is a Pharmaceutical Executive with 25+ years of experience in Drug Development and Commercialization. She is currently SVP and Global Head of Pharmaceutical Technology and Development (PT&D) in Astrazeneca. She leads a global, integrated network of scientists and engineers (1500+) in 8 countries. In her current role in AZ Dafni has designed, developed and launched more than 15 new medicines since 2016, and delivered more than $500m in productivity gains. Prior to AstraZeneca Dafni led the Manufacturing Science and Technology organization in Bristol-Myers Squibb in New Brunswick, NJ, and spent 10 years with MERCK's Global Pharmaceutical Commercialization in West Point, PA. She began her career at Procter & Gamble's European Technical Center in Brussels, Belgium. She holds a PhD in Materials Science and Engineering from the University of Pennsylvania, a Master of Science in Materials Science and Engineering from the University of Rochester, NY, and a Diploma in Chemical Engineering from the National Technical University of Athens, Greece.

Product-Service Design for Factory of the Future: The OMiLAB Community of Practice

Iulia Vaidian, Xavier Boucher, and Wilfrid Utz

Abstract The digital era requires a re-evaluation of the infrastructures, networks, and processes needed in designing and managing innovative solutions. Within this context, experimentation environments are necessary for facilitating collaboration, knowledge transfer, and idea generation among stakeholders from various domains in a joint effort. The OMiLAB Community of Practice operates in and is supported at conceptual and technical levels by such an environment, actively enabling knowledge transfer through a wide range of activities. The core component of the community is the Digital Innovation Environment powered by OMiLAB. Conceptual modelling is the shared domain of the community, and it is utilized to connect the business world and the digital world with physical devices. This paper discusses the human–machine interaction challenge of the digital era and the three elements that are required to tackle it. As main contributions, a product-service design case driven by the OMiLAB Community of Practice for the Factory of the Future (FoF) ecosystem is presented. The findings are based on the community experience and their work as part of the EU-funded projects DigiFoF and CoDEMO 5.0.

1 Digital Era: The Challenge

Digital Transformation has become the defining buzzword of recent years. To effectively navigate this transformation's various aspects and characteristics, it is crucial to rethink the infrastructures, networks, processes, and organizational structures necessary for designing and implementing innovative solutions in the digital era (Moser

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et al., 2019). For this purpose, a comprehensive approach is required, combining exploratory methods with feasibility evaluations to address key challenges. One of the many challenges in the digital era is coordinating the interaction between humans and machines, as both parties form essential roles when creating, designing, and engineering innovative business models (Muck et al., 2022).

Humans contribute through their knowledge, domain expertise, and idea generation capabilities, while machines, robots, and cyber-physical systems form integral components of smart environments that characterize the digital era. The interaction between humans and machines must occur bidirectionally, with humans interacting with machines and machines providing responsive feedback (Karagiannis et al., 2022). Notably, a shift in the type of collaboration is taking place, as machines are no longer mere support systems for humans but actively collaborate and interact with humans and other machines within connected networks.

Consequently, humans and machines operate on the same "production layer" in the digital era, i.e. tasks should be allocated optimally between humans and machines, depending on who is better suited to perform the task. In a connected network of machines and humans, there is bidirectional information and knowledge exchange between the two (EFFRA, 2013). Machines, in this context, refer to physical devices enhanced with functionalities and capabilities that enable "smartness". These devices can be interconnected to facilitate information exchange. To realize this active interaction and collaboration on the same production level, bridging the gap between humans and machines is necessary and hence one challenge of the digital era. For the design of product-service for Factory of the Future, the bridging approach was imperative and employed in the DigiFoF project. Three essential components have to be considered for achieving the requirements of the human–machine interaction in the context of product-service design, labeled in this paper as the "bridging" concept:

- Certain *ingredients* are significant to support the emergent business models of the digital era,
- An *experimentation and exploration environment* to design, realize, and evaluate these models, and
- A *community of practice* to provide expertise and experience.

"Bridging": the Ingredients

The requirements of the digital era are shaped by increasingly complex business models, which are part of ecosystems, involve dependencies, integrate physical objects, and propose disruptive and innovative solutions. These business models place a strong emphasis on the interaction between humans and machines, as they require domain-specific knowledge and technical realization. In terms of conceptual representation, model artifacts form the desired output of these business models. The bridging process and the means to achieve the design of these model artifacts involves three ingredients (Karagiannis et al., 2022): concepts, methods, and tools.

In this context, concepts are understood as abstractions for a specific purpose of the corresponding business model. The conceptualization process is required to enable machine interpretation of the model artifacts, which are visually represented knowledge structures (Karagiannis et al., 2022). To achieve such a visual representation, modelling methods are applied, including dedicated modelling languages composed of notation, syntax, and semantics. To enable machine interpretation and evaluation of models, certain algorithms and mechanisms have to be implemented (Karagiannis et al., 2022). Along with the modelling procedure, which describes the methodology, these elements form the Generic Modelling Method Framework, which applies to multiple domains (Karagiannis, 2018). The third ingredient essential for achieving model artifacts is the tooling element. Each modelling method is deployed as a software tool, empowering users to create and design modelling artifacts. Furthermore, exporting and processing these models generates value in the business model by enabling machine interpretation and interaction.

These three ingredients (i.e., concepts, methods, and tools) are part of the Agile Modelling Method Engineering (AMME) framework and are further explained in (Karagiannis, 2015). To evaluate their feasibility, an experimentation environment like the Digital Innovation Environment powered by OMiLAB (Open Models Initiative Laboratory) is employed. The domain input and domain-specific requirements mentioned earlier stem from the expertise of the Community of Practice. These aspects will be further explored in the following sections.

"Bridging": The Experimentation Environment

The second component of the "bridging" between humans and machines in the digital era is an environment that encompasses both a physical and virtual space, equipped with software and hardware to foster collaboration among machines and stakeholders with diverse expertise. This environment facilitates iterative experimentation, testing, and evaluation of the interaction and collaboration between humans and machines (Bork et al., 2019). The Digital Innovation Environment by OMiLAB integrates all these elements, which are organized into three foundational pillars that shape the physical installation of the laboratory. Figure 1 shows each pillar (OMiLAB Team, 2020).

Conceptual modelling (Pillar II) is an invariant within this environment, as all the work driven by and emerging from it is based on conceptual models. Modelling is understood as a mean to represent domain-specific knowledge and operationalize it, enabling the integration of a business-oriented view with a technical view (Karagiannis et al., 2022). The business-oriented view (Pillar I) focuses on disruptive business models and ecosystems. The aim is to foster co-creation through design thinking by involving and collaborating with different stakeholders from the start of the "bridging" concept (Muck & Palkovits-Rauter, 2022). Design Thinking has gained popularity in recent years as an approach that enables domain experts to express innovative ideas and to develop solution spaces for problems that require

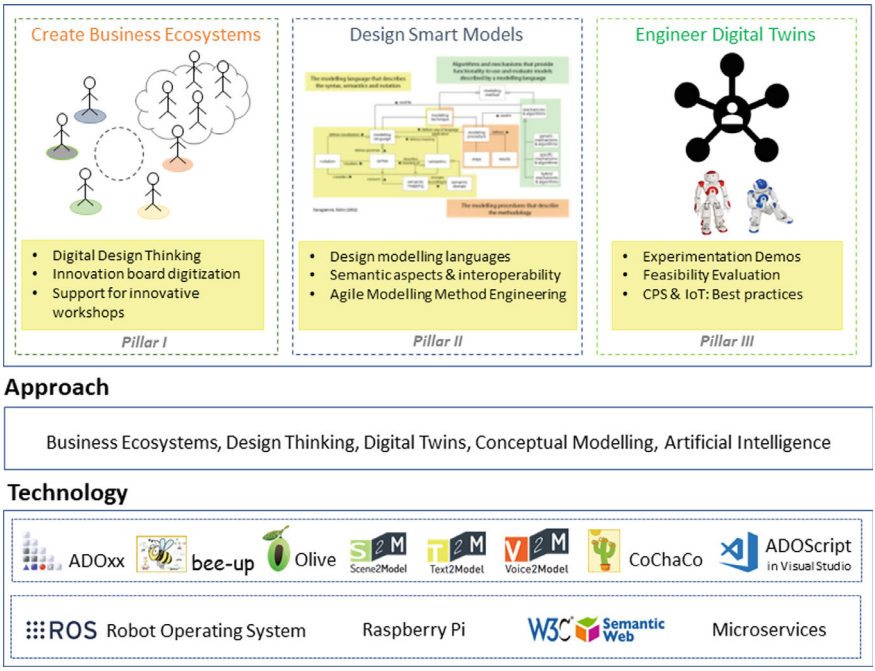

Fig. 1 OMiLAB digital innovation environment pillars (OMiLAB Team, 2020)

the knowledge and perspective of different actors within an organization and beyond (Dam & Siang, 2021). Furthermore, the technical view (Pillar III) benefits from a variety of model-driven approaches, tool deployments, and experiments with cyber-physical systems (OMiLAB Team, 2020). Intelligence in models is provided by tool functionalities that can perform model analysis, model transformation, model execution, and model integration with other systems (Karagiannis et al., 2022). These functionalities add value to models and transform them into smart models, thereby distinguishing them from mere diagrams used only for visualization purposes. Smart models can be understood and interpreted by both humans and machines (Völz et al., 2023). The Digital Innovation Environment, supporting the OMiLAB Community of Practice at both conceptual and technical levels, provides an experimentation space for challenging the design and management of innovative solutions that involve the collaboration between humans and machines.

"Bridging": The Community of Practice

In an era marked by technological advancements and transformative changes in industries, the exchange of know-how, experiences, and expertise remains an important component, which might evolve into a necessity in the digital era. Communities of practice thus continue to emerge in the digital era to guide the transformation with their specialized knowledge. One example is Ignite, an internal initiative by JPMorgan Chase for their tech employees to cultivate collaborative learning and skill enhancement in machine learning, big data, cloud computing, etc. (Wenger-Trayner et al., 2023); secondly, a successful implementation of an integrated information system in healthcare is reported by (Kanjo et al., 2022) where different communities of practice, from policy makers, developers, facilitators, and users came together; and as a third example, the benefit of a community of practice to support large-scale agile software development is discussed based on a case study in (Paasivaara & Lassenius, 2014). When creating and designing innovative business models, it is essential to consider multiple elements that should be integrated, such as technological input, domain knowledge, and practical know-how.

The Community of Practice serves as a platform for practitioners and researchers to come together, and exchange perspectives, methods, insights, and expertise derived from their respective practices to achieve this integration (Wenger-Trayner & Wenger-Trayner, 2015). Figure 2 illustrates the mindset of communities of practice, emphasizing the collaborative nature within them. The overarching objective is not only to learn from one another but also to learn with each other. Therefore, members of the community should benefit from the resources and ideas provided by the community, applying them to their work. Subsequently, members can share their experiences, reflecting on what aspects did or did not work effectively. In this way, communities of practice facilitate a key learning resource in an ongoing learning engagement, known as experience storytelling (Wenger-Trayner et al., 2023).

The discussed ingredients necessary for realizing the bridging in the digital era, namely concepts, methods, and tools, are conceptualized, created, designed, and evaluated by the Community of Practice as part of the ongoing learning loop within the experimentation space of the OMiLAB Digital Innovation Environment.

To instantiate the concept of Community of Practice to OMiLAB, three criteria must be met according to (Wenger-Trayner & Wenger-Trayner, 2015), which have also been described in more detail in our recent works (Völz & Vaidian, 2024) (Vaidian et al., 2022):

- *The domain*: It defines the focus of the community, which in the OMiLAB case is conceptual modelling and model value creation to design innovative solution spaces.
- *The practice*: It encompasses the experience gained from working with artifacts and open-source resources.
- *The community*: It provides the expertise and supports the sustainable exchange of research and industry development results, and actively contributes to knowledge transfer through various activities.

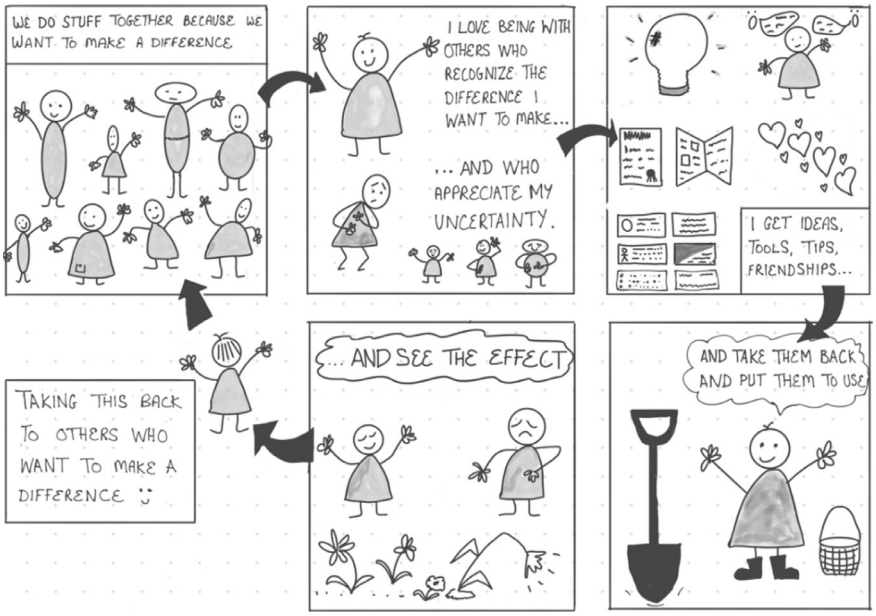

Fig. 2 Community of practice: ongoing learning loop (Wenger-Trayner et al., 2023)

The community members from all over the world come from diverse backgrounds, representing academic institutions, research organizations, industrial innovation partners, and individual participants who share a common interest in conceptual modelling and model value (Völz & Vaidian, 2024). Gradually, the growing community has established itself in response to the increasing need for exchanging experience reports and knowledge regarding the assessment of model value among conceptual modelers. Further, the community takes a multidimensional approach combining human and technological aspects. These collaborative efforts have resulted in numerous achievements, however, operative aspects such as conflict management or potential bias and their respective mitigation strategies are not discussed in this paper. The focus is on one of the practical applications of the "bridging" concept presented in the following section.

2 FoF Ecosystem: Motivation

Digitalization has been influencing and triggering changes in all areas of the industry. Thus, the processes within a factory itself have to be reimagined and adapted to the digital era. Factory of the Future (FoF) builds toward developments of Industry 4.0 where processes, infrastructures, and production flows, are adapted to act more efficiently and intelligently on the global market. The factory of the future should

integrate the physical and digital worlds (v. Heynitz et al., 2016). The manufacturing enterprises understand that, by adopting digital transformation initiatives, they can benefit from a competitive advantage. New skills and competencies are required not only for the workforce but also for the leading managers, to successfully implement, manage and lead the transformation. Significant developments from a "traditional factory" to a "factory of the future" can be observed during the Industrial Revolution from Industry 3.0 to Industry 4.0, as summarized in Table 1 (Heynitz et al., 2016; Kagermann et al., 2013).

Product-Service is one of the core elements of the transition toward FoF, as it embeds the relationship between the industry and the consumers. The consumer has become a multi-dimensional participant, serving as both a user and stakeholder in the value-creation process. Product-Service describes an integrated solution between a "product" and a "service" with value-adding functionalities to solve a problem along the solution lifecycle, supported by physical and digital infrastructures (Boucher et al., 2022). Hence, the evolution of consumer needs and anticipation of their preferences should be captured within the FoF ecosystem. The concepts and methods developed for the FoF design aspects (discussed in Sect. 2.2) facilitate the impact assessment of the multi-dimensional stakeholder participation in the ecosystem (Boucher et al., 2024).

Observing the transformation roadmap from "traditional factories" to FoF and the knowledge gap present in this context, the OMiLAB Community of Practice, based on expertise and experience and following the "bridging" concept mentioned in the first section, set out to develop FoF resources. The question, "What does a FoF ecosystem require from a scientific- and technical-based perspective?" had to be answered and supported by proof-of-concept results. The organizational structure for the development of FoF resources was guided by the EU-funded project DigiFoF "The FoF Designer: Digital Design Skills for Factories of the Future" (digifof.eu, 2022). Three pillars contributed to the core of DigiFoF, as seen in Fig. 3. These are:

Table 1 Brief overview of developments from the traditional factory to FoF

Development	Traditional factory	Factory of the future
Industrial revolution	Industry 3.0: automation	Industry 4.0: connectivity
Production	Digitalization. The integration of software and hardware in the production workflow	Smart manufacturing. Consolidation of processes along the chain to produce and deliver on a decentralized basis in real time
Value chain	Sensor systems in individual machines (one way)	Network of connected and communicating machines (bidirectional)
Data	Central production management systems for internal process optimization	Local intelligence of interconnected data from planning, production, logistics, to quality control for network optimization

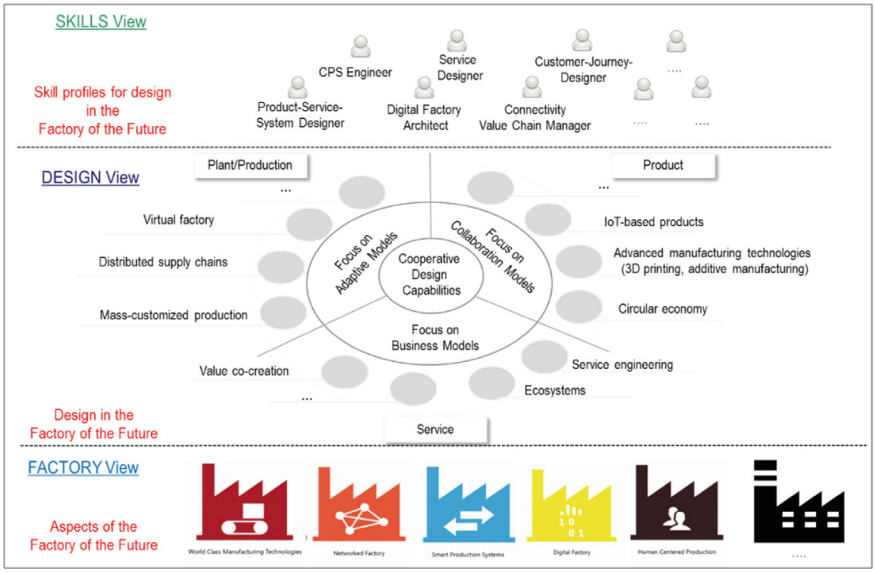

Fig. 3 DigiFoF pillars: skills, design and factory view (digifof.eu, 2022)

- The *skills view* (a collection of skill profiles for FoF design that are defined by the market environment, such as Service Engineer, Product-Service-System Designer, Digital Factory Architect, etc.),
- The *design view* (meaning a model-based approach for developing resources), and
- The *factory view* (takes into consideration aspects, such as manufacturing technologies, smart production systems, digital factory, human-centered production, etc.).

The FoF ecosystem is strongly linked also with the paradigm of Society 5.0, which builds upon these advancements, to enable human-centric approaches to all aspects of society (Deguchi et al., 2020). Hence, the EU-funded project CoDEMO—"Co-creative Decision Makers for 5.0 Organizations" was initiated to analyse the 5.0 dimension and aims to address the skills requirements and development for 5.0 organizations (codemo-project.eu, n.d.). The OMiLAB Community of Practice developed a framework for the FoF ecosystem that builds upon the "bridging" concept (i.e., ingredients, experimentation environment, community of practice) and the three characteristics (i.e., domain—focus, practice—experience, community—expertise). The following sections explore the contribution of the OMiLAB Community of Practice to the selected case and highlight future work of the community regarding skills development research within CoDEMO 5.0, as a continuation of the DigiFoF project.

FoF Ecosystem: Focus

The domain in which the community is active for the selected case has been determined based on the requirements from various sources, like the market, business, or Industry 4.0, that influence and define the skills and competencies needed in the industry. Academic and research institutions then integrate, teach, and train these skills. The skills and competencies for this selected case result in the Digital Engineer for Factory of the Future (Karagiannis et al., 2020). The notion of Digital Engineer is not new; however, it takes on additional meaning in the current changing market climate with the continuous addition of technological advancements. The authors in (Holland & Crompton, 2013) suggest that the Digital Engineer can integrate physical and business operations with digital technology. Abstracting their definition, three main areas can be identified and related to the skills needed to work in an experimentation environment (i.e., the OMiLAB Digital Innovation Environment):

- The Digital Engineer should seek improvements in both physical and business operations; hence he/she should understand the business view, placing focus on business idea development, co-creation, and innovation. A similar perspective has been described in more detail also in (Völz et al., 2023) where the authors use the notion of "Digital Leader" for the business view and evaluate the feasibility of the skill profile.
- The Digital Engineer should use engineering with digital technology, thus having an engineering view to realize proof-of-concept experiments. This aspect is also discussed in (Karagiannis et al., 2022).
- The Digital Engineer should combine engineering knowledge with technology to generate value, so having a conceptual modelling view that acts as a semantic bridge between the business ideas and the experiments. The authors in (Karagiannis et al., 2020) consider and analyze this view as well.

The advancements of the digital era define and expect a broader range of skills and capabilities, besides the Digital Engineer, which is specific to the FoF environment. Thus, key members of the community who worked on this aspect, to ensure the continuity of the learning outcomes and the holistic integration of innovative strategies within organizations, started a more specific research work on the skills required for the next decision-makers (i.e. the CoDEMO 5.0 EU-funded project). The paradigm of "Society 5.0", where the human is positioned in the center of all aspects of society, considers among others the convergence between digital innovation and green skills. It provides an integrated vision to address challenges of digitalization, agility, flexibility of supply chains, sustainability, mass customization, etc. (Deguchi et al., 2020). The 5.0 Organization, for example in an industrial field with FoF resources, will require from its workers more resilience, green mindset, capability of human–machine interaction, digital literacy, etc. Future work by the community related to designing and developing a framework for 5.0 skills within CoDEMO 5.0 relies on collaborative value-creation processes (codemo-project.eu, n.d.) and employs the "bridging" concept discussed in Sect. 1. The design of the

FoF ecosystem acts as a best practice example for the conceptual approach. Related information about CoDEMO 5.0 and research on 5.0 skills for decision-makers is available at www.codemo-project.eu.

FoF Ecosystem: Experience

The collaborative work of the community was directed toward supporting the Digital Engineer for FoF with resources and know-how. The laboratory setting of OMiLAB (cf. Figure 1), which has been installed on-site at various members of the community, has been the place where the community carried out its activity. This laboratory space, both physical and virtual, is equipped with the OMiLAB open-source resources, such as software tools (i.e., Scene2Model, Bee-Up), hardware (i.e., mBot, Dobot, NAO), and the ADOxx metamodeling platform. By extending it with functionalities for ICT-based teaching and learning of FoF design (i.e., PS3M, SEEM, DiMaP) it became OMiLAB4FoF. Each member with an OMiLAB4FoF at their premises is known within the laboratory network as a node and defines its own area of expertise. For example, the node in Italy (OMiLAB@UNIBG) is for "service and manufacturing operations management", the one in France (OMiLAB@EMSE) for "industrial business model transformation", in Romania (OMiLAB@ULBS) for "embedded systems, smart city domain, and manufacturing systems and processes", in Poland (OMiLAB@PB-BIALYSTOCK) for "process management", and in Finland (OMiLAB@UNIOULU) for "robotic applications". An instantiation of the generic OMiLAB Digital Innovation Environment for the FoF ecosystem with design method and goals for the first two pillars (i.e. Pillar I—Collaboration Environment, Pillar II—Conceptual Environment) is shown in Fig. 4.

The collaborative environment was the starting point for the community to get a better understanding of the FoF aspects. During a Design Thinking workshop of the community, FoF design aspects were identified and assessed. The principle of "separation of concerns" was applied to foster innovation. Hence, members were grouped based on their know-how and capabilities and assigned one "concern" to be explored in more depth. Examples of these kinds of "concerns" are FoF design aspects for manufacturing, service, and product. The challenge of making distributed knowledge around the FoF design aspects tangible and usable is addressed through a co-creative approach using the Scene2Model tool for digital design thinking, in which expert knowledge becomes transparent through storyboards in both haptic and digital formats (Muck & Palkovits-Rauter, 2022). The gathered knowledge can be further processed by translating haptic scenes into digital conceptual models. The FoF ecosystem should also facilitate a model-based interaction between machines and humans, and a model-based design of cyber-physical systems (Karagiannis et al., 2022).

Conceptual Modelling is used by the OMiLAB Community of Practice as a bridge between the physical and digital environment (Völz et al., 2023) (Vaidian et al.,

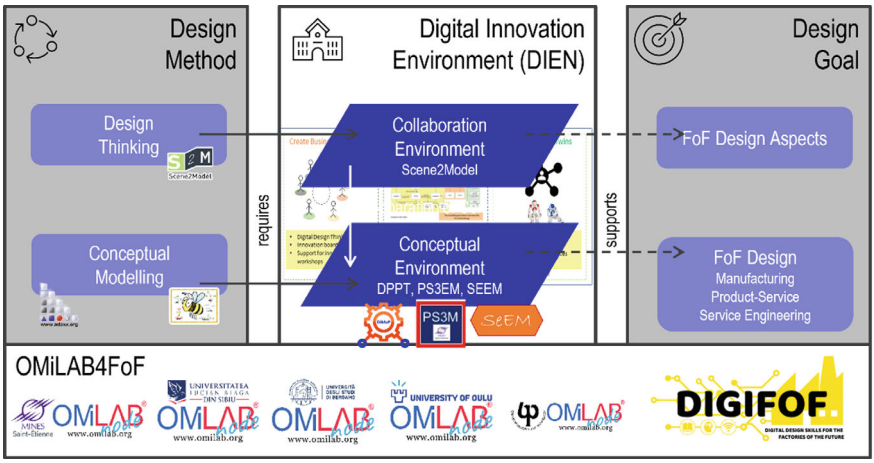

Fig. 4 OMiLAB4FoF (digifof.eu, 2022)

2022). Stakeholders with different expertise in FoF, backgrounds, and skills create conceptual models that map specific aspects of the ecosystem and provide the basis for its realization (OMiLAB Team, 2020). These conceptual models are the outcomes of a domain-specific modelling method. The conceptual model is referred to as the abstraction of the real world, or the "system under study", to a level that can be understood by all actors and can be interpreted as a digital artifact by humans (graphical representation) but can also be evaluated by mechanisms and algorithms (deployed software tools) (Karagiannis et al., 2022). The modelling method defines the graphical notation, the rules, and constraints, and by being based on a specific domain it can be customized to the respective needs and demands (Karagiannis, 2015). Thus, for each of the identified FoF design aspects (e.g., manufacturing, product-service, service engineering) for the ecosystem, the OMiLAB Community of Practice created a domain-specific modelling method and a corresponding tool, to enable the realization of smart models (as described in Sect. 1.2) for each design aspect of the FoF ecosystem:

- *Manufacturing*: The Digital Production Planner (DPP) enables an environment that simulates intelligent production processes. The modelling language created aims to represent the logical and functional dependencies of the activities of a production process for optimization. The elements of the modelling language represent graphically conceptual building blocks used by professionals in the field of production process planning to elaborate solutions, such as the production under time and cost pressure of product variants, taking into account different materials and quantities (Florea et al., 2021).
- *Product-service*: The PSS Scenario Modeller (PS3M) aims to provide a visual representation of product-service system organizational scenarios and a starting point for their analysis and discussion. It is driven by the need for integrated

product and service design, to support decision-makers (Boucher et al., 2016). A case study that focuses on the design of a smart PSS using this software tool in a real-case application, namely for heating appliances, is elaborated by the authors in (Boucher et al., 2024).

- *Service engineering*: The Service Engineering Methodology (SEEM) tool supports users in the development and design of PSS, capturing both product and service perspectives and balancing customer satisfaction and internal efficiency, which are essential for defining a competitive offering. SEEM supports companies in their transformation by providing a modelling environment that allows them to consider all the important aspects that contribute to defining an effective PSS offering (Pirola et al., 2022).

The experimentation and exploration environment of OMiLAB4FoF enables the carry-out of feasibility assessments for the FoF ecosystem, which aim at understanding if the digital transformation and innovative approaches chosen, serve the intended purpose. Further cases have been evaluated in the OMiLAB Digital Innovation Environment (cf. Figure 1), such as a proof-of-concept implementation experiment in (Woitsch et al., 2022) for a model-based digital twin of a paint production pilot to facilitate data integration along the product and service lifecycle and build toward a PSS. An experience report of supported decision-making by using functionalities of OMiLAB has been given in (Woitsch, 2020), where the author is providing insights into the creation of new business models for manufacturing SMEs (based on Pillar I from cf. Figure 1), design of digital twins for the renovation sector (based on Pillar II from cf. Figure 1) and proof-of-concept prototyping for analyzing robot behavior (based on Pillar III from cf. Figure 1).

The aforementioned ongoing learning loop of the Community of Practice (cf. Section 1.3) is seen not only in the development of these software tools specific for FoF-design but also in the numerous other types of resources created together, such as training modules, curricula, courses, case studies, where the experience and learning outcomes from practice are shared, as well as a series of webinars for keeping informed the broader community and interested individuals about the progress in FoF ecosystem research. All the resources and materials are available at https://www.digifof.eu/ and serve as a foundation for future work on the 5.0 organization and corresponding skills development.

FoF Ecosystem: Expertise

The OMiLAB Community of Practice members, which encompass the expertise to create the FoF ecosystem, are those that have a specific interest in the topic of Industry 4.0 or expertise in the fields of manufacturing, production, product service, as well as clusters that represent pioneers in the industrial digital transformation. The communities of practice have certain principles that they follow (Wenger-Trayner &

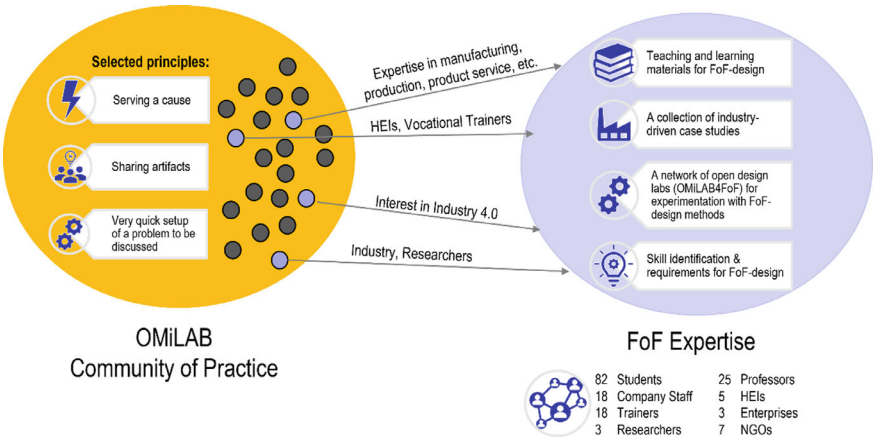

Fig. 5 FoF ecosystem expertise

Wenger-Trayner, 2015). Three have been selected to show how they are applied specifically for the DigiFoF case by the OMiLAB Community of Practice:

- *serving a cause*: the facilitation of the transformation of a factory toward a factory of the future, by identifying the skills needed and requirements for FoF design and building a FoF expertise network.
- *sharing artifacts*: the collection of resources created, and digital artifacts developed by the community are provided open-source to be accessible by all the community members and anyone else interested to learn.
- *very quick setup of a problem to be discussed*: OMiLAB4FoF laboratory installation at various community members to facilitate the exploration and feasibility assessment of innovative solutions for the FoF ecosystem.

The selected principles have been illustrated in Fig. 5, as well as the members of the OMiLAB Community of Practice that build the FoF expertise:

3 Takeaways

Communities of practice are an important part of the digital era. The way that communities look like and interact with each other may have changed over the years, however, they still play an integral role in business and society. The core values of a Community of Practice stay the same, namely, to share experiences and to learn both from and with each other.

The FoF ecosystem delivers impact to students, academic and research institutions, enterprises, and industry professionals through the materials that it provides and the range of resources that it facilitates to develop. The impact generated is long-term, considering better employment opportunities (i.e., competencies acquired

from training materials), increased market competitiveness (i.e. innovative processes triggered in a factory), and awareness of the FoF design elements. The continuous maintenance of the results achieved, and their further development based on new advancements is important for the sustainability of the community. The management framework is based on continuous cooperation and collaboration between community members.

The overall aim of the OMiLAB Community of Practice and demonstrated through the FoF ecosystem is to challenge the interaction between humans and machines in the digital era, by creating an environment that supports exploration and experimentation. The experts forming the community provide guidance, and knowledge and share their experiences to learn together. The resources created for the FoF ecosystem show the need for collaboration between different experts and the importance of having a shared environment and community space in the digital era. Moreover, the community continues to build upon the learnings and targets the integration of skills (digital innovation, digital engineering, green, resilience, etc.) for the decision-makers of 5.0 organizations. It addresses the evolution of digitalization and its impact on the FoF ecosystem with multi-dimension stakeholder participation.

In this work, the "bridging" challenge of human–machine interaction for the digital era has been discussed and related to one application, namely the Factory of the Future domain, and continues with the 5.0 organization. Nevertheless, the concept is an invariant that can be transferred to other domains, where the Community of Practice can continue the ongoing learning loop with a focus on other scenarios. An experimentation environment, such as the OMiLAB Digital Innovation Environment is needed, that provides physical infrastructure and digital space for co-creation and feasibility assessment, along with the three criteria that must be met: domain-focus, practice–experience, and community-expertise. For further application instances please see recent work by the authors in Völz and Vaidian (2024), Völz et al. (2023), Woitsch et al. (2023).

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Digital Twins as an Integral Part of Manufacturing Digital Transformation

Timoleon Farmakis, Stavros Lounis, Ioannis Mourtos, and Georgios Doukidis

Abstract Digital Twins (DTs) are among the emerging and enabling technologies alongside Artificial Intelligence (AI), Internet of Things (IoT) and Optimisation that will shape the future of manufacturing in the era of Industry 4.0 and beyond. This technology lets manufacturers digitally simulate, predict, and control physical assets, offering valuable information based on real-time data. DTs also incorporate intelligent capabilities by utilising additional services and tools, affecting production processes toward new business strategies for developing and maintaining a competitive technological advantage. To this end, DTs can drive digital transformation, enabling real-time monitoring, data analysis, and process optimisation. Nevertheless, although DTs have the potential to accelerate digital transformation in manufacturing, this relationship has not been adequately studied. This research utilises a practitioner-oriented framework for Digital Transformation (DX) to examine and map the potential benefits and impact of DTs in the digital transformation efforts of manufacturing companies by analysing four real-life production cases in different manufacturing industries and identifying the similarities and differences among them (in terms of DT purpose and deployment).

1 Introduction

While transitioning to Industry 4.0, digital transformation has placed manufacturing and production processes at the front and centre of interest (Frank et al., 2019). Advanced capabilities, such as situation-aware manufacturing are envisaged to enable perceiving, understanding and acting upon real-time information from the ongoing production states to produce appropriate response actions (Eirinakis et al., 2021). The systems that enable such capabilities have thus received a strategic role in

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automating processes, informing the workforce and, in general, transforming businesses (Dehning et al., 2003). One such system is Digital Twins (DTs), which were initially (and preliminarily) formalised by Grieves (2015) as "the virtual representation of what has been produced". From then on, depending on the physical-to-digital directionality of data and actions, relevant definitions include Digital Models, Digital Shadows, or Digital Avatars (Kritzinger et al., 2018). The concept of Digital Twins (DTs), as articulated by Pethuru et al. (2020), is essentially a "virtual representation of a physical object or system throughout its unique lifecycle." This involves leveraging real-time data from various sources, enabling the DT to learn, reason, and contribute towards actionable insights. As further elucidated by Rosen et al. (2015), this idea supports information continuity. It also plays a crucial role in product data management, as noted by Abramovici et al. (2016), and in optimising production line design, as highlighted in Zhang et al. (2017) work, among other functions.

The continuous advancement of Digital Twin (DT) technology has led to significant enhancements in its capabilities, closely mirroring human cognitive functions (Saracco et al., 2019). Advanced DTs are now equipped with sophisticated features such as anomaly detection, learning algorithms, and optimisation tools, which significantly bolster decision-making processes (Eirinakis et al., 2020). DTs do not just replicate physical entities, but actively contribute to achieving optimal production outcomes by providing critical insights and predictive intelligence.

As such, DTs have received the attention of both industry and academia (Cimino et al., 2019; Liu et al., 2021; Tao et al., 2019a). Despite the growing interest in the design and development of DTs over the last few years, most literature has focused on the technical aspects. However, the business value of these technologies has yet to be adequately studied (Holopainen et al., 2022). The decision and, even more importantly, the process and potential outcomes of introducing such a novel and business-transforming digital technology as DTs is strategic for each manufacturing firm, and requires a substantial amount of upfront investment, operational changes and resource commitment to fulfil its goals. Such an essential change in the processes and resources requires a structured approach to examine its potential, application process and expected benefits. This is why DTs need to be examined having more empirical evidence available (Dhar et al., 2022; Kritzinger et al., 2018).

To this end, further research is needed to investigate the relationship between DX efforts of manufacturing companies and DTs. This has also been highlighted in a recent DX literature study, where it is stated that "it appears relevant to initiate more research aimed at studying the impact of certain technologies for realising and supporting different DX-related efforts, e.g. improving processes, operations, or business models." (Kraus et al., 2022).

Using the lens of a prominent DX Framework (Doukidis et al., 2020), this study examines real-life manufacturing DT applications with the transformations of DX pillars to identify which among the potential DTs' outcomes are observed in process or discrete manufacturing. The study was performed in the context of an EU-funded project called FACTLOG.

The present paper is structured as follows: Sect. 2 provides an overview of the study's theoretical background. In Sect. 3 we showcase four industrial production DT

cases. Section 4 presents the results of DX mapping for these cases, highlighting how DTs can support business process transformation in manufacturing and potentially enhance customer experience and business models. Finally, Sect. 5 presents the theoretical contribution, implications, limitations, and future research avenues.

2 Theoretical Background

Digital Twins in Manufacturing

DTs are twinning different entities in manufacturing, such as production machines, production processes and lines, and an overall factory or supply chain (Cimino et al., 2019; Liu et al., 2021), aiming to simulate and optimize them (Tao et al., 2019b). Several studies support that DTs can offer several benefits to manufacturing companies. In particular, using virtual asset representations, DTs facilitate developing, maintaining, and modifying individual parts or entire factories (Cimino et al., 2019). Intelligent manufacturing processes and product design can also be aided by DTs (Tao et al., 2019b). On top of that, DTs can support validation in different phases of product development, enhancing quality assurance (Liu et al., 2021). Despite the benefits, there have been few real-world implementations of digital twins in manufacturing. Challenges inhibiting their industrial application include the need for practical implementation strategies (Scheer et al., 2023). Also, as mentioned above, most of the literature has concentrated on the technical elements of DTs (Holopainen et al., 2022), and, even though DTs design and development has garnered increasing attention in recent years, empirical evidence from actual implementations is only scarce (Dhar et al., 2022; Kritzinger et al., 2018).

Digital Twins Under the Lens of Digital Transformation

Digital Transformation (DX) fundamentally changes the value creation paths by using digital technologies and leveraging digital assets and capabilities (Verhoef et al., 2021). According to Gong and Ribiere (2021), DX is enabled by the innovative use of digital technologies and is associated with various economic and capability-driven outcomes, such as cost reduction, business model innovation, error elimination, process automation and agility.

One industry that has been profoundly affected by digital transformation is manufacturing (Frank et al., 2019), where technologies such as DTs can revolutionise how products are designed, produced, and delivered to customers, thus resulting in improved organisational performance, increased revenue and higher productivity

(Savastano et al., 2019). Digital transformation is essential for leaders and organisations in the digital era (Vial, 2019), as businesses try to leverage innovative technologies, capabilities, and resources as an ongoing process that is based on the dynamic capability theory (Warner & Wäger, 2019). Despite this excitement around the concept of DX, many organizations fail to implement its principles, ideas, and methods effectively, resulting to a lack of positive outcomes and creating a gap between theory and practice (Gökalp & Martinez, 2021, 2022; Doukidis et al. 2020). To this end, Doukidis et al. (2020) propose a framework for how modern digital technologies can radically transform the customer experience, business processes, business models, and whole organizations, while it also offers a lens for researchers and practitioners to analyze DX efforts in companies (Table 1). This study utilizes this framework as a lens to analyze and enhance understanding of the implications of leveraging digital twins in the industrial setting.

3 Four Industrial Production Digital Twins Cases

Digital Transformation efforts can be applied to transform the customer experience (CE), the business processes (BP), the business model (BM) and the organization (OT). Utilizing this framework, we examine the scope and potential outcomes of DX in 4 real-life DT cases in manufacturing. We follow a triangulation approach whereby we leverage project reports and the active participation of four investigators on the case studies to acquire and analyze the empirical data.

Below is an overview of the four real-life business cases examined in a European-funded project of DTs in the manufacturing sector: an oil refinery, a textile production factory, an automotive parts manufacturing factory and a steel processing factory. This selection covers both discrete and process manufacturing, as well as different levels of digital maturity factories (relevant to DX) and allow for diverse perspectives and insights on the potential use and implementation of DTs. Each pilot in the course of a three-year-long project followed their own path of user requirements. Each case was examined through iterative discussions/focus groups, with the objective to identify the problematic events and the stakeholders involved, the potential, ability and need to develop DTs, as well as the additional services that would be needed. A detailed description of each pilot can be seen in previous research by Eirinakis et al. (2022).

In Pilot A (Oil Refinery), DTs were implemented for the production process units, input feeds, and output tank, and aimed to address the business problem of off-spec liquified petroleum gas (LPG) production. The scope of the DTs was to ensure on-spec production under specific conditions. On-spec refers to LPG meeting required quality standards, while off-spec indicates those that fail to meet these criteria. The team involved included production process engineers and staff from the planning and energy departments. In Pilot B (Textile Production), DTs were implemented for loom and finishing machines, and for production processes. The driving reasons for DT's deployment were machine malfunction, managing new orders and priorities, and

Table 1 The four pillars of DX

CE: Customer experience transformation	BP: Business process transformation	BM: Business model transformation	OT: Organizational transformation
(1) Comprehension of customer's needs and behavior (1.1)CRM and loyalty scheme (1.2) Business analytics (1.3) Personalization	(1) Business processes digitalization and redesign (1.1) Automation and redesign (1.2) Agile development, collaboration, and integration (1.3) New supporting services	(1) Digital organizational modifications (1.1) Supplementary digital channel (1.2) Digital modifications (1.3) Digital innovations	(1) Integrated business strategy (1.1) Compliance (1.2) High investments (1.3) Integrated strategy
(2) Upgrading customer's experience (2.1) Customer journey (2.2) Multichannel (2.3) Omnichannel	(2) Support and improvement of employees' daily tasks (2.1) Info reporting and support (2.2) Personalized services (2.3) DSS and artificial intelligence	(2) Establish new digital activity/ service and business model (2.1) Customer-centric targeting (2.2) New digital services (2.3) New business models	(2) New organizational structures/ functions/ alliances (2.1) New structures (2.2) Supervision process (2.3) Alliances
(3) Automation and digitisation processes (3.1) Information reporting and support (3.2) Upgrade salesperson's role (3.3) Customer self-service	(3) Business performance management (3.1) KPIs and balanced scoreboard (3.2) Real-time reporting and analytics, continuous integration (3.3) Precision management	(3) Digital international expansion (3.1) Consolidation of subsidiaries (3.2) International service/support (3.3) Think global and act local	(3) Human resources development talent acquisition, and exploitation (1.1) Training and talent acquisition (1.2) New methods (1.3) Innovation structures

Adopted from Doukidis et al. (2020)

disruptions due to yarn breakage. The goal was rescheduling production, considering potential machine failures and order changes. Essential personnel included loom and finishing machine operators, and production managers.

Pilot C (Automotive Parts Production) also focused on the machines of the PCB (printed circuit board) final assembly line. The DT implementation aimed to mitigate machine breakdowns and improve predictive maintenance. The objective was to reschedule production, and focus on machine failure and predictive maintenance/ production. The personnel involved included machine operators, maintenance engineers, and production managers. Finally, in Pilot D (Steel Processing), DTs were

deployed for steel bending machines, steel cutting machines, and cranes. The challenges addressed were production delays due to crane movement bottlenecks and machine malfunctions. The aim was to reschedule production accounting for process times and equipment availability. The workers involved were operators of cutting/bending machines, crane operators, and production managers.

Across all pilots, DT supporting services included real-time monitoring, anomaly detection, root-cause identification based on knowledge graphs, impact assessment of a problematic event, and decision support for optimal process parameters or rescheduling.

4 Results and Discussion: The Digital Transformation Perspective

Digital Twin-Enhanced Business Process Transformation in Manufacturing

The overall mapping of DT applications in all pilots relevant to DX can be seen in Table 2. When examining the scope of the four different DT cases, we realize that DTs are focused extensively on supporting the Business Processes Transformation Pillar of DX, thus enabling the digitalisation and redesign of the business processes, the support and improvement of the employees' daily tasks and the enhancement of business performance. Interestingly, when examined individually, each pilot's need for DTs related to a problematic area that focused on a particular problem to be solved and a specific function of the company (and not company-wide), leading to a potentially myopic scope, especially when considering other potential functions, the DTs could have assisted.

Based on the findings of the mapping of DTs' application under the lens of DX, we observe that DTs in the involved real-life manufacturing cases were predominately focused on transforming business processes relevant to the scope of the final digital transformation that took place. In particular, DTs enabled the redesign of processes (1.1) in all involved pilots and for the processes involved in the scope of the DTs/DX. DTs predominately enabled a process–comprehensive visibility of actual production involving all manufacturing entities.

Another identified benefit of employing DTs in production was evident in the oil refinery case, where several employees from different divisions were involved in the same process (of LPG production). In this case, the DTs enabled the collaboration of the involved divisions (in the decision-making process), which belongs in the DX pillar (1.2—increased agility and collaboration between departments). Through the visibility of the whole process within a single Factlog DT dashboard, all involved divisions (and respective employees) could simultaneously consider the effect of their decisions on their respective manufacturing entity, to the other entities, as well

Table 2 DTs' application categorisation in DX Framework

Pilot DTs applications	DX pillar 2 BP: Business processes transformation		
	1. Business processes digitalisation and redesign	2. Support and improvement of employees' daily tasks	3. Business performance management
Pilot A Oil refinery	(1.1a) Automation of reception of real-time data from physical twins of respective DTs (Machines or Production Process DTs) (1.1b) Redesign all involved processes within the scope of each pilot (1.2) Intra-departmental exchange of information (1.3) New supporting services for employees	(2.1) Timely information relevant to the potential need for machine downtime due to maintenance needs/ malfunction (2.2) Division-specific and role-specific User Interface and info for the production process engineers, and employees from planning/energy departments (2.3) Decision support on selecting the optimal parameters on all process units to return to on-specs LPG production	(3.1) Support for the production and monitoring of KPIs relevant to product quality and off-spec production (3.2) Real-time reporting and analytics for LPG production (3.3) Precision management when it comes to on-spec production
Pilot B Textile production		(2.1) Timely information relevant to potential delays in production due to machine malfunctions/ yarn breakages (2.2) Division-specific and role-specific UI and info for loom/finishing machine operators and production managers (2.3) Decision support on production scheduling, taking under consideration order priorities and the status of machines	(3.1) Support for the production and monitoring of KPIs relevant to energy needed during production and production scheduling (3.2) Real-time reporting and analytics for machine malfunction, disruptions and optimal prioritisation

(continued)

Table 2 (continued)

Pilot DTs applications	DX pillar 2 BP: Business processes transformation		
	1. Business processes digitalisation and redesign	2. Support and improvement of employees' daily tasks	3. Business performance management
Pilot C Automotive parts production		(2.1) Timely information for potential machine maintenance needed (2.2) Division-specific and role-specific UI and info for machine operators, maintenance, engineers and production managers (2.3) Decision support on optimal production scheduling taking under consideration pre-emptive maintenance	(3.1) Support for the production and monitoring of KPIs relevant to energy consumption, equipment efficiency and maintenance (3.2) Real-time reporting and analytics for machine breakdowns (3.3) Precision management of maintenance
Pilot D Steel processing		(2.1) Timely information relevant to potential delays in production due to crane movement bottlenecks and machine malfunctions (2.2) Division-specific and role-specific UI and info for cutting/bending machine operators, crane operators and production managers (2.3) Decision support on production scheduling, taking under consideration crane movement times and machine status	(3.1) Support for the production and monitoring of KPIs relevant to asset utilisation, production and energy (3.2) Real-time reporting and analytics for production delays due to bottlenecks in crane movement, machine malfunctions, and order optimal prioritisation

as to the overall process. This comprehensive process dashboard was a new internal supporting service (1.3) offered within the factory for the specific pilot.

When considering intra-departmental communication, DTs in the Oil Refinery case were found to be extendable to all remaining pilots within their respective contexts. In the textile case, the planning system can consider a loom malfunction and inform the operators of the observed problem so they can proceed to fix it and return to regular operation. In the steel processing pilot, crane operators need information relevant to completing a new steel product to proceed to unload it from the machine that processed it, involving the workers who operate the machines and the

crane operators. Lastly, in the automotive case, the production planning department can consider the time windows of planned and pre-emptive machine maintenance and any unforeseen downtime in the schedule. For those mentioned above to be enabled, personalised (and division-specific and role-specific) user interfaces (UIs) and reports for various departments and employees (2.2) can be produced in the system, constituting another key DX positive outcome. When examining the overall Factlog system and the respective DTs, the system was designed and developed as an advanced technology for decision-making (2.3) that is based on the measurement of essential and pilot-specific KPIs (3.1) that real-time analytics reporting (3.2).

Another result relates to the challenges and issues faced during the creation and deployment of the overall system and DTs. The most challenging issue identified was the ability to cognitively retrofit (by instrumentation) the manufacturing entities towards creating their virtual counterparts. This was found to rely heavily on the different pilots' digital maturity degrees. Pilots A and C were already technologically advanced, and had a smoother creation, integration and operation of DTs with a broader scope and increased data sources availability. Pilot B, on the other hand, had decades-old looms in its fleet, operating in parallel with newer oness—a characteristic of the textile industry, thus making the DT-required interfacing with the looms challenging. Finally, Pilot D required the most significant change, as it needed to be started from the digitalisation phase. The difference in maturity also affected the potential room for improvement (as seen from the KPIs), as less mature pilots obviously have ample room for improvement. Additionally, when examined on a per-pilot basis, although the overarching technological infrastructure for the DTs was horizontal, its instantiation required effort to "cognitively retrofit" the plants that were different as the technological and organisational barriers were also different among the cases. They all needed to reach a similar level to enable the DT application, with the minimum being the ability to have the physical manufacturing machines become able to transmit data to their virtual counterparts (i.e. their Digital Twins).

Digital Twin-Enhanced Customer Experience, Enabled Business Models and Organisational Requirements in Manufacturing

From the above, it is concluded that the predominant application of DTs is found in Pillar #2, the business process component of DX. However, there was also potential for transformation in the customer experience and the business model components. For example, transforming processes in all pilots led to quality assurance and reliability for customers through operational efficiency. Also, manufacturers can prioritise production based on customer-related data by utilising digital twins. Production prioritisation ensures timely product delivery that aligns with customer expectations, ultimately enhancing the overall customer experience. This outcome was observed in Pilot B (Textile Production) and Pilot D (Steel Processing), where DTs can reschedule

production by considering various production and customer parameters. Generally, and as supported in the literature (e.g., Ibarra et al., 2018; Timperi et al., 2023), integrating DT technology has paved the way for innovative business models and changes in value creation, something observed in our cases, as well.

Furthermore, we have also identified an additional requirement for the successful implementation of DTs, stemming from Pillar #4, Organizational Transformation, with respect to human resources development, talent acquisition and exploitation. In these areas, there is a need to train all involved workers in the new processes to the operation of the DTs and respective services, as well as a need for new talent acquisition relevant to the operation of the newly installed DT technology. Those findings highlight the importance of investing in technological resources and organisational development to achieve success and competitiveness using emerging technologies such as DTs. They also align with existing literature the importance of new skills is emphasised (Parmar et al., 2020). Similarly, previous research by Brynjolfsson et Hitt (2000) has shown that companies with a robust computer infrastructure and an effective organisational structure tend to have much higher market values than those without one.

5 Conclusions and Future Research

Digital Twins will play a crucial role in the digital transformation efforts of manufacturing companies in the years to come, by creating several benefits, mainly through the Process Transformation pillar. More specifically, it is evident that automation, redesign, enhanced collaboration among departments, and improved decision-making through real-time analytics and reporting emerge as critical benefits. Nevertheless, there is also potential for DTs to enhance customer experience and enable new business models in process and discrete manufacturing. Moreover, there is evidence that organisational transformation is essential to maximise this innovative technology's potential benefits and impact.

Theoretical Contribution and Business Implications

The theoretical contributions of this study lie in examining the business value and potential transformation outcomes associated with Digital Twins, mainly through the lens of digital transformation as motivated by Kraus et al. (2022). This research enhances the existing body of knowledge by revealing the roles that DTs can play in transforming manufacturing processes on different levels. While most existing studies on DTs in manufacturing have primarily focused on the technical aspects of the technology (Holopainen et al., 2022), this study shifts the focus towards understanding their business-related implications through a mapping of the potential benefits and the impact of the application of DTs in different transformation pillars.

This study shows how DTs contribute technically and strategically to the manufacturing sector, by leveraging empirical data from real-life industrial cases, and by providing more empirical evidence, something that the DT literature needs (Dhar et al., 2022; Kritzinger et al., 2018). Also, despite the great interest in digital technologies such as DTs, few real-world implementations (Gökalp & Martinez, 2021, 2022; Scheer et al., 2023) are reported. To this end, the study employs a practitioner-oriented DX framework, proposing a methodological approach for assessing emerging technologies' transformation outcomes, such as DTs, to close the gap between the theoretical promise of Digital Transformation (DX) and its practical execution.

Additionally, this study goes beyond theoretical contributions, by offering valuable practical insights for organisations and practitioners undertaking DT initiatives within their digital transformation strategies in manufacturing. It advocates for digital leaders to conduct transformation analyses of such technologies' transformative potential, as those technologies need great investments, organizational changes and resource commitment. Digital Transformation mapping is essential for manufacturing companies before any design and implementation of DTs to avoid a myopic perspective and also to understand the technology's full potential benefits and impact on processes, customers and overall organization. Proposed DX mapping can be used by practitioners as a design tool guiding the implementation of DTs, or other relevant technologies projects. The study confirms companies' strategies, provides further strategic considerations and underscores the importance of addressing organisational needs, particularly emphasising the necessity of training programs and the need to improve the workforce's digital skills, for organizations to ensure that their teams are well-equipped to leverage the full potential of Digital Twins, thereby driving successful digital transformation. Thus, this study aims to enhance the understanding of the implications of leveraging DTs in the context of digital transformation and technology management, building upon the identified gap by Holopainen et al., (2022).

Limitations and Future Research Avenues

Nevertheless, it is essential to acknowledge certain limitations and potential future directions of this study. One primary constraint is the absence of a final evaluation of the systems regarding achieved Key Performance Indicators (KPIs). Such an assessment could quantify the business benefits and examine in a comprehensive way the actual transformation outcomes. In addition, there is a significant need to conduct in-depth interviews with the project managers of the pilot initiatives following the evaluation to provide additional valuable insights into the challenges, enablers, and triggers for implementing DTs.

Further research could include a more thorough exploration of the strategic outcomes, thus enhancing the depth and understanding of the study's findings. It is noteworthy that the current analysis predominantly adopts a practitioner-oriented approach. For future research, it would be beneficial to integrate a theory-based

DX perspective, particularly leveraging frameworks like the digital transformation building blocks and the unified digital transformation definition proposed by Gong and Ribiere (2021) or other relevant theories from management literature, such as dynamic capability theory. This theoretical grounding would complement the practical insights and enrich the analysis with a more structured and comprehensive understanding of digital transformation dynamics, especially in the context of DTs and bridge the gap between practice and theory.

Finally, future research is also needed to examine the business value and the impact of DTs in supporting manufacturing's DX efforts. For example, the following research questions could be of interest to explore: What is the measurable outcome of digital twin implementations? How does the manufacturing environment impact the digital transformation outcome of digital twin projects? How could the digital transformation analysis identify further strategic transformation roles and the future evolution of the digital twin's project?

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Artificial Intelligence's Impact on Personal Selling: A Profession in Danger?

Anastasios Koukopoulos, Adam Vrechopoulos, and Chris Lazaris

Abstract This study investigates the impact of Artificial Intelligence (AI) on Personal Selling through a multivocal literature review. AI is transforming the sales profession, creating new opportunities and challenges for salespeople and managers as well as for customers in both B2B and B2C relationships. In the context of a multivocal approach, we include both academic and non-peer-reviewed sources of information (gray literature). This allows us to capture the perspectives and insights of both academics and practitioners, and to identify the current state of knowledge, the existing gaps, and the directions for future research. Results indicate the promising role of AI in Personal Selling under critical prerequisites and highlight the challenges and opportunities reflected to the optimum blending of digital technologies with human skills. However, the need for empirical research attempts on this highly evolving topic is evident. To this end, multidisciplinary research approaches could contribute to an integrated investigation of this rapidly developing phenomenon.

1 Introduction

In an age of ChatGPT, Artificial Intelligence (AI) is increasingly embedded in customers' lives permeating various processes across diverse business activities (Agarwal et al., 2022). More than ever before, these computer algorithms are transforming the working environment, redefining customer interactions with businesses, and reshaping organizational operations, in ways we don't fully understand. Furthermore, the foundations of technological advancements and innovation are driven by frontier academic research (Le et al., 2022). Although, research on artificial intelligence in the field of marketing is not a new subject (Chintalapati & Pandey, 2022), recent technological advancements have emerged a portrayal of a rigorous field

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of study characterized by both the unpresented capabilities of AI and its boundless accessibility for academics and practitioners. Consequently, there's a need for research in the topic of artificial intelligence and consumer studies (Paul et al., 2023).

In parallel, we ascertained that seminal literature over the last years has stated the potential of Artificial Intelligence (AI) to revolutionize personal selling (Flaherty et al., 2018), the process of building relationships and persuading potential customers to purchase products or services (Vlačić et al., 2021). As AI technology continues advancing, it is increasingly being integrated into sales processes in various ways, from B2B personal selling and sales management (Elhajjar et al., 2023; Paschen et al., 2020), to AI coaches (Luo et al., 2021) and robo-advisors (Meyer & Greve, 2019). One of the primary advantages of using AI in personal selling is its ability to improve efficiency (Zoltners et al., 2021). Exposure of large language models (LLMs)—e.g., ChatGPT—to mid-level professionals, results in increased job satisfaction and self-efficacy, balancing productivity distribution by benefiting low-ability workers more (Noy & Zhang, 2023). AI can assist with lead generation by identifying and targeting potential customers, applying recommendation techniques based on their interests and demographics (Huang & Rust, 2021). Additionally, it can help with customer segmentation, allowing salespeople to tailor their sales presentations to specific groups of customers (Campbell et al., 2020). Similarly, Fan et al. (2022) report that AI can be used to create personalized sales presentations, utilizing data on customers' preferences and behaviors to generate customized pitches.

However, there are also potential challenges and ethical considerations to using AI in personal selling, constituting potential research gaps. One concern is the potential for job displacement (Singh et al., 2019), as AI can automate certain tasks that were previously performed by human salespeople (Moncrief, 2017; Schneider et al., 2021). Eloundou's et al., (2023) research reveal that 80% of the workforce in United States could have their work tasks affected by LLMs by 10%. Telemarketers is on the top of the list of the most exposed occupations to language models according to Felten et al. (2023). In addition to the aforementioned, there are also fruitful areas of research around data privacy, as AI systems often rely on the collection and analysis of large amounts of personal data (Mazurek & Małagocka, 2019). Finally, there is the risk of bias in AI-powered sales processes, as the algorithms used may perpetuate or amplify existing biases in the data they are trained on (Monod et al., 2022).

While AI's integration into the workforce presents opportunities for enhanced efficiency and productivity, its implications vary significantly between roles such as salespeople, telemarketers, and customer service employees. Specifically, AI is particularly effective in automating routine tasks in telemarketing and customer service, where repetitive and script-based interactions are common (Magnani, 2022). However, even though AI telesellers, tend to bring more advantages in the selling process, their lack of empathy often results in consumers being less patient or serious with the technology, leading to a preference for human interaction (Li et al., 2023). In contrast, the complex, relationship-driven nature of sales, especially in B2B contexts, poses challenges to AI automation (Chang, 2022). B2B sales roles often involve intricate negotiations and relationship management, areas where AI currently lacks the nuanced understanding and adaptability of human salespeople (Mingotto et al.,

2021). This distinction is less stark in B2C roles, where transactional interactions are more amenable to AI-driven automation.

To address these concerns, it is important for companies to adopt responsible AI practices, such as provision of training for salespeople on the use of AI tools and ensuring transparent communications on the use of AI in the sales process (Chen & Zhou, 2022). By taking these steps, companies can harness the benefits of AI in personal selling, while minimizing the risks and ethical concerns. In conclusion, AI has the potential to significantly enhance personal selling, but it is important to carefully consider the challenges and ethical considerations involved (Davenport et al., 2020). As AI technology continues to advance, it will be crucial for companies to stay abreast of the latest developments and ensure that they use AI in a responsible and ethical manner.

Motivated be these developments, the aim of the present study is to understand, through a systematic literature research, the relationship between artificial intelligence and personal selling, the benefits that a salesperson can seize from the adoption of AI and finally to analyze relevant literature on the subject of sales representatives' replacement from artificial intelligence. To attain that goal, two research questions are formulated:

RQ1: How can personal selling benefit from AI?
RQ2: Can AI replace human sales representatives?

Apart from addressing those research questions through a systematic review of the existing literature, this work adds value by describing research insights, existing gaps and future research directions (Hulland & Houston, 2020; Palmatier et al., 2018). We explore the current literature on personal selling and artificial intelligence not only limited to the peer reviewed (white literature) published literature but also taking into consideration the voices outside of this scope (grey literature). Following this approach, we intend to strengthen the links between academia and industry, presenting results that interest both sales practitioners and researchers.

The remainder of this study is organized as follows: we present a background on the research of artificial intelligence in personal selling, also providing recent use case scenarios. Thereupon, we elaborate on the methodology of the study on the process of multivocal literature review. Finally, we discuss the results and implications along with the theoretical contributions of our findings and their implications for future research.

2 Background and Methodology

Background in AI and Personal Selling

It was 1984 when Collins (1984) put first on the subject of personal selling the potential of this new technology (AI) along with several challenges. One year before Windows were launched and almost a decade before what we now call the Internet, Collins evaluated the use of artificial intelligence in personal selling, in MS-DOS 1.1. Thirty-seven years later, the produced literature remain scarce concerning the attention technologies as artificial intelligence and machine learning, on sales (Kitanaka et al., 2021). In addition, this comes as a consequence of AI decentralization (Cao, 2022) and mass personalization (Hermann, 2022) aligned with the embodied forms of artificial intelligence in numerous use cases that affect our daily lives.

Artificial intelligence (AI) has garnered significant attention in the field of personal selling, with some positing that it has the potential to enhance the efficiency and effectiveness of the selling process. One perspective on the use of AI in personal selling suggests that it can be utilized to automate repetitive tasks (Trivedi & Patel, 2020), freeing up sales reps to focus on higher-value activities such as relationship building and deal closing (Syam & Sharma, 2018). AI can also provide real-time insights and recommendations to sales reps based on data analysis, enabling them to make more informed decisions and to tailor their sales pitch to individual customers (Picareta et al., 2021).

Another perspective argues that AI can be utilized to augment the skills and expertise of sales reps, enabling them to deliver more personalized and effective selling experiences (Stone et al., 2020). For instance, AI can be used to analyze customer data and provide sales reps with customized recommendations on which products or services to offer, based on the customer's interests and needs (Ravindar et al., 2022). Additionally, AI can be utilized to identify patterns and trends in customer behavior, helping sales reps to anticipate and respond to changing customer needs and preferences (Perez-Vega et al., 2021).

However, the use of AI in personal selling has also sparked concerns about its potential to replace human sales reps and to disrupt traditional selling processes (Chang, 2022). Some argue that even though AI may not be able to fully replicate the interpersonal skills required for effective personal selling, its adoption could nonetheless displace human sales representatives, leading to potential job losses (Guenzi & Nijssen, 2021).

Nowadays, modern applications of AI in personal selling can be found in CRM applications, as well as in ecommerce platforms, chatbots or standalone software. For example, Salesforce has innovated with Generative AI and Prompt Engineering in its Sales Cloud app in order to generate emails for sales representatives, guide them to effectively discover new sales opportunities, provide AI-based guidance during sales presentations and speed up data analysis of the sales pipeline (Liao, 2023). Along these lines, Microsoft introduced Sales Copilot for Dynamics CRM as an AI assistant designed for sellers, providing AI-generated meeting summaries, detailed call

transcriptions, contextual email responses, real-time call insights, content recommendations, and post-call analysis to improve interactions with customers (Microsoft, 2023). In this manner, Hubspot provides AI tools such as a content assistant that can write sales messages and proposals, personalized messages to the format, tone, and goal for each prospect, as well as provide sales coaching and training by simulating sales conversations (Bray, 2023). Furthermore, Nibble pioneered with an AI-powered negotiator bot for Shopify E-Commerce platform, that aims to replace live sales representatives (Cummings, 2022). Last but not least, other AI for sales implementations include software to provide sales intelligence with predictive capabilities (Accenture's Value Insights Platform (VIP)), along with AI-Powered Social Selling tools (Seismic LiveSocial) that searches social media content from more than 10,000 sources a day and identifies relevant information for lead generation (Jim et al., 2022).

In summary, the use of AI in personal selling is a complex and multifaceted issue that requires careful consideration of the potential benefits and drawbacks (Good et al., 2022). While AI can certainly enhance the efficiency and effectiveness of the selling process, it is essential to ensure that it is used in a way that complements and augments the skills and expertise of human sales reps, rather than replaces them.

Methodology

MLR

This research adopts a Multivocal Literature Review (MLR) approach to understand the role of artificial intelligence in the future of sales profession and personal selling. Ogawa and Malen (1991) defined MLR, that in a simpler perspective is a Systematic Literature Review (SLR) that includes grey literature (GL) along with peer reviewed published literature (Garousi et al., 2019). Grey Literature (GL) was defined as the information "produced on all levels of government, academics, business and industry in print and electronic formats, but which is not controlled by commercial publishers".

Multivocal literature review is a common literature review method in information systems and software engineering (Calderón et al., 2018; Peltonen et al., 2021; Saltan & Smolander, 2021; Scheuner & Leitner, 2020). On the contrary, to the best of our knowledge, scientific research published in the field of marketing with respect to this particular methodology, is scarce. Similar to the need of gaining insights from the "state of the practice" in software engineering (Garousi et al., 2016), we evaluate the usefulness of multivocal literature review in personal selling.

Specifically, two search engines were used for the retrieval of the publications. Google search was preferred for the location of grey literature, in view of the fact that it offers convenient customization throughout the search process (Godin et al., 2015). As for the white literature, Gusenbauer (2019) points Google Scholar as being "the most comprehensive academic search engine". Google scholar provides wide academic publication coverage (Jacsó, 2008).

Search Method

To answer the research questions, two separate search strings with relevant Boolean search were conducted. The search method followed the steps proposed by Brereton et al. (2007). Specifically:

- For Research Question 1:

("ai" OR "artificial intelligence") AND (("benefit" OR "improve efficiency") AND ("salesperson" OR "salespeople" OR "sales representative" OR "personal selling" OR "sales professional"))

- For Research Question 2:

("ai" OR "artificial intelligence") AND ("replace" AND ("salesperson" OR "salespeople" OR "sales representative" OR "personal selling" OR "sales professional"))

Establish the Inclusion/exclusion Criteria

As a part of the research protocol, setting inclusion and exclusion criteria comes as a necessity in the process of source evaluation and selection. The criteria used are the following:

- *Inclusion Criteria*
  - The literature must be relevant to the research questions
  - The literature should make direct reference to Artificial Intelligence
  - Literature that highlighted the benefits of AI in the personal selling and sales management field
  - Literature that highlighted the issue of human salesperson replacement from AI
  - The web page should be text-based
  - Literature that appears on the 5 first pages of Google search results
  - The literature must be written in English language
- *Exclusion Criteria*
  - Web pages which main content presented audio files, video or images
  - Inaccessible literature
  - Literature that contained only a summary

Table 1 Search results of the study

Search engine	Initial results	Title, abstract, keywords	Full text
Google scholar	65	12	10
Google search	38	14	14

3 Results

Stage one, initial results, displays the number of publications retrieved from Google scholar and Google search. The second stage displays the number of publications selected based on the title, abstract and keywords and the third stage displays the number of publications selected after the full text has been read and scrutinized. Table 1 summarizes the search results. On Stage one, 65 results were initially selected from Google scholar and 38 from Google search. Manual screening conducted by the authors, downsized the number to 12 and 14 accordingly, for results selected based on the title, abstract and keywords. The final set of articles has 10 academic studies, labeled D1 through D10 (see Table 2), and 14 studies from the grey literature search, labeled G1 through G14 (see Table 3).

4 Discussion and Implications

Through the process of systematically reviewing both white and grey literature, in research question 1, we came across unanimity in opinions. Artificial intelligence can only benefit personal selling but not without presuppositions and not ad lib (i.e., adequate training programs for sales representatives and managers). The adoption of responsible AI practices and proper training of salespeople and managers are critical parameters to utilize the benefits of such technologies. For the second research question, the academic literature converges to the conclusion that artificial intelligence will not eliminate the human representatives' jobs. On the contrary, analysis of grey literature showcased a dichotomy of opinions on the subject. This consensus underscores the distinctive value that human sales professionals contribute, encompassing dimensions beyond the purview of artificial intelligence technology.

The study's use of grey literature broadens its perspective but also brings in potential biases. As this study only considers the first five pages of online search results, it might have overlooked important but less prominent results and unintentionally give more weight to content that appears at the top of search results, possibly due to advertising and the potential influence of commercial interests.

As Vrechopoulos et al., (2022, p. 55) note, "since technology cannot totally replace all human aspects in the retailer-consumer interaction process, an optimum blending of technical and human resources is crucial". In this context, they thoroughly discussed the role of Digital Technologies in personal selling providing several insights that are in line with the findings of the present study. Pushing the

Table 2 Primary studies in academic literature

ID	Title	Venue	Year	Reference	RQ
D1	Drivers of salespeople's AI acceptance: What do managers think?	Journal	2022	Chen and Zhou (2022)	RQ1
D2	Are sales as we know it dying … or merely transforming?	Journal	2017	Moncrief (2017)	RQ1,2
D3	Customer-salesperson interaction technologies: Are robo-advisors replacing personal selling?	Conference	2019	Meyer and Greve (2019)	RQ2
D4	Collaborative intelligence: How human and artificial intelligence create value along the B2B sales funnel	Journal	2020	Paschen et al., (2020)	RQ1,2
D5	Waiting for a sales renaissance in the fourth industrial revolution: Machine learning and artificial intelligence in sales research and practice	Journal	2018	Syam and Sharma (2018)	RQ1
D6	Reshaping the contexts of online customer engagement behavior via artificial intelligence: A conceptual framework	Journal	2021	Perez-Vega et al., (2021)	RQ1
D7	The effectiveness of AI salesperson vs. human salesperson across the buyer–seller relationship stages	Journal	2022	Chang (2022)	RQ2
D8	Sales profession and professionals in the age of digitization and artificial intelligence technologies: concepts, priorities, and questions	Journal	2019	Singh et al., (2019)	RQ1
D9	(Un)intended consequences of AI sales assistants	Journal	2022	Monod et al., (2022)	RQ1
D10	A strategic framework for artificial intelligence in marketing	Journal	2020	Huang and Rust (2021)	RQ1

technology trajectory towards as also the way Artificial Intelligence is being used, in a way that its existence stands as a tool for salespersons, an amplifier of the sales process, governance should be in the core of the activities regarding private sector. An ethical, symbiotic way that benefits both customers and businesses while at the

Table 3 Studies in grey literature

ID	Year	Title	Type	Company/Organization	RQ
[G1]	2023	How Generative AI will change sales	Ad-Hoc blog	HBR	RQ1
[G2]	2023	How AI in sales is changing the selling process	Blog post	AIbees	RQ1
[G3]	2022	Salesperson of the future: What role does AI play?	Newsletter	LinkedIn	RQ1
[G4]	2023	Will AI replace salespeople? separating fact from hype	Blog post	SRG	RQ1,2
[G5]	2023	How will AI impact the work of sales reps?	Newsletter	LinkedIn	RQ1
[G6]	2021	Will AI replace salespeople? Opinions differ between experts in the industry	Community	Hackernoon	RQ2
[G7]	2023	Is AI going to be the death of the salesperson?	Blog post	Cleanfax	RQ1
[G8]	2023	AI in sales: Will AI replace salespeople, or boost them?	Ad-Hoc blog	Oneflow	RQ1,2
[G9]	2023	Can AI replace salespeople?	Ad-Hoc blog	LURU	RQ2
[G10]	2023	How can salespeople stand out against ChatGPT?	Ad-Hoc blog	Imparta	RQ1
[G11]	2018	Why Artificial Intelligence will eliminate millions of sales jobs	Blog post	Forbes	RQ2
[G12]	2023	Sales revolution: Will AI ever truly replace the human touch?	Community	Medium	RQ2
[G13]	2023	Death of a salesperson; Could AI be the ultimate killer?	Ad-Hoc blog	Starboard Cre	RQ2
[G14]	2023	No, AI can never replace salespeople	Blog post	Sales pop	RQ2

Table 4 shows these hyperlinks

same time facilitates the work of personal selling professionals emanates from the analysis of the literature.

Finally, it should be reminded that while technology offers a plethora of low-cost and challenging mass customization and personalization opportunities, such an option should always be considered in the context of Strategic Marketing Planning decisions. Specifically, the "standardization vs. adaptation" marketing dilemma also stands for personal selling as an element of the promotional mix. Thus, AI capabilities and their potential exploitation in the context of personal selling, should be approached by companies and researchers taking into consideration also this perspective.

5 Future Research Directions

Future research should aim to gain a deeper understanding of the impact of artificial intelligence on personal selling. Likewise, this study unfolds the current literature in the subject of AI and personal selling profession, empirical studies that adopt a multidisciplinary research approach will further advance the knowledge on the subject. As industries are looking for ways to gain a competitive advantage by leveraging generative AI, sales teams will be significantly more efficient and personalized in the future (Chui et al., 2022; Taulli, 2023). Building on the research conducted by Lin et al. (2021) and Lee and Heinze (2020) on virtual salesperson (VS) role and technology-based sales support materials (TSSM) respectively, novel research should revisit these topics in light of recent technological advancements.

In sum, while AI is continuously adopted by both businesses and customers in personal selling processes, there is need for further research that will provide specific evidence regarding several critical aspects of this multidisciplinary domain. To this end, both academic and businesses should investigate the role of AI in personal selling through empirical research attempts, employing various research methods and approaches (e.g., personal in-depth interviews, experimental design) that will shed more light on this emerging topic. Such research initiatives should focus on different business sectors (e.g., apparel, tourism, software), cultures, size of companies (e.g., SMEs vs. large companies), customer profiles, etc. as well as on different types and applications of AI technologies.

Finally, researchers could attempt to explore the dynamics of a post AI era in the topic of personal selling. Such research approaches could derive challenging research questions and interesting sources of potential competitive advantages. Systematically reviewing the past to explain the present and predict the future along with the execution of empirical research initiatives (e.g. experts and consumer in-depth interviews) could adequately operationalize such a research objective.

Appendix Grey Literature

See Table 4.

Table 4 Grey literature URLs

ID	URL
[G1]	https://hbr.org/2023/03/how-generative-ai-will-change-sales
[G2]	https://www.ai-bees.io/post/how-artificial-intelligence-in-sales-is-changing-the-selling-process
[G3]	https://www.linkedin.com/pulse/salesperson-future-what-role-does-ai-play-alexander-low/
[G4]	https://www.salesreadinessgroup.com/blog/why-ai-wont-replace-your-salespeople-anytime-soon
[G5]	https://www.linkedin.com/pulse/how-ai-impact-work-sales-reps-karen-ercoli/
[G6]	https://hackernoon.com/will-ai-replace-salespeople-opinions-differ-between-experts-in-the-industry
[G7]	https://cleanfax.com/ai-death-of-salesperson/
[G8]	https://oneflow.com/blog/ai-in-sales/
[G9]	https://www.luru.app/post/can-ai-replace-salespeople
[G10]	https://imparta.com/resources/how-can-salespeople-stand-out-against-ai-and-chatgpt/
[G11]	https://www.forbes.com/sites/forbesagencycouncil/2018/01/02/why-artificial-intelligence-will-eliminate-millions-of-sales-jobs/
[G12]	https://medium.com/@jaureguied/sales-revolution-will-ai-ever-truly-replace-the-human-touch-9b719921f81c
[G13]	https://starboardcre.com/salespersons-corner/death-of-a-salesperson-could-ai-be-the-ultimate-killer/
[G14]	https://salespop.net/artificial-intelligence/no-ai-can-never-replace-salespeople/

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The Impact of Trust in AI Chatbots on Users' Behavior in Online Health Communities

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Abstract Current literature lacks sufficient evidence on adoption of AI conversational agents (chatbots) in the healthcare industry. This research paper aims to fill this gap by investigating the acceptance of chatbots in Online Health Communities (OHCs) through a defined research model. The study examines the influence of specific features on users' intentions and actual usage of these communities. A quantitative methodology is employed, utilizing the proposed research model to analyse users' behavior and intentions towards AI conversational agents/chatbots in OHCs. A total of 632 responses were received from 62 countries, of which 443 were complete. The findings highlight the interconnectedness between AI conversational agents/chatbots and OHCs, particularly their impact on users' Behavioral Intention (BI). The Trust variable is found to significantly influence participants' Behavioral Intention (BI) and Usage Behavior (UB) towards AI conversational agents/chatbots in OHCs. Additionally, factors such as experience in chatbots, experience in technology, occupation, and geographical zones are identified as significant moderators that affect BI and UB.

1 Introduction

Healthcare is constantly evolving and faces numerous challenges, particularly highlighted by the recent COVID-19 pandemic. Reports of miscommunication between healthcare professionals and patients, as well as patients' friends or family, have emerged. Healthcare providers often lack the expertise to effectively address the

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informational needs of patients who may already possess inaccurate information regarding their health-related concerns. Improved coordination and communication are essential between healthcare professionals and patients, as well as healthcare practitioners and patients' families or friends. The implementation of Artificial Intelligence (AI) and AI chatbots in healthcare professional-patient communication has the potential to enhance auditing and feedback processes (Butow & Hoque, 2020) to systematically monitor and evaluate the interactions between the chatbot, healthcare professionals, and patients. This serves multiple purposes such as quality assurance, compliance monitoring, performance evaluation, training and learning, and continuous improvement.

AI is considered one of the most disruptive technologies, raising concerns and uncertainties (Garrett, 2012). Ongoing research aims to mitigate risks associated with AI. The demand for healthcare-related information has increased, and online health communication has amplified this need (Wright, 2020). Osta et al. (2022) conducted a study on the impact of AI conversational agents on users in Online Health Communities (OHCs), using the Unified Theory of Acceptance and Use of Technology (UTAUT) model. They emphasized the importance of exploring the influence of trust on users' behavior.

In the healthcare context, chatbots or healthbots provide personalized health and therapy information, suggesting diagnoses and treatments based on patient input (Morris et al., 2018). The concept of AI for social good has gained traction in information societies, aiming to address social and health issues through AI-based solutions (Cowls et al., 2019).

Different perspectives on trust have been identified by researchers based on end users' experiences with various software developments related to building human trust (Liao et al., 2018). Trust, no longer solely linked to risk, significantly influences the decision to adopt a technology system and behavioral intention (Sharma & Sharma, 2019). Trust has been extensively discussed in the context of human-AI interaction (Cheng et al., 2022; Hu et al., 2021), emphasizing the importance of trust-building between patients and health professionals (Asan et al., 2020). According to Skjuve et al. (2022), in the initial phase of forming relationships with human chatbots, early self-disclosure may signify exploration, where individuals engage with the chatbot as a coping mechanism or for its designated purpose. On the other hand, self-disclosure occurring later in the interaction, driven by increasing trust and confidence, indicates a progression towards a more intimate relationship.

This research aims to investigate the impact of trust in AI chatbots on user behavior in Online Health Communities (OHCs). The study utilizes a quantitative methodology with a hypothetico-deductive approach. Statistical analysis was conducted on a convenience sample of 443 participants who are members of OHCs. The results reveal a significant correlation between trust and user behavior. Participants generally agree that the use of chatbots in OHCs effectively meets their informational needs and is trustworthy. However, several existing factors contribute to a decline in trust when using chatbots in OHCs. Establishing trust in the adoption of AI in healthcare practices within OHCs remains a critical challenge.

To accomplish this objective, we will provide a concise overview of the relevant literature on AI, chatbots, trust, and technology. We will then present the proposed model and hypotheses for testing. Subsequently, we will outline the methodology employed and present the results, followed by a comprehensive discussion of the findings. Finally, we will conclude our work by highlighting our contributions, managerial implications, and limitations.

2 Literature Review

AI and Generative AI

AI conversational agents or chatbots as they are often called, for three main reasons: information provider; execution of specific processes and capturing of data. Chatbots is a class of AI applications that rely on Deep Learning (DL) (Long, 2020) to assist the provision of information. These chatbots can offer instant replies to health questions from patients while analyzing symptoms and predicting diseases (Tripathy et al., 2015). Also, they are accessible through different digital hubs: websites, mobile and messaging applications, SMS, embedded services on mobiles, connected speakers, etc. Due to their accessibility, flexibility, and low cost, such applications are employed for the convenience of both end-users and organizations (Przegalinska et al., 2019). Chatbots connect with users using natural language and efficiently respond to their questions (Ciechanowski et al., 2019). In the context of healthcare, personalized health and therapy information is being provided by chatbots or healthbots to provide support to patients by suggesting diagnoses and treatments based on patient indications (Morris et al., 2018).

However, the field of healthcare is a very diverse one that is always evolving. While some patients share characteristics, the majority have unique psychological and physical profiles and react to treatment in various ways. There is a continuum between the diagnosis and the results. It is difficult for physicians and the current generation of AI chatbots to neatly resolve complicated and highly changeable difficulties in the diagnosis and care of human patients.

To effectively respond to medical queries or address specific medical issues, a chatbot must have access to accurate, domain-specific, and up-to-date real-world information. Regular updating and training of the underlying datasets are also necessary. It should be noted that the most widely used model of generative AI algorithms current version of ChatGPT, a generative AI model, may lack crucial components required for providing accurate medical answers (Vaishya et al., 2023). This study highlighted various challenges associated with the use of generative AI, such as ChatGPT, in healthcare. These challenges include a lack of specialized medical knowledge, potential biases, difficulties in comprehending complex medical concepts, ChatGPT's acknowledgment of being outdated in medical knowledge and literature, as well as limitations in diagnosing medical conditions. Although

there have been anecdotal observations and speculations regarding the applications of ChatGPT in healthcare, the technology is relatively new, and there are only a limited number of systematic studies that have explored its potential uses (Haque et al., 2022).

Trust and Technology

Trust is defined as a subjective position that accepts the existence of an action that matches positive predictions (Köksal & Penez, 2015). So, according to (Gefen et al., 2003), trust is developed when a sufficient amount of benevolence, integrity, and ability is created in a defined system.

While certain aspects of good customer service align well with chatbots' capabilities (e.g., speed, availability, scalability), others correspond better with human competencies (e.g., empathy, judgement, critical assessment) (Vassilakopoulou et al., 2023) and Trust can be considered in this context. Concerning AI and trust, Accenture (2023) identifies various risks in this domain. These encompass the unethical or potentially illegal utilization of insights, the exacerbation of biases rooted in social and economic justice issues, and the utilization of data for purposes to which its original contributors have not provided their consent. As per Alsharhan et al. (2023), new independent variables have the capacity to influence the user's interactions with chatbots, including factors like anthropomorphism, trust, enjoyment, and interactivity.

In the IS literature, trust is widely recognized as having an impact on UB while adopting new technologies (Amoako-Gyampah & Salam, 2004; Ha & Stoel, 2009). Also, it is always crucial to grow trust within a team (Zheng et al., 2022), and the feasibility of using Conversational Agents for trust-building (Sebo et al., 2018). However, in the case of healthcare delivery based on patient personalization (Berry & Bendapudi, 2007), the patient must allow healthcare organizations access to his or her personal data and previous health information.

Researchers found different perspectives based on end users' experiences following various software development related to building human trust (Liao et al., 2018). Because trust is no longer connected with risk, this construct has been shown to have a significant impact on Behavioral Intention's (BI) decision to adopt a technology system (Sharma & Sharma, 2019). Loh et al. (2021) examined the users' trust perceptions in an AI-driven collaboration context because trust is a crucial determinant for the success of technology. Trust has been frequently discussed in both human-AI interaction (Cheng et al., 2022; Hu et al., 2021).

When AI algorithms are validated in real clinical cases, clinical trust will be built strongly. These cases include social and human responses, which are usually hard to predict and manage, but for which AI techniques must contribute to this context. Also, patient trust must be taken into consideration in addition to clinical trust because it includes privacy issues (Esteva et al., 2021).

To conclude with this part, trust in technology is a critical factor that influences users' willingness to adopt and use technology effectively. The factors that influence trust in technology are multifaceted and interrelated, and research has identified several key factors that influence users' trust in various technologies. Understanding these factors is essential for designing and developing technologies that are reliable, secure, and effective, and that promote trust among users.

3 Proposed Model and Hypothesis

Osta et al. (2022) studied the impact of the main variables on the level of the acceptance of health AI agents/chatbots in OHCs through the UTAUT model (Venkatesh et al. 2003). The choice of this model is explained by the fact that it provides a comprehensive synthesis of users' intentions to adopt new technologies. They concluded that there is a need to test additional variables such as trust and fear of technological advances (FOTA), as well as other moderators such as technology experience, experience in chatbots, occupation, and geographical zones. In view of these, this research examines the impact of Trust in AI chatbots on users' behavior in OHCs. Table 1 presents the variables and moderators of our model with the relevant hypotheses (See Fig. 1).

4 Methodology and Data

In this article, we will employ a quantitative methodology following the hypothetico-deductive approach. Our statistical analysis was conducted on a convenience sample of 443 participants who were members of OHCs. Various social media platforms like Facebook, LinkedIn, and Instagram were utilized to engage active OHC members worldwide.

To establish contact with OHCs and gather comprehensive responses, three Facebook boosts were employed after creating a business account. Due to a standard process, the researcher's Facebook account was temporarily restricted for a few days. As a result, the researcher began actively joining groups on LinkedIn from April 13th, 2021. LinkedIn users, especially students, responded promptly and in a professional manner to such inquiries. A request to post on OHCs was made to fourteen different groups. Respondents were asked to provide their feedback, and the following communities exhibited high levels of activity: "Nature for Health Online Community," "Health Informatics Forum: A Community for Digital Health Discussion, Networking," "Healthcare Professionals Community," and "Intelligent Health AI: The World's Largest Emerging Tech in Medicine Community." Smaller OHCs tended to engage more with each other compared to larger ones. This strategy aimed to increase awareness and foster interaction with community administrators. Communication with administrators was crucial as all messages had to be authorized before

Table 1 Presentation of variables, moderators, and main Hypotheses

Variables	Description	Hypotheses
Trust	Trust in technology, in particular, is a crucial part of social trust, since in the current reality digital ecosystems are becoming embedded in people's lives (Kireeva et al., 2023)	H1. Trust will strongly influence BI (Behavioral Intention) to use platforms or chatbots within OHCs
Experience in technology	User experience objectives diverge from objective usability goals as they prioritize the way users interact with an interactive product based on their perspective, rather than assessing the system's effectiveness or productivity from its own standpoint (Preece, 2001)	H2: Experience in technology moderates the relationship between trust and BI to use chatbots in OHCs
Experience in chatbots	From a user experience perspective, chatbots are designed to maximize pragmatic quality—that is, the character of the chatbot as useful and usable, serving the instrumental needs of the user	H3: Experience in chatbots moderates the relationship between trust and BI to use chatbots in OHCs
Geographical zones	In this study, geographical zones are delineated based on the accessibility of members/patients within online health communities and their respective locations	H4: Geographical zones moderate the relationship between trust and BI to use chatbots in OHCs
Occupation	To generate precise outcomes, it is important to incorporate occupational, as outlined in Johns' (2006) conceptualization. When dealing with the management of chronic diseases, it is essential to consider occupational factors, such as the work environment. This can be achieved by integrating occupational data into the health model. (Rajamani et al., 2018)	H5: Occupation moderates the relationship between trust and BI to use chatbots in OHCs
Behavioral intention	BI refers to individuals' future intentions regarding the use of technology	H6. BI will strongly influence users' intention to use platforms or chatbots within OHCs

The research model used is shown below.

being posted. These administrators played a positive role in the survey process by encouraging OHC members to participate.

To connect with various online communities interested in the research topic from around the world, the researcher participated in online meetings such as the Facebook community meeting on April 7th, 2021. These meetings proved valuable in reaching

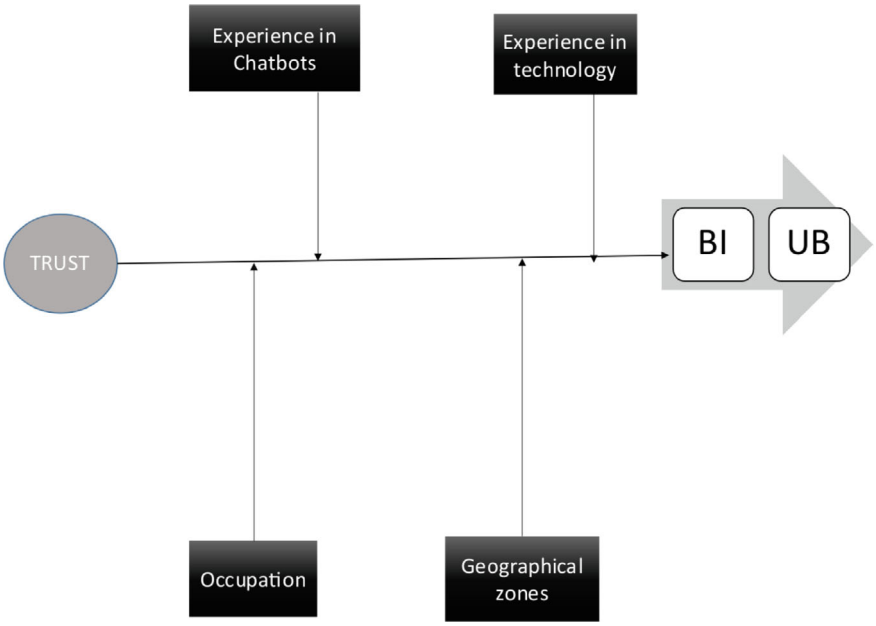

Fig. 1 UTAUT model and adapted by the authors

out to these communities. People with inquiries had the opportunity to personally speak with the researcher before submitting their responses. After extensive discussions with the administrators of the Askapatient.com website, the suggested study was featured twice in their newsletter, reaching a total of 3500 individuals. Communication occurred on the websites of twenty-eight OHCs, although seven of them declined to publish the information.

A total of 421 participants participated in the study. Their demographic characteristics are as follows: Participants were distributed between 217 females (51.5%) and 204 males (48.5%). The mean age was 34.4 $\pm$ 10.9 years, median age was 32 years with a minimum of 18 years and a maximum of 68 years. Participants were in Europe (42.3%), North America (24.2%), Arab countries (21.1%) and other countries (12.4%) and engaged in many occupations including business and financial operations (27.6%), architecture and engineering (12.8%), education (12.4%), healthcare administration (11.9%), and 16.2% were students. The top two educational levels were master's degree (43%) and bachelor's degree (32.5%).

With respect to the participants' technology use experience, 50.4% considered themselves adequate technology users, 25.2% considered themselves experts in technology, 18.3% were progressing in technology, and 6.2% had limited experience in technology. In addition, 70.5% were familiar with the term Online communities and 55.8% were familiar with the term Chatbots. Also, 57% had limited experience in the use of Chatbots and/or online communities, 18.8% were progressing in the use of

Chatbots and/or online communities, 20.9% considered themselves adequate Chatbots users, and only 3.3% considered themselves experts in the use of Chatbots and/or online communities.

5 Results and Discussion

The statistical analysis performed on the 421 participants showed an interesting correlation between Trust and BI. Participants almost agree that using chatbots in OHCs can fulfil their informational needs. Also, they believe that using chatbots in OHCs is trustworthy. Trust is a crucial factor/variable that influences the use of these online platforms. However, many existing factors are decreasing the trust in using chatbots in OHCs. In fact, gaining the trust in the adoption of AI healthcare in OHCs is a major challenge to the successful integration of AI in healthcare practices.

Trust Items

Trust (T) is measured on a 7-item scale following a Likert scale from 1 to 7 (Kireeva et al., 2023; Montag et al., 2023). From the analysis, the top three items with highest mean were:

(1) "Using chatbots/online communities has the ability to fulfil my informational needs" (4.26 ± 1.73),
(2) "I believe that using chatbots /online communities is trustworthy" (3.94 ± 1.68), and
(3) "I do not doubt the honesty of chatbots/online communities' participants" (3.87 ± 1.72).

TRUST score is valid in our population with a Cronbach's Alpha value equal to 0.770 (> 0.7). The mean TRUST was 24.43 ± 8.26 over 49 with a minimum of 7 over 49 and a maximum of 49 over 49. The median of TRUST was 24 over 49 showing a moderate trust in the study population.

Factors Affecting Trust Scores

The factors affecting the Trust scores include demographics, technology-related data and experience related to the use of chatbots.

Correlation Between Trust Scores and Demographics

Trust was demonstrated in 52.1% of males and 50.5% of females with no statistically significant correlation between Trust and gender ($p = 0.745$). In addition, Trust was demonstrated in 51.4% of participants aged less than 32 years and in 51.2% of participants aged more than 32 years with no statistically significant correlation between Trust and age ($p = 0.976$). Trust was high in participants working in the food and beverage sector ($p = 0.001$), and low in participants working in the business and financial operations ($p = 0.038$), and the architecture and engineering ($p = 0.025$) sectors. Trust was higher in lower educational levels (trade school and high school) and the Trust rate was found to be decreasing as the educational level of the participants increased ($p = 0.029$). Trust was not statistically correlated with the living country ($p = 0.689$) where trust rate was 51.1% in Europe, 52% in North America, 47.2% in Arab countries and 57.7% in other countries.

Correlation Between Trust Scores and Technology Related Data

There was a statistically significant correlation between Trust and technology use experience ($p < 0.001$). Trust rate was higher in participants with limited experience and those progressing in technology (65.4% and 68.8% respectively), and lower in adequate users and experts in technology (50.9% and 35.8% respectively). Trust was not statistically correlated with the usage of majority of apps noting online text messages ($p = 0.409$), interactive whiteboards ($p = 0.225$), forums (discussion boards, discussion groups etc.) ($p = 0.869$), email ($p = 0.323$), and social networks (Facebook, Instagram, LinkedIn etc.) ($p = 0.484$). Whereas Trust was lower in participants using video conferencing (Zoom, Teams etc.) on a regular basis ($p = 0.004$); more specifically, the Trust rate was 48.3% for video conferencing users and 51.7% for non-video conferencing users.

Correlation Between Trust Scores and Experience Related to the Use of Chatbots

There was a statistically significant correlation between Trust and experience related to the use of chatbots and/or online communities ($p = 0.034$). The Trust rate was higher in participants with limited experience and those progressing in the use of chatbots and/or online communities (54.2%), and lower in adequate users and experts in chatbots and/or online communities (42.2%).

Trust was statistically higher in participants who are not familiar with the term chatbots (58.1%) comparing to those who are familiar with the term (46%) ($p = 0.014$). Trust was not statistically associated with being familiar with the term online communities ($p = 0.768$).

A statistically significant and positive correlation was found between Trust and BI. This finding discussed above is associated with the fact that ethical questions include

trust issues about human behavior and AI, human value judgment and compatibility of machine, AI discrimination, and moral dilemmas (Dwivedi et al., 2019). So, gaining the trust of the public in the adoption of AI healthcare is a major challenge to the successful integration of AI in healthcare practices (Whittlestone et al., 2019). In parallel with regression analysis, Trust has a significant correlation to BI ($p < 0.001$).

As it was pointed out in Lee et al. (2003), Trust in AI-based tools (such as AI medical devices) is shown to be a significant factor. This variable has an impact on adoption decisions. Also, the autonomy of AI applications has an impact on the individuals' perception of trustworthiness. According to Arfi et al. (2021), an environment of trust should be developed in the context of the healthcare sector and eHealth services because it can reach success when implementing technological tools.

The results showed that almost all participants agree that deploying chatbots in OHCs may meet their informational demands, based on the percentages provided by this study. This point appears to have a positive impact, but while participants believe that using chatbots in OHCs is trustworthy, they still require other reasons to boost their trust in these technologies.

Although the relationship between trust and transparency in the context of AI conversational agents/chatbots is yet unclear, the issue of trust should be always considered when building and using AI conversational agents/chatbots systems. Humans can not only develop and build AI conversational agents/chatbots, but also classify them in various social contexts, such as in the various OHCs via a project that connects chats/conversations and discussions through these online communities. This strategy should address ethical conduct and present a positive image of OHCs, particularly because patients frequently have privacy concerns and lack trust when working with AI conversational agents. Clearly, collaborating with human-AI agents/chatbots helps to improve these online platforms and develops trust in AI systems' cooperative approach to human partners and their environment.

The concept of humanized AI has the potential to boost patient/user trust. AI conversational agents/chatbots lack certain competencies based on their elements of competencies (cognitive, social intelligence, and emotional). As a result, our participants are not improving their trust in the use of chatbots in OHCs. Trust is a crucial factor/variable that influences the use of these online platforms.

Regarding experience in technology, results showed that the participants who had limited experience or are progressing in technology have intentions to use chatbots in OHCs. Regarding experience in chatbots, Trust was significant with this moderator because it is considered as highly significant with the aim and research questions of this study. The study findings contribute to knowledge about user experience because a huge potential was detected with people that either have limited experience or they are progressing in technology and use of chatbots. When users are not experienced enough or they are progressing in their experience in technology, they increase their intentions to use chatbots in OHCs.

6 Conclusion

In this article, our aim was to emphasize and analyse the intention behind utilizing health AI agents/chatbots applications within the framework of OHCs. Using our research model, we explored the technology use experience of OHCs members with regards to their intention to use AI conversational agents/chatbots in OHCs. BI and UB were found to be strongly correlated with Trust and other moderators of the research model, playing a significant role in influencing the relationship between variables and the BI of the participants.

Our study reveals that an increase in Trust leads to an increase in BI. Following Pavlou and Paul (2003), Trust is defined as the confidence that the other party would demonstrate in a socially responsible manner that would meet the expectations of the trusting party without exploiting their vulnerabilities. The challenging aspect here is that the other party was not human. Consequently, our findings indicate that users of these systems worldwide have concerns about the potential exploitation of their information (Alomari et al., 2010). Since trust plays a vital role in the decision-making process of using chatbots in OHCs, users who have a higher inclination towards this construct quickly and confidently accept the service. Most participants are unfamiliar with how to use these applications, underscoring the importance of establishing trust to facilitate their adoption.

This study makes a twofold contribution. Firstly, it contributes to the existing theory by examining the Trust variable and various moderators such as technology experience, chatbot experience, occupation, and geographical zones in the context of OHCs regarding the use of AI agents/chatbots. By testing the proposed research model, this study addresses the need for further research and empirical studies on intelligent automation in the healthcare industry. Additionally, it fills a gap in the current literature concerning the use of chatbot technology in healthcare.

The research model employed in this study has demonstrated its strength and reliability in assessing the adoption and application of new technology. The findings have provided a deeper understanding of users' acceptance and readiness to use chatbots in OHCs. As a result, this study contributes to the literature by offering valuable insights for both practitioners and scholars interested in examining patients' behavior in relation to the use of chatbots in OHCs.

Another contribution of this study is that it provides important information concerning the factors influencing the use of chatbots in OHCs. This contribution could lead to the proposal of new policies and activities that would help Europe turn into a global centre for trustworthy AI and the use of chatbots in OHCs. The combination of the UTAUT model and a strategy plan given to European governments, as well as a new Coordinated Plan with the Member States, could ensure patient safety and fundamental rights, while also boosting chatbot adoption, investment, and innovation across the EU. Users' trust in the new generation of chatbots in OHCs may be reinforced by new rules on machinery that adapt safety rules. Although the EU regulation on the use of chatbots in OHCs has not yet gone into force, the contribution of this research presents a clearer picture of the future of these applications. Now is

the opportunity to start learning about the implications and preparing for them, as well as the regulations that will inevitably follow. These actions could also help to ensure that present regulations are followed and that other, non-regulatory chatbot risks are minimized. In the same context, text-based services can be used by cities in the United States and Canada to assist people and government employees. Chatbots were an important part of numerous states' response to the Coronavirus outbreak. These technologies have proven to be capable of assisting departments in dealing with a big amount of consideration under the worst circumstances.

It is crucial for technology developers to ensure that chatbots in OHCs can interact in multiple languages, offering customers an improved user interface experience. Practitioners should also take measures to prevent any technology-induced anxiety caused by chatbots, thereby strengthening the trust relationship.

In the future, patients can utilize health chatbots as an initial point of contact for primary care, enabling them to directly connect with physicians for diagnosis or treatment support through interactive conversations or text-based interactions with intelligent algorithms. Rather than relying on physicians, nurses, or other medical experts to answer every health-related question, including frequently asked questions (FAQs), healthcare providers may prioritize the use of chatbots as the first line of assistance. In cases where the chatbot is unable to address specific concerns, the patient's case will be transferred to a real-life doctor. In addition, healthcare practitioners should ensure that chatbots are developed with customization and personalization capabilities to meet the individual needs of patients. This customization is essential to create a sense of security for patients when utilizing chatbots for healthcare purposes.

While the literature review demonstrates the robustness of the research model and its validation in previous studies, it is important to recognize certain inherent limitations. For example, future studies should consider the intention-behavior gap and the influence of external factors, as identified by Venkatesh and Bala (2008). Additionally, it is recommended that other moderators and variables be incorporated into the research model for testing in future studies and different contexts. Using a qualitative approach in upcoming studies would be highly intriguing as it would enable the authors to delve deeper into the responses and emotions of users. This would provide a better understanding of their concerns regarding the use of these technologies.

In conclusion, our research reveals a methodological limitation in terms of generalizing the results. The study was conducted over a specific duration, highlighting the need for future research to incorporate longitudinal evaluations to ensure the reliability of UB findings. Furthermore, future research should delve into the exploration of ethical principles and practical implications of chatbots, considering the saved costs, 24/7 availability, faster response time and regional influences on BI and UB.

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The Future of Work

Human Resources Issues in Metaverse

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Abstract Digital technology is becoming increasingly connected with our everyday life, transforming not only the way we communicate, learn and relax but also how we live and work: a Metaverse workplace is in the making. Initially adopted by industries like gaming and fashion, an expanding array of sectors, including technology, finance, and health, are now utilizing the Metaverse for commercial applications. The results are increased brand loyalty and revenues, optimization of the product design and creation processes, offering a new avenue towards sustainability. As businesses navigate this novel terrain, the role of Human Resources is pivotal in shaping the future of work. A new strategy will be required for virtual recruitment, employee training and development, and at the same time businesses will need to consider how they can create safe and effective virtual workspaces that foster productivity and engagement, while addressing potential challenges such as virtual fatigue and burnout. The primary objective of this paper is to elucidate the role of HR in ensuring that the Metaverse evolves into a safe and inclusive work environment. Furthermore, it underscores the urgency of establishing a legal framework to regulate this complex and largely uncharted domain, thereby providing a foundation for sustainable and ethical practices in the Metaverse workplace.

1 Introduction

Human creativity and imagination have been instrumental in the advancement and development of society. Our capacity to envision possibilities beyond existing realities has catalyzed numerous innovations and breakthroughs. Technology has been a pivotal tool in realizing our aspirations, exploring new horizons, and enhancing our

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understanding of the world, thereby increasing our sense of control over our environment and lives. The ambition to further extend these capabilities has led to the conceptualization of the Metaverse—a unique virtual universe that allows for novel levels of immersion, control, and ownership, even in non-tangible forms. The Metaverse presents an opportunity for individuals to participate and create virtual representations of themselves, fostering true ownership within applications and digital communities (Hackl & Bartolo, 2022).

The way it has been conceived, the Metaverse will be persistent and reactive, with life continuing even when users are offline, and inhabitants responding in real-time to user actions. Limitless, in experiences and user capacity, decentralized, and user-defined, promoting active engagement with content rather than passive consumption. Interoperability, a key component of the Metaverse, will facilitate users' movement between platforms.

The Covid-19 pandemic has accelerated the shift towards hybrid work models, including remote work or working from home. This transition, already in progress, offers benefits such as flexibility, increased productivity, reduced commuting time and costs, and access to a broader talent pool for employers (Lund et al., 2021).

Human resource management has emerged as a critical practice for managing organizations in the twenty-first century. The objective of the paper is to explore and address the multifaceted HR challenges and opportunities presented by the rapid evolution and integration of the Metaverse into various industries and workplaces. It seeks to understand how HR practices must adapt to accommodate the unique aspects of working within virtual environments that blend physical and digital realities.

The paper underscores the necessity for HR professionals to develop strategies that align with the Metaverse's distinctive requirements, ensuring fair compensation and employee well-being in digital contexts. It also highlights the need for a reevaluation of traditional performance management practices as well as the creation of a specific legal and regulatory framework. It addresses the technological, organizational, psychological, and social implications of transitioning to a digital workplace, emphasizing the need for comprehensive strategies to navigate these challenges effectively.

2 Definitions and Methodology

The word "Metaverse" is the combination of the Greek prefix "Meta" meaning "beyond" and verse referring to the "universe." The term "Metaverse" was first used in Neal Stephenson's novel Snow Crash, published in 1992 and is described as "a shared imaginary realm that is made available to the public across the worldwide fiber-optics network and projected onto virtual reality goggles" in the novel (Stephenson, 1992).

We can find different expressions and definitions referring to -and trying to capture the essence of- the Metaverse: "A parallel, immersive world that blurs with the real one where people assume one or multiple identities. At its core, it puts individuals at

its center. The next generation of consumer engagement: an immersive experience with self-sustaining, community driven economy at its center." (Hackl & Bartolo, 2022) "A massively scaled and interoperable network of real time rendered 3D virtual worlds that can be experienced synchronously and persistently by an effectively unlimited number of users with an individual sense of presence, and with continuity of data, such as identity, history, entitlements, objects, communications and payments" (Ball, 2022).

This research employed a mixed-methods approach. For primary research, an online questionnaire comprising 18 multiple-choice and 11 open-ended questions was created, garnering responses from 57 individuals between February and April 2023. Additionally, 22 in-depth interviews were conducted. The participants were primarily C-level executives across various sectors including technology, legal, education, consulting, marketing, advertising, pharmaceutical, and banking. Two thirds of the respondents (66.7%) were actively using/investing in Metaverse while the 75.8% stated that "The Metaverse is an important consideration to the digital transformation of our organization".

The secondary research involved a comprehensive literature review, focusing on existing studies and reports relevant to the topic. Data triangulation was utilized where necessary to ensure the validity and reliability of findings, integrating insights from both primary and secondary sources to present a holistic understanding of the subject matter.

3 A New Workplace in the Making

The Metaverse has rapidly evolved into a dual-function space, serving both as a Marketplace and a Workplace. Initially embraced by gamers and the fashion and apparel industry, its utilization has expanded across various sectors, including technology, finance, health and wellness, and automotive industries for commercial activities. As of the time of preparation of this paper (January 2023), the Metaverse engages approximately 400 million active participants monthly, boasting an estimated market value of $47 billion (Metav.rs, 2022–23).

The Metaverse appears to represent a new frontier of possibilities for *service industries*, enabling them to offer new and innovative services in a virtual environment. With the growing adoption of virtual reality (VR) and augmented reality (AR) technologies, service industries can create engaging and immersive experiences previously unattainable in the physical realm. Virtual events and conferences for example, offer benefits such as cost reduction, enhanced accessibility, and flexible scheduling.

A defining attribute of the Metaverse is its creation of a boundless universe, unfettered by physical laws, merging physical and digital realms to unlock limitless possibilities and amplify economic potential. Service industries can leverage

this to establish virtual spaces where customers interact with digital service representatives in real-time, fostering personalized, engaging experiences and strengthening customer relationships. Additionally, these virtual environments facilitate 24/7 customer support without the need for physical infrastructure.

The growing trend of prominent brands establishing virtual stores in the Metaverse reflects its escalating significance in the *retail industry*. Virtual storefronts offer a fully digital shopping experience, allowing customers to browse and purchase products without ever leaving the Metaverse. *Banks* are also transitioning into the Metaverse, with J.P. Morgan being the first to establish its presence, foreseeing a potential market opportunity of $1 trillion in annual revenues by 2030. (Morgan, 2022).

The *hospitality and tourism* sectors are two sectors that might undergo a profound transformation within the Metaverse. Through the creation of immersive virtual environments, it stands to augment the guest experience significantly, presenting novel avenues for engagement and interaction. The implementation of virtual tours within hotels presents a novel approach, allowing prospective guests to virtually navigate through rooms, amenities, and surrounding locales prior to booking. Such interactive experiences not only enrich customer understanding but also serve as valuable tools for collecting data on guest preferences and behaviors, empowering establishments to tailor their services and marketing strategies accordingly. Furthermore, the Metaverse enables the provision of virtual concierge services, where guests can communicate with staff and make requests remotely, augmenting the traditional guest service model.

Virtual tourism emerges as an economically feasible and accessible alternative to physical travel, offering individuals the chance to immerse themselves in diverse cultures and environments from the confines of their homes. This avenue not only caters to those seeking unique experiences but also extends a novel prospect to individuals restricted from traditional travel due to health, economic, or other constraints, expanding the industry's reach and impact (Buhalis et al., 2023). The incorporation of *Digital Twins* (a virtual replica of a physical asset, system, or process that is continuously updated with real-time data) poses an avenue to furnish guests with personalized experiences while concurrently optimizing operational efficiency for property managers (Gould, 2022).

Healthcare appears to be another sector that might be significantly transformed in the Metaverse, since this innovation has the potential to revolutionize health education and training, as well as enhance clinical treatment and patient care. The utilization of virtual reality (VR) in healthcare allows medical professionals to simulate various medical procedures, providing a safe and controlled setting for practitioners to develop and hone their skills. Additionally, the Metaverse facilitates virtual healthcare services, including telemedicine consultations and virtual therapy sessions. These services offer increased accessibility and convenience, particularly beneficial for patients facing mobility or transportation challenges.

Augmented reality (AR) within healthcare presents another avenue for advancement, especially in surgical procedures. AR can offer real-time guidance and vital information during surgeries, thereby enhancing precision and minimizing the risk of complications. The Metaverse also shows promise in the fields of physiotherapy

and rehabilitation, potentially making these processes more efficient and effective, especially with the integration of technologies like exoskeletons. (Kladovasilakis et al., 2022; Ahmadi Marzaleh et al., 2022).

Finally, the Metaverse is poised to fundamentally transform the *learning industry*, by making education more accessible, inclusive, and engaging for learners from diverse backgrounds and abilities. The principle of "learning by doing" is especially effective in skill and knowledge acquisition. In the contemporary, complex world, continuous learning is vital for personal and professional development. The Metaverse offers a platform for ongoing learning opportunities for employees, enabling them to remain abreast of the latest trends and technologies in their respective fields. This continuous learning paradigm within the Metaverse can play a critical role in career advancement and skill development (Tlili et al., 2022).

4 The New Role of HR

The escalation of globalization, technological advancements, and the competitive drive for innovation have significantly altered organizational approaches to human resource management. In the aftermath of the COVID-19 pandemic, the rise of remote work and hybrid models, coupled with the emergence of the Metaverse, has presented novel opportunities for virtual collaboration and communication. This paradigm shift necessitates a proactive role for HR in sculpting the future work landscape (Purdy, 2022).

According to our survey to assess the potential impact of the Metaverse on various HR areas revealed five key domains: engagement of new workforce generations, building relationships in a hybrid work environment, collaboration, immersive learning, and onboarding. When participants were queried about prioritizing HR areas for successful Metaverse integration in the business model of their organization, the top responses were Learning/ training (33.3%), Employee experience (21.2%), Collaboration/ communication (18.2%), and Onboarding (15.2%).

For organizations to thrive in the Metaverse, the right talent acquisition is crucial. This underscores the need for HR to focus on recruitment and selection strategies that align with the Metaverse's unique requirements. New challenges include formulating job descriptions and hiring criteria that reflect the specific skills and competencies needed for effective virtual work. Additionally, businesses must prioritize candidates proficient in virtual communication and collaborative skills suitable for virtual environments. This shift also influences retention strategies, necessitating flexibility in work arrangements and opportunities for upskilling and reskilling to meet Metaverse demands. Furthermore, HR policies must adapt to ensure fair compensation, employee well-being, and safety in this digital context.

Onboarding in the Metaverse introduces new complexities, with employees needing to be introduced to the virtual world and trained on how to operate in it, while also demanding the integration of the virtual world's operations with the company's culture, values, and conduct codes. It should also cover virtual security and privacy

policies. Virtual onboarding programs need to facilitate connections between new hires, colleagues, mentors, and managers through various online interactive activities.

Training and development remain integral to any successful HR strategy, and the Metaverse is no exception. As it continues to evolve, investment in employee training and development is crucial to equip them with the necessary skills and expertise for this new environment.

Our survey also addressed the requisite skill sets for the Metaverse, and the answers highlighted not only hard skills like digital communication, programming, and 3D modeling but also emphasized soft skills such as adaptability, empathy, and emotional intelligence. In virtual environments, strong interpersonal skills are essential for effective communication, collaboration, and conflict management. HR professionals should identify these critical soft skills and develop training programs to cultivate them.

The Metaverse represents a fundamentally different working environment, necessitating a reevaluation of traditional performance management practices. HR professionals are tasked with developing new approaches to assess and measure employee performance, including establishing novel metrics and KPIs that reflect the unique aspects of the virtual world. Additionally, managers require training and tools for effective performance evaluations in this new context.

5 Opportunities and Challenges of a Digital Workplace

The transition to a digital workplace within the Metaverse encapsulates a spectrum of challenges that are both multifaceted and intricate, demanding concerted efforts across various domains. Technologically, the foremost challenge lies in developing and maintaining a robust and scalable infrastructure capable of supporting complex, immersive virtual environments. This encompasses addressing issues of interoperability between diverse virtual platforms and ensuring a seamless user experience. Additionally, cybersecurity emerges as a critical concern, with the need to safeguard sensitive information against more sophisticated and potentially unfamiliar digital threats.

From an organizational perspective, the metamorphosis of traditional work models to align with Metaverse capabilities entails a significant restructuring of both operational frameworks and corporate cultures. Implementing virtual training requires specialized skills and the acquisition and maintenance of the necessary equipment and software can be cost-intensive. Furthermore, not all training types are suited for virtual environments, and some skills may still require traditional methods. In terms of HR, the transition to virtual training necessitates new policies for effective training delivery, employee privacy, and data security. HR must collaborate with IT departments to establish comprehensive policies and guidelines around virtual communication, addressing issues like appropriate behavior, language, and the prevention of harassment and discrimination. The successful implementation of virtual training

programs will require careful planning, effective execution, and ongoing evaluation and improvement.

Skill Acquisition and Competency

The Metaverse offers a unique opportunity for companies to provide their employees with job *training* in a virtual environment that is both safe and cost-effective, and can be scaled globally. Virtual simulations allow employees to acquire and refine specific skills or procedures, building confidence and competency in a realistic, engaging and risk-free environment, while reducing the company's overall training costs.

This training encompasses not only practical skills but also soft skills such as leadership, problem-solving, active listening, stress management, and communication. Virtual environments enable employees to develop and polish these skills, thereby improving their interpersonal competencies, communication abilities, and collaborative teamwork.

Child services departments in the states of Georgia and Indiana implemented AVEnueS (Accenture Virtual Experience Solutions), a tool that gives the opportunity to caseworkers practice their skills and make decisions in a safe, supported and consequence-free environment. This initiative led to a nearly 20% decrease in caseworker turnover after implementing the VR solution (Tierney, 2020).

In the hospitality sector, VR experiences are helping corporate team members to develop empathy and appreciation. Hilton uses the Oculus for business platform in order to create a unique learning experience. With VR, Hilton is expected to reduce the in-class training from 4 h to 20 min and at the same time increase the success ratio; 87% of the team members changed their behavior after VR training (Hilton case study).

Learning in the metaverse could provide major cost savings for the companies. While at first an investment will be required in order to develop and deploy virtual training solutions, long-term savings are anticipated through decreased training durations, reduced job turnover, enhanced efficiency and improved knowledge and skill retention. It also serves as a tool for documenting the learning process, ensuring a comprehensive understanding of specific tasks.

Workplace Transformation

The shift to remote work has increased the importance of *virtual workspaces,* enabling better collaboration and connectivity, thereby improving employee engagement and motivation. Employees could feel a greater sense of ownership and investment in their work environment when they can shape offices and workplaces with a personal touch, increasing at the same time the elements of creativity, spontaneity and surprise.

The Metaverse also has the potential to dismantle traditional hierarchies, creating a more egalitarian environment. In a virtual world, physical location and attributes such as age, gender, race become less relevant, allowing individuals to engage and collaborate based on skills and knowledge. This could foster a more inclusive culture, where everyone has a voice and an opportunity to contribute to the organization's success. Additionally, the metaverse allows for more flexible and remote work arrangements, which can help to improve work-life balance and attract a more diverse workforce.

Self-expression is one of the key elements of Metaverse, as users will be able to represent themselves in the way they choose, creating customizable, embodied *avatars.* According to our survey ("How you would create your Avatar if there were no restrictions") a 57% of respondents desired special features, creating avatars distinct from their real personas.

Diversity, Equity, and Inclusion in a Metaverse-Centric Workplace

To start with, the psychological and social implications on inclusion are profound. Potential risks include heightened feelings of social isolation due to diminished physical interactions and the psychological impacts of prolonged immersion in digital environments, such as virtual fatigue and stress.

Equity and accessibility also pose significant challenges, particularly in bridging the digital divide and ensuring inclusive access for all, irrespective of technological means or physical abilities. The diversity in avatar creation and customization options (facial features, hair, skin tones, body shape and size) in addition with clothing and accessories options is crucial. A truly diverse, equitable and inclusive metaverse requires that the technology, programmers and companies building it, are diverse and bias-free (Martins & Wolfe, 2023). However, the underrepresentation of diverse groups in tech-related fields is a concern. In the US, just 17% of tech leadership positions are held by ethnic minorities, and in the UK, this figure falls to a shocking 2.6% (Fury, 2023; White, 2021). While women account for 48% of the global workforce, they remain significantly outnumbered in the technology industry—only 26% of jobs in computer-related sectors are occupied by women and just 27.1% of managers and leaders in the industry are female (Gruman, 2020).

In the Metaverse users will have the opportunity to create and use identities different from their own ethnic group and gender, posing questions about inter-personal relationships and self-perception ("self": a person's perception of themselves, including their physical appearance, personality, and characteristics) (Morin & Racy, 2021). While offering opportunities for self-expression and exploration, this aspect also raises issues of representation and cultural appropriation within companies. This complexity necessitates thoughtful consideration in developing a Metaverse that is inclusive, equitable, and respectful of diverse identities.

Digital Emigration

The Metaverse holds considerable potential to foster economic opportunities for individuals in emerging and frontier economies. It enables people from these regions to engage in the global marketplace, access employment opportunities, and partake in training and educational programs without necessitating physical relocation or incurring substantial travel expenses.

A shift towards digital emigration in the Metaverse could significantly mitigate the need for physical emigration, thereby enhancing psychological safety and facilitating social integration. Furthermore, the Metaverse can offer a sense of community and belonging for those who may feel marginalized in their physical surroundings. By fostering connections with people globally, individuals can find support and a sense of belonging within the Metaverse, potentially diminishing the necessity to physically relocate for community inclusion.

From a Human Resources perspective, managing digital emigration involves establishing uniform protocols for evaluation and payroll. This includes considering the taxation and legislation variances across different countries to ensure equitable opportunities and career progression for all employees. However, the implications of Metaverse migration warrant careful consideration, particularly the risk of social isolation stemming from an over-reliance on virtual interactions and attachments to virtual spaces. This aspect underscores the need for balanced engagement with virtual environments to maintain healthy social connections in both digital and physical realms (Oleksy et al., 2023).

Legal Challenges and Regulatory Framework

The ongoing evolution and expansion of the Metaverse are poised to introduce a range of novel and intricate legal challenges that necessitate thoughtful consideration and effective regulation. The Metaverse, characterized by its seamless and interconnected virtual nature, unanchored in physical space, poses distinct challenges to the existing legal framework (Li & Lalani, 2022).

A primary legal issue emerging from the Metaverse is the question of jurisdiction. The transcendence of virtual worlds over physical borders complicates the determination of applicable legal jurisdictions. This raises potential conflicts of law and regulatory discrepancies, as various countries and regions may attempt to enforce their legal standards within these virtual environments.

Data privacy and security are also critical concerns in the Metaverse. The paramount challenge lies in ensuring the security and protection of users' personal information. As virtual environments grow more interconnected and data-driven,

establishing stringent cybersecurity protocols and privacy policies becomes imperative to protect user data from unauthorized access, modification, or disclosure. Platform owners bear the responsibility of ensuring secure data storage and protection against breaches.

Moreover, privacy concerns in the Metaverse extend beyond data protection to issues of identity and surveillance. User interactions through avatars may inadvertently reveal personal real-life details, risking identity theft, harassment, or discrimination. Moreover, the capability to monitor and track behavior in virtual environments raises significant concerns about surveillance and data collection. Regulatory bodies must tackle these privacy issues, setting clear guidelines for data collection, usage, and sharing. Additionally, the Metaverse's allowance for anonymity and accountability, especially in contexts of hate speech, harassment, and theft, warrants attention (Cheong, 2022). The anonymity and the sense of detachment afforded by virtual worlds could engender abusive and discriminatory conduct. After Covid-19 there was a spike in online abuse (particularly against women and minorities) (Taylor, 2021). Incidents of sexual harassment/groping (Basu, 2021) have led Vivel Sharma (Vice President of Horizon) to announce that Horizon Worlds and Horizon Venues will include a default personal boundary "creating more personal space for people and making it easier to avoid unwanted interactions" (Orland, 2022).

Intellectual property and ownership rights present another complex legal dimension in the Metaverse. As users generate and disseminate digital assets (e.g., virtual real estate, custom avatars), questions about ownership, licensing, and copyright emerge. The legal framework governing intellectual property -copyright and trademark- must evolve to address the unique aspects of virtual environments. Determining ownership in the Metaverse, especially in collaborative efforts often conducted anonymously through avatars, introduces ambiguity about the rightful ownership of creations. This underscores the need for revised legal approaches to address the intricacies of intellectual property and collaborative work within the Metaverse.

6 New Technologies and Mental Health

In a world where the Metaverse is expected to play a crucial role, the boundaries between physical and virtual reality become blurred, as actions in one realm can have consequences in the other (Henz, 2022). This raises important questions about how socialization and our perception of reality may be affected.

The level of control that Metaverse users gain over their environment, where they can navigate and alter it, can have significant implications for their mental health (Paquin et al., 2022). This degree of control extends beyond the digital realm, allowing users to customize their appearance and identity. Since the Metaverse is not bound by the laws of physics or biology, users can create human-like or even non-human avatars (Henz, 2022). This ability to interact through a different body in the Metaverse can lead to an altered perception of the self.

Social science experts widely acknowledge the positive impact of psychological support from social relationships on well-being (pressman et al., 2019), while social isolation is considered a risk factor for depression and premature mortality (Cacioppo et al., 2010). It is important to consider whether communication and social interaction through new technology environments may pose risks (Lee et al., 2021). There is notable evidence of how negative technology-mediated communication can lead to antisocial behaviors such as aggression, loneliness, gaming addiction, cyberbullying, and other detrimental outcomes (Holt-Lunstad, 2018).

During the COVID-19 pandemic, remote work became the norm for many individuals, and communication with colleagues and others shifted to video conferencing platforms. Research suggests that the limited human communication in this virtual sphere has created a significant gap, leading to potential negative consequences in the future. People now find virtual communication appealing but may be less inclined to initiate or continue physical interactions. The loss of in-person interactions poses a significant threat to future generations, who may become increasingly isolated in their virtual bubbles, exacerbating mental health conditions. Thus, long-term exposure to the Metaverse is likely to have a profound impact on mental health due to reduced physical interactions (Bale et al., 2022).

The results of our study support the above research. Specifically, when participants were asked "Which of the following concerns you most in terms of the potential impact of the Metaverse on mental health?" the 48,5% cited "Social isolation and disconnection from real-world relationships", 30,3% expressed "Preference of the digital world instead of the physical one", 12,1% identified "Increased feelings of anxiety and stress", 6,1% "Addiction to Metaverse technology", and only a 3% reported "None of the above".

Given the nascent stage of the Metaverse, predicting its full impact on mental health is challenging, and much of our current understanding is extrapolated from the effects of existing technologies, due to their relevance to the potential applications of the Metaverse.

Several studies have highlighted the complex effects of teleworking on mental health (Benrimoh et al., 2022). These effects are attributed to factors such as the level of organizational support, the presence of social connections outside of work, and work-family conflict (Oakman et al., 2020). However, the Metaverse distinguishes itself from traditional teleworking via video conferencing applications by allowing employees to be present in their work environment from within their homes (Benrimoh et al., 2022). While this may reduce isolation for some teleworkers, it could blur the boundaries between work and home life, potentially exacerbating the conflict between work and family responsibilities and reducing workers' well-being (Zoonen & Sivunen, 2022).

Virtual reality (VR) immerses users in a computer-generated virtual world, offering a heightened sense of realism and presence (Seth et al., 2011). While VR has valuable benefits in mental health care, studies have also reported negative effects associated with its overuse for over three decades (Sherman & Judkins, 1992). Adverse outcomes include cybersickness (vertigo, nausea, and dizziness) and decreased cognitive performance (Mittelstaedt et al., 2019).

Contrary to concerns surrounding the potential impact of the metaverse on individuals' professional lives, the potential advantages of the metaverse include the anticipation of increased workplace diversity, enhanced mental well-being, decreased presenteeism and improved relationships between remote and office-based employees (Regus, 2022).

7 Recommendations and Conclusions

The Metaverse is poised to substantially alter societal interactions with technology, brands, and each other. Ensuring that this technology is accessible and inclusive for all users is paramount in cultivating a diverse and welcoming virtual world. It is important that companies develop customization options that encourage self-expression and empowerment, and stakeholders collaborate to establish ethical guidelines and principles that champion social cohesion, equity, and access.

To address the evolving challenges and opportunities in a Metaverse-centric world, companies and organizations should consider establishing *a "new task-force."* This team could comprise individuals who are both experienced and passionate about the Metaverse, focusing on developing a comprehensive vision and strategy. Key to this initiative is the recruitment of personnel with specialized skills pertinent to virtual worlds, alongside the development of novel training programs and performance management metrics. Formulating strategies to foster employee engagement and retention is also crucial. A pivotal aspect of this strategy involves prioritizing diversity, equity, and inclusion. This should be complemented by transparent communication regarding ongoing activities, and robust data privacy and security policies to protect employees. Remuneration strategies need to be transparent, considering location adjustments based on the cost of living in the employee's country, integrating both a base salary and merit-based pay.

Additionally, companies should consider promoting awareness and provide tools to maintain work-life balance. This includes organizing real-world activities to mitigate social isolation and enhance human interaction. Implementing measures to limit daily usage of the Metaverse, providing necessary breaks, lifelong learning opportunities, educational sessions, psychological support, and team-building activities are also essential.

From a legal perspective, the attribution of legal responsibility to avatars for their actions in the Metaverse is a complex issue. This would entail granting avatars legal personhood, complete with rights and responsibilities, within a legal framework recognized across different jurisdictions. It also requires establishing standards and criteria to differentiate between a legal avatar and the real-life individual operating it. The creation of an international law of the Metaverse would necessitate the collaboration of legal experts, policymakers, and various stakeholders globally. This process would involve formulating legal principles and standards addressing jurisdiction, avatar legal personhood, liability, and dispute resolution mechanisms.

HR departments should concentrate on developing appropriate processes and procedures to not only facilitate a smooth transition to the Metaverse but also ensure it evolves into a fair, healthy, and equitable workplace. The strategies implemented by HR will not only shape the experience of employees in the Metaverse but also potentially set precedents for future digital work environments. As such, HR's role in this digital transformation is not just operational but also profoundly strategic, influencing the future trajectory of workplace dynamics and culture.

The decisions taken by regulators and business leaders in this domain will significantly affect our future lifestyles. Therefore, educating the forthcoming generation of Metaverse researchers, platform developers, game designers, and content creators is crucial for forging a more inclusive and improved world.

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Enhancing Healthcare Employees' Hope in the Digital Era: The Role of a Training Intervention and Its Impact on Patient Satisfaction

Evgenia Pavlakou

Abstract This paper explores the role of increasing Hope among staff in the healthcare workplace, especially in the context of the challenges that the digital era has imposed on healthcare workers. Employing Snyder's principles of Hope, the study uses a training intervention to foster Hope among healthcare employees in a hospital unit. Hope, as part of the HERO model, promotes overall well-being particularly in health professionals who experience an excessive workload. Digital technology is not always beneficial, and often causes stress and anxiety, and our intervention seeks to mitigate this to some extent. We observed that the intervention increased Hope and optimism among staff members, which had positive impacts on goal-setting skills and problem-solving abilities, which ultimately improved patient satisfaction. The findings underline the beneficial effects of such interventions in various sectors, particularly in an 'always-on' digital work culture.

1 Introduction

Digital Era (DE) is a widely used term that describes the impact of technologies that *increase the speed and breadth of knowledge turnover within the economy and society* (Doukidis et al., 2004). These technologies increase the speed with which employees are expected to act, while also increasing the amount of information that they are expected to access before acting and expected to record after acting. As a result, while some employees may believe that they are empowered and achieving better performance, others may suffer from increased stress and experience reduced well-being and job satisfaction. After the COVID-19 pandemic new trends like remote work appeared in the work environment, an additional aspect of digital transformation with uncertain impacts on employee satisfaction.

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This shift has led employees to feel empowered on one hand by the new forms of freedom and flexibility, but also to suffer, on the other hand, from increased isolation and loss of face-to-face communication with their colleagues (Cai et al., 2020). Technologies, and changes associated with remote work, have created a new culture in which employees are "always on". Employees are now expected to respond to emails and messages at all times, not merely during normal working hours, thus blurring the line between work and personal life. These changes in the workplace, including increased pace, increased information overload, increased isolation, and loss of personal time, have been correlated with increased stress and anxiety among employees. This in turn can lead to mental exhaustion, reduced well-being, and ultimately to burnout (Becker et al., 2022; Juchnowicz & Kinowska, 2021). Digital transformation has brought many advantages to Healthcare since professionals have new digital tools that improve their productivity and reduce some aspects of their workload (Borges do Nascimento et al., 2023). However, studies have shown also negative impacts of technology such as *accelerated work, increase in workload, the need for constant learning of new technical skills and reduction in social interactions.*

It is crucial for employers to implement methods that support their employees transition to the strains that digital transformation imposes on the modern workplace. This need is even greater in environments, like healthcare, where new technologies have created the most extreme stresses on employees. Appropriate responses often involve training opportunities (Carnevale & Hatak, 2020) designed to teach employees more effective ways of coping with all issues in their transformed workplace.

These challenges motivate our intervention in the modern healthcare workplace. Hope can play a pivotal role in employee welfare and performance. Consequently, we have designed a training intervention, grounded in Snyder's (2002) principles, that is designed to enhance Hope within the context of the modern workplace. The notion of Hope in the workplace will be described, along with the consequence of loss of hope in the healthcare sector. The nature of the intervention and the results we observe will be presented. We will conclude with a discussion of the benefits that result.

Perhaps most importantly, new layers of technology can interfere with the relationship between the patient and the healthcare workers responsible for their care. Being treated for medical problems is a period of stress, even terror, for many patients, who are totally dependent upon strangers for their survival. These strangers have their own unique professional jargon and their unknown technologies and may appear inscrutable and even incomprehensible. Anything that improves the relationships between patients and care professionals will certainly improve the patients' experience.

2 Hope in the Workplace

Several definitions of Hope have been provided in various fields within the social sciences. We adopt the definition provided by Snyder (2002), which sees Hope as "a positive motivational state that is based on an interactively derived sense of successful (a) agency (goal-directed energy), and (b) pathways (planning to meet goals)." He refers to goals, pathways, and agency as the trilogy underlying his concept of hope. Hopeful thinking is goal-oriented, with emotions playing a significant and contributory role (Snyder, 2002). Snyder claims that people are generally goal oriented; that is, people behave in such a way that they are trying to accomplish something (Luthans et al., 2010), and that Hope improves both the ability to set goals and to achieve them.

When someone is trying to achieve a goal, complications arise, which can create threats to Hopeful thinking. If an individual has high levels of Hope, it is easier to cope with complications. With hope one can see challenges as requiring changes to strategies, rather than as barriers leading to abandonment of goals. Hopeful individuals are able to implement the feedback they have received, in order to keep pursuing their objective. People who experience low levels of Hope face several difficulties in their future efforts and may be unable to continue pursuit of their objectives. Hope thus directly improves individual performance and the productivity of the organization. Profoundly, the notion of Hope has many applications in the workplace environment since it can have a positive impact on issues such as the well-being of employees and the overall productivity of the organization (Yotsidi et al., 2018).

Different elements of Hope are studied in business behavior. Hope is included as an element of Positive Organizational Behavior (POB), a field that highlights human psychological capabilities and skills that are useful in the workplace (Luthans, 2002; Luthans & Jensen, 2002). Hope is also included as an element of Psychological Capital (PsyCap), which addresses a person's self-awareness (who you are now) and, notably, what a person can become through their development (who you are becoming) (Luthans & Youssef–Morgan, 2017). Hope is part of the HERO model of employees' psychological profiles; HERO is the acronym for four traits, Hope, Efficacy, Resilience, and Optimism. Hope is considered as a crucial factor in an individual's overall well-being and job satisfaction, as it provides a sense of direction, motivation, and optimism. Hope can be regarded as the capability to set goals, produce solutions, and overcome obstacles.

Snyder (2002) argues that Hope leads to production of a clearer vision of objectives, an ability to achieve them, and the ability to set further goals as initial goals are met. Snyder also argues that Hope leads to a greater ability to anticipate and avoid harmful outcomes.

In an assessment of Snyder's model, Luthans and Jensen (2002) and Youssef & Luthans (2007) conclude that it provides "willpower," which can be interpreted as determination to achieve a goal. In this context, hope seems to apply in various areas of everyday life and especially in the workplace including parameters such as

performance, job satisfaction, job happiness and organizational commitment, with these positive outcomes being widely discussed (Adams et al., 2002).

Apart from the drawbacks of digital technology, healthcare professionals have to face issues which by definition are integrated parts of their specialization. They have to maintain a high level of performance in their job even if economical compensation is not the appropriate, carrying out excessive workload and administrative duties along with a constantly changing working environment (Tomlin, 2020). Therefore, Hope is considered a crucial factor in an individual's overall well-being and job satisfaction, as it provides a sense of direction, motivation, and optimism (Youssef-Morgan & Luthans, 2017). Hope is goal oriented and relevant to the workplace.

Our next step is to determine the role of Hope among Healthcare professionals.

3 Hope in Healthcare Professionals

The role of Hope in Healthcare has been highlighted as factor reducing burnout (Antoniou et al., 2013) particularly when it is combined with social support and life satisfaction (Feldman et al., 2020). Yıldırım & Guller (2021) highlight the role of Hope in mitigating the impact of stress even in periods of excessive workload during the Covid-19 pandemic, which enhances employees' resilience.

In our study we will focus on the indirect impact of employees' Hope on patients experiences during healthcare, rather than the direct role of employees' Hope on their own experience. More specifically, we focus on employees' hope as a factor that improves the relationship between the healthcare worker and the patient. This relationship is complicated since it requires mutual trust and shared knowledge, in order to achieve cooperation between patients and healthcare personnel, which is essential to the successful completion of treatment plans (Olsman, 2020; Chipidza et al., 2015; Mok et al., 2010). As we noted, the digital transformation of healthcare, and the layers of technology that now separate patients and caregivers, complicates the development of cooperative relationships.

However digital technologies can play a crucial role in mitigating the impact of stress in healthcare professionals by improving working conditions. They offer better accessibility and flexibility with applications such as telemedicine, which helps to alleviate pressure in healthcare systems. Patients can also enjoy the advantages of digital technology with optimized diagnosis, consulting and treatment (Senbekov et al., 2020). It is anticipated that hospital admissions for chronic diseases will be reduced as result of digital technology (European Commission, 2019). In that context many scholars are discussing issues such as remote treatment and diagnostics along with the notion of "big data" and "artificial intelligence" which encompass universal electronic record systems and customized treatment protocols (Mitchell & Kan, 2019). Thus, despite the potential drawbacks, the digital era brings numerous opportunities for healthcare professionals and patients, improving the provision of services.

4 Developing and Implementing a Hope-Based Intervention

Conceptual Framework

Our developing an intervention for fostering Hope is based on previous findings about the feasibility of resources of POB and PsyCap Hope, Optimism, Efficacy, and Resilience being open to change and development (Luthans et al., 2010). Snyder's (1995, 2002) studies played an important role in the design of educational interventions aimed at enhancing Hope. In the literature there is a plethora of intervention typology including group interventions and counseling and digital interventions (De Kock et al., 2022; Tay et al., 2022) that include digital means such as smartphones (Daugherty et al., 2018). Finally, it is proposed the model of Brief Hope Intervention featuring goal mapping exercises and sharing previous successes. It is therefore obvious that digital interventions have a beneficial effect in boosting Hope and can perhaps be combined with more traditional methods, like the one we have applied in our study.

The main objective of the research was not only to examine the notion of Hope in the workplace but also to conduct training interventions. These are based on Luthans' trilogy (goals, pathways, agency) and seek to make subjects more able to do the following:

- View difficulties faced as resulting from an incorrect strategy, not a lack of talent
- Think of unmet goals as challenges, not failures
- Be reminded of past successes
- Get to know success stories of other people
- Be trained in specific skills, as well as learn how to learn
- Be able to readjust goals

Snyder (1995) highlights the importance and role of goals in everyday life. Goals set should be achievable, and the participants should be able to divide their main objective into sub-objectives.

Snyder believes that training to achieve hope should include the following:

- Learning about success through talking about success
- Thinking about difficulties that were addressed as a strategy error rather than a lack of talent
- Thinking of goals and non-achievement as challenges rather than failures
- Recalling past successes
- Success stories of other people
- Training in specific skills, but also in learning how to learn
- Ability to adjust goals

These interventions are especially relevant whenever employees are adapting to new and transformed environments, which can produce anxiety and stress. A Hope-based intervention, based on Snyder's principles, aims at enhancing employees' skills in handling anxiety and stress in a team-based setting. There are few studies in the

current literature that address the role of Hope in goal-setting. That is the objective of our own research. We have used Snyder's work to develop a training intervention based on fostering Hope. We performed our study in the cancer unit of a large private hospital in Athens.

Sample Population and Research Methodology

Our sample population was patients at a private hospital that has Radiotherapy Department. We submitted a request to the hospital administration and then to the Radiotherapy Department, in order to obtain necessary permission for our intervention. We presented the theoretical framework for the role of Hope for health professionals, within the context of digital transformation. We also explained the benefits that the hospital and the radiation department could obtain from the intervention. The Administration referred the request to the Scientific Committee of the Hospital, which accepted the request. Working together with the hospital administration and the Radiation Therapy Department we developed a sampling plan and a procedure for obtaining informed consent from patients volunteering to participate. Sampling was not random, because we required cooperation of voluntary participants (Jupp, 2006).

The sample of medical professionals participating in the study is $N = 68$ volunteers, who self-selected from the medical staff of the large Athens hospital. These professionals participated in our intervention. We divided the population into two groups of 34. The first was a population that did participate in the intervention group and the second was our control group, which did not participate in the intervention. As always, a control group was required to assess whether or not the intervention had any effect on participants. The intervention group received two three-hour sessions over one month. Sessions were conducted in person by members of the research team. The central element of the training activity was the participants' recording of valuable, achievable and measurable goals, while creating pathways to realization and dividing the larger goal into sub-goals. After the intervention we sampled 300 patients to assess the impact of the intervention on patients. We divided the patient sample into two populations of 150 participants; the first population were patients of medical professionals who had participated in the intervention and the second were patients of professionals who had not participated. As before, this was a non-random sample since patients had to self-select by choosing whether to participate.

The intervention given to medical professionals was divided into phases T1 and T2:

- T1: a pre-training 24 item-questionnaire was issued into both groups

  The intervention group received two in-person training sessions over one month Each session lasted three hours

- T2: a post-training 24 item-questionnaire was issued into both groups

A post-training patient satisfaction survey was conducted assessing attitudes of the two patient populations.

The participants of both groups were asked to complete the 24-ITEM PSYCHOLOGICAL CAPITAL QUESTIONNAIRE (PCQ) (Luthans et al., 2007) which was developed to measure the construct of PsyCap (Psychological Capital). This concept is a higher-order construct comprised of four positive psychological resources: Hope, efficacy (confidence), resilience, and optimism, each represented by six items in the questionnaire. Only Hope was critical. The other three dimensions of the HERO construct were of secondary importance. Respondents rate their level of agreement with each statement in the survey using a six-point Likert scale ranging from "strongly disagree" to "strongly agree". The patients were also asked to complete the Risser Patient Satisfaction Scale (RPSS) (Charalambous, 2012), allowing us to correlate medical staff' hopefulness with their patients' satisfaction. We were then able to examine Hope, Satisfaction, and their correlation and explore differences attributable to educational interventions received by the healthcare professionals who treat certain patients.

Conducting the Intervention

The intervention was conducted in two 3-h- sessions with a time interval between them of 15 days, consistent with Youssef and Luthans (2007). In both sessions the group of the participants were divided in two parts and embodied the methodology of Luthans and Jensen (2002), which is briefly described below:

- Formulation of achievable, specific, organizational and personal goals with set timeframes.
- Division of the major objective into individual objectives and steps towards its achievement (Snyder's stepping method).
- Creation of at least one alternative route to achieve the goal with a specific plan.
- Ensuring that the subject can enjoy the whole process of working towards the goal and not focusing solely on the outcome.
- Developing perseverance when obstacles are presented, which can sometimes be anticipated when paths to achieving the goal are determined.
- Preparing people to follow alternative paths when the original path is not feasible or does not produce the desired outcome.
- Ability to redefine the goal in order to avoid the case of false hope.

It is essential that the intervention set valuable and measurable goals, along with determining specific criteria for measuring success. The major goal is then divided into sub-goals, which provides a concrete pathway towards goal achievement (Snyder stepping method).

For each day of the intervention the following educational objectives were set (Table 1):

Table 1 A brief summary of the interventions

Stage of the intervention	Short description
Structure of the intervention	Two 3 h sessions with a 15-day interval
Method	Systemic training
Criteria	Skill development, teamwork, interpersonal experience
Sampling/participants	Radio therapists from a private sector hospital

- *Day 1: (A) Enhancing their self-awareness:* motivating participants to share with the group stories and experiences in order to understand how they set their goals and how these goals reflect their values. *(B) Prior-goals self-assessment:* They recall prior failures to achieve their goals and the reasons for not achieving them. This allows subjects to analyze the methods and strategies for going forward, in order to avoid prior mistakes.
- *Day 2: (A) Goal reassessment and overcoming future obstacles:* creating alternative pathways and strategies in order to achieve robust strategies for overcoming future obstacles. This ensures future success, based on lessons learnt from their past failures. *(B) Utilizing Snyder Hope Theory:* Based on Snyder Hope Theory the intervention group members set professional, realistic and tangible goals, along with alternative pathways for achieving success.

5 Demographic Comparison of the Intervention Group and Control Group

Interventions were administered to 34 health care professionals and there were 34 in the control group. Tables 2 and 3 compare the gender and ages of the two populations. Tables 4 and 5 compare the years of experience of the two groups.

Table 2 Comparison of genders of the two populations

Control group			Intervention group		
Gender	Frequency	Percent		Frequency	Percent
Male	19	55.9	Male	16	47.1
Female	15	44.1	Female	18	52.9
Total	34	100	Total	34	100

Table 3 Comparison of ages of the two populations

Control group			Intervention group		
Age Range	Frequency	Percent	Age Range	Frequency	Percent
24–34	11	32.4	24–34	13	38.2
35–45	9	26.5	35–45	7	20.6
45+	14	41.2	45+	14	41.2
Total	34	100	Total	34	100

Table 4 Years of experience of the two populations

Statistical element	Control group	Intervention group
N	34	34
Minimum	1	1
Maximum	27	27
Mean	11.71	12.09
Std deviation	8.41	8.63

Table 5 Comparison of hope levels of control group before and after intervention

Control group				
Hope	N	Mean	Standard deviation	Standard deviation mean
T1	34	3.67	1.15	0.20
T2	34	3.62	1.22	0.21

6 Statistical Analysis

The statistical analysis of the data gathered was performed with IBM SPSS software 2.0. Initially, the demographics of control and intervention groups are presented including sex, age and years of experience.

Hope Levels

Table 5 compares the average value of Hope levels of the control group before and after the intervention.

It is obvious that there is no statistically significant difference in levels of hope before and after intervention, since in the 2-sample t-test the p value (sig2 tailed) is equal to 0.865. In contrast, the intervention does produce statistically significant increase in the level of Hope, as shown in Table 6. The increase in Hope is significant, since the 2-sample p value (sig2 tailed) is equal to 0.000. Our results show that

Table 6 Comparison of hope levels of intervention group before and after intervention

Intervention group				
Hope	N	Mean	Standard deviation	Standard deviation mean
T1	34	4.00	0.82	0.14
T2	34	5.06	0.71	0.12

participants in the intervention group were able to use goal achievement skills more effectively and also create alternative pathways in overcoming obstacles.

Other Elements of Psychological Capital

We also found a positive relationship between the increase in Hope and the increase in other dimensions of the Psychological Capital in the intervention group, after the conduction of the educational intervention but these findings are secondary prior to the objective of the current research. The PCQ-24 questionnaire that was completed by the participants includes items about all the dimensions of Psychological Capital. The comparison of the sample in the two phases T1, T2 is shown in Table 7. Moreover, in all cases the statistical significance was high since p value = 0.000.

On the other hand, in the control group the changes were not statistically significance. For Efficacy the p-value was 0.761, for Resilience 0.686, and for Optimism 0.809 (Table 8).

The survey also measured patient satisfaction employing the Risser Patient Satisfaction Scale. This scale comprises 25 items categorized into 3 dimensions (Technical—Professional, Interpersonal—Educational, Interpersonal—Trusting). Each Healthcare group (control & intervention) encompassed to a group of 150 patients. A comparative analysis of the responses of both groups of patients is provided in Table 9.

From the above table it is evident that the patients of the intervention group have achieved better scores in all dimensions of the questionnaire. The next step involves

Table 7 Comparison of the other dimensions of Psychological Capital in the intervention group

Intervention group					
		N	Mean	Standard deviation	Standard deviation mean
Efficacy	T1	34	3.84	0.71	0.12
	T2	34	5.02	0.63	0.11
Resilience	T1	34	3.74	0.70	0.12
	T2	34	4.56	0.58	0.10
Optimism	T1	34	3.73	0.60	0.10
	T2	34	4.07	0.46	0.08

Table 8 Comparison of the other dimensions of psychological capital in the control group

Control group					
		N	Mean	Standard deviation	Standard deviation mean
Efficacy	T1	34	3.87	1.00	0.17
	T2	34	3.78	1.35	0.23
Resilience	T1	34	3.74	1.22	0.21
	T2	34	3.61	1.36	0.23
Optimism	T1	34	3.79	1.16	0.20
	T2	34	3.72	1.33	0.23

Table 9 Summary table of descriptive measures of patients in the control and intervention groups

	Patient group	N	Mean	Std deviation	Std error of mean
Technical—professional	Control group	150	3.1667	0.46503	0.03797
	Intervention group	150	4.2505	0.43850	0.03580
Interpersonal—educational	Control group	150	2.9543	0.29714	0.02426
	Intervention group	150	2.9790	0.27911	0.02279
Interpersonal—trusting	Control group	150	3.0400	0.36886	0.03012
	Intervention group	150	3.6309	0.32296	0.02637

the determination of the statistical significance if there is any statistical significance with a t-test (Table 10).

The results from Table 10 present statistical significance between two of the three dimensions (Technical—Professional, Interpersonal—Trusting) where the p-value is equal to 0.000. It is therefore evident that patients in the intervention group show a significantly better picture in relation to their satisfaction with the services they receive.

7 Discussion, Limitations, and Future Research

Discussion

The research findings demonstrated that our intervention enhances levels of Hope in Healthcare workers in the Digital Era. Moreover, statistically significant increase in Hope after our intervention appears to have increased their skills in both goal-setting and goal-achievement. This includes increased ability to develop alternative

Table 10 T test for control and intervention group patient samples

		Levene's test for equality of variances		t-test for equality of means						
		F	sig	t	df	Sig. (2-tailed)	Mean difference	Std. deviation difference	95% confidence interval of the difference	
									Lower	Upper
Technical—professional	Equal variances assumed	1.085	0.299	−20.768	298	0.000	−1.08381	0.05219	−1.18651	−0.98111
	Equal variances not assumed			−20.768	296.978	0.000	−1.08381	0.05219	−1.18651	−0.98110
Interpersonal—educational	Equal variances assumed	0.024	0.877	−0.744	298	0.458	−0.02476	0.03329	−0.09027	0.04074
	Equal variances not assumed			−0.744	296.840	0.458	−0.02476	0.03329	−0.09027	0.04075
Interpersonal—trusting	Equal variances assumed	0.208	0.649	−14.762	298	0.000	−0.59091	0.04003	−0.66969	−0.51213
	Equal variances not assumed			−14.762	292.888	0.000	−0.59091	0.04003	−0.66969	−0.51213

pathways to success and a reduction both in failure and in frustration. Synder explains this because an educational intervention not only increases Hope but also empowers individuals to move beyond workplace frustrations, including obstacles created by the digital transformation of their work and their careers. These findings may be tempered by the high levels of Hope exhibited by employees even before our intervention, which may be partially explained by self-selection bias.

Hope has also resulted in the increase of the other dimensions of Psychological Capital (self-efficacy, resilience, and optimism). This highlights the importance of Hope in fostering psychological well-being and cultivating a positive psychological state. As noted, it is widely accepted that this contributes to employee goal achievement. Most importantly, we observed an indirect effect, where the intervention produced statistically significant increases in satisfaction among patients whose care-team participated in the intervention. Further exploration of this indirect effect will enable us to design interventions that produce greater improvements in patients' perception of their experience, which can have significant value in a wide range of marketing settings out of the healthcare sector.

Limitations of the Research

We note the following limitations of our research. First, the sample is small, in a single setting, at a single point in time, which always raises questions of significance. This also causes us to ask to what extent the findings generalize. Would these results generalize either to employees outside healthcare or to "customers" in other forms of business? We were not able to conduct follow-up studies, so we do not know if the benefits of the intervention persist. We do not know if Hope among professionals reverts to former levels in the weeks or months after our intervention. Likewise, we do not know if satisfaction among patients reverts to former levels in the weeks or months after their healthcare team participated in our intervention.

Moreover, reliance on a single small sample may introduce numerous forms of bias. First, of course, is self-selection bias. We cannot compel busy healthcare professionals to participate in our intervention, and the subjects who chose to participate may exhibit a stronger sensitivity to increasing both Hope and their problem-solving skills. Second, the authors may have created an additional selection bias, since their study was conducted among patients and healthcare professionals in radiation therapy for treatment of cancer. Many of these workers will have experienced a large number of deaths among their patients, and many of these patients will be coping with serious anxiety and fear of death. Both groups would appear to benefit greatly from an increase in hope and in empolyees' problem-solving skills. Would similar results be observed if the study had been conducted in an environment that was already more hopeful, such as the maternity section where both patients and their care teams are exposed constantly to the joys of new life?

Additionally, while we observed both direct and indirect effects, we did not have an opportunity to directly observe the interactions among healthcare professionals

and their patients. Thus, we did not have an opportunity to observe how the intervention altered these interactions. Thus, while we are confident that the intervention produced improvements in patient satisfaction, we do not yet have a causal model or the specification of the pathways by which the interventions improved patient satisfaction. This limits our ability to design interventions to produce greater indirect benefits among the patients who were treated by health care professionals who experienced our intervention.

Plans for Future Research

Our future research will address all of the limitations listed above. We will repeat the study, with larger sample sizes, in different settings, to explore how well the findings generalize to other settings. This will include settings outside critical healthcare, like radiation therapy, and settings outside healthcare entirely. We will seek to combine an intervention on Hope and problem solving in the continuing education curricula of one or more professional groups, to address the issues caused by selection bias among subjects. And we will perform follow-up studies of both healthcare professionals and their patients, to assess whether or not the benefits from the intervention persist over time.

As importantly, we will observe interactions among healthcare professionals and their patients, both those involving professionals who participated in our intervention and those who did not. The differences that we observe between the interactions of the two groups will help us develop a causal model and an analysis of the pathways by which professionals improve patient satisfaction in their interactions after participation in the interventions. This in turn will allow us to develop more effective interventions, and interventions designed for different segments of the economy.

Concluding Remarks

Transformation profoundly affects the workplace for healthcare professionals, and increases their workload, their stress, and their alienation from their patients. An intervention that increases the Hope of these workers directly increases their sense of well-being and indirectly increases the satisfaction and well-being of their patients. Our intervention demonstrably increases employees' sense of well-being and patients' satisfaction, and the results were statistically significant.

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Does Capacity for High Quality Connections Drive Team Resilience in the Adversity of a Hybrid Corporate Landscape? A Case Study in a Greek Consulting Firm

Anastasia Kleo Hanzis

Abstract The new post covid corporate work environment resurfaced the need to transform traditional work settings and explore temporal teamwork structures, as we experience a rise in the need for "project capable workforce" (Cooke in Developing a project capable workforce: the number one task for project-based organizations. Paper presented at PMI Global Congress 2012—North America, Vancouver, British Columbia, Canada. Newtown Square, PA: Project Management Institute). But what happens to teams in case of adversity, such as the recent covid lockdowns? And more specifically to project teams that are bounded by strict deadlines, change and ambiguity? Our research investigates the capacities of high-quality connections and swift trust, as factors that drive team resilience in project teams that work in hybrid work settings. A qualitative methodology was used, with semi-structured interviews conducted with 23 consultant professionals, and the data extracted was analyzed using the method of thematic analysis. The conclusions that emerged were related to the contributors of the capacity of high-quality connections determined through the lenses of the second order factors that characterized such relations (Dutton and Heaphy in Positive Organizational Scholarship: Foundations of a New Discipline, Berrett-Koehler Publishers, 2003), and the normative action components of swift trust that revealed team resilient behaviors as per (Kroeger et al., Cambridge J of Economics 45:129–150, 2021). In addition, discussions revealed social etiquette matters of virtual settings and virtual skills that are reported mandatory for hybrid work models. The present study advances the knowledge on hybrid work environment and project teams.

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1 Introduction

The aftermath of the pandemic brought change in the corporate work structures, creating a new normal hybrid work model with flexible schedules and locations for knowledge workers (Hopkins & Bardoel, 2023). In recent decades, temporary structures in organizations, such as project-based organizations, have gained significant importance. These structures, rely on projects to carry out most of their work and achieve their objectives. This trend has become so significant that some experts argue that society has undergone a process of "projectification". Empirical evidence provided by Lundin et al. (2015) and Schoper et al. (2018) support this claim, and the phenomenon is also noteworthy globally (Cova et al., 2002; Welch et al., 2008). Philip Scranton and Patrick Fridenson proposed many compelling issues that business historians might explore in their book "*Reimagining Business History*", projects being one of them. According to the authors, around 20% of the world's economic activity occurs within projects, as estimated by the World Bank.

In an effort to create a more dependable method of assessing the significance of projects in various economies, Schoper et. al (2018) have presented examples of strong economies such as Germany, Norway, and Iceland, where projects contribute 34.7, 32.6, and 27.2% of the economic activity respectively, thus making projects a fundamental aspect of company operations. Project studies have become a flourishing topic of research in management, and the "idea of engaging in projects has long-term effects on businesses capabilities and structures". The concept of "projectification" impacts team work and is changing organizational structures (Schoper et al., 2018). Meyerson, Weick, and Kramer (1996) defined project teams as temporal systems whose participants have diverse skills, tasks with deadlines, and are required to interrelate. Cohen and Bailey (1997) referred to project teams as a time bound work team with the scope to produce a sole outcome, at which point the members either move on to another project or return to their functional unit.

For our research we will use a combination of both definitions. Project teams often "deal with multiple stakeholders who may confront them with ambiguous and/or conflicting requirements, and/or simply overload them with too many quantitative or qualitative task requirements, given available resources" (Savelsbergh et al., 2012, p.2). Also, the requirements may dictate interim members, in addition to part-time and limited lifespan memberships (Turner, 2006). The fluidity in team membership, that can include members that are drawn from different parts of the organizations to work for a given time on a specific task, is changing the way teams are connected and empowered (Tannenbaum et al., 2012). Also, project arrangements include "*gig workers*", a word that refers to temporary or freelance arrangements, a type of workers that is expected to rise to 78 million by the end of 2023 (Mastercard, 2020).

Empirical research indicates that projects are comparatively complex, include numerous external participants, and team members must possess specialized skills and abilities in order to perform. So, we identify a tendency towards temporary structures with various types of work arrangements and a need for knowledge workers to support a project base workforce that is called to perform in the new normal hybrid

work arrangement. Knowledge workers are defined by Davenport et al. (1996) as employees who apply knowledge for the purposes of the quality of their outputs and involves reliance on their capabilities of knowledge. Knowledge work competences, such as collaboration and problem solving, are essential to ensure project success (Owen & Linger, 2008). Survey results during the transitional post covid phase, showed that the majority of knowledge workers enjoy hybrid work arrangements (Pickert, 2022) as they have "less commuting time, a granted autonomy, and work-life balance" (Chafi et al., 2021, p.1), despite challenges related to social and professional isolation (Bailey & Kurland, 2002), and perceived threats for professional advancement (Charalampous et al., 2019).

Employers are utilizing resilience as a viable strategy to enhance the flexibility, performance, and the well-being of their workforce in response to work pressure (Bardoel et al., 2014). Correlation between teamwork and resilience is empirically examined by scholars. In such, López-Gajardo et al. (2023) revealed significant, reciprocal, and positive relationships between teamwork and characteristics of resilience. Research has demonstrated that organizations with project-based activities rely on project managers in order to successfully manage project execution, and are, thus, requiring them to function as knowledge workers who are possessing and effectively utilizing both "hard" and "soft" skills to manage tasks, people and relationships (Bourne & Walker, 2004). In HR practice, the role of the Project manager is not necessarily assigned to one individual, but it can rotate per project (Fabi & Pettersen, 1992) – this is the case in our research. In this context, researchers are called to explain the formation of team resilience in the face of adversity, as adversity is unavoidable and resilience is necessary for teams to perform (King et al., 2015). Researchers encounter aspects that drive individuals and teams to perform better than before after "bouncing back" from such adversities (Stoverink et al, 2020).

As previously mentioned, adversity is very common in project teams, and it results from the uncertainty and complexity of the project environment (Kutsch & Hall, 2016). The complexity increases with interdependencies of processes and people (Azim et al., 2010). For example, an expert can participate in different projects simultaneously. This perspective necessitates that project team members are not viewed mechanistically in a predictable setting but should be regarded as having a degree of influence on their environment in order to foster learning, innovation, and adaptation (Antoniadis, 2011). As King et al. (2015) point out "adversity is unavoidable and so the question is never "if" resilience is necessary but how teams will get along with adversities, avoid failure, and perform" (p. 4). Our study examines the resilience of project teams and its relationship to high quality connections and swift trust in a hybrid work setting. Our research is based on a suggestion by Kristof et al. (1995) that especially virtual teams are "a self-managed knowledge work team, with distributed expertise, that forms and disbands to address a specific organizational goal" (p. 230).

2 Team Resilience as a Desired Outcome

Workplace team resilience has been suggested as a possible advantage for work teams to sustain performance despite unfavorable circumstances. In a work setting, resilience is characterized by the need to respond adaptively and flexibly to challenges (Kossek & Perrigino, 2016), and is mostly examined as a personality trait (Windle, 2011), a set of attributes (Fisher et al, 2018; Moenkemeyer, Hoegl, Weiss, 2012), a capacity (Hartmann et al., 2019), or a cognitive and behavioral process (Britt et al., 2016). But considering resilience on the individual level could lead to a perception that some individuals "don't have what it takes to overcome adversity" (Sutcliffe & Vogus, 2003, p. 96). Team resilience is not simply a collection of individuals which happen to be resilient at the individual level. Team resilience is a collective attribute that relies on the individuals within the team and their interactions. This emergent idea has been defined by various factors such as trust, collective efficacy, cohesion, and social support (Blatt, 2009). Research on team resilience has been characterized by conceptual and methodological inconsistencies. Team resilience has been defined in "as a capacity, a process, a behavior, or outcome, and as a response to an adversity" (Hartwig et al., 2020, p. 175).

For our research we will use Hartwig et al. (2020) team resilience definition "*as a team's capacity to withstand or recover from adverse events* (*i.e. events that may lead to losses or breakdown of independent team processes*) *which we conceptualized as an emergent team state that results from preparative, adaptive, and reflective team processes and which is demonstrated by a persistence, recovery, or growth trajectory of team functioning following exposure to adversity*" (p. 186). This developmental perspective argues that resilience is "a generalized capacity to investigate, to learn, and to act, without knowing in advance what we will be called to act upon" (Wildavsky, 1988, p.70), a characteristic that is common in project teams. Research on the antecedents of team resilience, identified "structural and relational characteristics of the team" (Hartwig et al, 2020, p.175). As such, interdependency and tenure relate to team resilience. Also, the size of a team negatively affects team resilience and performance, where the density of the social interaction has an opposite effect (Giannoccaro, Massari, and Carbone, 2018). Lastly, Fisher, Ragsdale & Fisher (2018) recognized the temporal aspect of resilience and proposed that "chronic ongoing experiences and accumulation of stressors can represent adversity triggers" (p. 29). Our study takes into consideration the limitations of the above antecedents and incorporates the temporal aspect of a project team as an adversity, along with the effect of the hybrid work environment as an adversity trigger with lower intensity but chronic in nature.

3 High Quality Connections as a Team Characteristic

Dutton & Heaphy introduced the notion of the high-quality connections, as "*short-term, dyadic, interactions that are positive in terms of the subjective experience of the connected individuals and the structural features of the connection*" and where quality was defined either as "*life-giving or life-depleting*" (Stephens et al., 2011, p.263). The capacity of those connections is developed via three primary types of contributors which serve as fundamental social-psychological mechanisms that foster and enhance high-quality connections in the workplace. Those are cognitive, emotional, and behavioral mechanisms (Stephens et al., 2011). Cognitive mechanics are both conscious and unconscious cognitive processes contributing to the formation of high-quality cognitive structures. Emotional mechanics highlight how feelings facilitate interpersonal connection and are mutually experienced, fostering high-quality connections And behavioral mechanisms demonstrate the influence of various types of actions and methods of interacting that explain the level of the connection.

When considering the quality of the connection at the team level, the dyadic concept presented by Dutton and Heaphy (2003) must be extended to multiple team members, in order to consider team high quality connection as shared among all team members. Dutton and Heaphy (2003) also determined two second order factors that characterized such relations. The first factor is *structural capacities,* which includes the notion of emotional *carrying capacity, tensility*, and *connectivity*, while the second factor is *emotional experiences* which includes *positive regard*, *mutuality,* and *vitality*. Emotional carrying capacity is the authentic and constructively expressed emotions, that "have the capacity to withstand the expression of more absolute emotion and of varying kinds" (Dutton & Heaphy, 2003, p. 266) as well as the safety team members feel in displaying these different emotions. Tensility is defined as the "capacity of the connection to bend and withstand strain, and to function in a variety of circumstances" (Dutton & Heaphy, 2003, p. 266). Tensility drives teams' resilience and allows teams, with high quality connections, to respond constructively to conflict, enable the connection to undergo changes without compromising its strength and manage disputes and tensions that arise (Dutton & Heaphy, 2003).

The degree of connectivity measures a relationship's "generativity and openness to new ideas and influence, and its ability to deflect behaviors that will shut down generative processes" (Dutton & Heaphy, 2003, p. 266). According to Dutton and Heaphy (2003) connections that exhibit a significant level of connectivity are characterized by a sense of joy, fostering positive emotions within an environment, and facilitate the emergence of opportunities for both action and creativity along with a sense of vitality and aliveness. Individuals who are engaged in relations with high-quality connections, are more prone to experiencing excitement and positive energy (Quinn & Dutton, 2005). Stephen et al. identified a link between emotional carrying capacity and team resilience. The researchers found "relationship closeness and trust to more resilient responses to adversity" (p. 33). Experiencing a high-quality connection is also perceived through an intensified sense of positive regard and so individuals who engage in high-quality connections often report an experience of instantaneous

affection with no reference to romantic attachment (Dutton & Heaphy, 2003). The sensation can be more accurately characterized as a condition in which "worries, vanities and desires vanish" (Dutton & Heaphy, 2003, p. 267). Additionally, the subjective experience of being in a high-quality connection is marked by a felt mutuality which "captures the sense that both people in a connection are engaged and actively participating" (Dutton & Heaphy, 2003, p. 267). Warren and Warren (2019) concluded that the self -report survey that Brueller and Carmeli (2011) developed on the above structural capacities of high-quality connections and the subjective emotional experiences, is best applicable as a model of six distinct factors. In our study we considered the quantitative questions of Brueller and Carmeli (2011), when creating the structured interview questions.

4 Swift Trust as an Individual Characteristic

Traditionally, trust has been examined in the context of long-term relationships. In order for a team to be receptive to ideas and maintain a willingness to share information, it is imperative to possess a strong foundation of trust (Ring, 1996). The notion of trust is a key characteristic of teams, as it allows the development of interpersonal connections and a sense of psychological safety (Mathieu et al., 2008). According to empirical research, high levels of trust are associated with commitment, team satisfaction (Costa, 2003) and autonomy (Langfred, 2004). Trust also enhances a group member's desire to share information and request assistance from fellow team members (Edmondson, 2018). Also, it reinforces team coordination and cooperation (Breuer et al., 2019), and a member's ability to create a collaborative team culture (Barczak et al., 2010; Chiocchio et al., 2012). Such behaviors are important in building the capacities needed to deal with adversity (Hobfoll, 2012), and in obtaining social characteristics that can deploy resilience as a team's unrevealed capacity (Stoverink et al., 2020). As trust is identified as a team state that facilitates team resilience (Sharma & Sharma, 2016; Stephens et al., 2013), it is intriguing that short-lived groups, which do not undergo conventional trust-building processes, might yet reap the advantages of trust within the group.

The notion of *swift trust,* which was initially introduced by Meyerson, Weick and Kramer (1996), implies the type of trust that is formed at an initial stage, occurring in temporary organizational structures or teams, such as project teams. The researchers proposed that swift trust provides the initial, cognitive confidence for a temporary team to initiate interactions as if trust was already established. However, this assertion needs to be verified in terms of the team capacity to address vulnerabilities and fulfill expectations (Meyerson, Weick & Kramer, 1996). Swift trust comprises of two components, the *cognitive* and the *normative action components* (Meyerson, Weick & Kramer, 1996). *Cognitive components* become "immediately apparent as soon as the temporary system begins to operate and are based on expectancies consisting of categorical assumptions and interpretative frames" (p. 175). *Normative action components* strengthen trust through "active, proactive, enthusiastic generative style

of interaction among members, and provide social proofs and fail-safe mechanisms to avoid exaggerated confidence" (pp. 180–187).

Other researchers further examined this initial trust. McKnight et al. (1998) suggested that when individuals are not familiar with or have not interacted with others, they tend to see themselves and their team as inseparable entities, which promotes positive beliefs and actions based on in-group attitudes. These pertain to prominent social identities and the act of self-categorization within the context of belonging to a valued group (Hogg & Terry, 2000; Tajfel, 1978). Crisp and Jarvenpaa (2013) explored these initial trusting beliefs as a cognitive component and assured that early trusting beliefs are "critical for the emergence and exertion of normative actions" (Crisp & Jarvenpaa, 2013, p. 53). According to McKnight et al. (1998), initial trusting beliefs have a persistent influence on the overall perception of a team, unless there is contradictory information that challenges these beliefs. Even in such cases, the disappointments experienced may not be significant enough to change the initially established trusting beliefs.

Although the cognitive elements of swift trust play a crucial role in initiating team collaboration, they may not be adequate to maintain long-term trust and enhance team performance in situations characterized by significant uncertainty. Crisp and Jarvenpaa (2013) argued that normative action components, such as early trusting beliefs, serve to reinforce team member trusting beliefs, which in turn influence positively team performance. Especially in the context of virtual settings, it makes sense to analyse the emergence of social influence through normative actions, by adhering to behaviours that are associated with the specific nature of normative influence (Ehrhart & Naumann, 2004). Such an example is the frequency of communication, something that impacts virtual teams positively and determines task performance (Jarvenpaa et al., 2004). According to Crisp et al. (2013) "Sarker and Sahay described a set of normative actions demonstrated in virtual teams, including: planning, understanding project goals, monitoring deadlines, mandating use of technologies, and appealing to external facilitators to intervene when necessary" (p. 47). Also, according to Piccoli et al. (2004), the implementation of team normative activities allows members to effectively monitor and adjust work structures in response to environmental and task changes. Capiola et al (2020) identified antecedents of swift trust such as "ability, integrity, benevolence, communication, mission-focus, self-awareness, shared perspectives/ experiences, and calm" (p.237).

In our study we explore the relationship of swift trust, with trust defined in terms of how one expects another to act (Holmes & Rempel, 1989; McAllister, 1995), and as an initial behavior that drives the capacity of high-quality connections as suggested by Carmeli, Burller and Dutton (2009). As we review above, the definitions presented by researchers conceptualise trust as a dyadic construct, involving two parties: the trustor, who places trust, and the trustee, who is the recipient of that trust. When considering trust at the team level, the dyadic concept must be extended to multiple team members, for the trustors as well as the trustees (Jarvenpaa et al., 2004). We therefore consider team trust, as trust shared among all team members (Breuer et al., 2019).

5 Methodology, Sampling, Analysis

The purpose of our research is to contribute to the study of hybrid work settings by linking capacities of high-quality connections as a team characteristic and swift trust as an individual characteristic, to building team resilience in project teams. The research questions expected to be answered are as follows:

- R1. Is team resilience a "collective property" that emerges through team member interactions and the demonstration of specific behaviors (Alliger et al, 2015)?
- R2. Is team resilience a dynamic, psychosocial team process that "protects a group of individuals from the potential negative effect of the stressors they collectively encounter"?
- R3. Is swift trust and high-quality connections an attribute that enhances the development of team resilience?

The methodology used in this research was qualitative, as we wanted to observe participants and discuss their behaviors, and ideas in depth. The research tool that was deemed most appropriate was the semi-structured interview, which included a basic question guide, but offered the flexibility to additional explanatory questions (Francis et al., 2009). The research tool consisted of 30 open-ended questions, divided into 3 categories: the hybrid experience and the organization, the hybrid experience and the team, and the hybrid experience and yourself. After the pilot interview, the questions were reduced to 21 due to a content overlap. In addition to the semi-structured interviews, the researcher spent 6 months as a consultant for the firm, and kept a participant-observer journal (Jorgensen, 1989) allowing for a direct personal experience of life as an employee in the firm. The primary research relationship with the firm began when the executives invited the researcher to study how the values of the organization have evolved following the changes in the organization post pandemic era, and to revise HR policies in relation to the firm's new hybrid work model that they wished to incorporate. Following the pandemic in 2020 and the great resignation that was also evident in Greece, during 2021–2022 the firm faced a turnover of 30% which initiated the above study. The researcher had the chance to also attend meetings and observing the employees as they worked and interacted with each other.

The research participants were at the time all full-time employees of the business consulting firm in Greece. The firm is a local office franchise of a global brand. The office was founded in 2003 and has become a top leadership advisory firm in the local market. Its areas of expertise include top-level and senior management executive search, corporate governance, and board advisory, leadership and organizational culture management, digital acceleration, and sustainable innovation services as well as people data transformation and analytics. The firm employees 31 business consultants and back-office staff and is managed by a 5-shareholder scheme, of which 3 members act as executives, and are included in the number count. Following a personal email to the business consultants with an invitation to a voluntary "hybrid

work academic research", 23 out of the 28 consultants accepted the terms and conditions of the research and participated in a 1 h online discussion via MS Teams with the researcher.

From a demographic's point of view the sample consisted of 5 men and 18 women. Their age ranged are distributed evenly between age brackets with 9 participants being over 40 years old, 6 being between 30 to 40 years old and 6 participants being under 30 years of age, giving this research a distribution of opinions in the generational side. Regarding their tenure in the firm, there is an even distribution between participants under 2 years and over 2 years tenure, with 5 participants being new, under 1 year in the firm. Regarding their education, half of the participants hold a bachelor's degree and the other half, Master, and Doctoral degrees and all of them several skills and competence certificates, representing fairly the knowledge worker. The employees of the firm have adopted the hybrid work setting following the pandemic lockdown, without any specific rules. A couple of weeks though prior to the interviews, the researcher had introduced a new hybrid work HR policy where, all employees would be required to work 3 days from the office and 2, if they wished, virtually. Most of the participants reported that they didn't work in the past in such hybrid settings. Regarding the temporal aspect, the firm's 28 consultants are structured into 3 sectorial subgroups that interact on project basis and needs. All 23 research participants are members of those 3 subgroups working in projects. Participants reported that the formation of project teams each time was based on prior experience in the project subject, as well as availability and personal interest in the subject of the project.

The researcher also asked participants if behavioral criteria play a role in project team formation, but it was reported that such are not taken into consideration at project team formation stage. Rather in the annual evaluation of the employees, behavior was reviewed, and it was known to everyone that in case of behavioral or performance issues reported by managers or clients, then a termination of the contract would follow. Additionally, participants reported that the project teams are frequently reinforced with external business consultants, as interim solutions with limited lifespan, to assist either with an expertise that the team was lacking or as "extra hands" to minimize pressure. These temporary additions to the project teams, even so very helpful and needed, are reported by all participants as destructive arrangements. Regarding participants' performance level, we consider all 23 as performing employees, because they all participated in the end of the year performance bonus scheme, which requires achievement of targets.

A thematic analysis was used in this study, as "a method for identifying, analyzing and reporting patterns (themes) within data" (Braun & Clarke, 2006, p. 79), based on the Gioia methodology which was recently codified by Gioia et al. (2013). The Gioia methodology allows the systematic presentation of a first-order analysis (for example by using interviewee-centric terms and codes) and a second-order analysis (for example by using researcher-centric concepts, themes, and dimensions), which were building blocks for provision answers to the research questions. A quantitative survey was also distributed to the interviewees for triangulation purposes, but such results are not presented in the current paper. The thematic analysis was done by the researcher with the support of another researcher with experience in qualitative

methodology. The results were coded by each researcher independently and then the codes were discussed. The different opinions were not necessarily at the original concepts but more on the aggregated dimensions. The researcher took into consideration the comments and incorporated them in the results. The results are presented, guided by the research questions, in the sub-sections below accompanied by extracts of interviews that confirm the findings.

6 Results and Discussion

From the process of thematic analysis, three thematic areas emerged which were relevant to our research questions. From the responses, we conclude that our interviewees understand the new hybrid work setting as a chronic challenge, but they still strangle to find their way around and thrive under the circumstances. The responses confirm Alliger et al. (2015), who proposed proactive measures of resilient teams that include distinct forms of behavior such as: (1) proactively anticipate challenges and develop contingency plans; (2) continuously monitor and assess readiness; (3) diligently identify early warning signs of potential problems; and (4) prepare to handle difficult situations. In our case participants reported that it is company practice to have an original plan and timelines that they constantly revisit to maintain process and avoid missed deadlines and employee burnout. The responses verified the structural features of the characteristics of high-quality connections. Additionally, examples pointed to social etiquettes in virtual settings that enhance the absence of nonverbal clues, and support conscious and unconscious cognitive process, as well as emotional and behavioral mechanisms that emerge. Lastly, responses on normative actions allow members to effectively monitor and adjust work structures in response to environmental and task changes (Piccoli et al., 2004) and confirm the literature.

Theme 1—Ways in Which Teams Maintain Process Under Stressors Created by Adversities

The first theme is distinguished into four sub-themes which are concerned with how to assess challenges quickly and accurately, how to address "chronic" stressors such as the hybrid environment in our case, and how to maintain processes under stress and seek guidance as per Alliger et al. (2015). This theme relates to our first questions on team resilience as a "collective property" that emerges through team member interactions and the demonstration of specific behaviors which are presented in the 1st order. Participants reported actions that are established in team processes to navigate and endure challenges (Table 1).

Examples of how the interviewees addressed the above are below:

Table 1 Ways teams maintain process under stressors created by adversities

1st order	Themes	Aggregate dimensions	Interviews
Handle team emergency	Proactively anticipate challenges and develop contingency plans	Challenge resolution	11, 13, 15, 21, 22
Ask & seek assistance	Diligently identify early warning signs of potential problems	Resources, address "chronic" stressors	1, 2, 3, 6, 7, 18, 20, 22, 23
Status updates & reaching out	Continuously monitor and assess the team's current readiness	Maintain processes under stress, mental health and team spirit	1, 2, 3, 5, 7, 9, 10, 11, 12, 17, 20
Project plan	Prepare themselves to handle difficult situations	Project recovery	All 23

Handling team emergency: "*Several times we also take on more responsibilities and initiatives that do not fit 100% to the level of seniority to support other team members*" (interview 11). "*I think that because we've all been in this work arrangement for some time now, we're used to being remote, so we're also more immediate in responding, in looking at our messages, our emails, so we're a little more alert in terms of responsiveness*" (interview 22).

Asking and seeking assistance: "*Even if you have the best manager, unless you have a common line with the other members and you follow basic steps like looking at each other's availability, or being correct in what you say to each other, the processes will be delayed*" (interview 3).

Status updates reaching out: "*We have established follow up meetings on Mondays*" (interview 5)."*When working remotely, we have daily updates, so this also creates a sense of security for me, that even if something happens, or if I don't communicate for several hours, that we are still on the same page with my team, we are all fully informed of where we are and so even if we fall into mistakes, someone always checks and corrects. Generally, in projects we don't follow hierarchy, but we check on each other so as not to expose the team member or the company to any risks*" (interview 3).

From the interviews, it was apparent that most of the teams had already built relationships from physical interaction in the office, and so this type of hybrid work landscape was working efficiently for them. For the few cases they mentioned that they had not met physically before, it was reported that communication was more business focused with no social interaction. Such an example is: "*I had a better connection with some teammates, not because I like them more, but because I see them in the office more often and we interact*" (interview 14).

Theme 2—Conditions Necessary to Advance Substantial Relationships

The second theme distinguishes the structural features of the characteristics of high-quality connections (HQCs) which are emotional carrying capacity (authentic and constructive expressed emotions), tensility and openness-based connectivity, as well as the emotional experiences and characteristics of high-quality connections which are positive regard, mutuality, and vitality (Carmeli et al, 2009; Dutton & Heaphy, 2003; Warren & Warren, 2019) (Table 2).

Examples of how the interviewees addressed the above are below:

Team members are accepted: "*There was no good communication in the beginning to be honest, but we discussed as a team, and we have improved it a lot. I think and there is still room for improvement*." (Interview 14)

Team members are valued even if they fail: "*I have never felt that if I need something/help, and that I would not be able to contact the rest of the members under any circumstances*" (interview 3).

Table 2 Conditions necessary to advance substantial relationships

1st order	Conceptualised indicators of HQC	Aggregate dimensions	Interviews
Team members are accepted	Positive Regard		all 23
Team members are valued even if they fail	Positive Regard	Emotional experiences	3, 9, 14, 16, 23
Team members have substantial relations	Mutuality		3, 6, 7, 11, 16, 18, 19
Team members express constructively	Emotional Carrying Capacity		1, 2, 5, 6, 7, 8, 9, 14, 16, 17, 20
Emotional interactions in virtual teams	Emotional Carrying Capacity		5,6,7,8,9, 12, 16, 17, 20
Team members have common social activities that give them joy	Connectivity	Structural capacities	3, 8,9, 14, 16, 20
Team members are open to other members' ideas	Connectivity		3, 5, 8, 9, 10, 11, 13, 17, 19, 20, 21
Team members are aware of misunderstanding in remote work	Tensility		3, 12, 15, 17, 22, 23
Team members solve any conflict	Tensility		1, 2, 3, 12, 13, 15, 17, 22, 23
Social etiquette			All 23

Team members have substantial relations: "*I call my colleague who is at home to have lunch together online to see how she is doing, how is her project going*" (interview 11)

Team members express constructively: "*We hold several workshops among ourselves when we have to work on something demanding or new and we will all dedicate two hours so that we can all work on it together and exchange knowledge*" (interview 2). *Nothing is pre-determined; everyone's contribution is important. All ideas are heard, we adjust when there is a need for strong change. We are committed to the project and do our best to reach results and when needed we can take initiatives"* (*interview 1*).

Emotional interactions in virtual teams: "*We always use feedback very regularly for the team, so I can say that on a daily, weekly basis, I receive feedback, depending on the deliverables, depending on the actions taken*" (interview 12).

Team members have common social activities that give them joy: "*I like coming to the office as I meet my colleagues, we have lunch or coffee together at the kitchen, learn her news and share good ideas to solve any problems we may face at the project*" (interview 3).

Team members resolve any conflict: "*Because misinterpretation is common when online, as I don't "read" the nonverbal cues of the one I talk to, I make sure I repeat and verify in the end of the meeting with everyone all we have agreed. Generally, through arguments we resolve any conflicts without much drama*" (interview 15)

The subject of the social etiquette in remote MS Teams communication came across many times in the discussion from all respondents who were concerned on how to simulate behaviours of face-to-face interactions in virtual settings. The researcher considered the responses relevant to theme 2 in relations to structural capacities. First discussion was related to camera on/ off when in a meeting. Except for one participant, the rest mentioned that they want to keep the camera on while talking to others in a virtual meeting, to simulate a face-to-face conversation, but they would switch off the camera in larger groups presentations. Having the camera on and looking directly to the camera to simulate the notion of paying attention, seemed also important to show interest in the conversation. Actions like eating or drinking during interaction as well as dressing casually, sitting in a way that the window shows face and shoulders, and speaking closely to the microphone, were also mentioned by all participants as important and indications of professional behavior.

A second discussion was about the use of the chat in MS Teams. All participants mentioned that they do use the chat and emoticons, to exchange behavioral clues and substitute for lack of nonverbal cues. This confirms Cheshin et al. findings that emotions can be shared across individuals in many ways, both implicitly or explicitly in virtual teams without having non-verbal cues, as team members were able to also use texts to assess others' behaviors and express their emotions. In our research all participants agreed that in virtual interactions they don't get to use all their senses, and so it takes time to form a holistic view of others.

A third discussion was in relation to how often participants "check out" oneself during a meeting. All participants mentioned that they do check how they look when on MS teams, especially during the first minutes of the meeting, to make sure that they look proper on camera and adjust their presence accordingly. The seven participants under the age of 30 mentioned that they were very familiar with virtual interaction and this was a common practice, where the remaining sixteen participants mentioned that it took them a while to get used to seeing themselves all the time during a meeting and at the beginning they felt conscious of themselves.

A fourth discussion was connected to the screen background which is used in a virtual meeting. All participants mentioned that they position themselves with a wall behind them, or they use a virtual background when in a remote meeting to look professional, to keep the privacy of their personal space, and to center the focus of attention to themselves and not to whatever is happening in the background. An interesting comment by one of the participants was: "*By seeing the privacy of the others' home, it creates an impression subconsciously about them that doesn't help the interaction. It is also unprofessional. The virtual background eliminates such feelings and keeps the focus to the presenter*" (interview 19). Remote interactions were reported by all the participants as efficient, highlighting that working virtually was more efficient because no time was lost in social interactions. Yet in building connections, the face-to-face interactions were reported by all participants as vital, because individuals get the nonverbal cues and use all their senses in the interaction.

Theme 3—Cognitive and Normative Action Components that Allow for an Early Trust to Be Present

The third theme is distinguished into two sub-themes: normative action components and cognitive components. The normative action components regulate behavior and promote predictability in team actions (Bettenhousen and Murnighan, 1991). They are important in the beginning of an interaction, but may not be sufficient for maintaining trust, especially in the face of high uncertainty, as is the case in virtual teams (Crisp & Jarvenpaa, 2013). The cognitive components interrelate early trusting beliefs that create expectations of team cohesion (Meyerson et al, 1996) and relate to collective perceptions of the group that are immediately apparent; they are based on expectations related to social identities and self-categorizations (Hogg & Terry, 2000) (Table 3).

Examples of how the interviewees addressed the above are below:

Social proof interaction: "*There is sufficient communication between us in this work model. It's easy to reach your colleagues and manager when you need them. With this hybrid model it is also more direct. because I can write something in MS Teams and my manager will reply immediately, at any time of the day*" (interview 14).

Table 3 Action components that allow for early trust

1st order	Themes	Aggregate dimensions	Interviews
Social proof interaction	Benevolence	Normative action components	1, 3, 4, 6, 7, 8, 9, 11, 13, 17
Avoid exaggerated confidence	Ability		7, 8, 15, 17, 21, 22, 23
Fail safe mechanisms	Integrity		3, 5, 8, 9, 11, 12, 13, 15, 17, 19
Early trusting beliefs	Communication	Cognitive components	1, 3, 4, 6, 7, 14, 16, 18, 23

Avoid exaggerated confidence: "*This model made it possible for managers to have greater confidence, as they don't need to constantly follow up on the employee to do the work, since they understand that the result is what matters, and they can count on their team.*" (Interview 7).

Fail safe mechanism: "*I think trust was strengthened more with this hybrid model as well as ownership of deliverables*" (interview 3).

Early trusting beliefs: "*We have freedom, everyone has their own impact, not everything is so boxed*".

Normative actions are based on initial notions of trust and serve to enhance the team's confidence in their abilities, enabling them to overcome challenges. The team strengthens the social cohesion by establishing norms and agreed-upon standards, and by behaving accordingly. As a result, normative activities can foster favorable attributions of the behavior of other members within the group (Crisp & Jarvenpaa, 2013).

A recurring topic by participants was how important trust is when working remotely, and how initial trust is needed especially by managers. As one interviewee mentioned: "*Employees and managers develop trust and micromanagement is not possible in hybrid environments*" (interview 3). Active strategies of team members to create trust from interactions in the office seemed also crucial for the connection. For example: "*I make sure when I am in the office to go for much with my colleagues, to see how they are as we don't see each other every day*" (interview 16). In this notion, all the participants reported that the skills required to manage people and projects in the hybrid landscape included strong organizational and communications skills that enabled connection within team members and clients. Lastly, twenty one participants reported resilience, self-discipline and focus as important skills for the performance of the team.

7 Validity, Reliability, and Limitations

The results of our research are not to be generalized, as extensive replication will be needed both in comparable and dissimilar circumstances in order to validate the theory. But our intention was to follow a qualitative research methodological approach, which it is based on phenomenology, and which gives emphasis on human experience. Additionally, the findings of this study must be seen considering some limitations in relation to the demographics of the population. Even though we have an equal distribution among age, education, and tenure between the respondents, such diversity does not exist when it comes gender. This imbalance between men and women, could act as a potential source of bias. Also, the observer bias that arises from personal judgment cannot be excluded from the limitation of this qualitative methodology.

For this research we considered the findings on the antecedents of team resilience—such as structural and relational characteristics (Hartwig et al, 2020), interdependency, tenure and size of a team (Giannoccaro, Massari, and Carbone, 2018)—as a filter when writing our conclusions (as proposed by Maxwell, 1996). Regarding the analysis of the results, another limitation could be the coding verification, that was reviewed among two researchers since additional inputs might bring a different perspective. Lastly, the sample size was small, yet representative of a corporate environment with structures characterized by temporality and a hybrid setting. Although the validity of our findings can be affected by the above limitations of the research design, we consider the present study as a starting point, to further explore with empirical studies for greater conceptual depth, clarity and generalization.

8 Conclusions and Future Directions

Empirical work verifies that high-quality connections among members of teams are correlated with higher levels of psychological safety and trust (Stephens et al., 2011). The mechanisms of those connections also facilitate our comprehension of fundamental relational processes and team resilience (Stephens et al., 2011). From our research we identified examples of cognitive, emotional, and behavioural mechanisms that support the quality of connections in hybrid work models. Those connections, as indicated by participants, seemed to be strengthened from interactions in the office as virtual interactions miss the social side and require extra effort to avoid misunderstandings.

Our study also supports Dutton and Heaphy (2003) findings that "it is the features of the tie that indicate its resilience or the capacity to bounce back after setbacks" (p. 266), and in fact, our participants mentioned several examples of accommodating to adapt to the changing conditions. From the second order factors, quality relations, structural capacities and emotional experiences were reported by participants. Tensility and connectivity were considered as most important when in virtual

settings, to avoid conflict and tension, especially with new members. As Kroeger et al. (2021) proposed, we observed role-based interactions as predictors of swift trust, which leads to more rapid development of trust even in the absence of previous connections.

Individual reputation based on prior work ('shadow of the past') was reported as a valuable basis for swift trust, especially with external partners joining a project team. Overall, as project teams were formed with specific criteria (previous knowledge, availability, and interest in the subject) team composition was observed to affect swift trust, as Kroeger et al. (2021) proposed. In such scope, all participants mentioned that weekly meetings were important to make sure that all members are sharing their successes and challenges, in order to create a tensility and connectivity and built trust.

Our research identified themes that show a relation among research constructs and contributes to the growing number of studies of team resilience in project teams performing in hybrid work settings. The study has provided insights on the types of processes that teams engage in on a day-to-day basis under the adversity of the hybrid work landscape. It has also identified a range of behaviours influencing the collective property of team resilience. Although it is relatively small-scale, it represents a starting point for examining team resilience and its relations to high quality connections among team members. In addition, discussions on the social etiquette of virtual settings emerged, along with the virtual skills needed in such work settings.

These finding present a basis for further research on the future of hybrid work structures and how they can become "places for building relationships, creative forms of collaboration, and strengthening a sense of shared purpose and culture" (Chafi et al., 2021, p.18). We observed that the capacity for HQCs in project teams enhance swift trust mechanisms, especially normative actions, and show evidence of team resilience, something that could be of interest to managers. Future research could also consider how organizations preserve connection among team members in this hybrid work environment and develop team resilience capabilities as a process to support work teams under the pressure of the new landscape. Hybrid work settings, even though preferred by employees, require knowledge workers to revaluate their skills and adapt to this new normal, by investing in building quality relationships among team members, something that shows evidence of driving performance.

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Sustainable Development and Its Link with Human Resource Management in the Digital Era

Nancy Papalexandris

Abstract Sustainable Development is an important area in management research. However, its link with Human Resource Management (HRM) has only recently been widely established in the literature. Lately great emphasis has been placed on the United Nations (UN) Sustainable Development Goals (SDGs) and the dimensions of the Environment, Society and Governance (ESG) which form the criteria for documenting and reporting relevant practices implemented by business firms (United Nations. Transforming our world: the 2010 agenda for sustainable development (2015)). Therefore, HRM is facing the challenge of active involvement in sustainability. Given the quest for HR to actively participate in sustainability efforts with an emphasis on social criteria, this paper will try to explore the degree to which digitalization can assist in meeting sustainability through careful examination of HR sustainable practices implemented by Greek firms over a 10-year period and in-depth interviews with HR managers to examine the role of digitalization in applying sustainability. The main conclusions from our research are that there is room for a wide range of policies and practices which can add to sustainability. HR digitalization can prove of great help to sustainability provided certain aspects affecting ethical issues are taken into consideration. Companies can use sustainable HR to enhance their corporate sustainability and enjoy the benefits of a higher reputation and an enhanced ethical profile.

1 Introduction

Sustainability and Sustainable Development are important issues in the field of management research (Ehnert, 2009; Wilkinson & Hill, 2001). However, the link between HRM and sustainability is not well established in the literature. Systematic studies are still scarce and there is a wide range of interpretations and several overlapping terms that often cause confusion to practitioners. Also, HR practices

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included in the Corporate Social Responsibility Programs of a company are often linked with sustainability.

The terms sustainability, sustainable development and corporate sustainability are widely used in the management literature and seem to receive more or less similar interpretations. Corporate Social responsibility (CSR) is widely known for the set of practices it entails which are often promoted and communicated to the public in order to enhance corporate reputation. Sustainable HR seems yet to need some clarification.

In view of the above this paper with try: First, to clarify terms linked with Corporate Sustainability, Social Responsibility, and Sustainable HR and examine the role of Sustainable HR in supporting corporate sustainability through relevant practices aiming both at the internal and the external group of company stakeholders. Second, to describe and clarify Sustainable Development Goals (SDGs) introduced by the UN, their history and the three pillars, i.e., Environment, Society and Governance (ESG), which form the basic criteria for organizations to implement and report relevant practices. Third, to refer to various changes occurring in HRM due to digitalization and their possible impact on sustainability. Fourth, to present various sustainable HR practices implemented by Greek firms, during the last decade following the economic crisis and the pandemic and present views of HR managers about Sustainable HR and the challenges they are facing in view of the increasing demand for digitalization of HR.

2 Sustainability, Corporate Social Responsibility and Its Link with Sustainable HR

According to the World Commission on Environment and Development (WCED, 1987) "Sustainable Development is seeking to meet the needs and aspirations of the present, without compromising the ability to meet those of the future".

At the company level, the term is referred to as Corporate Sustainability (Dyllick & Hockerts, 2002). Corporate Sustainability (CS) is placing extra emphasis on the effects business operations have on environmental issues such as pollution, global warming, carbon footprint, recycling, protection of eco-systems etc., on social issues such as poverty, hunger, social inequality, lack of proper education etc. and economic issues such as economic insecurity, corruption, business scandals etc. Interest in Corporate Sustainability is constantly increasing due to the growing role of activists and the inability of many companies to meet demands of their stakeholders.

A useful tool serving to clarify sustainable development for business is the "Triple Bottom Line" which was introduced by Elkington (1997), including the 3 Ps, i.e., Profit, Planet and People. This means that corporate results should be measured not only by the financial bottom line (profit) but should include environmental (planet), societal and ethical (people) performance. Starting in the 80's a growing interest was shown by companies in Corporate Social Responsibility (CSR) activities as a

practical response to society's demand for Sustainability, a crisis of confidence in business and the inability of many companies to face needs of their stakeholders. CSR can be considered as the implementation of sustainability by companies (See Fig. 1).

The concept of CSR is widespread in today's business world showing a transition from the importance given to shareholders in past years to the stakeholders' approach which implies that the interest of various groups interacting with a company (employees, customers, providers, local community, society, etc.) should be taken into consideration. The most well-known model of CSR is the pyramid by Carroll. It shows the economic dimension at the base and adds the legal, ethical and philanthropic dimensions. Carroll (1999) points that these dimensions should be balanced simultaneously and that the "CSR firm should strive to make a profit, obey the law, be ethical and be a good corporate citizen" (See Fig. 2).

CSR could be closely related to Human Resource Management (HRM) as, in practice, CSR activities offered by companies include apart from the environment and society, their own employees. Furthermore, it is widely recognized that HR practices aimed at employee wellbeing are closely related both to immediate as well as to long-term organizational outcomes.

The growing emphasis on the long-term value of HRM has led to the belief that HRM could help in the realization of corporate sustainability goals (Cohen, 2010; Ehnert, 2009). However, as analysed by scholars (Stahl et al., 2020), despite the attention given to CS and CSR, the role of HR in their design is quite limited although,

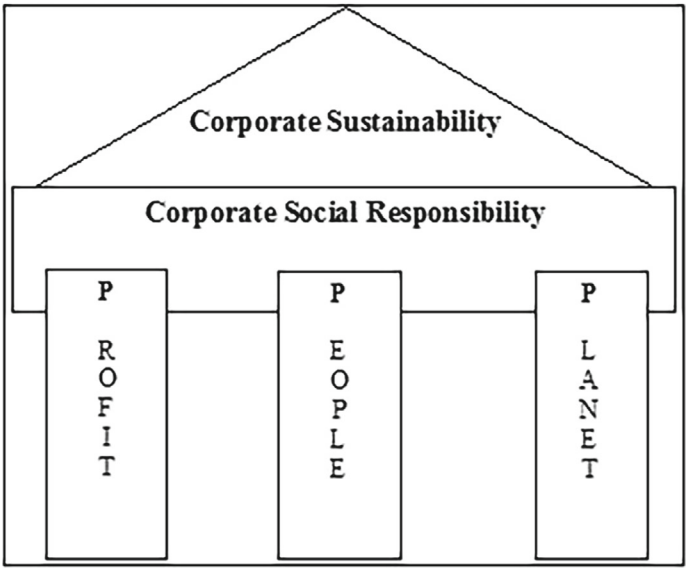

Fig. 1 Relationship between the balance in Profit, People, Planet, CSR and corporate sustainability (Rompa, 2011)

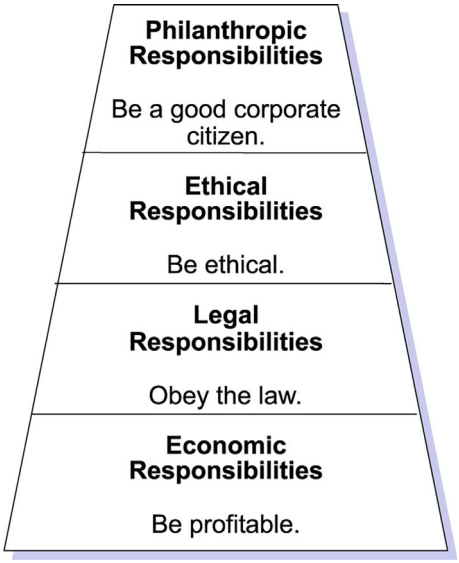

Fig. 2 CSR pyramid (Carroll, 1999)

as it is well documented, many companies have realized the need to contribute to economic and societal development in a globally sustainable way (GRLI, 2017:3).

Larger and global corporations wish to be considered as change agents, responsible for meeting needs of a wide range of their stakeholders both inside and outside their firms. Yet, research shows that in many cases companies show only symbolic social or environmental activities i.e., "greenwashing" (Wright & Nyberg, 2017) and that there is little involvement of HR in strategic decisions about CS or CSR initiatives. As pointed out (Stahl et al., 2020), HRM should be deeply involved in CS/CSR and vice versa CS/CSR strategies should aim both internally and externally covering ways of treating people within the organization and addressing needs of the wider community.

Starting mainly after 2010, HR involvement in sustainability has improved due to the concept of Sustainable HR which gained ground due to the growing conviction of certain scholars that HRM policies and practices should be adding to sustainability. Sustainable HRM stressed the need for adopting a more long-term approach in HRM policies including the growing need for skill upgrading, issues of employee ageing, issues of diversity, keeping employee morale, addressing the war for talent etc. (Losey et al., 2005). All these challenges which stress the need for more human-centered and time conscious HRM practices aiming at sustainability have created a strategic potential for HRM. These needs have helped in establishing Sustainable HRM which was gradually regarded as a value-added alternative based less on cost cutting or profit generation and more for its contribution to individual and collective well-being in the long run.

Wagner (2013) defines a sustainability oriented HRM as that which meets the current needs of a firm and society at large without compromising its ability to meet any future needs.

On a more practice-oriented level, Sustainable HR can be defined as the long-term socially and economically efficient and fair recruitment, development, retainment and treatment of people. (Ehnert, 2009).

Looking back at the evolution of the link of HR to sustainability, we can see that in the 90 s it was mainly based on compliance, typically referred to as Environment, Health, and Safety Offices (Lenox & Chatterji, 2018). Later with the appearance of Sustainable HR and the growing social, economic and environmental challenges the approach to HRM's role has gradually changed. However, due to a lack of progress and the continued uncertainty about the Grand Challenges of our time (Doh et al., 2021) the UN's "2030 Agenda for sustainable development consisting of 17 Sustainable Development Goals has emerged as an important benchmark for both business and HRM" (Chams & Garcia-Blandon, 2019).

Recently, scholars proposed to widen the concept of Sustainable HR into "Common Good HRM" which can better assist in serving the UN Sustainability Agenda (Aust et al., 2020).

3 UN Sustainable Development Goals

In 2015 the 2030 Agenda for Sustainable Development was adopted by the UN. Member States (UN, 2015). This agenda aims at promoting peace and prosperity for people and the planet, now and into the future. Its implementation is based on the 17 Sustainable Goals (SDGs) which invite all countries to engage in a global partnership to end poverty and deprivation while improving health, education, equality and the environment. (See Fig. 3).

UN member states signed the 17 SDGs in response to widespread concerns over climate change, issues of inequality and widespread corporate scandals which as already mentioned have led to a demand to take into account not only shareholders but also the interests of the stakeholders such as employees, customers, suppliers, the local community and wider society. (Squire, 2022). There is a growing interest in exploring how HRM can reframe policies and practices in a more sustainably way and thus contribute to achieving the UN's SDG (Ghauri & Cooke, 2022).

These goals may appear quite ambitious, especially for smaller or local companies and it is true that large multinational companies are more in a position to make an impact. However, as research has shown (Davila & Elvira, 2018; Lenox & Chatterji, 2018; Voegtlin et al., 2019) even smaller companies can have an impact. They can engage in social projects for their local community to fight poverty or improve good health (SDG 1&3), improve quality education by offering internships, upskilling and reskilling both for their employees and the wider community (SDG 4), reduce inequalities by applying diversity programs for women and minority members (SDG 5 & 10) providing decent work and economic growth by encouraging

Fig. 3 The 17 UN sustainable goals

entrepreneurship and social innovation through partnerships for the goals (SDG 8 & 17).

Several business firms, acting as social partners, have taken an active role in implementing and reporting sustainability. The already mentioned Triple Bottom Line or the notion of People, Planet, Profit urged companies for the first time to focus on the two other P's beyond profits. This concept was the starting point of what later became ESG (Environment, Society, Governance). Since the launch of Principles of Responsible Investment in 2006 the laws and standards of ESG has moved to the top of the financial services agenda. Recently in 2021 the Sustainable Finance Regulation stresses the promotion of ESG values for investment purposes and fund management and everything shows ESG will play an important role with 80% of investors intending to have an ESG plan in place by 2023 (S&P, 2022). The fiduciary duties of investors require them to incorporate ESG factors into their investment decisions and encourage high standards of ESG performance in the companies in which they invest. It also appears that ESG yields financial returns as during the Covid-19 pandemic, ESG stocks performed better than traditional stocks (Squire, 2022).

The three dimensions of ESG include in general the following policies and practices.

Environment: Assesses a company's impact on the planet involving energy use, waste disposal, raw material sourcing, carbon emissions, water usage and recycling processes.

Social: Assesses a company's impact on its workforce and the wider community. Issues include diversity & inclusion, gender equality, employee rights, charitable

activities, assistance to the community, care about agency workers and volunteer work.

Governance: Looks at how a company is directed and controlled i.e. the composition of board members, investor and stockholders' relations, internal audit and risk management, executive pay, shareholders' rights and gender equality in Boards. Responsibility for ESG factors is now the norm in the investment community.

A risk facing the emphasis on reporting and documenting sustainable practices has to do with the distinction between substantive and symbolic implementation of sustainability. Examples of green washing and fem-washing often reported mean that certain companies wishing to promote an environment friendly, or gender friendly profile exaggerate or present a false picture of what they are really doing. However, if a company decides to be substantive in its sustainability practices it can heavily rely in the involvement of HRM. Especially the Society dimension of ESG is a natural place for HR to lead, show results and fully acquire the much desired position as the firm's strategic partner.

4 Effects of Digitilization on HRM and Sustainability

HRM, like other business functions, is witnessing major changes due to digitalization. Changes in the workforce as well as the use of the latest technology seem to have a serious impact on the way of delivering its activities. Three main areas seem to be affected by digital changes which can be categorized as follows: digital employees, digital work and digital HRM. (Strohmeier & Parry, 2014).

Digital employees include the new generation of digital natives or the next generation who possess apart from digital qualifications, different expectations such as instant gratification, frequent rewards, and demand for responsible management. These characteristics affect ways for hiring, retaining, developing, and rewarding younger employees. With reference to sustainability digital employees possess as a rule a growing awareness about environmental issues. In fact, most international movements against climate change, about conservation of natural resources and biodiversity are initiated and followed by young people. Younger employees can be attracted to volunteer groups for recycling initiatives, energy saving and support to social causes.

Research shows that younger employees demand responsible management and prefer to work for an ethical employer. On the other hand, digitalization affects part of the existing workforce who do not possess or cannot acquire the required digital skills. McKinsey & Co. (2019) found that by 2030 advances in Robotics and Artificial Intelligence will lead to the automation of 39% of current work activities in the U.K. meaning that some roles and related skills will be lost. Sustainability requires vast efforts for upskilling and reskilling which can be largely enhanced by digitalization of training. Furthermore, as Cooke (2022) stresses, digital technologies may replace previously knowledge-intensive service jobs in sectors such as banking, insurance,

financial services etc. Careful relocation is needed, which fortunately can be assisted by digital platforms.

Digital Work refers to the increased electronic content of work which decreases the need for physical presence and implies virtual distant work even across borders. Working from home, which became the norm during the covid-19 pandemic had already appeared before and is now spreading under various forms of distant or hybrid work arrangements. Such work arrangements also affect ways of leading, evaluating performance and training employees. Remote work can add to sustainability by attracting people with disabilities and people with family obligations who were formerly excluded from the labor market. It also reduces carbon footprint due to less commuting and travelling to work and helps some employees in their work-life balance and wellbeing. However, not all employees prefer remote work especially if they lack workspace at home, lack the technological infrastructure or wish to have a break from their home environment and seek socialization with colleagues. This applies also to women who have disproportionately lost jobs during covid-19 and often face the extra burden of caring responsibilities. Therefore, all employees should be offered a choice in terms of flexible working arrangements.

Digital HRM. The third change in HRM is the digitalization of handling its various activities. Cloud based technologies, digital platforms and various digital tools are increasingly used by HR to automate daily processes and help in faster decision making. Owing to the digital revolution E-HR emerged which has dispersed among all HR services including recruitment & selection, training & development, performance management & compensation (Baykal, 2020). Digitilization has provided means for reducing use of paper through Zero-touch payroll, robotic interviewing and digital onboarding. E-HR is environmentally friendly and cost saving as it helps automate standard routine practices and concentrate more on transformational practices such as the ones included in sustainability. According to Lazazzara and Galanaki (2018), E-HR is expected to give many advantages such as more strategically oriented HR functions.

With reference to sustainability and the social aspects of ESG, great emphasis must be placed on employee rights, well-being, health and safety and diversity, equity and inclusion to which belongingness has been added recently (DEIB). As already mentioned all these efforts require changes in HR policies which can be greatly assisted by digitalization.

Some examples of digital HR adding to the social aspects of sustainability, involve recruitment among passive jobseekers and selection through social media with the help of on-line games. Digital apps which can add to employee wellbeing and decent work by making clear and transparent terms of employment and helping the process of employee onboarding with quick answers to various questions such as holiday policies, expenses etc. Digital learning platforms which are giving employees fully customized experience and coaching with AI and various employee self-service apps make the workplace easier to navigate especially for newly hired employees. Some companies have introduced an employee chatbox for all kinds of questions which adds to employee self-confidence and helps in better performance. Also, digital tools can identify common interests shared by people in the workplace and organize

group activities to improve team spirit and collaboration. Some more sophisticated examples include the use of AI to track the time spent by employees with their customers and providing suggestions for improving the effectiveness of their working style. Also analyzing employees' voices in order to detect distress and improve employee wellbeing. These last examples show that apart from administrative tasks, HR digitalization can interfere with issues of personal privacy and can monitor closely employee behavior while also replacing decisions about performance or selection where personal judgement is still necessary. Various ethical dilemmas are presented which are being addressed by legislators and policy formulators. (Diefenhardt et al., 2023).

Overall, with reference to sustainability the benefits from digitalization are very important as all sustainable practices can be reported in digital platforms and help in creating a sustainability report which adds to a company's good record and reputation. However, we must bear in mind that digital tools which are used to improve costs, speed and quality of HR processes are not free of problems such as limited personal contact, lack of user acceptance, privacy threats plus the additional workload demands imposed on HR units.

5 The Case of Greece During the Past Decade (2012–2022)

Research Methodology

Having described the concept of sustainable HRM and the UN SDGs agenda, we examined practices linked to sustainability which have been applied both by smaller and larger companies operating in Greece with main emphasis on the role of HR in their implementation. To identify practices, we studied in depth websites and published reports by companies belonging to the Greek Network for Corporate Social Responsibility and the QualityNet Foundation. We focused on practices aimed at the wellbeing of employees in the workplace or their involvement in volunteer work aiming at social and environmental issues. We also studied reports by a number of Institutes and Associations organizing award-winning contests for CSR, sustainability and HRM practices such as the Best Workplace Institute and the HR Annual Awards. We then approached eight HR Managers for in-depth interviews about their involvement in sustainability, their efforts to report practices under the ESG and especially the Social criteria of sustainability, the various obstacles encountered and the degree to which digitalization of HR is helping them in implementing sustainability.

Evidence from Published Sources

Our study of published sources showed that many large and a considerable number of small-medium companies felt the need to assist their people in facing social problems and also encouraged them to get involved in volunteer work both within the company for the benefit of co-workers and outside the company for the benefit of society. A careful study of reported practices showed emphasis on the following:

- Health and safety programs, which became very important during the Covid-19 Pandemic.
- Distance or hybrid flexible working systems adapted to job requirements with special emphasis on work/family balance needs of employees and provision of appropriate technological equipment for distance workers.
- Outplacement Programs during downsizing, which was very extensive during the first years following the 2010 economic crisis.
- Concern for employee well-being especially at the psychological level with provision of counseling, hot lines for personal advice and Employee Assistance Program Services offered by external consultants especially during the Covid-19 and the post-Covid period.
- Re-skilling and Up-skilling to enhance employee competencies, improve their digital skills and retain their employability in the labor market for cases of job loss.
- Diversity, Equality and Inclusion programs with an emphasis on gender balance, promoting women to leadership positions, facing gender pay gaps and sensitivity training to face hidden bias against underrepresented or diverse groups within companies. Also, inclusion programs, for people with special needs, different race, religion, ethnicity and sexual orientation.
- Programs to help unemployed, older people, migrant workers and women returning to the workplace to get employment or practical experience.
- Programs against workplace bullying and harassment, including awareness training, appointing a responsible person for handling complaints, communicating the procedure for facing such incidents, supporting victims and penalizing violators.
- Career counseling and talent management, especially for young graduates and older people, following downsizing of their company and the need for professional re-orientation.
- Employee involvement in volunteer programs for the local community, offering help especially to underprivileged groups, unemployed and poverty-struck individuals following the economic and health crises.
- Employee participation in projects to protect the environment, plant trees, clean beaches and save resources both outside and within the company through recycling, waste management, energy and water saving, etc.

The practices described above, and especially those receiving distinctions at the Best Workplace, the QualityNet Foundation and the HR Annual Awards were quite

impressive. The interesting part was that not only MNCs—which follow as a rule parent companies' guidelines, but also smaller family-run Greek firms had implemented employee-centered practices. It is true that following the 2010 economic crisis, solidarity among company members became important for survival reasons. Employees' ideas and suggestions were taken into consideration, suggestions for improvement were invited and people especially in SMEs were mobilized to help navigate their companies across dangerous waters. It is interesting to note that the economic crisis led to an increase in Greek exports, since the local crisis urged companies to look for solutions abroad (Papalexandris & Nikandrou, 2014).

The Covid-19 pandemic which occurred when the economy was recovering showed the need for digitalization and use of modern technological tools both for employee wellbeing and organizational survival. This was quite evident from our study, which showed the extra emphasis placed on digitalization of services and internal processes during and following the pandemic.

In-Depth Interviews

Following identification of sustainable HR practices, a series of eight in-depth interviews with HR managers in companies most active in employee-centered activities took place in October 2022. Respondents were asked about the degree to which they believed that their HR practices were part or contributed to corporate sustainability, their knowledge about the notion of sustainable HR, their willingness to report practices under the ESG criteria, their motives for applying sustainability, their involvement in decisions about relevant practices and the role of digitalization of enhancing sustainability.

All respondents were very enthusiastic about their HR practices given the fact that they had the opportunity to present them and gain recognition for their initiatives. They were also proud for receiving an award and thought that the impact on their employees' motivation and commitment was very favorable. They believed that they had a lot to gain from continuing their efforts especially with employee well-being, diversity and inclusion and anti-harassment/bullying policies. Volunteer programs and initiatives with an impact on the environment, such as tree planting and beach cleaning were also considered important as they created a sense of common purpose among employees, boosted their morale and helped them better identify with their organization as an ethical employer. Efforts for saving energy and controlling carbon emissions were the responsibility of production departments with HR assisting mainly in employee communication and events aiming at improving sensitivity and awareness about sustainability. It was generally evident that HR managers were more ready to engage in practices for the benefit of their internal than their external stakeholders. This coincides with Ehnert (2016) who examined sustainability reporting practices by the world's largest companies and found that the overall reporting of HRM performance is equally high as environmental performance

and that companies tend to report more on their employees than on their external stakeholders.

Respondents were very familiar with the concept of corporate sustainability but had a much better understanding of CSR. All HR managers interviewed came from companies who had received prizes for their HR initiatives. Initiatives aiming at external stakeholders were jointly organized with CSR or Communications Department, while initiatives aiming at employee wellbeing were the responsibility of HRM with the involvement of Communications in spreading the message to external audiences. In all companies our respondents had heard about SDGs which they considered more relevant to corporate governance and the environment and more relevant to large global companies. However, they knew about the growing importance of the ESG criteria, and some had already participated in conferences or events aiming at informing companies about the increasing pressure to comply and report ESG practices. Although they were informed about the emphasis placed on a series of regulations regarding corporate governance, reporting guidelines and compliance standards, and knew that these were very high on the corporate agenda, they considered them the responsibility of auditors, financial services, and legal departments. Their involvement in the corporate governance criteria had to do with gender balance requirements for boards of listed companies. This had to do with diversity, gender equality and inclusion which was very high on their priority list. In fact, three of our respondents came from companies who publish sustainability reports mainly with the assistance of external consultants and all the rest were very positive about the need to move towards ESG compliance in order to improve their company's reputation, access to capital and market competitiveness. As one respondent told us, ESG criteria and reporting offer a great opportunity to HR to gain credibility because it can prove the added value of its initiatives which was rather difficult to prove so far.

With reference to the environment, they also felt that their companies were quite active in improving their ecological profile and they considered themselves responsible for convincing their employees to get involved in company-sponsored efforts such as recycling, tree planting and day-to-day energy saving initiatives. Larger environmental interventions were the responsibility of technical staff with the assistance of external experts,

As far as initiatives for internal and external stakeholders were concerned, although our respondents were actively involved and with great fervor in their implementation, they did not consider them as an important part of the sustainability agenda but rather as part of CSR. It is true that the boundaries between CSR and the Social criteria of ESG are not clear and many companies are not yet aware of the need for documenting and reporting employee-centered practices.

With reference to sustainable HRM, the term is not so popular and the same holds true for green HR which they mostly considered a fad rather than a real movement. All respondents believed that the link between HR and sustainability has become critical after the economic and the Covid-19 crises and that what can be generally classified under sustainable HRM is becoming an important part of corporate strategy and an important tool for improving the workplace. As was mentioned by most respondents, the great resignation which took place in the US as a result of the pandemic rang a bell

about the need for more anthropocentric and human oriented company initiatives to safeguard the retainment, wellbeing, motivation and commitment of the workforce.

Finally, our respondents felt that HRM involvement in sustainability expands the HR agenda and improves their status as strategic corporate partners. Their main reservations had to do with the lack of clear guidelines for reporting and the recent booming but sometimes confusing available platforms. They were also afraid of the extra burden imposed on HR departments with the addition of extra tasks such as handling diversity and inclusion, workplace bullying and harassment, health and well-being issues, which had gained extra importance especially after the pandemic. An extra preoccupation came from the demand to adapt distance or hybrid working systems to meet employee work/life balance needs and the gap in leadership and team supervisory skills existing mostly among middle managers which they would have to cover with extra training and development. Overall, they were pleased about the expanding role of HRM but were afraid of the lack of staff which due to economic difficulties, top management was reluctant to hire. A possible solution was the use of external consultants which are available in the Greek market and the collaboration with NGOs which offer their services in initiatives for the community without extra charge as they try to secure funding from Institutional Donators. One of our respondents expressed her concern about sustainability reporting becoming a box ticking exercise instead of a means of social improvement and stressed the need for culture changing interventions which must be assisted by top management.

With reference to digitalization, our respondents felt that it offered important release from administrative tasks and that it could gradually provide opportunities for increasing HR sustainability in matters of inclusion, training, employee performance, employee collaboration and employee wellbeing. They were not fully involved in reporting for ESG criteria but were very interested in learning more and contributing to sustainability reporting.

6 Study Limitations and Conclusions

This study is still in progress, as only a few HR Managers were interviewed and practices were identified after examining only companies showing active interest in Sustainability, CSR and Sustainable HRM practices. Our research will continue in order to describe the existing situation among a representative sample of Greek companies and the role of digitalization which seems to expand very fast. We believe that given the comparatively small size of the country, the growing availability of digital tools and the great emphasis and publicity given to sustainability, an increasing number of companies will start applying sustainable practices especially under the pressure expected by banks and investors.

Issues which must be examined in future research is the distinction between symbolic or compliance-induced versus substantive or values-driven implementation of sustainability given the common accusation that sustainability is a fad or a marketing and communications tool. The extensive use by activists of terms such

as greenwashing and femwashing urge companies to be more transparent and able to prove the truthfulness and the real motives behind their practices. Finally, the degree of tensions arising between environmental/social and economic goals and the need to find a balance between these opposing forces should be explored. It is our belief that through ESG this conflict will become less evident as resources spent for social or environmental purposes will serve economic goals of securing funds and investors' preferences. Towards this end, good use of digital tools can provide, speed, effectiveness, and transparency.

To conclude, this paper has tried to stress the need for more involvement of HR in sustainability. Our general impressions about Sustainability and HR in Greek firms based both on published sources and interviews was that HRM practices adding mainly to the social dimension of Corporate Sustainability are gaining attention and that various employee and community-centered activities for and with the assistance of employees have increased during the Greek economic crisis and the pandemic which succeeded it. It is now commonly accepted both at the top management and the Board level that better treatment of employees in the workplace is an important element of corporate sustainability, keeping employees' morale and enhancing their performance. Furthermore, the launching of the 17 SDGs by the UN in 2015 and the emphasis on the ESG criteria for reporting their implementation has mobilized initially listed companies and gradually smaller non-listed ones to observe standards and engage in relevant policies and practices. The availability of various digital tools can greatly assist in this direction.

All these late developments will definitely help in designing and implementing sustainability practices and improving sustainability reporting for social and employee-centered activities thus adding to the credibility and importance of HRM. Therefore, taking advantage and considering the benefits of digitalization, an excellent opportunity is presented for HRM to report its initiatives, improve its status as a strategic partner and add with its policies and practices both to the well-being of its people and the competitiveness of business firms.

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Cyberthreats in Everyday Life: Challenges and Opportunities

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Abstract This study addresses the escalating threat of cyberattacks by exploring the awareness levels among individuals and their perception of cyberthreats and cybersecurity measures. Adopting a mixed-methods approach, the research combines quantitative techniques, such as sentiment analysis and topic modeling, with qualitative methods, including comprehensive interviews with senior executives across various organizations. The aim is to gain a deeper understanding of their attitudes, behaviors, and strategies for dealing with cyberthreats. Our findings underline the crucial role of effective governance and the development of a robust cybersecurity culture in organizations, highlighting how these factors are instrumental in reducing risks. The insights garnered from this study are pivotal for guiding strategic decision-making, refining cybersecurity protocols, and bolstering organizational resilience against the evolving landscape of cyberthreats.

1 Introduction

In recent years the use of technology is increasingly prevalent in everyday life, amplifying dependency on the internet and digital services, and propelling the interconnectivity of users. In the same vein, the number of cyber threats has also increased, posing a significant risk to individuals and organizations. From data breaches to malicious software and phishing scams, cybercriminals are constantly finding new ways to exploit vulnerabilities in digital systems.

The COVID-19 pandemic is a major catalyst of the noticeable rise in the number of cybersecurity incidents, as it compelled widespread technology adoption in all sectors in a hasty fashion (Lourenço & Marinos, 2020a). ENISA, (i.e., European Union Agency for Cybersecurity) conducts annual assessments regarding the state of the

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cybersecurity threat landscape and then publishes its findings. These reports include the most significant developments in threats, their instigators, their techniques, their motives, and their impact.

The most prevailing threats recorded in th past few years can be classified into the following eight categories: ransomware, malware, social engineering threats, threats against data, threats against availability, disinformation and misinformation, supply-chain attacks, and insider threats/non-malicious threats (Ciobanu et al., 2022; Lella et al., 2021; Lourenço & Marinos, 2020a). These threats can have a noticeable and severe impact on organizational procedures since they have the ability to disrupt business operations and cause leakage of corporate data. Recent examples of cyber-attacks with such consequences are the attacks on the Greek organizations Hellenic Post and DESFA, which manifested in March and August of 2022 respectively. The former resulted in the halting of business operations for, approximately, four days and the latter resulted in the illegal upload of more than 350 GB of data in the dark web. Both attacks involved the same type of malicious software: a ransomware.

Ransomware represents a cyberattack method where attackers seize control of a victim's assets, demanding payment for their return and the safeguarding of their confidentiality. Typically, such an attack commences with the infiltrators breaching the system, followed by compromising the integrity and/or confidentiality of targeted assets through encryption, deletion, or theft. The attack culminates in the extortion of the victim for payment to recover the impacted assets (Garcia et al., 2022). A notable example is the attack on AXA, a major French insurance firm, orchestrated by the Avaddon Ransomware Gang. This group accessed approximately 3 TB of data, predominantly containing sensitive Personally Identifiable Information (PII) such as ID cards, passport copies, and customer medical records. They encrypted files within AXA's systems and demanded a ransom for decryption. Additionally, they threatened a Distributed Denial of Service (DDoS) attack to disrupt AXA's website availability if their demands were not met within a specified period.

To name a few of the most common threats, *malware* is malicious software that can be designed to do many tasks, like granting the threat actors permanent access to a system or a network or spying on a user to obtain valuable sensitive information (e.g., credentials) (Lourenço & Marinos, 2020b). *Social engineering* attacks are malevolent behaviors carried out with the aim of exploiting human inadvertence, resulting in individuals being misled into divulging critical information directly to the perpetrators or committing security blunders. *Phishing*, one of the most pervasive social engineering attacks, is a way to steal information held by users by convincing them that the sender is a trustworthy source and that they should download a malicious attachment or click a link and get redirected to a fraudulent URL. It can be executed, for example, via an e-mail, an SMS (smishing) or a phone call (vishing). An incident that combined phishing and malware was the attack carried out to the SWIFT system through the internal system of the Bank of Bangladesh. The attackers sent employees looking to hire new personnel phishing emails that contained a link to download a zip file with the resume of a, supposedly, interested candidate. What the zip file also contained was a malicious executable that let the perpetrators enter the bank's system.

This study emerges from the pressing need to understand the widespread impacts of cyber threats, which have precipitated major cybersecurity incidents globally, resulting in significant organizational consequences such as revenue loss and diminished customer trust. Our research is driven by the imperative to recognize how these threats influence individuals in both professional and personal spheres. Ignoring the far-reaching effects of cybersecurity incidents, whether targeted at organizations or individuals, is no longer a viable option. Therefore, this research aims to explore two primary areas: the influence of cyber threats on individuals' daily lives and their impact on the management and governance of teams and organizations.

In today's era, where data processing is a constant activity, a critical question arises: How aware are individuals of potential online dangers? The perception of cyber threats and cybersecurity by individuals, especially those in decision-making roles, is crucially intertwined with broader organizational perspectives. The challenges faced in a technology-driven business environment are parallel to those encountered in consumer technology, but on a larger scale. Consequently, management and governance professionals must adeptly navigate and leverage technological advancements in their competitive domains, while also addressing and mitigating associated risks.

Organizations consist of individuals with varied expertise. To effectively harness emerging technologies while minimizing vulnerability to digital threats, a foundational understanding of cyber threats and their consequences is essential. Our study seeks to address pertinent questions: What is the impact of cyber threats such as malware and phishing on individuals and, consequently, on organizations? What proactive steps are being taken to protect against these threats? How aware are organizational leaders of emerging cyber threats, and how does their perception influence the management and governance of their teams?

2 Literature Review and Approach

Literature Review

Awareness of cyber threats is variable across individuals and organizations, with many still underestimating their risks. Studies reveal ongoing challenges in recognizing phishing emails and malicious websites, and a lack of knowledge on self-protection methods (Lella et al., 2021; Lourenço & Marinos, 2020c). Analysis of the ENISA Threat Landscape Reports from the past three years (2020–2022) indicates a consistent ranking of threats, with the notable addition of supply-chain attacks in 2021. Despite repeated warnings about key threats like ransomware, malware, and social engineering, which have consistently topped these lists, the frequency of related incidents remains high. This persistent threat vulnerability is troubling, as attackers increasingly adopt more sophisticated and targeted strategies, elevating the risks of system infiltration and data compromise.

Particularly alarming is the trend of 'whaling,' a refined phishing tactic aimed at high-ranking executives to extract sensitive corporate information. The success of such an attack can be devastating for an organization. Thus, the need for heightened vigilance and awareness, especially among those in authority, is paramount to counter these sophisticated cyber threats effectively.

In order for executives to fully comprehend the ramifications of cyber threats, it is essential to consider cybersecurity as a pivotal part of organizational processes. The ever-evolving cyber threats are both a call for organizations to reconsider their leadership principles, governance structure, and management approach, but it is also a chance to prove themselves worthy against competitors, by using cybersecurity as a competitive advantage (Chronopoulos et al., 2018). Proactive leaders who prioritize cybersecurity have the power to establish a culture of awareness and preparedness and invoke a change in the governance of their organizations; one that can effectively and efficiently deal with cyberthreats, detect shortcomings in an organization's governance, policies and procedures and minimize exposure to risks. Based on literature review, governance is critical for cybersecurity management in an organization (Dhir et al., 2021). It can establish a cybersecurity culture which promotes an understanding of the respective risks and the importance of protecting organizational assets. Consequently, it can help promote awareness among employees and other stakeholders, like partners, by enforcing training programs and establishing the necessary policies and procedures. Furthermore, since cyber threats have the potential to cause downtime to systems, disrupting operations and affecting the overall performance, they should be taken into consideration by the management as an indication that further investments may be necessary towards that end, like investments in software (e.g., anti-virus), hardware (e.g., firewall), techniques (e.g., encryption), training (e.g., cybersecurity mandatory training for all employees) and other countermeasures (e.g., physical security of IT assets) (Jeyaraj & Zadeh, 2022). If users are ignorant, on the other hand, they end up with their personal data stolen, exposed, and maybe even permanently deleted. This begs our question; how aware are users in commercial and organizational environments of the current threats, what measures are they applying to protect themselves and how significant is the impact of an attack, caused by one or more of these threats?

In response to the escalating complexity, frequency, and sophistication of cybersecurity incidents, this project was initiated. It is vital, as it illuminates the current landscape of cyber threats and the level of user awareness, providing valuable insights into individuals' perceptions and their preparedness against these threats. This research endeavors to enhance cyber awareness and inform the public about the ever-changing nature of digital dangers.

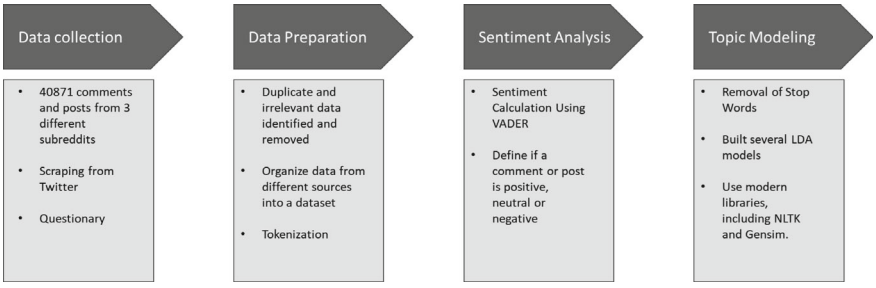
To achieve this, we will gather data from diverse sources, including surveys and online forums. This data will undergo rigorous analysis through sentiment analysis, topic modeling, and statistical methods, enabling us to extract key themes and trends in how individuals view cybersecurity issues. Our research employs the Sentiment Analysis and Topic Modeling (SATM) framework, a proven methodology in information and library science for understanding information behaviors and shaping information services (Ali et al., 2020; Cengiz et al., 2021; Dahal et al., 2019).

The outcomes of this study are expected to be instrumental for security experts and technology firms, guiding them in refining their cybersecurity strategies and offering better protection against cyber threats. Ultimately, this research aims to contribute significantly to enhancing individual and organizational resilience in the digital era.

Methods

Quantitative Research

In this study, we employed a methodology centered on the analysis and representation of linguistic patterns in free-text data. This approach was facilitated through the creation of text-mining tools, grounded in the distributional hypothesis. This hypothesis, as posited by Harris (1981), suggests that words occurring in similar contexts are likely to have comparable meanings. By leveraging this principle, our methodology effectively interprets and categorizes linguistic patterns within the texts. The results of our analysis are anticipated to offer significant insights for security professionals and technology companies. These insights will be instrumental in enhancing cybersecurity strategies, ultimately leading to better protection of individuals against cyber threats.



The first step of the methodology is data acquisition. In this step, the data is collected from both primary and secondary sources. The data collected so far stem from individuals' posts and comments on three different subreddits (Cyber Security, AskNetSec, and Information Security), since Reddit is a platform that offers a valuable and diverse cross-section of opinions and insights from everyday individuals, providing an accessible and egalitarian space for the candid expression of thoughts on cybersecurity. The engaged and collaborative nature of the Reddit community further enhances the potential for a comprehensive exploration of common perceptions and attitudes towards cybersecurity among a broad demographic spectrum. Potentially we can scrape data from other subreddits relative to our scope of the study. We selected these as they demonstrated a substantial community membership and exhibited content that was notably pertinent to the thematic focus of our study, thereby providing a diverse and comprehensive source of information. As for now, we

have gathered a total of 40,871 comments and posts (from Reddit) related to cyber security, all from individuals. The data collection process utilized the 'requests' library, an open-source Python module designed for handling HTTP. Contrary to the earlier statement, the 'requests' library does not directly connect to the Reddit database. Rather, it facilitates the issuance of HTTP requests to the Reddit website (or any other web server) to retrieve the required data.

The second step of the methodology involves data preparation. In this step, the collected data will be organized, structured, and standardized. This is done to ensure that all data is consistent, accurate, and free from errors. Any duplicates and/or irrelevant data will also be identified and removed. Since we scraped data from three different subreddits, using API and Python request library, our data collection process involved interfacing with a specific API. In particular, we interacted with the Reddit API using the PRAW (Python Reddit API Wrapper) library to gather the necessary data. Using Python, we stored the data in a dataset where we cleaned missing values. For example, many comments were deleted by the user, so we had the value "deleted" in our dataset. Lastly, we used the technique of dividing a huge body of text into smaller tokens, which is known as tokenization. Words, characters, or sub-words can all be used as tokens. The method most commonly employed for processing raw text is tokenization. In this context, tokens are considered the fundamental units of natural language, representing individual words or sub-word units.

The third phase of our methodology involves sentiment analysis, a process designed to automatically extract subjective information, such as opinions and sentiments, from natural language texts. The objective is to transform these insights into structured knowledge that can aid decision-making processes or support decision support systems. The relevance of sentiment analysis has been amplified in the context of the burgeoning social media landscape (Fersini et al., 2017). For this study, we employed the Valence Aware Dictionary and Sentiment Reasoner (VADER) for sentiment analysis, a tool specifically calibrated for social media content, utilizing rule-based methods and lexicon (Bonta et al., 2019). VADER not only analyzes the polarity of sentiments (positive/negative) but also their intensity.

Our research delves into two primary emotional dimensions: the intensity and polarity of sentiments within cybersecurity discussions on various subreddits. The aim is to discern the emotional undercurrents in these conversations, providing insight into public sentiment on cybersecurity. VADER facilitates this analysis by assigning scores to sentiments—negative, neutral, and positive—based on a polarity metric that ranges from -1 (entirely negative) to $+1$ (entirely positive). Sentiments are classified as negative if the score is below 0, positive if above 0, and neutral if the score is 0 or close to it.

Additionally, VADER computes a compound score, ranging from -1 to $+1$, where -1 indicates extreme negativity and $+1$ indicates extreme positivity. This score represents the cumulative sentiment of the text. In our analysis, we primarily utilized the compound score to evaluate user sentiment in our dataset (Hutto et al., 2014). Our analysis revealed the following distribution of sentiments of the total 40,870 comments or posts.

- 8518 negative comments or posts
- 9834 neutral comments or posts
- 22,518 positive comments or posts.

Upon examining the set of 40,870 comments and posts, our focus narrows to understanding the dynamics within the posts alone. We hypothesize that the nature of a post can significantly influence the sentiments expressed in its accompanying comments. For example, a post with a negative viewpoint on cybersecurity might set a generally negative tone. However, within this context, some comments might actually convey positive sentiments, directed more towards the post's content or presentation rather than the broader subject of cybersecurity. This approach enables a more layered analysis, distinguishing between the overall sentiment towards the topic and the reactions to individual posts within an intricate online discourse. Using the same approach and putting as input only the posts of the three subreddits, we found out that we have:

- 413 negative posts
- 88 neutral posts
- 1336 positive posts.

of the total of 1837 posts.

The sentiment analysis conducted on comments and posts related to cybersecurity in specific subreddits yielded predominantly positive results. Our findings indicate that 55.1% of the analyzed comments and posts exhibited a positive sentiment, while 20.4% displayed negative sentiments, and 24.1% remained neutral. A more focused examination of the posts alone reveals an even higher positivity rate, with 72.72% characterized by positive sentiments, 22.48% by negative sentiments, and a mere 4.8% classified as neutral. These outcomes suggest a generally favorable perception of cybersecurity within these online communities. Notably, the predominance of positive posts appears to influence the overall sentiment of the ensuing comments. Such insights hold considerable value for security professionals and technology companies, offering guidance on enhancing cybersecurity strategies and fortifying the digital defense against cyber threats.

The fourth step is topic modeling. The collected data will be analyzed to identify the topics and trends related to cybersecurity. This will help identify the most important topics in the field, as well as any emerging trends.

The presence of latent subjects across the corpus is taken into account by topic modeling. Sets of words from the texts that were learned without guidance serve as the latent subjects' representations. To improve our understanding of corpus content, we use subjects as term abstractions contextualized for specific use. This approach, discussed by (Gómez-Suta et al., 2023), employs latent representation to improve generalization. It enables us to derive conclusions from data that may not have been previously observed. Different from rule-based text mining methods that rely on regular expressions or dictionary-based keyword searches is topic modeling. It is an unsupervised technique for finding and following a cluster of words in big collections of texts (Blei et al., 2003). Topic modeling identifies abstract topics that reoccur in

a corpus of writings using a probabilistic model. It's a text mining technique that's frequently used to find semantic patterns in massive amounts of data. Themes were discovered in a corpus of reddit posts and comments in our example, using the Latent Dirichlet allocation (LDA) model.

Qualitative Research

In the context of our study, the application of qualitative methods is particularly pertinent in addressing the research queries in cybersecurity studies. Fujs et al. (2019) highlight that these methods yield comprehensive and insightful results, often leading to high citation rates for papers due to their depth and valuable contributions. Qualitative research excels in delving into the intricacies of behaviors, emotions, and personal experiences, thanks to its inherently flexible and responsive nature (Creswell & Poth, 2017). Creswell & Poth (2017) also emphasize its suitability for exploring new research areas, aligning seamlessly with the objectives of our study.

For our research, we conducted interviews with key decision-makers from various-sized businesses. The participant sample included CEOs, Chief Operating Officers (COOs), and Marketing Directors representing diverse industries and organizational structures. Selecting executives for interviews was strategic, as their roles in decision-making provide unique insights into cybersecurity from a business perspective. This selection enabled us to examine the complex relationship between cybersecurity issues and broader business goals, offering a thorough understanding of how such considerations are integrated into the larger organizational fabric. This approach was not limited to their professional responsibilities; it also encompassed their personal perspectives, acknowledging the overlap between professional and personal views on cybersecurity.

By engaging with these high-level professionals, our study aimed to gain an in-depth understanding of their decision-making processes and perceptions of cybersecurity threats, both within their organizations and in their personal lives. This comprehensive approach was vital to fully grasp the multifaceted nature of cybersecurity awareness, thus contributing to a broader understanding of the nuanced aspects of cybersecurity perception among decision-makers.

3 Results

Quantitative Research Results

The algorithmic approach we followed underwent iterative execution to produce a varying number of topics. In sum, the first iteration generated 10 topics, the second one generated 9, and the following iterations generated progressively fewer topics, with the final one generating 3. Once the results of all iterations were visualized, we

documented the identified keywords from each topic. The words that were visualized by the algorithm are the ones that appear with the highest frequency in the posts and comments of the selected subreddits, ignoring articles, prepositions, and pronouns and not differentiating between singular and plural (i.e., the algorithm will return the word "tool" if a post contains the word "tool" or "tools").

Taking into account that Reddit is a website where users discuss various topics, seek advice, and provide knowledge and insights, words like "good", "time", "thing", "thank", "email", and "experience" are to be expected. Table 1 includes our interpretation of 5 out of the total of 52 topics the algorithm produced:

The approach demonstrated in Table 1 was carried out for all of the identified topics. After studying the topics and keywords, the following observations were made: as the algorithm output fewer topics, the thematic distinctiveness and coherence of the identified subjects markedly improved. Notably, when the algorithm generated 10 topics, certain thematic areas appeared vague. However, with a reduction in the number of topics, the algorithm yielded more refined themes. By the final iteration producing 3 topics, we observed a culmination of clarity and distinctiveness, allowing for a concise encapsulation of the overarching discussions across all iterations (Table 2).

The topic modeling results from the analysis of the input data reveal dominant themes regarding cybersecurity which encompass a range of key areas, including attacks, vulnerabilities, education, management, and technologies. This part of the research revealed that online discussions regarding cybersecurity span across three main topics:

- **Risk Mitigation and Secure Communications**: this topic's discussions focus on strategies for mitigating cybersecurity risks and ensuring secure communication practices. In a personal context, individuals can apply password best practices, secure their personal devices, and practice safe online behaviors, enhancing their overall digital security and protecting personal data.
- **Education and Career**: this topic's discussions revolve around the educational and career aspects of cybersecurity, addressing the skills, experiences, and certifications necessary for personal and professional growth in the field. Individuals can leverage the insights gained to plan their cybersecurity education, make more informed career decisions, acquire relevant certifications, and foster continuous learning, enhancing their personal knowledge.
- **Vulnerability Management**: this topic's discussions focus on the identification, assessment, and management of vulnerabilities to fortify cybersecurity defenses in an organizational setting. Individuals can utilize such knowledge if they wish to acquire deeper knowledge regarding cybersecurity and learn more about the ways in which organizations proactively address potential threats.

Having examined the landscape of online discussions pertaining to cybersecurity, it is pertinent to shift our focus towards the perspectives of a more targeted group, namely decision-making individuals, whose viewpoints will provide a nuanced understanding of cybersecurity considerations within the context of strategic decision-making.

Table 1 Topic interpretation

Topic	Topic keywords	Topic interpretation
1st Iteration—10 Topics Topic 5	Good, email, post, link, comment, reddit, people, send, look, think, question, message, hear, click, thread, hope	Users helping other users. Common phrases may include: "there is a good subreddit/post that you can look at", "send me an email/message for more details", "there are other people with this question, you can look at this thread", "click on the tab on the left of the screen", "I hope this helps"
1st Iteration—10 Topics Topic 6	Time, thing, team, companies, need, manage, problem, people, risk, business, report, respond, process, answer, question, good, interview	Users asking about cybersecurity in the work field. Common phrases may include: "how much time does it take to report an incident", "what questions will they ask me in an interview", "you should answer like this", "here are some things that helped me pass my interview", "is there a cybersecurity team in your company", "what is the process of managing risks"
3rd Iteration—8 Topics Topic 8	Password, user, email, account, network, device, data, server, file, change, encrypt, attack, address, traffic, need, phish, file, change, number	Users discussing cybersecurity measures and cyberattacks. Common phrases may include: "my account password got leaked", "users should use choose change passwords regularly", "when the traffic of the server/network increased we suspected an attack", "I got a phishing email from an unknown email address", "if the information is sensitive the device/file should be encrypted"
6th Iteration—5 Topics Topic 2	HTTPS, tool, Linux, vulnerable/ vulnerability, look, free, exploit, network, good, HTTP, check, test, learn, source, threat, start, hack, blog, Windows, GitHub	Users discussing vulnerabilities and learning resources. Common phrases may include: "it's more likely to get hacked if you use HTTP instead of HTTPS, because it's more vulnerable", "check these sources/blogs on how to get started on Linux/ Windows", "GitHub has free tools to help you test out and learn", "network vulnerabilities pose a great threat"
7th Iteration—4 Topics Topic 4	Years, experience, certification, delete, companies, cyber, interview, people, level, hire, cybersecurity, time, field, want, degree, start	Users discussing things related to cybersecurity jobs. Common phrases may include: "how many years of experience do I need to have for this job", "what certifications do I need", "you need to delete irrelevant skills from your resume", "what degree do I need to get hired", "how much time does it take for people to go from mid to senior level"

Qualitative Research Results

The qualitative research findings shed light on several noteworthy aspects pertaining to individuals' experiences, perceptions, and behaviors concerning cyber threats. In the study, the sample comprised nine participants, each possessing distinct attributes and backgrounds (Table 3).

Table 2 The 3 topics

Topic Category	Topic keywords	Topic interpretation
Risk mitigation and secure communications	Password, data, network, user, access, server, time, think, phone, Windows, thing, need, attack, account, encrypt, send, file, connect, device, email	Users giving advice regarding the digital security practices, like securing user accounts, protecting data, and ensuring the integrity of systems, devices, and communications. Common phrases may include: "passwords should change regularly", "sensitive files must be encrypted/password-protected", "you will need your phone in addition to your device to access your Windows user account", "you need to be careful when receiving files via email", "do these things before the network connection times out"
Education and career	People, years, experience, think, good, companies, learn, time, want, start, need, role, level, help, certification, thing, look, cyber, manage/ management, team	Users giving advice on how to start a career in cybersecurity. Common phrases may include: "people start their cybersecurity careers like this", "how many years of experience do I need to achieve this", "I think good companies to start your career are …", "how much time does it take to get to this level", "can you help me choose a good certification", "these are things that companies look for in professionals", "risk management is crucial", "cybersecurity teams are essential"
Vulnerability management	HTTPS, tool, vulnerability, delete, risk, read, list, report, threat, good, thank, look, write, great, respond, post, source, test, inform/ information, help	Users discussing about managing vulnerabilities by addressing security risks, using tools to identify vulnerabilities, and responding to potential threats. Common phrases may include: "HTTPS is safer for data transfers", "these are the most commonly used tools for vulnerability/risk assessment", "you need to delete sensitive information properly", "information about threats and vulnerabilities are typically contained in a list in a report", "OWASP is a good source of information for risks", "organizations usually run penetration tests"

After conducting one-on-one in-depth interviews with the participants, we extracted the following results, which encapsulate the insights garnered from the participants. Initially, it was noted that a relatively small fraction (22.2%) of the study's participants could explicitly identify a cyberattack by name. Nonetheless, every participant was capable of articulating detailed descriptions of representative cyberattacks, demonstrating an overall grasp of the concept. This depth of understanding appears to stem from their contextual awareness and familiarity with cyber threats, as evidenced in the study.

Table 3 Sample characteristics

Characteristics	Number of individuals	Characteristics	Number of individuals
Gender		Age	
Male	6	35–44	2
Female	3	45–54	5
		55–64	1
Highest level of education		> 65	1
Bachelor's degree	2		
Master's degree	6	Organization size	
Ph.D.	1	< 100	5
		< 500	1
Occupation		1000 <	3
CEO	3		
COO	3		
Marketing director	3		

Secondly, the study revealed the widespread nature and impact of cyberattacks, with a significant proportion (77.8%) of participants having experienced such incidents, either directly or vicariously. This finding highlights the pervasive influence of cyber threats in modern society and the extensive scope of their repercussions. Regarding the effectiveness of these cyberattacks, a notable majority (63.6%) of the reported past incidents were classified as successful. The primary causes identified for these breaches included factors such as human negligence, the sophistication of attackers, and inadequate defensive measures, including outdated systems and a lack of advanced technical controls. Specifically, human error was implicated in the majority (83.3%) of these successful attacks, closely followed by the inefficiency of countermeasures (66.6%). These statistics underscore the potency of cyberattacks in circumventing security protocols and underline the urgent need for comprehensive cybersecurity strategies. These strategies should encompass not only advanced countermeasures but also focus on enhancing education and awareness to mitigate the risk of such threats. When examining the context in which these attacks occurred, it was discerned that the majority (63.7%) of the reported incidents transpired within corporate environments, while the remaining instances (36.3%) manifested in personal settings. This finding signifies the heightened vulnerability of organizational structures to cyber threats and accentuates the imperative for fortified security measures within such domains.

Regarding the sources of information about cyber threats, participants revealed diverse channels: a considerable proportion (33.3%) relied on mass media sources for their awareness, while an equivalent percentage accessed information through online platforms. Additionally, two-thirds of the participants (66.6%) derived their insights from their respective organizations' IT departments, which indicates that internal knowledge plays a pivotal role in bolstering cybersecurity awareness.

Moving forward to the indicators that raised suspicion in email communications, a few recurring patterns arose. Participants identified various signs, including dubious email addresses and irregular formatting (e.g., misspellings or non-official logos). Moreover, a notable portion of the participants (33.3%) highlighted the efficacy of company network policies in filtering potentially malicious emails, indicating the significance of robust cybersecurity frameworks and preventive measures. Similar vigilance was observed with regard to suspicious SMS messages and social media communications. Participants commonly expressed wariness towards messages originating from unknown senders, further emphasizing their cautious approach when encountering unfamiliar sources.

Notably, all participants acknowledged resorting to logging into their accounts from public networks, as a last resort, even while being cognizant of the inherent risks associated with such actions. This observation highlights the delicate balance between convenience and security concerns, as individuals weigh the trade-offs when confronted with urgent circumstances.

Transitioning to a different aspect of the study, a consensus was observed among the participants, suggesting that there is a prevalent lack of cybersecurity awareness within the general populace. This stands in sharp contrast to their observations of their professional counterparts, who were noted to possess at least a fundamental level of knowledge in this domain. This disparity highlights the unique nature of the participants' professional environment, which evidently places a greater emphasis on the comprehension of cybersecurity issues.

In terms of the participants' initial understanding of cybersecurity, it was discerned that 25% of the respondents' acquired their knowledge during their academic studies, while the majority (75%) acquired practical insights through their professional experiences. This highlights the influence of real-world exposure and workplace dynamics in shaping individuals' cybersecurity acumen.

Lastly, an overwhelming consensus (100%) was reached by participants, claiming that the frequency of cyberattacks is expected to increase in the near future, while one-third of the respondents (33.3%) also expressed a concurrent belief that the sophistication of these attacks will grow as well. This anticipation underscores the escalating threat landscape and the urgent need for proactive cybersecurity measures to mitigate potential risks.

Considering the steps needed to prevent future cyber-attacks and mitigate their negative impacts, participants highlighted several recommendations. From an organizational standpoint, suggestions included greater collaboration with law enforcement agencies, stricter penalties in the criminal code, and investment in appropriate cybersecurity tools. At an individual level, emphasis was placed on regular awareness updates, system protection, and personal responsibility, and stakeholders were encouraged to support initiatives promoting education, vigilance, and the integration of cybersecurity practices into organizational culture.

Upon examination of the participants' answers, the main findings of this part of this study are the following:

- **Importance of Internal Insights**: the participants were able to demonstrate a basic understanding of cybersecurity topics, which is attributed to the updates and insights provided by professionals within their organizations, but also to the direct or indirect exposure to cyberattacks.
- **Recognition of Threat Indicators**: the participants exhibited the ability to recognize potential indicators of malicious emails and SMS messages, showcasing the level of vigilance when faced with such a test. Despite this aptitude, the participants candidly acknowledged instances where cyberattacks materialized, attributing these occurrences to human error or vulnerabilities within organizational systems. This finding unveils a nuanced understanding among decision-makers, who not only recognize the importance of identifying threat indicators but also acknowledge the multifaceted nature of cybersecurity challenges and the vulnerabilities they strive to exploit.
- **Anticipation of Increased Cybersecurity Threats**: the participants expressed a collective anticipation of an imminent surge in both the quantity and sophistication of cyberattacks. This forward-looking perspective is accompanied by concerns regarding the potential escalation of cyber threats, particularly when coupled with a perceived lack of vigilance from the side of the users. This foresight underscores a cognizance of the evolving nature of cybersecurity challenges, and emphasizes the critical importance of sustained vigilance, robust countermeasures, and continuous adaptation to counteract the advancing landscape of cybersecurity threats and mitigate potential risks effectively.

The qualitative research findings contribute substantively to the existing body of knowledge, unraveling multifaceted dimensions of individuals' experiences, perceptions, and decision-making processes concerning cyber threats. The obtained insights form a valuable basis for making informed decisions, improving cybersecurity practices, and strengthening organizational resilience in response to ever-changing cyber risks.

Integrating Quantitative and Qualitative Findings

To address the rising incidence of cyberattacks, our study employed a dual-method approach, integrating both quantitative and qualitative analyses. The quantitative component, executed through the analysis of online forum data, identified key themes in internet discussions about cybersecurity, notably focusing on best practices and educational initiatives. Concurrently, the qualitative aspect, which involved engaging with individuals in key organizational roles, revealed a widespread belief in the inadequate cybersecurity knowledge among the general population.

Our findings present a paradox: while the online dialogue indicates some degree of cybersecurity awareness among certain segments of the public, the qualitative data emphasizes a general lack of understanding and preparedness in broader society. A deeper interpretation of these contrasting results suggests that the online discussions

might predominantly involve those with a basic cybersecurity knowledge, representing a specific subset of the general populace. This hypothesis aligns with the views of decision-makers, who perceive a more widespread knowledge deficit.

Our integrated analysis of these findings highlights a significant gap in cybersecurity education and awareness. Drawing from the qualitative insights, it appears that there is a fundamental lack of crucial cybersecurity education and awareness in the general population, with implications that may extend into professional settings. On the other hand, the quantitative data indicates that the extensive online environment provides accessible resources and communities for initiating cybersecurity education.

To bridge this gap, there is a need for targeted educational interventions that equip individuals with essential cybersecurity knowledge. This effort should leverage the abundance of online resources to spread awareness and cultivate a more cyber-resilient society.

4 Contribution, Implications, and Future Research

Previous studies in cybersecurity management have highlighted critical factors influencing decision-making and the necessity of integrating cybersecurity into overall organizational strategy (Dhir et al., 2021). Factors like organizational culture, resource allocation, and employee awareness are pivotal, advocating for the incorporation of cybersecurity management into strategic alignment and governance for a comprehensive approach. Additionally, the education of decision-makers at various levels, from executives to employees, is crucial for the effective implementation of cybersecurity measures and informed decision-making (Arranz et al., 2023).

Based on the research study's findings, we offer insightful information about people's attitudes and actions in relation to cyber threats and explored the factors that influence their resilience, aiming to shed light on areas that require greater attention. More specifically, in the domain of cybersecurity, the principle "prevention is better than cure" emphasizes the critical importance of personal responsibility. Recognizing that each individual represents a potential target and entry point for cyber threats, educating oneself on safe online practices becomes paramount for safeguarding personal information and reducing susceptibility to cyberattacks. In this context, the empowerment of individuals through education is identified as a key aspect. Acquiring knowledge about the fundamentals of secure internet use, the ability to identify phishing emails, and proficiency in device security are essential skills that enable individuals to securely navigate the digital environment. Shifting attention to organizational contexts, a holistic approach positions cybersecurity as a fundamental component of organizational operations. This approach demands significant investment in cybersecurity measures, including technical safeguards, comprehensive policies, procedures, and extensive employee training programs.

Organizational strategies are crucial, but the influence of individual behavior on organizational cybersecurity resilience cannot be overlooked. There is a demonstrable symbiotic relationship between individual online behavior and the overall cybersecurity resilience of an organization. Moreover, this influence is bidirectional; organizational culture significantly shapes individual behaviors, not only within professional settings but also in personal digital interactions. By cultivating a culture of cybersecurity, organizations exert a substantial impact on their employees' security awareness and digital health behaviors, extending beyond professional boundaries to influence personal digital practices.

Future research initiatives involve continuous employment of quantitative methods, such as distributing a questionnaire to individuals, to delve deeper into users' thoughts, experiences and level of awareness regarding cybersecurity. By gathering comprehensive data on individuals' perceptions, knowledge gaps and attitudes towards cybersecurity, we can gain valuable insights to propose the development of more effective educational programs and strategies. These initiatives can bridge the gap between the awareness gap, empowering individuals to make informed decisions and better protect themselves against cyberthreats. This constitutes a continuous endeavor, reflecting the evolving nature of requirements in this domain over time.

Overall, this research enhances our understanding of the impact of individuals' attitudes and actions on their approach to cybersecurity, as well as on the broader context of organizational cybersecurity practices and management. The effects of cyberattacks, such as monetary loss, data loss, privacy invasion, expenditures related to data breaches, and harm to an organization's brand name are more present than ever and this is something that people in governance and management roles can use as an incentive to make more informed choices and lead a more cyber-resilient strategy.

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Leadership and Skills in the Digital Era

The Role of Altruism in a Digital Era: Developing an Ethical Framework for Responsible Managers in a Finite World

Jiro Kokuryo, Daum Kim, and Eric K. Clemons

Abstract An alternative ethical model for business, based on the altruistic traditions prevalent in Japan, may function more effectively than Western business norms. Industrial civilization has relied heavily on individualistic pursuits for personal wealth enhancement. However, we are gradually becoming aware that the success of industrialization has damaged the environment, which no longer has the capacity to absorb the resulting externalities. Digital technologies are being used to exploit and to manipulate individuals for economic gain, at the expense of societal cohesion and human dignity. The exploitation of AI's potential poses its own novel challenges. Business practices based on exploiting all resources and all innovations may no longer be sustainable. The digital economy, with characteristics such as network externalities and low marginal costs, warrants a shift towards sharing. This shift could also reduce excessive resource consumption. Altruistic thinking, fundamentally based on honoring others, can extend to include respect for nature. In a finite world, an altruistic mindset, where contribution to others is the ultimate virtue, may be imperative to avoid ecological and societal collapse. In conclusion, we propose considering trust as the final frontier to be cultivated in the cyber civilization.

1 Altruism Versus Individualism: A Call for New Ways of Thinking

As problems caused by global climate change become more obvious and more severe, issues of corporate social responsibility have become more salient in the West. A sense of responsibility for others is also prevalent in Japan but perhaps with a tone not fully shared with Western industrial societies which we stereotypically refer to

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as 'the West' in this chapter. We believe an analysis of the differences may provide guidance for developing an ethical framework that may be more globally applicable in the finite world we will inhabit in the future.

We also believe that we are now in transition from the last days of an industrial civilization to a new cyber civilization in which shared use of assets can bring greater benefits than competition for exclusive ownership. Such new realities seem to require a different set of ethics. Here again, Japanese norms that emphasize altruistic behavior and trust seem to match the new realities of the emerging cyber civilization. Yamagishi et al. (1998) frame trust in the context of "social uncertainty," which is "the risk of being exploited in social interactions." Following this line of thought, this paper recognizes trust as an expectation that the trusted party will act altruistically with respect to your interests, sometimes against its own. Altruism is not synonymous with trust in the sense that one needs to create expectations in the minds of beneficiaries. Isolated altruistic behavior may not earn trust. Repeated and mutual exhibition of altruistic behavior is a necessary condition for building trust.

To present our arguments, after this introductory section, we will examine the development of modern industrial civilization under individualistic ethics. Subsequently, we will delve into the distinctions in technology and wealth generation mechanisms within the emerging cyber civilization. Traditional attempts at governing it based on industrial norms have proven inadequate, failing to meet expectations. We will then explore the management of this new civilization and consider the potential consequences of inaction. Finally, we will conclude with a summary and final emphasis on recognizing trust as cyber civilization's wealth that can be accumulated infinitely.

The authors acknowledge and caution the readers that the illustrations of Western and Japanese societies in this paper are simplistic and admittedly overgeneralized. While this tactic is adopted to deliver our message effectively, we should be mindful of the diversity that exists in various regions, even among the western nations. We also acknowledge our hidden assumptions that various ethics may function better in different civilizational contexts, as Weber et al. (2002) argued for the role of Protestantism in the development of capitalism. The adoption of this perspective in no way suggests that any culture is superior to others. It is also useful to recognize the tension between economic systems that encourage the adoption of certain ethics across borders and the resilience of domestic cultures, as Hofstede (1994) indicated. Hofstede's Cultural Dimension Theory is particularly relevant in this paper as it points out individualism-collectivism. While altruism, defined in this paper as the willingness to behave in the interest of others even at the cost of one's own, is different from collectivism in the sense that altruism does not necessarily require contributions to collective interests, it certainly includes the attitude to make sacrifices for the collective good.

Japanese children are just as selfish as other people's children. Yet they are trained to think and act altruistically, and as adults, they do so. Adults who do not follow very pervasive group norms of behavior are treated as nuisances, and the Japanese learn to act (Yamagishi et al., 2008). Arguably, such conduct can be considered as avoiding the social stigma associated with selfish behavior and can be seen as conformity,

which is a manifestation of collectivism. The distinction can be made by whether altruistic behaviors are exhibited even when opportunistic behavior is possible in the absence of observers.

To achieve genuine altruism, education is important. The questions then arise: what should we teach and how and where do we teach it? From the day humans started using tools, instincts became insufficient to manage the power of tools. We need to think hard about how to manage technology and society so that we do not self-destruct. We needed to learn to live together in communities larger than our original hunter-gather bands. Now we need to learn how to work together to achieve planetary goals, like fighting pandemics (Adedoyin & Soykan, 2023) or reversing Global Climate Change (Dwivedi et al., 2022). The industrial norm of competing for a bigger share of the benefits from resources available on the frontier, be it newly-available land or newly-available technology, is leading to the exhaustion of the earth's capability to absorb the resulting externalities. Unlimited competition is also making it impossible to manage AI; the Godfather of AI, Geoffrey Hinton, has begun advocating for more careful attention to the dangers of AI (Metz, 2023). Companies seeking competitive advantage for their AI offerings have resisted attempts to impose a moratorium on AI research (Future of Life Institute, 2023). Regulation of AI has had limited success at this time.

As an illustrative example of Japanese altruism enforced by shared norms of behavior, Japan never had a mask mandate, and yet it had the highest incidence of mask wearing of any nation. Similarly, it had never implemented forced shutdown of cities that some countries implemented, but the populace followed calls for voluntary self-restraint (Rich and Dooley, 2022). Lack of strong enforcement sometimes invited cynical comments from abroad as sign of Japanese indecisiveness. Yet, in the end, Japan had the lowest number of Covid-19 death among the G7 countries, while having the second largest population. We note that in the mask example that authorities stressed that masks do not completely protect the wearer but reduced the transmission of Covid to others. The emphasis was on protecting others, rather than themselves. The vast majority of people complied, to avoid the appearance of being anti-social if not from true altruism.

Additionally, the emphasis was on relying on voluntary compliance rather than imposing penalties. This was coupled with the avoidance of direct accusations for non-conformance to the "recommendations" beyond receiving disapproving looks. And Japan is democratic enough to allow dissenters to behave differently. This helps prevent communal conformity and altruism turning into authoritarianism or paternalism.

There is actually an explicit concept in Japan called "Meiwaku" (may-wa-ku) (Mainwaring et al., 2008). The word means the negative consequence of your actions to others and is considered the biggest sin in Japan. Children are taught to always think about the Meiwaku their actions may cause and apologize for any Meiwaku they impose on others as soon as they recognize it. At the same time, individuals are expected to forgive the Meiwaku inflicted on them by others. The capacity and benevolent attitude to forgive Meiwaku is considered a virtue. To summarize, the avoidance of Meiwaku, compensation for the Meiwaku inflicted on others, and forgiveness for

the Meiwaku imposed on you are the central pillars of Japanese ethics. There is a significant social penalty for behaving otherwise, sometimes resulting in exclusion from communities. This simple concept has led to profound differences in economic theory and in regulation.

We contrast this kind of society, with its focus on Meiwaku, with a stereotypical western society, where independence of beliefs is respected, and where freedom of actions that pushes legal boundaries is seen as contributing to the welfare of society. Harmful disregard of others is corrected more directly, by confrontation, litigation, and the imposition of legal penalties. A similar contrast between the (stereotypical) west and the east can be seen in the perceived placement of the human being in the cosmos. Whereas the west places humans either at the top or the center of the world, eastern philosophies places human as a humble part of the cosmos around us.

As such, we recommend focusing on the advantages of Asian ethics as part of the education for the next generation of leaders, because these ethical systems provide essential guidance for how we can learn to manage in a finite and constrained world, where collaboration and sharing will have to become the norm. This can be contrasted with the prevalent norms in less-constrained worlds, which appeared infinite, and where competition to monopolize the gains from the frontier provided the most rapid advancement for society. The resulting material prosperity from exploiting the frontier was seen as producing greater value for entire societies, and not just for the individuals who first exploited the frontier.

We also suggest that people of the west consider adopting altruistic ethics in managing firms and in educating business leaders. This would contribute to higher levels of corporate responsibility for a finite world that is undergoing numerous forms of stress.

2 Individualism and the Frontier Spirit in the Industrial Civilization

Kokuryo (2022) defined civilization as patterns of society consisting of (1) primary technology used to create wealth, (2) primary wealth that the people in the civilization seek to accumulate, and (3) governing institutions that realize an orderly creation of wealth and its distribution. In the context of this definition, it becomes apparent that the industrial revolution gave rise to a new civilization, distinct from that of the agricultural society. The industrial civilization required a different set of institutions to govern society, along with new ethical principles to advance the civilization. We will pay special attention to the role of ethics in shaping civilizations. Therefore, it is essential to acknowledge how the concept of individualism has played a pivotal role in driving the emergence of our modern industrial civilization. By examining this, we can analyze the distinctive nature of the new civilization and assess the need for a new ethical foundation.

Since the days of Descartes that wrote the "discourse on the method" in 1637, the core principle of modern thinking has been the assumption of the existence of autonomous minds capable of reasoning. This belief grants individuals the rights of freedom and holds them responsible for their actions. This idea has been reflected in the Enlightenment movement and continues to be influential today. It has contributed to the advancement of modern industrial civilizations, where competition for creating new value has brought significant material wealth to humanity. The benefits of modernization are unmistakable (Pinker, 2018).

The scientific revolution, the development of individualistic ethics, and the rise of a market-based free economy developed in a relatively narrow span of time in human history. They developed concurrently because they were mutually beneficial. Science opened up various frontiers for humans to explore and exploit. Individualism, which encouraged the pursuit of self-interest, motivated human beings to invest in innovative ways to exploit these new frontiers. Scientific and industrial revolutions, along with the invention of the printing press, the rise of protestant faiths that glorified work and self-advancement, and the change in national governance, contributed to social structures that facilitated economic transformation. Max Weber wrote "the Protestant Ethic and the Spirit of Capitalism" in 1905 in which he portrayed how Protestantism encouraged the pursuit of individual wealth, leading to economic expansion. The increasing power of the bourgeois in Europe likewise contributed to a change in political philosophy, including the recognition of private property rights.

Geographical frontiers were exploited initially by Portugal and Spain in the 15th and 16th, rapidly followed by the Dutch and the British. Blocked by Islamic states from trading eastward, they turned their attention to exploring and exploiting Africa and America. Initially, the profits from such exploration primarily came the vast amount of silver extracted from the American continent, creating inflationary pressures that further transformed society and weakened the power of the hereditary aristocracies. The wave of economic globalization triggered by China's open policy, following Deng Xiaoping's 1992 southern tour, shows that new economic frontiers continue to emerge.

The second frontier involves the liberation of temporal and locational constraints using fossil fuels and communications technologies. Fossil fuels not only provide more power but also make power itself mobile, giving flexibility in where firms produce and where consumers consume. The storability of fossil fuels also removes temporal constraints on power usage. Similarly, refrigeration technology has made the storage of foodstuffs easier, enabling long-distance transportation. The temporal and locational reorganization of production and distribution systems has created a new frontier for industrialists to create new value. Even the primitive communications technologies enabled by the railroad and the telegraph allowed owners and executives to control sprawling corporations, leading to massive industrialization and wealth creation in the mid to late 1880s (Chandler, 1977).

Third, there is the data frontier opened up by information technology (IT). The use of IT has significantly increased the efficiency and creativity of knowledge work, expanding the cognitive frontiers of human beings. IT has also removed temporal and locational constraints, allowing us to work from anywhere and anytime. IT has

the ability to detect patterns in seemingly random data, providing new knowledge to humans. The application of IT is rapidly expanding, providing new frontiers for industry to cultivate and exploit. But altruism is almost totally absent from modern venture capitalism and private equity. The United States is the undisputed home of IT innovation and investment in digital transformation, and wealth inequality and income inequality in the US are approaching record levels, remarkable even by the standards of wealth distribution as it emerges in the digital world (Piketty & Goldhammer, 2014). This is not surprising when one realizes how few workers today's online platforms require and how concentrated ownership is in the hands of a small number of founders and early-round investors.

In a world where frontiers exist to be exploited, the freedom to think and act in pursuit of self-interest has facilitated the harvesting of gains from these frontiers. We may refer to this as the "frontier spirit." This line of thinking has driven business education to emphasize the importance of the frontier spirit and has equipped students with tools to compete for a greater share of the gains from new lands and technologies.

The frontier spirit and the exploitation of new frontiers has contributed rapidly to economic growth, and the pursuit of growth and wealth has been the foundation of business practice and of business education. Arguably, technological frontiers may continue to exist for exploitation in the foreseeable future; Moore's law may end, but other technologies may fill the gap. The geographical frontier envelope may expand into space, and renewable energy may address energy constraints. Rapid advances in artificial intelligence technology also present endless opportunities.

However, such optimism often fails to consider the external costs associated with the exploitation of these opportunities (Coase, 1960). Malthus may yet be proven correct: food insecurity has never been greater, with 702 and 828 million people suffering food insecurity in 2021, according to an FAO report entitled "The State of Food Security and Nutrition in the World 2022". The planet's resources may indeed be finite. War, mismanagement and governmental corruption have long played roles in food insecurity, but today's famines also have a component due to climate change and the massive crop failures that have resulted in famine throughout parts of Africa. This is not unprecedented; climate change has led to migrations and to the fall of empires before; consider the fall of Rome due to draught afflicting the homelands of the Huns and their invasion of Rome or the role of climate change in the collapse of Mayan civilization in meso-America. What makes our current crises unique may be the human role in catastrophic climate change (Ceballos et al., 2017). The depletion of the Earth's capacity to absorb carbon emissions from human activities is emerging as one of the most recognized costs associated with unlimited exploitation of the Earth's resources in a finite and interconnected world. The challenge of sustaining economic growth while reducing carbon emissions remains a significant task, serving as a stark reminder that we do indeed live in a finite world.

Today's online platforms, especially social media platforms, have increased intolerance, xenophobia, and societal polarization (Ressa, 2021). Furthermore, major platform providers have incentives to create social divisions as it attracts attention, which they can monetize. We need to recognize trust in the society as vital resource to maintain social integrity. Destruction of trust should be considered a critical external cost.

Professor Jonathon Haidt, Professor of Ethical Leadership at NYU, sees the combination of resource constraints and the tribalism created by online social networks as depleting this essential and limited resource. Clemons and his colleagues at the HICSS Symposium on Social Welfare Computing in 2023 have explored the threat of the depletion of societal trust (Alt, 2022).

In the next section, we will explore the structural reasons behind the systematic destruction of the social fabric and present our solutions to address these problems.

3 Why Cyber Civilization Requires a Different Set of Ethics

The authors argue that some of the problems surrounding the digital society are caused by the failure to develop a new set of institutions and ethical norms suited for the new cyber civilization. This civilization operates under different wealth generation mechanisms, and its technology requires a new set of institutions and ethics. As agricultural civilization was taken over by the industrial, the industrial civilization is now being taken over by the cyber. Rules and ethics that were originally developed for the industrial civilization have proven inadequate in addressing these new realities, resulting in serious confusion. Let us explain why such discrepancies are occurring and how they are causing contemporary problems.

Intangible information possesses economic qualities that are fundamentally different from tangible industrial products; the greatest differences are immediate and almost cost-free duplication and distribution, increasing the importance of economies of scale. Moreover, network effects increase the value of a communications network as the number of users increases, once again leading to economic benefits derived from scale (Shapiro & Varian, 1999). Platform envelopment strategies increase the value of platforms offering larger numbers of integrated applications (Clemons, 2018). All three lead to winner-take-all domination, with normal operation of the market unable to limit monopoly power. Information can also be used to provide accurate and well-designed manipulation of individual consumers, or to construct disinformation and fake news campaigns for well-designed manipulation of entire societies. Consequently, the application of individualistic rules and ethics designed for the industrial economy is insufficient in governing the cyber world effectively. A significant example of this mismatch is the recent panic surrounding copyright issues for creative works studied and modified by artificial intelligence (AI). The existing intellectual property rights system, which attempts to mimic the logic of market exchange of ownership, fails to govern creative works that are generated by machines. As importantly, they fail to acknowledge the increasing importance of creative reuse of protected artistic works. Attempts to address these regulatory gaps have been unsuccessful, leading to considerations of outright banning some uses of technology.

At a higher level of abstraction, two qualities contribute to this mismatch between technology and the rules governing its use. Firstly, information-based business models scale, because of the preponderance of fixed costs and the near absence

of marginal costs, because of network effects, and because of platform envelopment, leading repeatedly to monopoly control of vital infrastructure. And yet, there are reasons why society may wish to be cautious in its attempts to limit the use of information, just as society needed to permit monopoly control over early telephony in order to achieve network connectivity. Information gains meaning when it is placed in context. A single piece of information may have very little value until it is placed in context, with other information on the same individuals, with information on other individuals, or both. AI is powerful because it excels at identifying relationships among seemingly random collections of information. Therefore, while an individual piece of health data may not hold significant value on its own, its addition to a large collection can have groundbreaking implications. Just as excessive restrictions would have limited the value from early telephone systems, excessive restrictions may limit the effectiveness of health research and other forms of social planning that require large data sets.

Although barriers to entry for software-based businesses initially appear quite low, most platform-based businesses exhibit winner-take all characteristics. Despite apparent ease of entry, these businesses are not contestable (Baumol et al., 1982). Network effects and positive externalities make large platforms like X more valuable than smaller platforms. Economies of scope and the broadest coverage of products or services add value to platforms like Amazon. High fixed costs and negligible marginal or per-copy costs benefit platforms with the largest number of users. Super-additive value contribution from each app added, along with the ability to exclude some participants, enables platform envelopment strategies, which contributed to Microsoft's dominance of the desk-top and Android and Apple's dominance of mobile devices. Wealth inequality in the west is reaching levels that destabilize societies.

Social networks are replacing traditional news media as sources of information, and even traditional broadcast media become more extreme and less balanced, contributing to extreme polarization of society. Social media platforms benefits from user engagement, which is enhanced by playing to users' emotions, and thus they have incentives to embrace emotionally extreme content as its most profitable strategy. This, too, contributes to xenophobia, sub-group self-identification, fear of others, and extreme societal polarization. Combined with an increase in wealth inequality within societies, and increased pressures from various forms of migration, the strains on western nations may be unsustainable.

Recognizing the threats from large platforms does not imply Luddite-like rejection of all technology. But it does suggest that there are areas where greater regulation is essential. Not every problem can be anticipated, and thus some problems cannot be solved by regulation. This is why a change in management focus and in business education, to embrace ethical leadership and altruism, may be essential (Giacalone et al., 2006).

4 Governance of the Cyber Civilization

An emphasis on collective benefits available from shared data has the potential danger of promoting totalitarianism, paternalism, authoritarianism, or some combination of them. This caution is particularly relevant today when considering certain countries where the state assumes the role of a trustworthy owner, user, and regulator of all data. In some ways, this model has proven to be effective in developing AI that requires access to such data. A benevolent government may be able to use such power to the benefit of the people. The same can be said about big commercial platforms. The accumulation of data undeniably has the power to deliver social good. At the same time, we should wisely fear such assumptions of benevolence of concentrated power, as history teaches us that excessive power can become oppressive, and possession of data is a powerful means to become oppressive.

How can we develop a set of ethics that safeguards individuals' dignity while promoting the shared use of data? How can we design social and technical systems that support these ethical standards? And how can business education advance these goals? To provide a roadmap for changing the behavior of western executives and for changing the educational systems in the West to encourage these changes, we need to start by examining and then classifying the sort of problems we see in the West.

Recognition of Externalities and Imposition of Costs on Others

Incorporating externalities must begin with acknowledging their existence. However, today's corporate systems, which incentivize executives to reduce costs in order to boost profits, systematically encourage avoiding acknowledging the external costs inflicted upon society by these firms. Tobacco companies denied that cigarettes caused lung cancer. Oil industry think tanks are fighting studies that argue that fossil fuels are associated with climate change. Automobile companies and big oil companies forged its environmental impact lab studies and resisted regulation, even when they knew just how dangerous climate change could be (McCarthy, 2023). Short term orientation of management is another problem. Western CEOs are asked to manage quarterly returns, rather than to carefully consider and develop long term strategies. Consequently, rail companies fight to reduce required levels of crew staffing and use profits to reward shareholders rather than invest in safety. Corporate legal practices likewise do not appear to be designed to help limit harmful externalities contribute. Acknowledging the harm one has done—even unintentionally, through what were at the time standard business practices—can result in substantial and punitive financial penalties.

This is not to suggest that Japanese firms do not have similar tendencies. It is clear that the designers of the Fukushima Daiichi nuclear power plants deliberately underestimated the "inconvenient" possibility of a large tsunami overwhelming their

safety mechanisms. However, Japan does, in general, take a broader view of stakeholders based on the cultural ethics of altruism, and does take a longer term and more balanced view of strategy and strategic objectives.

ESG (Environmental, Social, and Governance) investment seeks to influence executive behavior through market forces by incorporating a multi-stakeholder perspective on the investor's side. With an increasing proportion of pension funds and government funds becoming investors, we anticipate that this approach will be an effective means of driving change. However, these funds ultimately seek financial returns. Therefore, unless we can develop effective methodologies to improve firm profitability while reducing externalities, executives will continue to face the challenge of balancing profitability and social responsibility. This will remain true as long the firm does not have to treat externalities as true costs.

Recognition of What Regulatory Measures Can and Cannot Do

While we would like to see the private sector's voluntary adoption of altruistic manners, forceful intervention may be necessary initially. Similarly, we would like to develop business models in which corporations and countries are rewarded for virtuous behavior, rather than being penalized for their abuses, but here again we may need to intervene when the market mechanisms fail to motivate firms to act in that direction.

Firms resist change imposed from the outside, especially change that reduces the scope and the profitability of their business models. Microsoft exploited platform envelopment strategies until forced by the US Department of Justice to make Windows more accessible to competing software developers, and Google benefitted from platform externalities until the EU Competition Commission imposed a multi-billion euro fine for abusing Android's power and abusing the power of the Mobile Application Distribution Agreement (Chan, 2022). Legal action and regulatory intervention clearly have begun. On the environment front, the EU is contemplating an environmental impact tax on goods from countries that represent extreme sources of CO_2 emissions and has already implemented restrictions on imports of goods associated with deforestation (Angel, 2021).

Regulators need to consider the various forms of externalities. Since they are numerous, and since there are as many forms of externalities as there are third parties that can be affected by a firm's actions, it is helpful to look at them systematically. First, of course, there are externalities like pollution, or the destruction of a neighborhood's social cohesion and essential character when residential units are converted to short-term Airbnb rentals; these affect individuals and communities that are neither customers nor competitors and would appear to have no contact with the company that is affecting them. Clearly, markets do not incorporate their opinions or their interests; the effects on them are the clearest examples of an externality.

Next, there are externalities that affect direct competitors of the service that the online companies are providing. Taxi owners are often destroyed by the introduction of Uber services into a community and hotels may be unable to compete with Airbnb rentals; this is not to say that these externalities should be prevented by banning on the online competition, or even to suggest that those harmed are entitled to compensation; for completeness, we need to be aware of these forms of externalities. Moreover, online platforms exhibit enormous economies of scale, and benefit from network effects and from platform envelopment strategies. They develop enormous monopoly power, which they can use to damage competitors and users alike (Clemons, 2019). Even near-monopolies like online gateways can evolve into mandatory participation third party payer systems (Clemons, 2019) again, damaging both competitors and users. There are other parties that benefit from the status quo before the introduction of platforms; local city and state governments needed the sales tax revenues from small businesses, and sales taxes are now collected by large online platforms like Amazon and distributed to the relevant local governments; again, we are not suggesting that this is good or bad, merely noting the range of possibilities when considering externalities.

Thirdly, regulators need to consider privacy protection. Violating privacy is not without cost to or harm to individuals. Even if there is no obvious fiduciary responsibility to safeguard privacy, as Kokuryo notes, there should be. We should protect people's privacy. It is important to recognize that privacy is not solely about safeguarding personal information. It is about preserving the dignity of individuals. This distinction is crucial because it is increasingly difficult and impractical to have complete control over one's own data. Eventually, individuals have to rely on institutions to hold and manage their data. Therefore, in the context of this paper, it is important to urge the trustee to assume fiduciary responsibility for managing the data in the best interest of the rightful owner. Criteria for regulating targeted marketing, for example, should be based on how well marketers uphold their fiduciary responsibility towards consumers. Ultimately, consumers desire to access information that is relevant to their needs. They simply do not want to be deceived into obtaining it.

Finally, there are externalities that affect the customers who use the platforms. Users of online platforms are subject to continuous monitoring as part of their transactions, and indeed this surveillance is considered "the cost" of using platforms; indeed, we are often told that we are paying for these "free" services with our data. Paying with data sounds harmless enough, but it is not how we pay for these services, since this data often has little value as an abstraction. This data is used to create detailed individual profiles, which can then be used to influence what we see, what we read, what we believe, what we buy, and how we vote. We are not paying by surrendering our data; we are paying by surrendering our agency, our free will, and right to choose for ourselves, and our essential human dignity, as described by various authors. (Alt, 2022; Clemons et al., 2022; Trzaskowski, 2021, 2022).

Regulations for reasons mentioned above seem inevitable in view of the platform providers' interest to manipulate and exploit users. Social media seek to maximize revenues which is achieved by sensational stories that maximize engagement. Platforms that sell products benefit by manipulating what we buy. Kokuryo (2022)

advocates for a stronger focus on the fiduciary responsibilities of platform providers towards the providers of data, but at present there is no fiduciary responsibility to protect parties affected by externalities because, of course, impacts on them do not directly affect the revenues of the company. However, as noted above, when platforms contribute to fueling and manipulating divisions, this undermines democratic society.

Regulatory measures are beneficial because they establish boundaries for permissible actions. However, we cannot anticipate all opportunities for abuse. Incentives should not encourage businesses or individuals to be economically selfish and to impose externalities within these new boundaries when regulatory gaps emerge. The Japanese experience suggests that it is indeed possible to create a world where people voluntarily adhere to norms of altruism and where tolerance is extended to those who have acceptable reasons for not being able to fully comply with the rules. Additionally, leveraging technology to promote altruistic behavior may be achievable.

Systems to Reward Altruistic Behavior

Recognizing the harsh realities we have portrayed so far in this section; we can also offer hope. In other words, some opportunities for abuse can be prevented through innovative uses of technology. An intriguing example is the Mebuku-ID initiative in Japan, which utilizes distributed identity to achieve "self-sovereign identity" (Allen, 2016). This allows individuals to selectively disclose their attributes to specific entities while retaining strong power to revoke access rights to their data. In in addition to such self-sovereign mechanism to protect privacy, there are technologies such as non-fungible tokens (NFTs), that can function as evidence of individuals' contribution to the society. Digital tokens as exemplified by NFTs can work as badges of honor that can be stored in distributed and user controlled digital wallets. Similar to collecting badges of honor, individuals can credibly present their NFTs as evidence of their achievements at their will. Self-sovereign identity and digital tokens combined can create a society in which privacy is protected while strong incentives are provided for making voluntary and altruistic contribution to the society.

Kokuryo (2022) portrays a world known as the "potluck economy," where individuals' contributions to society are recognized and rewarded societally. This stands in contrast to an industrial civilization market economy, where individuals exchange goods with one another, using money as both a measure of value and a form of storing value from exchange for use in future exchanges. Legal frameworks of ownership play a vital role in establishing this market economy. In a cyber civilization, the primary goal is to bring data and other assets together to create positive externalities and then to distribute its benefits fairly. The cyber civilization economic system could ultimately be one in which individuals altruistically share data with society while respecting the dignity of others and are rewarded for their contributions.

Table 1 Cyber civilization and industrial civilization

	Cyber civilization	Industrial civilization
Source of value	Network externality of data	Exploitation of frontier resources
Norm	Sharing	Competition
External cost	Violation of individual's dignity Destruction of trust	Depletion of natural resources Environment
Currency	Tokens of appreciation (often with granting of access rights to specific services)	Money (medium for exchange)
Governance	Community	Market

We can envision a potluck economy in which tokens (badges) of appreciation that provide access rights to specific services (Table 1). We may characterize that as an economy in which "trust" becomes the currency. Entities that build their reputation will receive greater access to user data for creating new value. While a significant portion of the profits from network externalities should be returned to society as dividends, corporate executives should receive fair compensation for building trust. Recent efforts in ESG reporting can be helpful in assessing the contributions of corporate executives to building trust in society. NFTs can be utilized by society to vote on the altruistic behavior of firms. We can and should strive for a world where corporations are rewarded for generating positive externality and penalized for imposing negative externalities.

Education

Governance is not only about developing technologies and creating laws, but also about educating people to behave ethically. What are the implications of the above analyses for the education of business leaders and managers? Given the limited efficacy of regulatory measures we discussed above, it is imperative that we provide a sound education to our business leaders. Business schools primarily teach how to compete, and competition is beneficial as long as the actions taken do not impose external costs on others.

Thus, the motivation to update our business curriculum is not just to train more responsible corporate citizens. It should also include designing companies that prosper when they meet altruistic standards. We have been looking into this topic in "Social Welfare Computing" for large online platforms. We know that in a finite and interconnected world, simple pursuit of profits can result in large negative externalities, which harm individuals as the global environment. Corporate actions need to consider the welfare of the planetary ecosystem, and not just customers and shareholders. Fortunately, two centuries of economics and three decades of research in

strategic use of information systems provides guidance on omissions in current strategy formulation (Alt, 2022; Rowe & Markus, 2022) first, we make sure that strategy is at least informed by the broadest set of stakeholders.

At a higher level, we should learn to design our socio-technical systems with a much broader perspective, cutting across the traditional boundaries of knowledge. Whether we call this Design Science, Corporate Social Responsibility, or Social Welfare Computing, we are learning how to design strategy and operations to include benefits to the broadest set of stakeholders once we have identified the appropriate set of stakeholders. It is not easy; indeed, it is a "wicked problem," with competing objectives, objectives that we may not know how to specify completely, and that we may not know how to balance against each other. The problems will exhibit strategic ambiguity, in that we may not be able to specify future environments completely, or to assess the implications of our actions. But we are learning how to plan in the presence of strategic ambiguity.

We are likely discussing the development of a curriculum for a 'system architect' in a broader sense of the term. This broad interpretation encompasses architects who can address problems by designing technological, economic, and institutional systems simultaneously. Achieving this requires not only knowledge in each subject but also expertise in orchestrating synergistic integrated systems. Such integrative capability is as much an art as it is science, and it can be acquired through both real-world and simulated experiences. To nurture these artistic capabilities, we must create cases, games, and other tools that enable our students to gain hands-on experience in designing solutions that integrate technology, the economy, and governance systems.

5 Trust as the Final Frontier

In this paper, we discuss how different civilizations fueled by distinct sets of technologies and economic systems may require varying sets of ethics to effectively promote wealth generation while providing adequate governance. We review how individualism aligns with industrial civilizations that rely on opening new markets and exploiting resources from the frontier. We then analyze how altruism may be a more suitable principle in cyber civilizations that prosper through sharing assets. Additionally, we discuss how altruism may work better in sustaining our finite environment, which bears the external costs imposed by the industrial system.

In conclusion, we propose considering trust as the final frontier to be cultivated in the cyber civilization and altruism as the key ethic to create trust. Unlike material goods, nurturing trust does not incur negative external costs. Trust can be produced and developed organically by continued practice of altruism, without depleting either physical resources or societal cohesion. Its absence severely limits the use of information technology, regardless of its power. And yet its accumulation can improve the efficiency of the economic systems drastically by reducing transaction costs and security costs.

Naturally, we should not be naive in thinking that people are inherently good. There are individuals with self-serving goals, and free riders will inevitably emerge. The temptation to abuse trust is real, but beyond a certain level of masquerading as trustworthy trust collapses. Fortunately, we are now equipped with better tools to accurately recognize altruistic behavior, such as the discussed use of NFTs issued within local communities. Instead of relying on a central authority keeping records of wrongdoings, individuals can hold tokens of appreciation given to them in their electronic wallets.

In a finite world, actions that harm others will eventually come back to harm oneself, if only indirectly, via the mechanisms of the Tragedy of the Commons. Similarly, acts of goodness will come back to benefit us, in the form of a sustainable world we can all enjoy. Let's strive to fill the world with altruism that respects the dignity of each individual. We have argued that competition is effective on the frontier. If trust is the final frontier, perhaps we can reintroduce the concept of competition altruistic behavior to foster greater trust.

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Emerging Forms of Leading and Context Curation in Agile Organizing

Aristotelis Alexopoulos, Nikolaos Mylonopoulos, and Mary Skordia

Abstract Agile forms of organizing are emerging to meet the imperative of organizational adaptation as the external environment is subject to broader social, economic, demographic, and cultural changes. In this chapter, we concentrate on a case study of agile transformation to explore the role of leadership in agile organizing. We find evidence of the changing role of leadership in current flat, collaborative working environments, and follow a move from *leadership* to *leading* as a way to shift the focus from the person or position to the essential characteristics of the practice of leading in such contexts. Our findings support and expand prior views regarding the plurality and the sense-giving character of leadership in agile organizations by pointing to its paradoxical nature. We contribute to this discussion by proposing context curation as an essential role of leading in agile organizing, defined as the ongoing care for sustaining over time the vitality of organizational conditions enabling the agile principle of constant adaptation. In doing so, we address the expressed call to reverse the lenses in contextual/contingency leadership theories.

1 Introduction

During volatile times, the ability to adapt is a priority for organizational survival and success (Birkinshaw & Ridderstrale, 2017). Traditional multi-layered hierarchies cannot support the demands for such flexibility, as they are characterized by formalized procedures, top-down communication, silos, and the command-and-control approach to managing (Girod et al., 2023). Agile management, in its varied

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guises, is enabling organizations to keep pace with and take advantage of today's environment (Singh et al., 2013). Despite the proliferation of studies on agile management, leadership in agile organizing has attracted comparatively less attention and only relatively recently (Annosi & Lanzolla, 2023). If organizational forms are so radically different in agile contexts, how do leaders' roles change?

This chapter contributes to the literature on the shifting role of leadership in agile organizations by examining the agile transformation of a traditional hierarchical company. Specifically, we take the standpoint of those in formal leadership positions and focus on the practical manifestation of leadership roles. In the following sections, we start with a review of the literature on agile organizing and leadership. After briefly describing our empirical context, we present our findings, confirming prior research regarding plural forms and the sense-giving role of leadership in agile environments. Further, we build on the concept of contextual leadership to propose the notion of leading as curation, a term pointing to the leaders' role in deliberately and proactively adjusting the elements of organizational context in which members can thrive in the pursuit of adaptation.

2 Agile Organizing

Agile methodologies, rooted in innovative industrial practices (Brown & Agnew, 1982), have been developed for and widely used in software development projects, ever since the Agile Manifesto (Beck et al., 2001), and predominantly focused on that practice for a long time (Dingsøyr et al., 2012). Agility in mainstream management theory and practice has met growing interest during the last decade, especially after the Doz and Kosonen (2008) article on strategic agility. Furthermore, despite being initially applicable to small numbers of project teams, agile approaches are increasingly implemented at scale within large organizations (Rigby et al., 2018).

Organizational agility is the capability of the unit "to capitalize on emergent opportunities or avoid emergent threats under constrained or unfolding time frames" (Salmela et al., 2022, p. 1083), notably by exploiting information and communication technologies. Approaches to agile management relate to two main domains. First, in the technology domain where the agility literature further splits in two streams. In the first stream (Diegmann et al., 2018), research in the information systems development field ranges from technical aspects (Balijepally et al., 2009) to sociological or psychological factors (Maruping et al., 2015), and from the individual to the organizational level (Zheng et al., 2011). In the second stream, the central question for digitally-enabled organizational agility concerns the ability of the organization to deploy and/or adapt its technological investments according to the changing external environment (Tallon et al., 2019).

Second, in the strategy domain, agility is conceptualized as the company's "constant ability to effectively change its course of action to sustain its competitive advantages" (Weber & Tarba, 2014, p. 6), or the capacity to continuously adjust the strategic direction of core business to create value for the company (Doz & Kosonen, 2008).

Strategic agility is a deliberate interplay between three meta-capabilities: strategic sensitivity, leadership unity, and resource fluidity (Doz & Kosonen, 2010). Dynamic capabilities, the routines by which organizations reconfigure their resources in response to environmental change (Eisenhardt & Martin, 2000), connect the strategic with the operational level and establish commonalities with the agile management literature. Dynamic capabilities include (a) sensing capabilities, for the identification of opportunities and threats, (b) seizing capabilities, for the mobilization of internal resources, and (c) transforming or shifting capabilities for continued renewal (Teece et al., 2016).

Research on strategic agility has proliferated to address issues in both agile transformation (Beretta & Smith, 2023), and agile strategy formulation and implementation (Morton, 2023). Further, research has emerged in fields as diverse as entrepreneurship (Xing et al., 2020), human resources (Ahammad et al., 2020), multinational enterprises (Fourne et al., 2014), mergers and acquisitions (Brueller et al., 2014), and investments (Cumming et al., 2020), among others.

We approach agility at the level of the organization as a system (Glaser & Halliday, 1980), connecting the strategic, the functional and the operational levels (Greineder et al., 2020). By following a leadership-as-practice approach (Raelin, 2023), we focus on the day-to-day lived experiences of those in formal leadership positions in an agile organization. Given the foundational differences between the hierarchical command-and-control and the agile organization, our central research question is: How is leading manifested in agile organizing? What is the role of leaders?

3 Agile Leading

A number of different leadership styles have been proposed as fitting to the agile environment (Greineder & Leicht, 2020), with servant leadership appearing as the most commonly referenced in both academic (Holtzhausen & de Klerk, 2018) and practitioner (Belling, 2020) sources. Furthermore, transactional, transformational (Weichbrodt et al., 2022), shared, emergent and visionary leadership, as well as situational, e-leadership, complexity and distributed leadership (de la Barra et al., 2015) have also been studied in this context. Members of an agile team tend to experience flexible leadership styles, with more frequent being the democratic, affiliative, visionary and coaching styles (Gutierrez et al., 2022). Managers in such environments become enablers of informal network dynamics, design good working conditions fostering employee motivation, implement enabling leadership, and act as change agents (Theobald et al., 2020).

However, leading in agile organizing confronts inherent paradoxes. Firstly, if leadership is generally conceived of as the source of decisions, then what should it look like in an agile environment which is intended to be self-organizing (Spiegler et al., 2021) with a significant degree of discretion to team members? Scrum masters facilitating self-organization at the team level (Hoda et al., 2010), are characterized by

servant leadership, defined as "an (1) other-oriented approach to leadership, (2) manifested through one-on-one prioritizing of follower individual needs and interests, and (3) outward reorienting of leader concern for self towards concern for others" (Eva et al., 2019, p. 114). Nonetheless, a servant leadership style alone may not always suffice given the high individual autonomy, low level of trust, and the absence of shared mental models which sometimes persist (Moe et al., 2010). In response, and depending on the particular circumstances, rotational leadership (Srivastava & Jain, 2017) may alleviate some of the difficulties (Carson et al., 2007) of leading self-organizing teams (Manz & Sims, 1987). More broadly, a contingency approach to distributed leadership (Gren et al., 2017) acknowledges the paradox that directive leadership (toward immature teams) may co-exist with leadership promoting self-organization (for mature teams). A more controlling style may be appropriate "when there is a need for speedy performance, cost control, and to avoid scope creep" (Fischer & Charef, 2021; p. 22).

In line with complexity leadership theory (Uhl-Bien & Arena, 2018), agile leaders respond to these paradoxes by being present, observing, and reacting in the moment. For example, agile coaches at Spotify practice enabling leadership by increasing the context-sensitivity of others, supporting other leaders, reinforcing simple principles, observing group dynamics, surfacing conflict, and encouraging constructive dialogue (Backlander, 2019).

A second set of paradoxes arises when the focus shifts from the single team to agile at scale (Rigby et al., 2020). C-level executives lead organizations which are typically only partly agile, while top management teams are not necessarily agile themselves as they tend to follow a functional structure. Furthermore, in agile organizations such as those exemplified by ING (Calnan & Rozen, 2019), formal leadership responsibilities are distributed in distinctive ways. For example, unlike the traditional hierarchy where middle managers are responsible for both people and business performance, in agile management contexts Tribe leaders are accountable for business performance without people responsibility, while Chapter leaders oversee people performance without direct responsibility for business performance. In such an environment, leaders must seek a balance between their fiduciary duty (including, for example, control and compliance) and enabling self-organization. In doing so, they enact sometimes contradictory roles: from running the agile operating system to overseeing business functions, and from serving as mentors to intervening in moments of crisis. This requires humility, a shared sense of purpose, and the capacity for continuous learning. The primary role of an agile leader is to create an environment empowering everyone to take the initiative as a problem solver (Hill, 2020).

Five paradoxical leadership practices in agile organizations have been proposed (Lewis et al., 2014): (a) valuing paradoxes as a vital ingredient of high performance, (b) proactively identifying and raising tensions, (c) avoiding traps of anxiety and defensiveness, (d) consistently communicating a both/and vision, and (e) separating efforts to focus on both sides of a paradox. Further, Annosi and Lanzolla (2023) point out the dual role of line managers in agile transformation as both "missionaries" and "priests" and their role in orchestrating both the autonomy and alignment of teams.

By acknowledging the central role of paradox in agile leading, our empirical research seeks to identify how leading is manifested when holding paradoxical tensions in different positions in the organization. For example, what are the differences between leading within a single team versus aligning multiple teams across the organization? To this end, we widen the theoretical lens of our investigation beyond servant leadership, to consider plural forms of leadership, leading as sense-giving, and leading as context curation.

4 The Case

We follow the single case research method (Siggelkow, 2007) at Interamerican, one of the oldest and most reputable insurers in Greece with more than 1000 employees, offering a full range of insurance services. Despite the company's financial success, its leadership sensed the volatile nature of the external environment, and in 2018 embarked on an ambitious initiative applying agile and lean principles, partly inspired by the case of agile transformation at ING Bank (Calnan & Rozen, 2019). The goals of this multi-year transformation emphasized transitioning from a mechanistic to a living organization, flattening the hierarchy, and accelerating digitization. For the agile part of the organization, they adopted the lexicon of agile (Conboy, 2009), redesigned all roles, and standardized to a small number of job descriptions.

This research involved 14 interviews between November 2022 and September 2023 mainly with leaders from the top and middle hierarchical levels (C-level, Tribe leaders, Chapter leaders, and others), virtual focus groups, and access to documents. All three authors were present in all interviews and focus groups, which were conducted online, recorded, transcribed, and subsequently analyzed.

5 Leading Within Agile Organizing

Reflecting the multiplicity of meanings, as well as the dynamic nature of leading in agile organizing, we favor the verb lead in its gerund form (*leading)* instead of the noun *leadership* (Hosking, 1988). This is consistent with calls in the literature for the use of the term "leading within" as a "break with conventions of the past sensemaking", describing the emergence of distributed leading, aided by digital technologies and based on networked systems of social relations (Clegg et al., 2023, p. 396). While analyzing our empirical evidence, we sought to recognize forms of leading that are well understood in the literature. Specifically, we have been able to organize our material in two main frames, namely plural forms of leadership and leading as sense-giving. However, we also found evidence of a crucial role of leading that points to a reversal of the logic of contextual leadership. Therefore, we adopt a third frame, the notion of *leading as context curation* to describe this role. These three frames do

not exhaust the manifestations of leading in agile organizations, while they overlap and interact with each other, as well as with other theoretical lenses in the literature.

Plural Forms of Leading

Plural forms of leadership is a broad prescriptive concept encompassing post-heroic approaches to leading (Fletcher, 2004), including shared, distributed, collective, collaborative, integrative, and relational leadership (Denis et al., 2012). Plural forms of leadership are associated with the knowledge-based economy, where power, authority and legitimacy are structurally diffused across groups controlling critical expertise. At Interamerican, we observed plural leadership within and across teams.

First, leadership is shared among members within a team. A Chapter Leader aptly remarked:

> The product owner is an equal member, it is just a role, in the team. [But] the product owner can set the [team] priorities and what the team will do the next two weeks. A little CEO, let's put it this way, within the team. [They are] equal in power with the rest of the team members and in very close cooperation with the tribe leader.

The top management of the company deliberately makes space for such distributed leaders, as an HR Advisor put it:

> We really want the leaders to have a very active role in all of this. We are here to do the advisory part, the coaching.

Incidentally, role transitions are easier in the absence of silos, and this enables the mobilization of individuals on the basis of their skills and competencies. For example,

> [as an HR professional] I will probably get involved with my old agile coach hat, to be able to help the team overcome the problem. But I will facilitate it. That is, I will not solve it. The teams are autonomous and are responsible for their continuous improvement. What the tribe leader can also do, is to go to them ... in order not to lose focus, and make it even more precise what is expected from them.

Second, a similar adaptive way of thinking applies across teams:

> [in the retro meetings] representatives of the teams, come and share problems that the team faces. So, they escalate and either solve [the problems] together with the [other teams], or, because they report to the tribe leader, he/she can take some specific actions to help. He/she will address them, or the chapter leader will, or they will come to me as an agile coach. (HR Professional)

At the enterprise level, the demands for alignment are more acute and the complexity is greater, because of the number of people and teams. One example is the strategy-making process which works largely bottom-up. As the Enterprise Portfolio Coordinator explains:

> Another good thing about the governance is that it is not top down; even in the creation of the business plan, it is done at the […] tribe level where the tribe leader comes together with the product owners and the teams to do a brainstorming and say, OK, we want to go in this direction, let's see together what initiatives to start.

Top management sets the strategic priorities, initiatives emerge bottom-up, and then collectively teams populate their plans while resolving dependencies through a fully transparent process. Leading in this context is challenging for the C-level executives who are expected to uphold the shared leadership culture and set an example. The CEO explains:

> There is a difference between helping the process toward a conclusion without dominating or monopolizing the conversation. It's a thin line to provide guidance without forcing the decision. [The decision] is not the most important thing. [We do not want] everybody to say their opinion and then ask [the CEO] what to do. On the other hand, neither do we want to keep going round and round.

Plural forms of leading in the agile setting appear in paradoxical ways. At the within-team domain, leading means being both "a little CEO" and "just a role", as well as "having an active role" while letting members decide by themselves. At the between-teams ground, leading takes the form of setting strategic priorities and letting go (at least some) of the authority vested in leadership positions in order to model a culture of autonomy and collaboration. Finally, at the organizational level, leading balances between imposing decisions top-down and being trapped in paralyzing discussions.

Sense-Giving

In ambiguous situations such as change processes, leader sense-giving (helping others construct meaning; Gioia & Chittipeddi, 1991) is an important leadership task (Kraft et al., 2016). Sense-making is a social process within organizations (Weick et al., 2005) and leaders have the privilege and duty to influence their followers' sense-making through their own sense-giving (Maitlis & Lawrence, 2007). We identified two areas where leaders' sense-giving is evident.

First, the practice of leading can yield results without formal authority. As the Interamerican COO explains,

> It doesn't mean that you will have a [formal] leadership position, but you will have a position in which you can make an impact". Or, in the words of a Chapter leader, "If there is one thing a leader must do, it is to be needed less – […] to create the environment where people can do their own work.

Enabling and facilitating, regardless of the official title or position held, is a core part of leading, as the Enterprise Portfolio Coordinator describes:

> "We are close [to the team members] but we are not like auditors, we monitor things but we have a different purpose: to help them unblock [their problems] to do their job better". The

> same thinking is echoed across the organization: "What I circle back to is the deep dive into people management, into coaching, into helping people grow without telling them what to do. Clearly leadership styles adapt somewhat depending on who you have in front of you. If it's a junior person who needs direction and guidance, of course you would adopt a different leadership style. Generally though, I prefer to help people develop, to give them the tools they need, the space they need and to be there whenever they need me".

Second, leading involves sense-giving to help members come to terms with what it means for them to exercise initiative. A Tribe Leader explains:

> Now, I have the responsibility for a large [number of] teams, but none of these people reports to me. Not one! They are all in chapters with chapter leaders and I am just there, in an environment that, if we go deep into [technical matters], I do not even fully comprehend. So, you have experts there and they know the system. You personally are in unchartered waters.

This issue presents a double challenge for the agile leader: help members shape expectations from leaders in agile organizations while, at the same time, revise the meaning of leadership for themselves. Another paradox in need of sense-giving is that autonomy relies on discipline:

> The new work model has a lot of discipline. It can be flexible, but it takes discipline (HR Director).

Further, becoming an agile organization is a never-ending pursuit for leaders:

> We need to think about which jobs do not belong to this team or might be automated. Such discussions are currently taking place but we always try to fine-tune the framework without redesigning the whole world. (Chapter leader)

As part of their sense-giving role, leaders have to come to terms with the new meaning of agile leading (e.g., having to lead without a formal leadership position, or holding a leadership position without directive authority over autonomous teams) while, at the same time, supporting their followers internalize the new meaning of agile leading (e.g., what it means for a team to have a leader without specialist expertise).

Context Curation

The notion that leadership does not occur in a void has its roots in Fiedler (1978) who suggested that organizational outcomes are a result of the balance between a leader's characteristics and situational factors (Levy & Lowe, 2023). Contextual leadership "examines whether situational factors lessen or enhance the impact of leadership practices and explores how leadership takes place in specific contextual settings" (Oc, 2018, p. 218). Addressing calls for "reversing the lens", we propose a reverse approach treating the leader as the shaper of the context, in what Oc (2018) defines as the "reciprocal effect of leadership on context" (p. 232). Based on the Interamerican evidence, we suggest that part of the role of leading in an agile system is to deliberately, proactively, and continuously adjust the organizational context in

order to sustain the collective capacity to self-correct, continuously improve, and adapt.

Context curation in agile organizing starts with leaders themselves. As an HR Professional describes it,

> Our main concern is, always, to establish the framework, the principles, and […] coach the leaders to support this whole framework.

This logic is self-evidently built into the retrospectives where members reflect on how they organize and work to take corrective action. However, retrospectives are effective because they take place within a context of given norms and principles. A Tribe Leader elaborates:

> If you do not have a clear and well-structured strategy, the teams can get easily lost. But when you do have [such a strategy] it is a lot easier for people to build on that better than you would have done on your own. So, this battle, this struggle, this tension is actually helpful. The balance between autonomy and [sticking with the] rituals sets a framework. This is very important. Wherever we do not have a framework, we have a problem.

A critical element of leading in an agile organization is this second-order reflection on, and dynamic curation of, the broader taken-for-granted context. In this framework, servant leaders assume a broader role:

> "My role is to function as a servant leader, i.e. to function as the person who will provide direction for the teams to achieve our goal, as defined by the business plan." (Tribe leader). In the words of another Tribe Leader: "Our role is more to give [an] orientation and help the teams."

Or, the way a Chapter Leader, puts it:

> Within the teams, we are not auditors; we are facilitators.

The next ability of leaders as context curators is judging when and how to act. A Chapter Leader identifies the relevant interpretative frame, pinpoints the timing, and enumerates potential improvements:

> What needs to happen though, because if we want to call ourselves an agile organization, we need to inspect and adapt. So, after 3.5 years working on this model we need to make adjustments based on our findings about what is not working well. We need to revisit certain basic things that have been violated. We need to see how we eliminate the silos within the squads. Certainly, we need to become more customer-centric than product-centric.

The HR Director offers the big picture of agile organizing as a never-ending pursuit demanding vigilance:

> Because this design was done 2–3 years ago, we are now putting together another team to implement 'transformation version 2', which is fine-tuning. Therefore, it is a living model, a live organism that doesn't stick to the initial design but continuously evolves depending on emerging needs.

Finally, during day-to-day operations, the most important task for a leader is to create the conditions wherein members can apply agility in practice:

> You have to find the ways to create the conditions for them to work undistracted. It has nothing to do with you and your expertise. It is about you creating the conditions. (Tribe Leader)

Leading in agile environments acquires a more dynamic essence, as a Tribe Leader describes:

> I know from above that it is coming. I will never tell my team before we complete the bottom-up. This needs fermentation. Because I know from above what is in front of us, team members say their ideas from below, somewhere in the middle I come and converge the above with the below.

The agile leader has to continuously follow external changes and internal developments to provide members with the best conditions (the resources and the work climate) to, simply, do their job.

6 Implications for Practice and Future Research

This chapter proposes an integrated perspective for agile leading based on three frames: plural leadership, sense giving and context curation. Notwithstanding the obvious limitations of the inductive nature of our research, it unlocks new avenues in both theory and practice. Future research could focus on the antecedents of agile leading. Does this agile leading perspective apply to every organization? Are some organizations more receptive to this perspective than others? Further, the factors differentiating successful agile leaders should be examined. What are the personal characteristics helping leaders adapt to the agile way of work? Can these characteristics be learned? The theory of mindsets is another promising area for future research in this direction, as pointed out by an HR Professional describing the selection criteria for leadership positions:

> Most of the times, it's the mindset you have to understand. So, [for example] if they are open to mistakes, if they can let people take control, if they can be strategic enough and not [limited] too much within their own expertise, whether they can do stakeholder management at a very high level, whether they can develop strategy, whether they can embrace the ambiguity [of the system].

Finally, future research should examine the expectations that members have from their formal leaders and the leadership behaviors that members themselves enact given the autonomy granted to them.

Plural leadership, sense giving and context curation, as identified in our research, reveal the complexity and nuance of agile leading in practice. Table 1 summarizes the three theoretical frames, the main paradoxes identified in each frame, and some of the practices that leaders can implement to pursue the promise of agility.

Table 1 Recommendations for agile leaders

Agile leading frames	Leading paradoxes	Recommendations for leaders
1. Plural leadership	a. Equal power between member and leader b. Control and autonomy	• Accept and continuously navigate the paradoxes • Focus on the process of participation and deliberation as more important than the outcome
2. Sense-giving	a. Leading without authority b. Leading members that are more technically knowledgeable	• Practice "leaderless leading", e.g., by coaching at the team level • Support members' sense-making by modeling values through behavior
3. Context curation	a. Leaders not on the foreground but part of the context b. 'Becoming agile' as always in-progress	• Focus on helping members be the protagonists in shaping the future, not on prescribing it on their behalf • Develop a mindset of deliberate continuous evolution of structure, process, and culture

7 Conclusions

This work was motivated by the paradoxical challenges arising from the apparent contrast between dominant models of leadership in hierarchical command-and-control organizations versus the foundationally different logic of agile organizing. How do leaders adapt to embrace such paradoxes? In exploring this question at Interamerican, we found evidence supporting recent literature on emerging forms of leading. Further, we discovered that leading in an agile organization also entails curating the broader organizational context. Interamerican's COO vividly explains the challenge, the answer, and its consequences:

> The nice thing about these day-to-day decisions, [is that traditionally] they come to you because you can't avoid them; a process is organized and they fill your days and, at the end of the day, you go home feeling relevant, right? [But] if your job is to give context and connection to people, you need to get yourself going. It's not going to come to you. You have an independent responsibility to work that out with your colleagues and bring it to people. That actually changes quite a lot.

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What Management Skills Are Needed in the Digital Era? A Business Executive Perspective

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Abstract The study presented in this chapter aims to improve our understanding of the skills employers consider valuable for the digital era and the gaps between those skills and the existing ones in the workplace. The findings presented are based on interviews with forty business executives in the U.S. and Europe. The skills these business executives reported as important in the digital era fall into four categories: digital competence, business acumen, leadership effectiveness, and personal effectiveness. These categories are discussed along with proposals aiming to contribute to effective business school curricula in the digital era.

1 Introduction

In today's world, characterized by volatility, uncertainty, complexity and ambiguity (VUCA) and by the rapid development of technology, digital transformation and constant crises, it is not surprising that the knowledge, skills, and abilities (KSAs) required of management professionals are evolving. Research on this topic shows that digitalization has altered management skills and styles and that organizations are looking for managers who possess a critical set of skills to enable a smooth, often

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ongoing, digital transformation (Abbu et al., 2022; Araujo et al., 2021; Ciarli et al., 2021; Eller et al., 2020).

Digital transformation is the use of digital assets of an organization to achieve business goals at both organizational and individual levels (Thomson et al., 2016). Studies focusing on digital transformation indicate that the KSAs needed are, for example, artificial intelligence, nanotechnology, and robotization (e.g., Schlegel & Kraus, 2023; Shakina et al., 2021; Sousa & Rocha, 2019). On the other hand, as Van Laar et al. (2017) show in their review of 75 articles, the KSAs needed in the twenty-first century go beyond KSAs directly relating to technology to include, for example, collaboration and critical thinking.

Similarly, Westerman et al. (2014) have identified five vital abilities that can help leaders navigate digital transformation, namely, devolved decision making, collaborative achievement, agility, purpose and direction and authenticity. Recently, Murphy and Ozgen (2023) introduced the concept of executive digital savviness and in their research with top executives found that, although they were personally involved in digital technology initiatives, they did not all believe they had sufficient digital savviness to support the proposed project.

Yet, our understanding of what KSAs employers consider valuable for the digital era and the gaps between those KSAs and what is typical in the workplace is insufficient (Sousa & Rocha, 2019; Van Laar et al., 2017). Furthermore, business schools need guidance to design curricula that help students develop the necessary KSAs for the digital era. With the goal of informing the management curriculum in the digital era, the Management Task Force of the MaCuDE[1] project launched a three-phase study. The first phase aimed to understand how textbooks incorporate digitalization (Begley, 2021a). The second phase focused on the effects of digital technologies on work and the workplace (Begley et al., 2021b). The third phase explored skills business executives consider important for the digital era (Begley et al., 2023). Combined, the three phases of this study indicate that most business schools have been slow to fully incorporate digitalization into their curricular and extra-curricular activities. As a result, a gap has emerged between the business sector's immersion in digital transformation and the extent to which business schools deliver education on it.

To shed light on this gap and make suggestions toward a management curriculum that better addresses today's and tomorrow's business needs, this chapter (1) presents the part of MaCuDE's results that are related to the perceptions of business executives as to what skills are needed in the digital era and (2) discusses how the management curriculum could incorporate these skills and by what methods. The rest of this chapter is organized as follows. We first present the methods we used to obtain and understand business executives' perceptions of what KSAs are needed for the digital era and the extent to which gaps exist in the workplace. We then present the results of interviews we conducted with business executives. Finally, we discuss how our findings inform business school curricula for the digital era.

[1] MaCuDE stands for Management Curriculum for the Digital Era. See: https://macude.org/.

2 Methodology

To understand what KSAs business executives consider important for the digital era, we conducted an exploratory qualitative study employing a grounded theory approach. Grounded theory is typically employed when there is no pre-existing theoretical framework; rather, the data collected were analyzed inductively to improve our understanding on the topic explored (Gioia et al., 2013; Glaser & Strauss, 1967).

Our data were collected through forty semi-structured interviews conducted by this chapter's authors in the U.S. and Europe. These interviews lasted approximately 60 min each and were part of a bigger project that included questions outside the scope of this study. Examples of the open-ended questions used for this study are, (1) have digital technologies affected the ways in which leaders function, (2) what skills should MBA graduates have in this digital era, and (3) what skills should business schools teach to prepare students for their careers in the digital era?

The participants were senior-level executives working for multinational companies and were selected to have a wide variety of experiences, e.g., manufacturing, technology, banking, consulting, etc. However, to a degree, the participant selection was guided by convenience (i.e., participants were invited through the authors' social contacts). Table 1 shows the participant demographic data. We interviewed 8 women and 32 men, and a total of 9 CEOs, 2 COOs, 5 VPs, 6 directors, and 11 managers. Participant work experience ranged between 7 and 40 years.

The interviews were transcribed by a professional transcriber, and the transcripts were inductively read and open-coded (Glaser & Strauss, 1967; Strauss & Corbin, 1998) by the authors. Specifically, the first and second authors read all forty transcripts and open-coded them independently. They then shared their open-coding results with the third author, who read half of the transcripts, and jointly developed the skill categories and key themes discussed in the section that follows. In the section that follows, we present the skill categories and themes that derived from our coding.

3 Results

Based on the responses from the business executives we interviewed, we organized the skills graduates need in the digital era into four main categories. These four categories are digital competence, business acumen, leadership effectiveness, and personal effectiveness. In the sections that follow, we provide a short description of each category, describe the main themes related to each category and provide related characteristic quotes from the interviews.

Table 1 Participant demographics

		Number of participants
Gender	Male	8
	Female	32
Country	USA	23
	Greece	7
	Switzerland	6
	Cyprus	2
	UK	1
	Italy	1
Years of Experience	Less than 10	1
	10–20	13
	More than 20	25
Title	CEO/Managing Director	9
	COO	2
	VP	5
	Director	6
	Manager	11
	Other	7
Company size (number of employees)	Under 1,000	15
	1001–10,000	7
	10,001–50,000	7
	Over 50,000	11

Digital Competence

In essence, it is almost impossible to succeed in the modern workplace unless a person has digital competence through proficiency with digital tools and it is increasingly important that they cultivate a digital mindset, that is, a perspective that places digital transformation as a central component of organizational advancement, accompanied by an openness to digital innovation and willingness to learn how to use new digital tools.

> Leaders usually are older in age, so maybe it is more difficult for them to adapt to new things. I think it's essential to somehow work on this limitation and be able to easily learn and adapt on the new tools. I have seen people that were very close to retirement and just never adapted to the new tools. They were good leaders and doing a good job in the old-fashioned way. I think they should be able to change the way they work practically.

The digital competence category has two dimensions, digital literacy or proficiency and digital mindset. Our interviewees referred to digital literacy or proficiency as a broad understanding of the digital world and the ability to use existing tools. A senior-level executive of a large multinational company based in the U.K. explains:

> [Digital proficiency is important] in terms of having an ability to navigate in this world, understand how consumers interact in this world, etc. When I talk to my kids, they have a much better understanding than I do of the apps that are out there, what people do in these apps, what the forms of communication there are like, what technologies exist which allow you to navigate through them.

A financial services executive in the U.S. discussed digital proficiency in more specific terms:

> It's the underlying ability to recognize and solve problems with limited information sometimes as the foundation and then use the tools which businesses are using. Sometimes the schools can be at the forefront of that. With machine learning, I think it takes time for industry to figure out how to use machine learning, for instance. I think that it's a great thing for people to be exposed to in school. I know that sometimes we hire people to -- every organization is different. It used to be we liked new people, and especially people coming out of school, to find out what the latest and greatest or interesting technologies might be that we're not using. Some places keep themselves at the forefront. Other places use new hires to bring in technology. [] I do see exposure to machine learning as being that. Whether companies are looking for folks to bring some interesting ideas or to grow the interesting ideas that are in place, I think that some basic technology, so computer language -- Java, and Python are a couple of popular languages. Being able to use the continuous integration pipelines and things like Git and GitHub and all that. The build stuff is useful for people to have. Again, if someone has some machine learning, if they have exposure, then that's just going to help them and maybe the company.

On the other hand, business executives reported that the speed at which digitalization develops makes it almost impossible for graduates (and employees) to have all the skills needed at any point in time. A based-in-Greece business executive with regional responsibilities in Europe explained the futility of expecting anyone to have full digital proficiency:

> You cannot expect them to be very proficient in specific tools and solutions. They also need to be familiar with new solutions and being able to adapt. Obviously, understanding how cloud services work and operate it's essential in the future. From then on, they need to somehow easily adapt to new things.

Therefore, what is of the utmost importance is a digital mindset. Digital mindset refers to a broad understanding of the digital world and a willingness to continuously learn how to use new tools. In other words, digital mindset is being open-minded about technological advancements and adapting to them. As reported by a based-in-Italy senior-level business executive of a multinational company,

> [Companies] look for a mindset of being able to adapt rather than being able to predict the future or having the skills already or having the skills that you think are going to be important in the future. It doesn't matter so much.

In the same vein, the based-in-Greece executive explained:

> Living in a world that we know will be changing fast, it's more essential to give the people the skills needed to learn and adapt to new things more easily. I'm guessing that we will be required to get out of our comfort zones more often in the future. In that sense, I don't think it makes sense to invest in very, very specific skills. It's more a broader knowledge and way to try to overcome the barrier of, I don't want to change, or I don't want to do new things. They will be asked to do that more and more often.

Business Acumen

Business acumen encompasses a strategic outlook, comprehension of the models that drive business success, such as technology-based innovation or high volume, low-cost production, and knowledge of its core functions.

> I need to have a very good understanding of the business processes and the way a commercial team works and operates to understand commercial policies. On the other hand, since I'm working in the delivery of IT projects, I need to have a very good understanding of the technical part of the solutions to be able to understand mainly, not how to configure or set up the solution because I'm not doing that, but in order to understand what the limitations are or what we could possibly do.

Our interviewees frequently referred to the need to balance digital competence with business acumen. The reason behind that is that digital competence without business acumen might result in work outcomes that are not useful for the business. As an example, a graduate who produces an outcome but does not understand how the business functions, might find it difficult to share their outcome (e.g., a potentially useful data analysis) with the relevant people. As a result, their outcome will never contribute to the business. In other words, the graduate would probably have wasted their time and company resources due to insufficient business acumen. Our interviewees referred to two dimensions of business acumen, an understanding of the big picture and an understanding of how the business functions.

First, an understanding of the big picture is important as new recruits will have to understand how their work fits in with the business and how it contributes toward reaching the business objectives. As an example, a graduate with digital competence might be able to use digital tools to analyze big data. However, without a good understanding of the business's big picture and how their big data analysis can help the business, their work might be of limited value. The senior-level executive based in Italy commented:

> Sometimes [] the "so what" is difficult for [newly recruited graduates]. They tend to be very broad in their thinking, but then what is the benefit in the P&L? What is the value for that? They lack being concrete. As if it's my own company, would I invest this money to do this activity?

Second, business acumen also includes the notion of understanding how the business functions. As the way of how a business is organized, implements plans, ensures compliance, etc., depends on the industry in which it operates, such an understanding is often industry specific. The comment below of a start-up executive in the U.S. serves as an example.

> I would use one word to characterize that, knowledge of workflow. So again, it goes back to how the world of health care – physicians, practitioners, organizations like hospitals, what's their workflow? What really happens when a patient shows up at the ER? What's that flow line like? Since things have become more digital, that information has mattered more and more to me and to our business. As business school educators, it comes back to some of the things we just discussed. Number one, the context, exposing students more to the mechanics of industries and why they operate a certain way? What are some of the entrenched behaviors and/or technologies, or the needs of that industry, how are they evolving?

It should be noted that some business executives pointed out that perhaps companies should not be looking for a combination of digital competence and business acumen in the same person. As the managing director of a relatively small company in the U.S. explained:

> Right out of college, I think they have the raw knowledge, but we must tell them the next level, what to do. Some I see get it right away. Some take a little longer. We need to balance that. Then I've seen some are very good at programming things, but then they are not as good at the business side of is as much. Some are good at the business side; they're not at the programming side, which is natural. I've dealt with a team of twenty people-plus, so I've seen that. Me as a manager, I was able to take advantage of what they were good at versus what I think they should be good at. I learned from one of my managers what not to do. One of my first managers expected everybody to do similar things. That was stupid. If I'm good at the business side, use my best skill. At the same time, give me time to learn the other part. The other guys, they're good at coding or whatever. Use that. Then teach them the business part.

However, as implied in the explanation above, as graduates progress in their careers and assume managerial roles, business acumen becomes critical. And an understanding of the business will be something that they will have to learn.

Leadership Effectiveness

Leader effectiveness involves dimensions that range from applying emotional intelligence to interpersonal interactions through team management skills, including virtual teams, to tasks that require a broader overview of key managerial responsibilities, especially those concerning disruptions to existing structures and processes from largely external sources.

> It's a bit of a looser type of leadership than the traditional model. It's not a leadership where you have somebody who is constantly needing to delegate and then approve, etc. The leader is more engaged, more part of the process. You can imagine these teams can recreate themselves. You can have people working in a team for some period. Then they can move to work in a different team. People can always have a bit of a short-term affiliation with some area because they carry their expertise with them. They can take that expertise to different teams.

The executives we interviewed consistently stressed that working with and through others remains integral to organizational life. Therefore, we include interpersonal skills as the first level of leadership effectiveness. Skills at this level largely center around the capacity to enrich one-on-one relationships. They include clear and supportive communication, empathy, conflict management, influencing, especially without authority as well as the ability to coach and mentor others. A person's capacity to motivate others and to generally understand work-related attitudes would also fall into this category. As an example of clear and supportive communication, an executive in the oil and gas industry in the U.S. commented on the importance of active listening.

> …a skill set, I think, is probably maybe even more important when there's so many options and so many potential distractions is active and effective listening.

When interpersonal skills were discussed, our interviewees tended to stress the importance of emotional intelligence (EQ) in developing and demonstrating effective interpersonal skills. For example, the founder of a relatively small company in Greece said:

> First, emotional intelligence. Since you constantly communicate with people and teams you need to have EQ.

Leadership skills at the team and group level center especially around creating the conditions for organizational members to share knowledge and information in order to collaborate and co-create. It also includes understanding how to create structure for work such as helping team members differentiate and integrate roles and responsibilities and align their efforts with broader goals and objectives. The comments of a CEO in the UK and a program manager in the U.S. are indicative:

> What I saw was [that digital transformation] meant that we became more reliant on highly skilled teams, big data teams, and highly skilled digital teams.
>
> Team building is huge. Not just…being an individual contributor but being a part of a team sort of that soft skill and knowing what resources to tap into when you need it….

One the one hand, this skill level involves mastering principles of inclusive leadership such as fostering diversity, enabling psychological safety and developing cross-cultural awareness/communication capacity. On the other hand, it also includes fundamental project management and meeting facilitation skills. Another especially important dimension of leadership at this level is the ability to engage and support others remotely, through technology enabled platforms. As the program manager in the U.S. commented,

> In that regard…it's very bizarre. People feel more connected than ever because it's that much more important to get it right, especially now during the pandemic and yet at the same time further apart because they're not physically together.

Finally, we note that the pace and breadth of work-related digital trends only amplifies how important it is for management students to understand the challenges and opportunities of enterprise level leadership. This level of leadership includes developing an appreciation for principles of boundary spanning and cross-functional integration. The same program manager commented,

> You don't just do your job and throw it over the fence to the next group. I think there's more integration, for example, for those developers that are producing and developing code to also serve in an operating role. So not just developing the code and throwing it but maybe serving as a tester or perhaps running operations when a customer calls for questions. They can work it through instead of waiting on a specific customer service representative.

Personal Effectiveness

Personal effectiveness refers to internally focused personal skills that are instrumental to individuals' performance and career advancement. It comprises watchwords of current organizational life like critical and innovative thinking, agility and resilience, self-management, communication skills, and, of increasing importance to career management, self-promotion. Our categorization of those skills includes four main subcategories, critical thinking and judgement, learning agility, self-management and self-care, communication/presentations and personal branding.

Cognitive skills such as logical reasoning, ability to filter and analyze information, intellectual curiosity, mitigating bias in decision making and innovative and creative thinking were regarded as particularly important by our interviewees. They also stressed that communicating effectively and presenting information clearly and effectively, such as through storytelling, are essential to getting your message across.

Learning agility, our ability to learn, adapt, unlearn, and relearn to keep up with constantly changing conditions is always important but even more so during this digital era. Having a growth—instead of a fixed—mindset and being resilient in turbulent times was also highly valued. As an example, the senior-level executive based in Italy commented:

> [We select] a new graduate, in terms of skill and learning. I think I'm seeing people being able to learn quickly. I'm trying to bring the example of the last couple of days of someone, a graduate we have in the company -- I look at them and see that they are quickly learning. They tend to be good at collaborating and working together. But I think sometimes they lack resilience.

Furthermore, the executive in the oil and gas industry in the U.S. emphasized the importance of intellectual curiosity:

> …one of the things that I encourage young people I mentor to do is [to] have intellectual curiosity. Your job is to learn and the people who I see with the brightest futures, not only are they adaptable, but they are intellectually curious in terms of how and what they want to learn more about.

Importantly, in the digital era, graduates (and business executives up and down the corporate hierarchy) are expected to own their learning and development. As explained by a Cyprus-based executive of a large multinational firm:

> In the workplace these days, each employee is responsible for his own learning. The company offers a wide range of training. For example, in our company, whatever you want to learn about is there. We have a very rich knowledge database, but nobody will force you to do it. It's up to you. You are an individual to take responsibility and prepare a plan, of course with the help of your manager, but prepare a plan where you want to be in two years' time or in one year's time or in the future and prepare your study. It is important for this skill, to start to have this from the university.

Finally, our interviewees told us that being able to take care of oneself and manage one's emotions such as anger or stress are of critical importance. Self-awareness and reflection as well as mindfulness can help in this direction. Furthermore, it is

becoming increasingly important for graduates to be proficient at using technology for networking and social media management to professional presence and advance their career. For example, self-awareness was highlighted by the program manager in the U.S.:

> …it's having that self-awareness to know where your strengths are, where you want to go so that you can apply those strengths...

Furthermore, the based-in-Cyprus executive made the following remark about managing stress:

> To be able to work under pressure, this is very important. Probably because of the way they grow up, they're not very good working under pressure and sometimes not very persistent in tackling a problem. They give up more easily compared to the previous generations.

In the section that follows, we make proposals for business school curricula in the digital era based on the findings reported in this section.

4 Business School Curriculum Proposals

Taking into consideration the findings reported in the preceding section, we developed two proposals for business school curricula. The first proposal focuses on which courses can prioritize which skills in the digital era. The second proposal is about how these skills can be taught.

Proposal 1. Aiming to propose which courses can prioritize which skills, we developed a matrix matching the skills identified in the preceding section with typical MBA courses. To do so, we first used MaCuDE's Phase I Report (Begley, 2021a) which identifies the courses most often included in MBA programs. We then matched these courses with skills required in the digital era. The resulting matrix is shown in Table 2.

As can be seen, the skill *Digital Mindset* from the Digital Competence category, matched with the following courses: Marketing Management, Leadership, Decision Making, Information Systems and Business Analytics. In other words, we propose that business schools aim to promote a digital mindset among the students taking these courses. This does not mean that, for example, digital mindset cannot be promoted in Financial Accounting. In fact, for example, a course in Accounting that does not introduce its students to digital tools used in business leaves them unprepared to related effectively with Accounting topics in their work lives. We only try to prioritize courses per skill based on our takeaways from the interviews we conducted.

Along similar lines, the skill *Business Functions/Roles* from the Business Acumen category and the skill *Critical Thinking & Judgement* from the Personal Effectiveness category matched with almost all the courses. Finally, the skill *Teams and Groups* from the Leadership Effectiveness category seem to better match with the courses: Organizational Behavior/Teams, Leadership, Business Ethics and Communication.

Table 2 Matrix of skills and courses

	Marketing management	Operations management	Managerial economics	Financial accounting	Financial management	Strategic Management	Organizational behavior	Leadership	Quantitative methods/ Stats	Business ethics	Social, political, legal, envir	Decision making	International	Communication	Information systems	Entrepreneurship	Business analytics
Digital competence																	
Digital mindset	X							X				X			X		X
Digital literacy	X								X			X			X		X
Business acumen																	
Business functions/Roles	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Big picture/Analytical skills	X	X	X	X	X	X			X			X	X				X
Leadership effectiveness																	
Interpersonal skills							X	X		X				X			
Teams and groups							X	X						X			
Enterprise		X	X			X		X					X			X	
Personal effectiveness																	
Critical thinking and judgement	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Learning agility							X	X		X		X	X			X	
Communication/Presentation							X	X						X		X	
Self-management							X	X		X	X						

Table 3 Proposed learning methods for the digital era

Learning through experience	Learning through reflection	Learning from experts	Learning through simulation	Learning through the web
Project-based learning (PBL)	360 feedback|feedforward	Mentoring by business executives	Case studies	Online courses
Internships	Personal development plan	Job shadowing	Role playing	Podcasts and blogs
Design Thinking	Journaling	Coaching	Business simulations	TEDx talks
Consultancy projects	Team building workshops	Guest talks by business leaders		AI learning tools (e.g., ChatGPT)
Service learning		Company visits		
		Lecturing		

Proposal 2. Our second proposal is about methods that can be used to facilitate learning in the digital era. This proposal is based on what we heard from our interviewees as well as our experience as educators. In Table 3, we identify a host of options grouped into five categories of learning: experience, reflection, from experts, simulations, and the web. It should be noted that interviewees from different countries tended to prioritize these methods differently. Learning from experience includes project-based learning, internships, design thinking, consultancy projects and service learning, which seemed more popular in the USA. Learning through reflection involves methodologies such as 360 feedback, personal development plan and journaling. Learning from experts includes traditional methods such as lecturing and guest talks by business executives, and more innovative such as job shadowing, coaching and mentoring. Learning through simulation includes business simulation asking students to solve a simulated problem and role-playing where students assume different roles in a business situation. Learning through the web includes online courses and artificial intelligence tools such as ChatGPT. Although educators are still in the process of thinking through how to deal with ChatGPT, there are already discussions about encouraging students to use it for assignments. Notably, although lecturing, the traditional "sage on the stage," is presented as an option, it is only one of the twenty-one learning methods listed.

5 Discussion

For this study, which is part of the MaCuDE project, we interviewed a group of business executives and used their input to improve our understanding of the skills graduates need for the digital era. Based on our analysis, we organized the skills suggested

by business executives into four categories: digital competence, business acumen, leadership effectiveness, and personal effectiveness. We then used this knowledge and our experience as educators to propose a skills-courses matrix and learning methods that can be used to develop these skills.

Our sense is that most business schools have not taken steps to inculcate a digital mindset and digital knowledge and competencies firmly into their MBA curricula. Two additional steps are necessary to narrow the gap between the digital workplace and teaching about it.

- The first is to follow through on skills and courses identified in Table 2 and the proposed methods in Table 3, develop classroom educational material in the form of simulations, cases, role-playing and other forms of instruction and outside-of-class experiences that offer direct exposure to digital technologies in practice.
- The second, based on comments from business school deans who say that many of their faculty members have insufficient knowledge of how digitalization is playing out in the industry, involves educating academic staff on digital transformation in action so they can use it to develop effective, up-to-date instructional approaches.

Regarding the limitations of the present study, it is worth mentioning that the way in which executives were recruited for interviews, mainly through personal contacts, means that we cannot say for sure that they are representative of business executives in general. Furthermore, only eight out of the forty interviewees were women. A reason for this can be the low representation of women in senior management positions. Nevertheless, greater gender diversity could have provided richer insights for this study. Therefore, future researchers should be more vigilant about this issue and make an extra effort to recruit more diversified samples. In addition, since most of the interviews were conducted during the pandemic, this may have affected the viewpoints expressed by our interviewees.

The results of the present study can help business educators and universities ensure that their curricula remain current and relevant, so that they can empower their students, and the organizations that employ them to fully engage with the emerging needs of today's rapidly evolving digital workplace and bring business school education more into line with the current realities of business life.

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Interplay of Skills in the Digital Era: A European Perspective

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Abstract Industry 4.0 and digital transformation play an important role in business, especially after the COVID-19 pandemic crisis. The changes occurring are not merely concentrated on technology implementation and digital business, but also involve understanding and reshaping labour forces, since the skills and knowledge needed are being transformed in terms of significance and importance. This research uses the European labour database to provide insights into how the occupation of managers is shaped in terms of skills and knowledge in the current digital era. In addition, it explores frequently appearing patterns of skills and knowledge, and provides insights for the skills needed for four distinct categories of managers. The results indicate a strong skill orientation among most subgroups of managers, while the need for lifelong training is highlighted especially for skills that seem more promising when the business environment becomes more digital.

1 Introduction

The importance of soft skills in the professional environment has always been recognised by employers because they facilitate successful communication, foster interpersonal connections, and engage in productive leadership, mediation, and negotiation. Effective communication requires, among other qualities, the ability to listen attentively, talk eloquently, and demonstrate empathy for others. Soft skills are attributes, behaviours and attitudes that are intangible and nontechnical (Seetha, 2014). Soft skills are also prerequisites for the effective application of technical knowledge and skills in the workplace. Schulz (Schulz, 2008) emphasized the importance of soft skills in the personality of an individual, while, according to Oladokun and Gbadegesin (2017), all interpersonal characteristics and attitudes that distinguish employees are the soft skills that they possess.

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The importance of skills and competencies has been widely accepted and represents the supply side of a labour market. However, the demand side has changed considerably in the past decade; the recruitment process is largely based on social networks and talent platforms, and the hybrid working model, enabled by the COVID-19 pandemic, is an emerging long-term solution for work arrangements. However, such flexibility sometimes entails risks for companies such as competition for talent, fragmentation of the workforce, issues of cybersecurity, etc. To this end, it is increasingly necessary to identify what are the skills and competencies needed, along with the training programs to develop them, both for existing employees as well as newcomers to the labour market. This need is further strengthened by the pressure on employers to move from low-tech jobs to new ICT-based ones (European Commission, 2022).

The objective of this paper is to propose a methodology for labour market analysis that identifies the predominant correlations between skills and knowledge. This paper seeks to provide guidance for future skill acquisition in order to facilitate labour supply as expressed by individual skills and knowledge. Additionally, it strives to enhance our understanding of labour demand by analysing specific subsets of skills and knowledge. The managerial role was chosen due to its complexity at all levels of the business. According to Katz (1974), effective managers should concentrate on technical, human, and conceptual skills. Companies train managers according to corporate standards, and managers' conceptual skills help to envision the future, plan, and make the right decisions for the company (Weber et al., 2009).

The European Skills, Competences, Qualifications and Occupations (ESCO) skill taxonomy is used to extract patterns, in terms of skills and knowledge, from existing job specifications. The Apriori algorithm is used to discover frequent item sets of skills and knowledge. Our work suggests that the role of manager encompasses different aspects of the organization and requires different skills and knowledge, so the association rules have been applied to the four subgroups of managers available in ESCO.

The main findings of this study, according to the taxonomy of the ESCO skills, are the following.

- The Chief Executives, Senior Officials, and Legislators subgroup is composed of both private companies and public sector organizations. Although both are responsible for making decisions at the highest level, they need a different mix of knowledge and skills.
- The Administrative and Commercial Managers subgroup is orientated to managing resources (human capital, budget, and procurement) according to company standards.
- The Production and Specialized Services Managers subgroup are skill-orientated and provide solutions to international trade and/or tackling financial issues.
- The Hospitality, Retail, and Other Services Managers subgroup is skill-orientated, and the main topics of managerial intervention include employees and customers.

This study suggests that the most prevalent skill or knowledge within a managerial subgroup is not necessarily the one that holds the highest significance.

2 Literature Review

Innovation, Industry 4.0, and digital transformation have attracted significant research interest in recent years due to increased need for process transformation (Kostakis & Kargas, 2021), new job requirements (Maisiri et al., 2019) and specialized skill sets (Grzelczak et al., 2017). With the digital era also creating the need for new managerial competencies (Čirčová and Blštáková, 2023), job positions are changing rapidly and new jobs and new requirements are expected to appear (Manakhova et al., 2020; Siaous et al., 2020).

Existing literature recognizes skills needed including problem solving, communication skills (oral and written), analytical and critical thinking, agility, adaptability, team work, networking and information literacy, creativity and imagination (Kumar & Komal, 2021; Sousa & Wilks, 2018). While these skills are recognized, there exists an ongoing research on the gap between competencies needed and skills/knowledge required in the digital era (Prifti et al., 2017; Shvetsova & Kuzmina, 2018). These new competencies are not related only to ICT skills (Schallock et al., 2018), but also include behavioural skills, lifelong learning and deep knowledge related with various business disciplines (Prifti et al., 2017).

These skills are more commonly related to entrepreneurship, teamwork orientation, strategic thinking, and communication ability (Mihai & Creţu, 2019; Sisthembiso, 2020). COVID-19 and increased digitalization established a new culture of lifelong learning (Manakhova et al., 2020), reskilling and upskilling (Bennett & McWhorter, 2021), learning agility and systematic future planning (Cordes & Weber, 2021; Schlegel & Kraus, 2023), self-management and ethical leadership (Pang et al., 2019), management of diverse teams and immediate communication (Jagger, 2020; Schiuma et al., 2022). A rather interesting competency includes a "quick failure" skill which involves the ability to learn quickly from any failure (Čirčová and Blštáková, 2023), along with cognitive, emotional, and social intelligence – skills that are not sufficiently developed under the current educational systems (Deming, 2015).

Such trends are not only related to employees but also to managers (Kraus et al., 2022), and the level of analysis includes both skills and knowledge, as well as education and training (Kane et al., 2019). Managers are a crucial element of a digital transformation process, since they can facilitate and enforce the process by disseminating across the organization their experience, and by cultivating a culture of learning (generally and from mistakes) among employees and new leaders. This is why the influence of managers on the development of a firm has attracted research interest from early on (Hambrick & Mason, 1984).

A number of studies have emphasized the characteristics of top managers, such as demographic characteristics, personality traits, and values (Carpenter et al., 2004), while the strategic leadership literature has focused more on how managers operate at the various functions (Finkelstein et al., 2009; Samimi et al., 2022), and how they influence the firm's strategies and performance (Certo et al., 2006; Finkelstein et al., 2009).

As a result, even though the impact of managers' performance on firms' outcomes in the digital era has increased (Quigley & Hambrick, 2015; Wangrow et al., 2015), the skills and knowledge required has only recently gained research attention (Kane et al., 2019; Kargas 2022). Under such a development emphasis is expected to be put on soft and interpersonal skills that machines cannot demonstrate (Bejaković & Mrnjavac, 2020).

The situation is unclear even when it comes to the analysis of digital literacy and skills of managers. There is a mixture of interrelated concepts when trying to define digital literacy (Bejaković & Mrnjavac, 2020). Gualtieri et al. (2017) named three groups of digital skills, according to their degree of complexity and demand for performing tasks:

- Basic digital literacy: basic competencies that empower users to become digitally literate,
- Necessary digital skills: required to survive in the labour market, and
- Advanced digital skills: usually appearing in ICT professions enhanced with additional skills such as creativity and innovative thinking.

Other definitions, such as the one provided by the European e-skills Forum, focus exclusively on ICT professions and act as a tool for European policy initiatives (Gareis et al., 2014; Husing et al., 2015). OECD has adopted a task-based approach and categorized users into 3 groups: 'generic, specialist and complementary' skills (OECD, 2016). Finally, the European Commission developed the Digital Competence Framework 2.0, proposing five areas of digital literacy, namely: (a) Information and data literacy, (b) Communication and collaboration, (c) Digital content creation, (d) Safety, and (e) Problem solving.

Several frameworks are available to understand the skills and knowledge of employees and facilitate the recruitment and talent management processes. For example, Bloom's Taxonomy (Stanny & Albright, 2016) is used to organize the set of potential learning outcomes that can be acquired by completing different levels of learning activities. This taxonomy uses three models to classify the learning objectives by complexity and specificity. In the cognitive domain, thinking skills are structured at six levels of learning starting with remembering knowledge (retrieve relevant knowledge from the long-term memory), and then understanding knowledge (the student should be able to explain, summarize and interpret relevant knowledge). Other frameworks are also used to understand the skills and knowledge of employees, define the desired competencies of the organization and shape their capabilities, thus improving human resources quality, generating trust, empowering employees, and increasing satisfaction, productivity, and employee engagement.

Several studies put emphasis on the relationship between leadership, training and development programme (Kaifi et al., 2014; Kargas, 2014; Kargas & Varoutas, 2015; Northouse, 2004; Schein, 1990; Vecchio, 1987). A framework to access and determine appropriate actions towards team members is the Skill Will Matrix. On the one hand, the Will denotes the employee's desire, purpose and determination to perform his duties on a team and, on the other hand, the Skill is defined as the skills and abilities possessed (Paritkar & Parchure, 2016). According to this segmentation, someone

is characterized as high performance having high Skills and high Will. The best way to motivate these team members is to challenge them. When someone exhibits higher Will and lower Skill, then managers need to guide, train, and mentor them. When someone has low Will but high Skill then motivation is required as a corrective action. Finally, when someone has low Will and low Skills then improvements are required both on Will or Skill.

3 Methodology

The Cross Industry Standard Process for Data Mining (CRISP-DM) (Shearer, 2000) is a widely used methodology employed in analytics initiatives. It offers a step-by-step approach to oversee data intensive projects, starting from comprehending business objectives to implementing and sustaining the outcomes. This work adhered to nearly all stages of the CRISP-DM methodology, apart from the deployment phase, in which the outcomes are incorporated into the operational setting. However, we did not achieve substantial advancements in this last phase. In the following, we outline the five phases of CRISP-DM as implemented in this work.

1. **Business Understanding:** The objective of this project was to gain insight into the European labour market. We found it interesting to focus only on the occupation of managers due to the diversity of skills and knowledge required. The labour market consists of the demand side, indicating the skills and knowledge that companies require from a manager, and the supply side, signalling the mixture of skills and knowledge available from prospective managers. This work accessed only the available skill taxonomy (ESCO) and focused on a key research question for each side of the labour market: on the demand side, to understand the importance of skills and knowledge based on the available job specifications, whereas on the supply side, to analyse the data and come up with recommendations as to the next skills or knowledge needed to reduce the skills gap.
2. **Data Understanding:** ESCO provides a classification system and a common language for describing and categorizing skills, competences, qualifications, and occupations in different industries and sectors. It covers a wide range of skills and competences, including technical and soft skills, and personal attributes. The taxonomy consists of a hierarchical structure with different levels of granularity, allowing for detailed descriptions of skills and their relationships. We noticed that ESCO has two limitations: (i) loose integration of information and communication technology related skills into the taxonomy and (ii) lack of leadership skills (e.g. relationship building, employee empowerment). A possible explanation is that the ESCO Skills taxonomy is continuously updated to reflect the evolving nature of the labour market and emerging skills requirements.
3. **Data Preparation:** The objective of this step was to understand, clean and transform the raw data into a suitable format for analysis. We used the available web services to retrieve the skill taxonomy. Additionally, the ESCO provided

two views for every job: (i) an essential view where the mandatory skills and knowledge were included and (ii) an optional view listing additional skills and knowledge. For simplicity reasons we selected to focus only on the essential view.

4. **Modeling:** We chose to utilize association rules to reveal and explore the relationships between skills and knowledge. The Apriori algorithm (Agrawal & Srikant, 1994) was applied to each of the four subgroups of managers. The results of Apriori are rules composed of the antecedent (the item(s) on the left side of the rule) and the consequent (the item(s) on the right side of the rule). In addition, the rules discovered are followed by various performance measures such as support, confidence and lift.
5. **Evaluation:**

   The evaluation of the results was facilitated by experts in the field. Three experts agreed to participate in the interpretation of the results. All experts have had more than 10 years of working experience as human resource managers in different industries (retail, finance and public organizations) sharing few common challenges of digital transformation. To facilitate communication, we used graph-based visualization with items and rules as vertices. In this work, we used different association rules measures, namely support and lift, to select different subsets of rules that correspond to the demand and supply of the labour market accordingly.

The support measure in an association rule expresses the popularity or prevalence of the itemset in the dataset and is computed as the number of jobs containing both the antecedent and the consequent of the rule, divided by the total number of jobs inside the subgroup. We utilized the support measure as a foundation in our study to understand the combinations of skills and knowledge that comprise an occupation. As a result, support can reveal patterns that match the labor market's demand side.

Lift measure, on the other hand, in an association rule, assesses the strength between the antecedent and the consequent. In other words, lift quantifies how many times the presence of the antecedent raises the likelihood of the subsequent occurring. In our situation, the rules with the highest lift were used as a potential suggestion tool to assist prospective employees in determining which talent or expertise adds the most value. In the next section we provide a brief description of our empirical work.

4 Results

The ESCO data set distinguishes four major subgroups under the manager category, with 311 different manager job specifications. Table 1 illustrates how the manager's occupation is classified in the ESCO data set. The prominence of the subgroup "Production and Specialized Services Managers" is striking because it contains 184 (59% of the entire category) distinct manager job specifications. In terms of different skills and knowledge, the above subgroup is dominant with 1357 different items, more than

Table 1 Summary statistics for the category of Manager occupation (numbers in parentheses are standard deviations)

Subgroup	Occupations	Skills and knowledge	Average skills	Average knowledge
Chief Executives, Senior Officials and Legislators	25	256	14.1 (7.64)	4.6 (2.22)
Administrative and Commercial Managers	57	668	18.1 (7.41)	5.6 (2.81)
Production and Specialized Services Managers	184	1357	19.1 (9.12)	5.67 (2.94)
Hospitality, Retail and Other Services Managers	70	523	26.1 (5.03)	3.54 (2.14)

double that of the subgroup of "Administrative and Commercial Managers". Taking into account the average number of skills per different occupation, the subgroup "Hospitality, Retail and Other Services Managers" is the most demanding with almost 26 skills on average. The extended number of skills is compensated by a low average knowledge (3.5), as shown in the last column of Table 1. The average number of skills consistently exceeds the average number of knowledge, indicating that the manager's work is skill-oriented overall.

Demand Side of the Labour Market

A critical question was how association rules may represent the demand side of the labour market. Our empirical findings imply that viewing top rules in a graph format based on the support measure is sufficient for understanding market needs since it retains just those roles that appear frequently in the data. As a result, graph-based visualization depicts the most popular paths and provides a comprehensive description of the demands on skills and knowledge.

Figure 2 shows the four visualizations of the association rules with the highest support value. Apart from the Hospitality, Retail, and Other Services Managers subgroup that reached a support value close to 66% due to the high similarity in the documented job specifications, the support levels observed in the other three subgroups were above 25%. This means that 25 out of 100 jobs follow the proposed rule and we consider it an adequate level of resolution. In Fig. 1a, it is apparent that two disjoint graphs are created and the top graph reflects the needs of private companies, while the bottom graph represents the requirements of public organizations. A vast majority of the C-Suite job specifications were found in this category and the

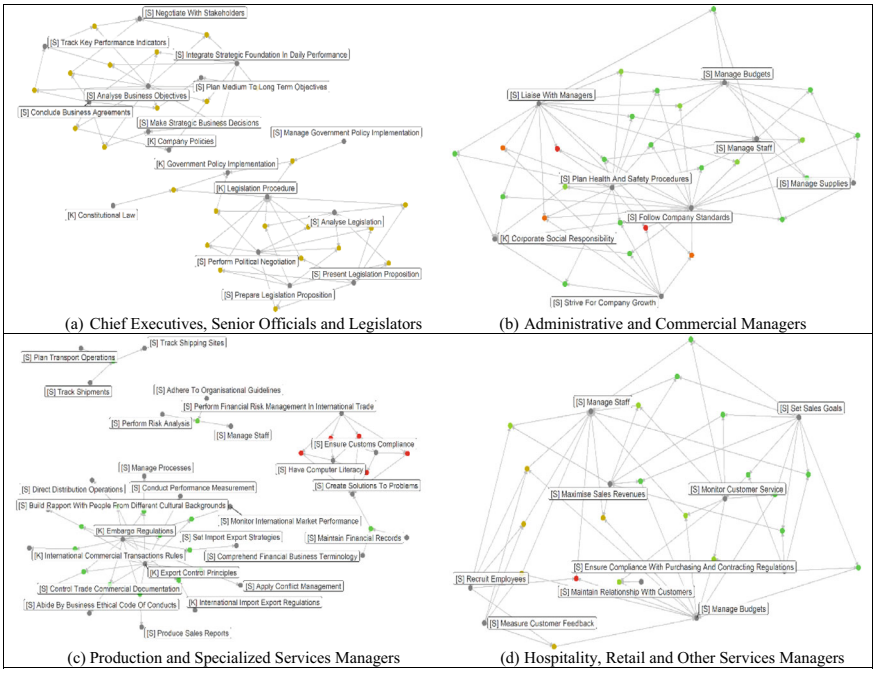

Fig. 1 Graph based visualization of association rules for labor demand side

experts agreed on the distinction as well as the items listed and their interconnectedness. Figure 1b illustrates the skills and knowledge requirements for the white-collar managerial professions and the most well-connected item is the follow-up skills of the company standards. In other words, managerial control and the implementation of company policies are highly regarded on the agenda of the job market. The discussion with experts revealed that this point might also explain to some extent the resistance to change demonstrated primarily by mid-level management (Prosci, 2023).

Figure 1c is of special interest because most of the job specifications are found in this category. The graph was composed of 4 different components. Two components picked our interest and displayed distinct characteristics. The first component demonstrated frequent interactions of skills and knowledge for implementing international trade and related financial issues. The second one focused on the planning aspect of international trade, specifically on the provision of computer literacy solutions to deal with financial risks. In other words, the group labour demand side requirements for the Production and Specialized Services Managers are to manage complex organizational, trade and production settings (e.g. supply chain) and provide solutions for international imports/exports as well as streamline the financial records. Finally, the Hospitality, Retail and Other Services Managers subgroup (see Fig. 1d) revealed the importance of managing resource management (employees and budgets) for a

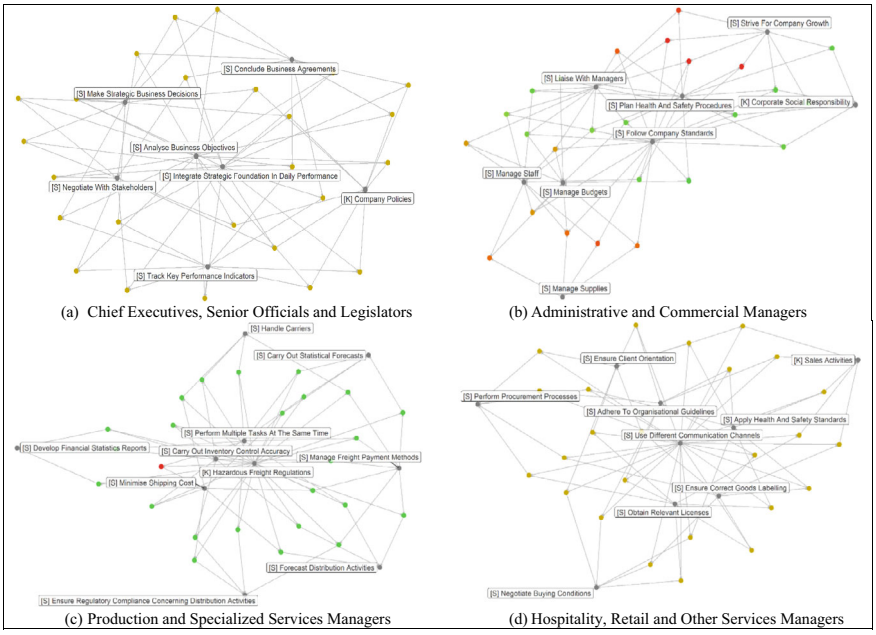

Fig. 2 Graph based visualization of association rules for labor supply side

typical store manager, which was expected and added little value to the discussion with the expert.

Overall, we found it interesting that the graph-based visualization of the association rules provided insights into the labour market's demand side by motivating the expert to discuss niche areas of job requirements. Illustrations of association rules were highly reflexive, resulting in a discussion of current job requirements.

Supply Side of the Labour Market

In this section, we present the results of the rules' graphs, as they emerged, for the labour market supply side. The lift value of the association rules in two subgroups (Chief Executives, Senior Officials and Legislators and Production and Specialized Service Managers) was found to be very high (Lift > 5.5) indicating a strong correlation between selected skills and knowledge. In the first subgroup, which contains Chief Executives, Senior Officials and Legislators, it was found that the most important knowledge is Government Policy Implementation followed by the skill Manage Government Policy and Implementation. In the rules graph, we notice that the most strongly interconnected nodes are the skills Analyse Business Objectives and the Integrated Strategic Foundation in Daily Performance. That practically means that persons who can analyse and integrate business principles and objectives in their daily

business life, can enable the development of the skills named as Make Strategic Business Decisions, Negotiate with Stakeholder and Acquire the Knowledge of Company Policies, because it is the gateway for the implementation of corporate strategy.

The group of Administrative and Commercial Managers demonstrated that the most significant knowledge is Corporate and Social Responsibility followed by the skill Manage Budgets. From the analysis we noticed three strongly interconnected (high degree) nodes namely Follow Company Standards, Plan Health and Safety Procedures and Liaise with Managers.

For the group Production and Specialized Service Managers it has been already revealed that the most important skill is the Manage Staff skill, followed by the Create Solutions to Problems skill. From the graph it appears that the most strongly connected nodes are the knowledge about Hazardous Freight Regulations. Moreover, the skills Carry Out Inventory Control Accuracy and Perform Multiple Tasks at the Same Time were found as the most important. From the analysis, it appears that at least one of those two (Hazardous Freight Regulations and Perform Multiple Tasks at The Same Time) gains value when followed by other skills addressing forecasting and inventory control methods.

Finally, for the Hospitality, Retail and Other Services Managers group, the most important skills appeared to be Manage Staff & Manage Budget. From the graph it was seen that the most strongly interconnected node is the skill Use Different Communication Channels, which is the basis for all the other nodes such as the skill Ensure Client Orientation, and is the basis for the acquisition of knowledge Sales Activities. Also strongly connected nodes appeared the skills Adhere to Organizational Guidelines and Apply Health and Safety Standards.

5 Discussion

The results presented in the previous section reveal the existence of two distinct orientations between managers, namely: (a) a knowledge-intensive orientation versus (b) a skills-intensive orientation. Chief Executives, Senior Officials, and Legislators have a knowledge-intensive orientation, while the remaining categories are skills-orientated. Results are consistent with prior findings (Kargas 2022) and apart from the skills versus knowledge orientation reveal that most frequent skills and knowledge are not always the most well connected.

Almost all job specifications reviewed are skill-dependent, a result consistent with previous research estimating that by 2030 soft skills will be the basis of nearly 66% of all professions. The results presented in the previous section were discussed with field experts from the Greek business environment who work in managerial positions. The discussions revealed that these experts were more likely to agree with rules that had a lift value greater than 2. It should be kept in mind that lift quantifies the importance that a rule has. A lift value greater than 2 indicates an interesting pattern and that idea was supported empirically by the experts. The Hospitality, Retail and Other Services

Managers subgroup demonstrated lift values below 1.5, thus we were not able to identify worthy correlations between skills and knowledge.

The proposed methodology, based on association rules, provided a useful framework for understanding and interpreting both the demand and supply sides of the labour market. By using the top rules based on support measure, useful information was extracted regarding the structure of job specifications in the labour market (demand size). Patterns that appear frequently reveal which skills and knowledge are valuable. On the other hand, by using the top rules of the lift measure, it is possible to provide consultation about the skills and knowledge that are worth developing (supply side). These skills and knowledge seem to be the most promising and provide additional value when looking ahead to the future. Covering both the demand and supply sides of the labour market can provide added-value information for employers and employees, but moreover, it can point out areas for lifelong education when it comes to educational institutions. The findings suggest that lifelong learning is necessary due to the substantial importance of skills in the labour market. Practically speaking, the findings show that the most frequently (common) occurring knowledge or skill within a managerial subgroup is not necessarily the most significant one. Rearranging the data structure of the ESCO database would allow it to take a more proactive stance in reframing job descriptions and separating critical skills from obvious and self-evident skills.

The presented study has certain limitations due to the data source. First, the job categories exclude those that are widely regarded as being highly influenced by digital technologies. Furthermore, the data are a few years old and are based on current jobs rather than expected jobs in the future. These limitations can be explained by the EU's bureaucratic nature, which focuses on managing available professions rather than planning for new job market requirements. Because jobs appear to be changing rapidly and digital skills are becoming increasingly important, ESCO should update its data more frequently. Instead of recording current deficiencies, it could forecast digital skills needed in the next ten or more years. By using ESCO's data in its current state, researchers accepted that the evaluation of the findings is solely based on expert opinion and judgement. External data sources could be used to enrich the results. Moreover, it should be noted that the ESCO framework has certain challenging characteristics:

- Lack of leadership skills: There are no skills directly related to leadership, despite the fact that management theory recognizes its importance both for companies and managers.
- Lack of digital component: Few digital skills seem to have a substantial role in managerial job specifications. Digital transformation is enabled by the knowledge and skills of the manager, as discussed with the experts. A possible explanation is that the ESCO framework was not sufficiently updated to reflect the new reality, taking into account that the role of manager is crucial to all the steps of digital transformation.
- Bias on resource management skills: There is a bias toward resource management skills, placing emphasis on supply chain management and international trade.

- Unbalanced subgroups: The subgroups of managers as organized in the ESCO framework are unbalanced, and most of the job specifications are classified under the subgroup of Production and Specialized Services Managers. We consider this an indication that ESCO has been developed to reflect the accreditation of skills and knowledge acquired by a typical educational system and, as result, undermine the role of soft skills.

It will be interesting for future research to review additional professions supported by the ESCO framework in order to develop a broader perspective regarding skills and knowledge and to shape a more holistic picture about how job specifications are structured. Moreover, it would be useful to validate managers' patterns that are presented in results with third-party data sources. That would be useful not only to increase credibility but also to enhance the scope of the findings. Finally, the Department of Labor of the United States supports the O*Net and we argue that it is worthy to conduct research that combines data from ESCO and the O*Net.

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Soft Skills for Responsible Leadership in the Digital Age: A Framework for Future Leaders

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Abstract The increasing focus on sustainable development and corporate social responsibility has led to a growing demand for responsible leaders and companies that can effectively address environmental and social challenges. The digital age has further complicated this landscape, reshaping the dynamics between organisations, society, and individuals through the intensification of digitalisation processes. As a result, non-cognitive competencies have emerged as a crucial differentiating factor for professionals operating within this context. The research question that guides this study is "What competencies are needed to develop responsible leaders' soft skills to face the socio-environmental issues and the challenges of digitalisation? Drawing on a Systematic Literature Review to identify primary soft skills indicated by the literature and the Delphi method seeking validation with specialists, this paper proposes a soft skills framework to help develop responsible leaders capable of dealing with socio-environmental issues and the challenges of digitalisation.

1 Introduction

Despite the initiatives to address major social, economic and environmental concerns, we have seen increased environmental degradation, political and institutional corruption, and inequality. All these issues have alerted society to a fundamental change in global challenges (Corriveau, 2020). This critical change requires preparing responsible leaders (Schiuma et al., 2021) with new skills, knowledge, attitudes, values and

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principles to guide their decisions and succeed in shaping a better future (Muff et al., 2020).

In recent years, the labour market has undergone significant changes. Many jobs and roles have undergone substantial transformations due to the emergence of new digital technologies, resulting to the need to re-educate and re-train a significant number of employees (Someshwar & Kerner, 2013; Villani et al., 2018). In certain industrial sectors, artificial intelligence now performs specific tasks, necessitating employees to develop different, unique, and distinctly human skills (Roy & Edan, 2020). Consequently, non-cognitive competencies are increasingly gaining prominence as a competitive advantage for professionals (Bustreo et al., 2018; Schiuma et al., 2021).

In this path, digitisation increases transformational complexity by reconfiguring the relationships between organisations, society, and individuals. It is characterised by technologies that increase the speed and breadth of knowledge turnover in the economy and society (Winfield & Ndlovu, 2019).

Education systems generally reflect society's aspirations. At the same time, the need to create new outcomes through the learning process increasingly calls for an educational system that develops and disseminates new curricula, learning methods, research, while it also promotes innovative capabilities for current and future leaders (Schiuma et al., 2021). Therefore, the accelerated pace of technological, demographic, and socioeconomic changes is transforming industries and business models and changing the necessary skills for managers and employees (Vaidya et al., 2020).

These new configurations allow us to understand which are the non-cognitive competencies that new leaders will need. Soft skills are competencies related to dealing with emotions on a personal and collective level (Wats & Wats, 2009). Since these skills depend on the ability of individuals to interact with other people, they relate more to "personal competencies" and less to theoretical knowledge, they go beyond professional technical requirements, and operate in a direction somewhat separated from the role of the individual (Albandea & Giret, 2018). In addition, they are identified as a factor in increasing employability, professional performance, and leadership skills, especially in digitalisation (Benson, 2018; Vaidya et al., 2020).

The research question that guides this study is "What competencies are needed to develop responsible leaders' soft skills so they can face the socio-environmental issues and the challenges of digitalisation?

This paper proposes a soft skills framework to help develop responsible leaders that are capable of dealing with the socio-environmental issues and the challenges of digitalisation by using a systematic literature review (SLR) methodology to identify primary soft skills indicated by the literature and the Delphi method seeking validation with specialists.

2 Theoretical Background

The Digital Age and the Transformations in the Labour Market

According to Kazancoglu and Ozkan-Ozen, industrial revolutions have always been triggered in history by technological developments, first by using steam and water power in the industry, then by the use of electricity, then by mass production, and finally by the use of information technology and automation; these were the fundamental concepts of the first three industrial revolutions.

The new industrial paradigm of the Fourth Industrial Revolution is at the centre of contemporary debates. Industry 4.0 is a socio-technical system that reconfigures the relationship between people and organisations, technologies and production systems, and production and consumption (Mumford, 2003), and proposes a new relationship between society and industry on behalf of the digitalisation process. Global digitalisation has changed not only the economic view but also the social view of the world. The digital age is determined by continuous flows of data containing information, knowledge, ideas, and innovations (Okhrimenko et al., 2019). We are experiencing a period of significant technological disruption. Technology is progressing rapidly, and today's organisations face massive changes (Colbert et al., 2016).

The labour market has transformed considerably. Many jobs for which people were educated and trained have changed significantly, and their configuration is determined by the emergence of new digital technologies (Roy & Edan, 2020; Villani et al., 2018). Artificial intelligence now performs specific tasks in several industrial and other sectors, forcing employees to exercise different, unique, human-like skills (Someshwar & Edan, 2017). According to Erol et al. (2017), the skills of the future are lifelong dedication to learning, social, personal and decision-making skills, leadership skills that involve complex interactions within a society as a whole, individual groups within that society, and the work environment, as well as skills that enable a critical perspective on technological progress and research.

The implementation of new technologies affects both employees operating in industries and organisations. The competency framework problem implies a three-dimensional approach involving the company's management level, the production process fields, and the types of competencies (Erol et al., 2017).

Leadership assumes a crucial role since digitisation occurs through the application of new technologies and their correct and ethical use (Bolte et al., 2018). Thus, leadership styles for I4.0 need to be open and geared toward a learning- and innovation-oriented culture, focusing on improving knowledge and thinking "outside the box" (Sivathanu & Pillai, 2018). In addition, digitalisation is characterised by the need for responsive leadership capable of meeting situations adaptively (Kelly, 2018).

Non-cognitive Skills: Concepts and Definitions

Non-cognitive competencies connect to personality, goals, motivations, and preferences valued in the labour market, education, and many other domains (Heckman & Kautz, 2012). There are several related denominations for the term non-cognitive skills: life skills (WHO, 1997); soft skills (Wats & Wats, 2009); skills for the twenty-first century (Aniadou & Claro, 2009); social-emotional skills (Boyatzis, 2009).

It should be noted that non-cognitive skills are firmly linked to plastic, sensitive, and elaborative skills, and are distinguished from cognitive skills, also called hard skills and technical skills, which indicate specific capabilities for performing a particular job, also to be defined as intelligence or acquired knowledge (Ricchiardi & Emanuel, 2018).

Non-cognitive competencies are linked to developing skills that assist in emotional awareness, constructive decision-making, proper goal-setting, and interaction with other individuals (Rivers et al., 2013). Heckman et al. (2006) reported that the impact of non-cognitive skills, such as motivation, self-esteem, or perseverance, can sometimes surpass cognitive skills' influence on academic success and the job market. Several other studies have explored employers' requirements regarding more general skills, proving that graduates with non-cognitive competencies are generally perceived as more employable (Andrews & Higson, 2008; Ito and Kawazoe, 2015; Taylor, 2005).

Over the past decades, research has consistently supported that non-cognitive skills can yield positive outcomes for professionals, particularly recent graduates. These are associated with a higher level of employability (Bowles and Gintis, 1976; Heckman et al., 2006; Someshwar & Edan, 2017; Tsarouchi et al., 2017) by achieving better professional performance and enhancing leadership skills that are crucial in the disruptive context of the digital era (Benson, 2018; Vaidya et al., 2020).

These are skills that operate in a direction somewhat separate from the role of the individual and go beyond the technical professional requirements, relating more to "personal skills" and less to theoretical knowledge. They depend on the ability of individuals to interact with other people (Albandea & Giret, 2018) and require the integration of affective, cognitive, and behavioural systems (Spinrad et al., 2006) from a broad perspective that can be built under two domains: intrapersonal and interpersonal skills.

Genc et al. (2016) described intrapersonal skills as those that are put into an individual mindset. Intrapersonal skills deal with feelings, thoughts and emotions internally aroused in individuals (Vijayalakshmi, 2016), and refer to self-concern and assist in regulating emotions (Chong et al., 2020). These skills are not visible, and others may not perceive them, given the nature of intrapersonal skill as a skillset that exists or occurs within the self or mind of the individual (Dadich & Olson, 2017).

Interpersonal skills are perceptible to others and configure an individual's competence to interpret and manage their feelings, actions, motivations, as well as those of others in social contexts (Vijayalakshmi, 2016). These are also life and personal skills

because they help individuals relate and communicate with others and groups (Chong et al., 2020). Thus, non-cognitive competence comprises three skills: (a) identifying the emotions that other individuals are expressing, (b) recognising and demonstrating one's own emotions, and (c) self-regulating emotions for social interaction (Garner, 2010).

Emotional Inteligence

A non-cognitive competence that most experts list as very important is emotional intelligence (Cimatti, 2016; Vaidya et al., 2020). Emotional intelligence can be considered intrinsic to the individual personality, but can also be optimised through attention and development (Boyatzis, 2009). Everyone is born with a level of emotional intelligence, but it is possible to enhance it. Goleman (1995) states that emotional intelligence is another dimension of knowledge that is more effective than rational intelligence in achieving accomplishments at different areas of life.

The definition of emotional intelligence (EI) was first presented by Salovey and Mayer (1990) as the ability of an individual to monitor their own and others' emotions, to distinguish between the positive and negative effects of emotions, and to use emotional information to guide their thoughts and actions. According to Goleman (1995, 2004), emotional intelligence is a set of emotional characteristics or skills that can motivate and suppress desires, identify and control emotions, and handle interpersonal relationships effectively.

According to Singh (2006), emotional intelligence reflects the ability and freedom to evolve from distrust to trust, from doubt to self-strengthening, from failure to trust, from isolation to synergy, and from disappointment to hope. EI is a powerful combination of deep insight into one's emotional and cognitive capacity and an empathetic and inspiring style, contributing to personal success, interpersonal confluence, and organisational excellence (Mohan, 2003).

3 Methodology

A qualitative approach investigated the non-cognitive competencies crucial for responsible leaders in the digital age. According to Cervo and Bervian (2002), qualitative research aims to understand, based on qualifiable data, the reality of established phenomena from the perspective of various social actors. Moreover, this approach contributes to comprehending the multiplicity of relationships among individuals and the patterns of analysis in modern society (Flick, 2009).

Furthermore, to achieve a deeper understanding of the non-cognitive competencies for responsible leadership in the digital age, a systematic literature review (SLR) was conducted to encompass and provide insights that will help us (i) identify the impacts of the digital age on the labour market and the role of leadership in the business

management literature, and (ii) analyse the role of higher education in Management for the development of responsible leaders.

The first research step was based on the SLR metyhodology (Denyer & Tranfield, 2009) to understand how this thematic research area has developed (Amui et al., 2016; MacLure et al., 2016). Web Of Science and Scopus platforms were analysed to map the literature from 2010 to 2021.

The applied research strings used were: "Industry* 4.0" AND ("Emotio* Skill" OR "Emotio* Competenc*"); "Digital Manufaturing" AND ("Social Skill" OR "Social Competenc*"); "Digital Transformation" AND ("Socioemotional Skill" OR "Socioemotional Competenc*"); "Fourth Industrial Revolution" AND ("Non-cognitive Skill" OR "Non-cognitive Competenc*"); "Advanced Manufacturing" AND ("Soft Skill" OR "Soft Competenc*").

The initial stage of the review involved the selection of 65 articles from the Web of Science and Scopus databases, with seven identified as duplicates. The exclusion criterion was based on whether the articles were relevant to the theme (digital era/workforce transformations/leadership). Articles in English and from journals were considered literature to support the framework.

By following the research protocol adopted for the systematic review, 15 articles that adhered to the theme were selected. The framework items comprised the competencies: '**solving complex problems**', 'communication', 'interpersonal relationship', 'management and collaboration', 'openness to the new', 'self-management', and '**perception and self-orientation**.

In the second stage, we applied the Delphi method (Okoli & Pawlowski, 2004; Rowe et al., 1991) to validate the framework (Markmann et al., 2021). The Delphi method is an anonymous research technique that involves multiple rounds, where the aggregated opinion of a panel of experts is calculated and fed back after each round (Markmann et al., 2021). Rowe et al. (1991) emphasise that the number of rounds can vary, although it often is at most two iterations, during which most changes in panel members' responses typically occur. The Delphi technique is considered effective in obtaining consensus by employing a set of predefined questions to gather data from a group of experts (Dalkey & Helmer, 1963; Scholl et al., 2004).

In assembling the panel, priority was given to experts in the Human Resources field, including executives, managers, and consultants who have been working in the industry for at least one year. The sample consisted of professionals with one to thirty years of experience in the field. Additionally, panellists included those who work in or for companies with sustainability-oriented policies and implemented digitalisation processes, as well as those who need to possess these characteristics.

The two Delphi rounds were structured on the Google Forms platform, and 23 specialists analysed the seven core competencies and their respective knowledge, skills, and attitudes through a Likert scale that varied between minor significant, unimportant, neutral, meaningful, and critical. The three main questions addressed were (i) whether the experts would keep the assigned answers to the previous questionnaire; (ii) how each of the seven groups of competencies can help responsible leaders exercise leadership in the context of the digital age; and (iii) which competencies, among the ones selected or others, the experts judged as necessary. During

the first round of the Delphi method, the experts showed a high level of agreement with the framework developed based on the literature regarding the non-cognitive competencies for responsible leaders in the context of the digital age.

Following the completion of data collection in the second round, the acquired data were tabulated, and an assessment of the trade-off between the feasibility of conducting a new round and the potential gain to be achieved was undertaken. Content analysis of the Delphi rounds' data was employed to analyse the obtained data (Bardin, 2011). This technique facilitated the categorisation of data into analysis clusters that contributed to the structuring of the framework.

4 Results and Discussion

The first stage of applying the SLR protocol resulted in 15 articles. It could be observed that there was initially an increase in the demand for professionals with higher technical skills (Golowko, 2018; Jerman et al., 2020). However, research has indicated that as digitalisation became more widespread and matured, non-cognitive competencies became increasingly required as a differentiating factor in the context of the digital age (Jerman et al., 2020; Woods et al., 2021).

Furthermore, non-cognitive competencies enable a better understanding and utilisation of technologies, allowing for the more effective harnessing of their potential (Egcas, 2019). Additionally, in a complex environment with a high demand for speed and the resolution of complex problems, professionals capable of managing their emotions, being resilient, creative, flexible, and critical thinkers are needed (Jerman et al., 2020; Zeidan & Bishnoi, 2020).

This context creates a disparity between newly graduated professionals and the needs of the job market in the digital age, prompting higher education institutions to reconsider how these professionals should be prepared and which competencies need to be included in the curriculum (Goulart et al., 2021; Low et al., 2019; Zeidan & Bishnoi, 2020).

From the 15 reviewed studies, three trends can be highlighted in the literature:

(a) Technical skills are no longer the focal point in the digital age work context, and there is a growing concern in analysing non-cognitive competencies as allies, either in enhancing employability or fostering human capital.
(b) Most studies focus on identifying competency gaps between the demands of the digital age scenario, how students are being prepared, and determining the lack of necessary competencies for professionals in this context.
(c) Non-cognitive competencies are identified as a factor that can contribute to better performance in leadership positions in the digital age context.

In addition, given that there is a growing concern to analyse non-cognitive skills as allies, either for increasing employability or for fostering human capital in the digital age (Egcas, 2019; Golowko, 2018), it was found that non-cognitive skills are

a factor that can contribute towards better performance in leadership positions in a continuously changing environment (Schiuma et al., 2021).

According to Spreitzer et al. (2012), it is worth noting that there are many reasons for managers to be concerned with human growth and sustainability. The foundations of responsible leadership are based on social and moral issues that have gained particular relevance not only due to corporate scandals, but also due to urgent issues affecting life on our planet and the realisation that firms and their leaders can contribute significantly towards to a better world (Pless, 2007).

It is worth noting that the highest disagreement was centred around using intuition to understand the essence of something or a situation, with seven out of twenty-three experts providing responses ranging from unimportant, slightly necessary, to moderately important.

Expert R3 stated, "I disagree with the question about intuition. Decisions should be based on data and facts." However, Hallo and Nguyen (2022) argue that senior leaders are currently exposed to increasing amounts of data that must be processed quickly, and the use of tacit knowledge acquired through intuition can enable a more holistic understanding of the profound nature of current problems. Okoli (2020) investigated the use of intuition in complex crises and the need for flexible and creative responses, with experienced experts likely approaching complex problems through intuitive and deliberative styles. According to Keller and Sadler-Smith (2019), analysis and intuition can be combined as a paradox that comprises contradictory yet interdependent and important elements.

Another point to highlight is that all the items that integrate knowledge related to the competency groups had at least one respondent who provided a response ranging from unimportant to moderately important. Expert R2 commented during the first questionnaire: "In my understanding, attitude should prevail over knowledge and skill. It is pointless to have a highly technically qualified professional if they do not have the attitude to utilise all their knowledge and skill." This may suggest that knowledge is underestimated because it is in the theoretical rather than practical realm.

Some items (knowledge, skill, and attitude) integrated the competency groups analysed by the experts, which received responses ranging from essential to very important. These include effective communication (skill)—communication; openness to new things and learning (skill)—openness to new things; and resilience (attitude)—self-management. This indicates a greater tendency to consider more practical items as necessary.

It is important to note that there was a propensity to provide responses ranging from unimportant to moderately critical (neutral) among the experts, according to the theory of generational cohorts (Inglehart, 1977). This was observed as there was almost a predominance of this type of response from experts belonging to generation X (1965–1982/57 to 40 years old), and characteristics associated with this generation include individualism, self-confidence (Murphy and Gibson, 2010), and scepticism.

The second round of the Delphi method allowed experts to analyse the responses attributed to the group and make changes accordingly. However, the panellists who participated (12 participants − 52.2%) chose to maintain their responses and

answered how key competencies could assist responsible leaders in the context of the digital age.

There were themes with a higher number of responses that deserve highlighting. Complex problem-solving was identified as a competency enabling creative and innovative thinking to solve new and constantly changing situations arising from the digital age (R2, R4, R5, R7, R8, R9, R10, R11, R12). The majority indicated communication as a competency facilitating better relationships, synergy, and conflict resolution in challenging and rapidly changing times due to digitisation (R2, R3, R7, R10, R12). The competency of interpersonal relationships encompassed two major themes. First, it helps achieve goals as it can direct the team to work with high potential, producing more and achieving tremendous success (R4, R5, R6, R8, R10, R11). The second theme relates to improving the organisational climate, generating greater motivation and engagement among subordinates (R1, R2, R3, R7, R9, R12).

Collaboration was identified as a necessary competency for leaders, as it fosters the integration and cohesion of subordinates, enabling them to work together towards common goals and optimise results (R2, R3, R5, R7, R8, R9, R10, R11, R12). Openness to the new, was indicated as a vital competency, because it allows someone to reinvent themselves, something especially important in the digital age, where leaders need to be prepared to deal with new situations and challenges, and seek new opportunities and ways of exercising leadership to adapt to the digital context (R2, R4, R6, R7, R8, R9, R10, R11, R12).

Experts indicated that self-management is also an essential competency for responsible leaders in the digital age, as it is necessary to manage one's own emotions to achieve self-control, to regulate feelings, and to manage one's career (R2, R4, R6, R7, R8, R9, R10, R11). Finally, perception and behaviour were important critical competencies as leaders need to act cohesively and be guided by ethics regarding how they think, conduct themselves (R1, R5, R9, R11) in order to motivate and inspire their team (R2, R4, R7, R12).

The experts indicated other competencies related to the seven key groups. The most frequently mentioned are generally linked to empathy and assertive communication (R1, R3, R4, R5, R6, R9, R10, R11, R12), creativity and thinking outside the box (R1, R2, R4, R9, R10, R11, R12), calmness and patience (R1, R2, R3, R4, R9, R10, R11), and ethics and personal values (R1, R5, R6, R7, R9, R11, R12). It is worth noting that assertive communication is encompassed within the critical communication competency, while calmness and patience are part of self-management. Finally, ethics and personal values refer to the competency of perception and behaviour. At the end of the second round of the Delphi method, panellists could offer suggestions for competencies that responsible leaders in the digital context should possess, independent of the critical competencies analysed. The most frequently mentioned competency was mediation and negotiation, which are correlated and were mentioned by respondents R3 (mediation), R9, and R10 (negotiation), which can be encompassed by the vital competency of communication (inspiring group cohesion/attitude).

The results of the rounds with the specialists are consistent within the framework (Table 1), in which the specialists observed minor changes.

Table 1 Soft skills framework for responsible leaders in the digital age

Competencies	Knowledge	Skills	Attitude
Solving complex problems	To know how to assess the complexity of problems	Being culturally aware—awareness of, respect for, and appreciation for different cultures	Being guided by a critical sense
Communication	To be aware of the importance of communication skills	Using effective communication	Inspiring group cohesion
Interpersonal relationship	To Know how to evaluate the role of social skills—interpersonal relationships	Having emotional intelligence	Being tolerant
Management and collaboration	Master leadership skills	Possess team spirit stimulating talents and group cohesion	Act with initiative and collective purpose
Openness to the new	To achieve entrepreneurial thinking—attitude, initiative, thinking about new methods, and executing actions	Being open to the new and learning	Being motivated to deal with new situations
Self-management	To know how to recover from problems or stress	Having the ability to persist in the face of adversity	Being resilient
Perception and orientation	To know how to guide yourself by a transforming vision and encourage engagement in different contexts	Using intuition to understand the essence of something or a situation	Act in accordance with ideals and goals

Concerning the competency of **complex problem-solving**, it was identified as enabling creative and innovative thinking to help solve new and constantly changing situations arising from the digital age.

The majority indicated the competency of **communication** as a facilitator of better relationships, synergy, and conflict resolution in difficult times and rapid change due to digitisation. The competency of **interpersonal relationships** covered two significant themes: first, helping to achieve the objectives since it can contribute to directing the team to work with high potential, producing more and therefore achieving tremendous success; the second concerns helping to improve the organisational climate, generating greater motivation and engagement among those led.

The competency of **management and collaboration** was pointed out as necessary for leaders, as it collaborates with the integration and cohesion of those being led, making them work in a way that seeks common goals and optimises results.

Regarding the competency of **openness to the new**, it was indicated as vital because it is necessary to reinvent oneself in the face of the digital age, which demands that leaders are prepared to deal with new situations and challenges, seeking new opportunities and ways of exercising leadership to become adjust to a digital context.

Specialists indicated that **self-management** competency is essential for responsible leaders in the digital age, as it is necessary to manage one's emotions to have self-control and regulate feelings and one's career. For **perception and orientation** competency, the leader must act cohesively about how he thinks and acts, be guided by ethics, and motivate and inspire his team. It should be noted that this last key group had the most significant disagreement focused on the ability to use intuition to understand the essence of something or a situation. However, using tacit knowledge acquired through intuition can allow a more holistic understanding of the profound nature of current problems (Okoli, 2020).

Other competencies related to the seven key groups emerged. The most cited ones, in general, were those related to empathy and assertive communication, thinking "outside the box," creativity, orientation to calm, patience, ethics, and personal values. It should be noted that assertive communication is included in critical competence communication, while calm patient orientation is part of self-management. Finally, ethics and personal values refer to perception and orientation competence.

5 Concluding Remarks

The proposed framework contributes to the literature on competencies, leadership, sustainability, digitisation, and education management. Analysing non-cognitive skills for responsible leaders oriented towards digital transformation is essential, as these skills become critical for professionals and leaders to face the challenges of the digital landscape and promote sustainable development.

Also, this paper contributes to the formation and management of responsible leaders capable of facing the continuous interconnection of all business sectors and adapting actors to the digital economy's requirements without failing to combine organisational performance with ethics and sustainable development.

Research limitations are linked to the possibilities of expanding the perception of soft skills in different economic, socio-political and environmental contexts and scenarios. Future research may seek to establish metrics and parameters to quantify these key competencies highlighted by the framework and conduct an analysis between different organisational contexts based on the digitisation perspective.

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Business Education in the Digital Era

Educating Marketers for the Digital Future

Neal J. Roese, Silvana Dakduk, and Can Uslay

Abstract Marketers are living through an unprecedented time of transformation, hinging on a massive increase in the acquisition and depth of information about consumer preferences and unlocking more efficient targeting of marketing communications and product development. We review insights gathered through the Management Curriculum for the Digital Era (MaCuDE, https://macude.org/) initiative, which aims to specify the educational requirements for the next generation of business leaders. The changing nature of marketing places Artificial Intelligence as the pivotal central theme connected to three challenges for future training: omnichannel distribution, proximity marketing, and ethical considerations. In addressing these challenges, we make education recommendations for each of three emerging roles for marketing professionals in the new digital economy: (1) Marketing Analyst, (2) Digital Strategist, and (3) Digital Transformer.

1 Introduction

In the contemporary landscape of marketing, professionals find themselves at the confluence of unprecedented transformation, a paradigm shift fueled by an exponential emergence in the acquisition and depth of consumer information (Pinheiro et al., 2018). This emergence, facilitated by the omnipresence of digital platforms, has not only redefined the contours of marketing communications but has also unlocked new dimensions in product development, propelling organizations towards superior revenue and sustained growth. The imperative for marketers to adapt to this

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information-dense ecosystem is compelling, necessitating a profound reevaluation of the educational frameworks employed by business schools worldwide (Williamson et al., 2022).

This chapter explores the imperative for educational evolution through a lens focused on the Management Curriculum for the Digital Era (MaCuDE) initiative, spearheaded by the Association to Advance Collegiate Schools of Business (AACSB). MaCuDE is a global initiative for the analysis and review of business school curricula with the intention of specifying the essential educational requirements that will guarantee the relevance of academic training for future generations of business leaders.

The task force in this project corresponding to Marketing was developed with the participation of nine business schools and efforts were structured in three phases. The first phase involved an analysis of the curricular content of marketing courses and programs globally to identify key trends and best practices. The second phase collected input from industry professionals and university professors regarding their observations of emerging educational needs. The third phase aimed to synthesize insights from the previous phases in order to specify recommendations for curricular reform in marketing education to better suit the needs of the future digital business environment.

Our analysis not only highlights the urgency of recalibrating marketing in terms of its content, themes and pedagogical development, but also considers tools such as artificial intelligence (AI) as the central axis of this transformation. The proposal for this transformation recognizes three challenges that confront marketers and educators alike: omnichannel distribution, proximity marketing, and ethical considerations. In addressing these challenges, we articulate a tripartite framework that delineates the evolving roles of marketing professionals in the emerging digital economy. These roles, namely the Marketing Analyst, Digital Strategist, and Digital Transformer, correspond roughly to the educational tiers of undergraduate, Master of Science, and MBA degrees, reflecting the nuanced progression of expertise and responsibility across career stages.

2 Trends in Digital Marketing

A brief summary of the changing nature of marketing places Artificial Intelligence (AI) as the pivotal central player that embraces and feeds into (1) Hyperpersonalization, (2) Precision, speed, and efficiency in marketing decision-making, (3) Algorithm-based ad buying, and (4) Universality of data and analytics in marketing operations.

AI automates, accelerates, and increases the precision of targeting, defined as the matching of a company's offerings to specific customer segments or profiles. First, AI enables hypoerpersonalization. That is, the current era of hypertargeting involves hyperpersonalization, meaning that both the product and the messaging that advertises that product may be customized to address micro-segments and even

the specific preferences of single individuals. Second, AI serves marketing in the realm of predictive analytics, which is the marshaling of vast quantities of data to extract statistical summaries of the interactive relations among input factors (e.g., customer demographics, prior behaviors) that are effective at forecasting future demand. Precision is a key benefit of AI: "The automated decision-making of AI reduces manual guesswork from marketers who try to personalize a customer's experience. This presents various marketing opportunities in the areas of content strategy, campaign strategy, product delivery, sales strategy, sales intent, retargeting, and more." (Kumar, 2021, p. 37). Companies increasingly use AI to meet demand with greater speed and efficiency than was previously possible. Third, the advertising market has evolved from one of slow purchases of blocks of media time to an automated auction-based marketplace in which advertisers buy digital ad placement more by algorithms than by human interaction, resulting in accelerated advertising dynamics. Fourth, marketing increasingly depends on the wrangling of large data and the leveraging of AI to personalize products. Thus, digital technology will enable the automation of extracting customer sentiment to provide faster input into the ideation stage of new product development, messaging, and distribution. All of these trends have profound impacts on consumers and organizations, and consequently on the skills that marketing professionals need to attain, which are summarized in Table 1.

Table 1 Implications of artificial intelligence in marketing—consumer experience, business operations, and professional competencies

Trend	Consumer perspective	Business perspective	Impact on marketing competencies
Hyperpersonalization	Experiencing a uniquely personalized product usage or service encounter via Al	Crafting personalized marketing offerings and messaging to enhance consumer engagement and loyalty	Fosters competence in consumer-centric marketing emphasizing individualized approaches.
Precision, speed, and effciency	Selecting the ideal products and services more easily	Utilizing Al-driven analytics for precise decision-making; optimizing resource utilization	Enhances competence in data-driven decision-making; emphasizing speed and efficiency
Algorithm-based ad buying	Enjoying a seamless and relevant ad experiences due to algorithmic optimization	Optimizing selection and placement of advertisements to enhance campaign effectiveness	Developing competencies in leveraging Al for targeted advertising; improving ROI
Universality of data and analytics	Benefitting from superior product and service solutions spanning diverse categories of offerings	Harnessing vast datasets for insights; informing marketing operations	Cultivating competencies in data analytics; emphasizing a holistic view of consumer behaviour

These four aspects of the changing nature of marketing connect directly to three more specific skill areas for which new marketers must receive training: Omnichannel, Geolocation, and Ethics.

Omnichannel Marketing

The rapid advancement of technology and the proliferation of digital channels have transformed the way businesses interact with their customers. Omnichannel refers to an integrated multi-product distribution approach to the sales function that is oriented toward optimizing customer lifetime value.

The emergence of omnichannel strategies in marketing has brought forth the need for interdisciplinary collaboration, connecting various fields such as human resources (e.g., performance incentives), information management (e.g., ability to track consumers across channels), business informatics, and data analytics (Salvietti et al., 2022). Omnichannel marketing has emerged as a response to this evolving landscape, emphasizing the seamless integration of multiple channels to deliver a consistent and personalized customer experience. However, the successful implementation of the omnichannel approach requires collaboration and interconnection among different disciplines with which marketing scholars may not be highly familiar. Omnichannel is thus an increasingly important skill, ranked number one by the industry leaders who gave input to us.

In practical terms, omnichannel embraces some combination of five key go-to-market routes: (1) direct retail in stores, catalog and e-commerce, (2) wholesaler/distributor/reseller route (i.e., intermediaries or Business-to-Business), (3) Direct-to-Consumer (DTC) using e-commerce of branded showrooms, (4) Amazon/Alibaba platform along with their fulfillment options, and (5) other platforms, from QVC to eBay. Omnichannel reflects the increasing appreciation for the role of platform or ecosystem approaches to business in which the marketing function is unified by a platform but nevertheless deployed in a number of ways (from advertising across different digital means of communication to distribution that embraces both retail and direct-to-consumer). Omnichannel is best executed with a single cloud-based platform that unifies data streams from customers and business collaborators, quantifies customer preference, and manages customer touchpoints in an integrated approach. As such, omnichannel centers on the total customer experience, and anticipates their flexible purchasing via multiple channels, including retail and branded direct-to-consumer web sites.

To see the value of omnichannel in action, consider the example of Amazon, a retail giant born in the digital world. Amazon took an important step toward omnichannel dominance when it integrated its online and offline channels with the Amazon Fresh and Amazon Go retail stores. Amazon deploys AI to manage in-store video and sensors in order to reduce the need for human intervention in the physical retail space. When a customer arrives at the store, their Amazon account is recognized and any product taken from shelves is charged directly to the account upon exit

from the store. It is not necessary to go through the cash register, because there are no cash registers nor employees to collect payment. Such automation allows customers to begin their shopping journey online, transition to a physical store without interaction, and complete the purchase through one digital tool. Importantly, data from both the online and offline customer shopping journey are collected and managed jointly. The richness of customer data permits future personalized efforts calibrated uniquely to individual customer preference. The successful implementation of omnichannel approach, however, requires collaboration and interconnection among different disciplines with which marketing scholars may not be familiar. Overall, through personalization and efficiency, the omnichannel approach holds the power to improve significantly the entire customer experience.

Proximity Marketing

Technological advancements have revolutionized the ability to gather real-time location information through mobile devices, leading to a profound impact on the evolution of proximity marketing (Loussaief et al., 2023). Essentially a powerful computer one can carry anywhere, the mobile phone is the always-on, always-accessible point of connection between customer and firm. Proximity marketing involves the ability to track customers in physical space via their mobile phone, and to personalize messaging unique to customer, time, and place. Perhaps even more important, the mobile phone connects the customer into broader brand communities with increasing power to inform the marketing function by way of product suggestions and enhancements to brand meaning. Further, the mobile phone stands at the center of the omnichannel revolution, in which the means of distributing products and services to customers connects through the phone. An omnichannel platform is a unified digital system by which customers may shop, receive promotional offers, purchase, arrange delivery, and provide feedback. The firm's app is the focal point; sales through other channels (e.g., brick-and-mortar) are increasingly best coordinated in conjunction with the app and doing so provides richer data on customer behavior that may feed back into new product and messaging decisions. Advertising that is not digital (e.g., print, billboard, etc.) may now be coordinated alongside digital ads under a unified platform.

Proximity marketing involves leveraging the concept of closeness between two entities: for example, a customer walks down the street, passes a Dunkin shop, and receives a personalized digital coupon for a discounted Dunkin coffee beverage. The digital coupon is valid only for that particular Dunkin retail location at that particular moment in time. With the availability of location-based data from mobile phones, it becomes possible to identify specific customer locations in relation to retail locations or other predefined virtual boundaries. By facilitating interactivity between mobile devices and proximity hardware, this technology enables the triggering of preprogrammed marketing actions and the delivery of relevant materials to customers at the opportune moment and precise location. Consequently, potential customers

can be influenced and redirected from their initial consumption intentions, allowing marketers to guide their decision-making process effectively. That customer walking down the street could have gone elsewhere for a refreshment, but instead chose Dunkin due to the relevance and immediacy of the marketing messaging. Clearly, the mobile phone currently takes precedence over hardware, but other technologies such as wearables (watch-based or head-mounted) may soon supplant the mobile phone. Regardless, the essential insight is that connecting the customer to the company in real-time with personalized eals brings enormous opportunities for business growth.

Another practice based on proximity marketing is to offer a free Wi-Fi signal. In this regard, Euskaltel, the Spanish telephone company, makes part of its Wi-Fi line available to all users, and drawing on this signal, Euskaltel offers free Wi-Fi connection in key locations in cities. To access the service, it is necessary to be a customer of the company to be able to enjoy the service, and it is also necessary to download the telephone company's application to be able to connect. It is through this app that the company offers messages to its customers, deploying direct and personalized campaigns aimed at the users of its services.

Ethics

Transparency trades off against privacy. Anyone charged with managing customer inevitably confronts the ethical challenge of managing privacy. As access to customer data increases, so do ethical concerns. Globally, there is wide variability in the regulatory protections for consumers regarding access to highly personal information, but for the most part protection is minimal, and in the recent past large organizations (including some governments) have engaged in data collection with minimal consent and control by customers.

An instructive example of the ethical challenge in data access is the case of Cambridge Analytica with regard to the U.S. 2016 general election. Cambridge Analytica claimed to have 5000 specific pieces of information about each American voter. By applying a proprietary psychographic analysis to the data, the firm created profiles of each voter which provided the basis for personalized political messaging. The most important source of data was Facebook. Through a third-party application, Cambridge Analytica improperly obtained data from up to 87 million Facebook profiles, including status updates, "likes," and even private messages. Although consumers are certainly accustomed to receiving tailored ad messages, there was nevertheless a public outcry that highly personal information could be used without consent with the purpose of swaying individual voting behavior. Cambridge Analytica did not survive the ensuing controversy, ceasing operations in 2018. This case highlights the vulnerability of the consumer and the power of organizations to persuade and achieve concrete actions on the part of the market (Amnesty International, 2021). Requiring mandatory registration of relevant personal information from consumers, and also requiring them to accept the terms and conditions to access promotional content on different platforms, is also a common practice in

marketing yet increasingly questionale on ethical grounds. Likewise, the increase in scraping technologies that capture public information from personal and organizational profiles on the internet has created awareness of the thin border between the ethical and the legal.

Given this new dynamic, authors such as Baalen (2018) have warned of three ethical challenges: informed consent and confidentiality, the collection, transfer and storage of confidential data, and the security and personal integrity of those who provide information. Moreover, intercultural competence demands an understanding of privacy rights, laws, and traditions in different regions of the world (e.g., the European Union is fundamentally different from the U.S. in this regard). The ethical dimensions of digital marketing, therefore, extend beyond mere compliance with legal frameworks; they encompass a deep appreciation for the cultural and legal diversity that characterizes our interconnected world. Recognizing these distinctions is not just an ethical imperative but a strategic necessity for marketers seeking to engage with global audiences in a manner that is both respectful and culturally sensitive. As the digital landscape continues to evolve, this understanding of ethics in the context of intercultural competence will undoubtedly shape the ethical frameworks that guide responsible and effective marketing practices on a global scale.

More broadly, some observers point to the rise of surveillance capitalism as the revolutionary practice of extracting without compensation innumerable details about individual customers' lives to be monetized via predictive analytics, creating "wealth by predicting, influencing, and controlling human behavior" (Zuboff, 2019, p. 190). The generation of enormous wealth by the top U.S. tech firms, especially Google, Facebook, Amazon, Microsoft, and Apple, rests importantly on such acquisition of personal data. Importantly, the recent emphasis on first-party data implies even more data clout and power for these tech giants. "Without any explicit debate, personalized, mobile, always-on, networked devices have allowed tech platforms to appropriate [customers'] personal information as something they can own" (Deibert, 2020, p. 79). The danger is that sheer invasiveness may create an atmosphere of fear and mistrust. On the other hand, an ethical approach that prioritizes the protection of personal data is a potential opportunity: "In today's environment, data privacy is a strength in your marketing strategy, and thus needs to be addressed as such" (Venkatesan & Lecinski, 2021, p. 107). Business leaders are recognizing the market differentiating position of a strongly ethical basis of business; the next generation of business leaders will benefit from being steeped in ethics and morality as an early, not later, part of their university education.

3 General Recommendations

As companies seek to leverage AI, they face a fundamental challenge to acquire deeper and richer data sets that capture variability in customer behavior. This challenge may be addressed by either internal means (developing in-house capabilities) or external means (outsourcing to collaborator data-management firms). This key

decision dictates one type of skill profile, the Ph.D. data scientist, which may be seen as the foundation level of a pyramid of "new-technology skills." Accordingly, some companies (typically larger) will decide to develop internally their AI expertise and the attendant requirement of large data management, and thus will need to hire data scientists, who are typically PhDs with training in computer science and statistics. Such experts write code and understand the basic architecture of the data management system, oversee AI implementation, and develop custom statistical models to provide answers to both predictive and causal questions. Other companies (typically smaller, or newly moving into the AI space), will outsource data management and thus have no need for Ph.D. data scientists.

Recognizing these changes in the digital marketing landscape, we conclude this section with four recommendations which provide background to the curricular recommendations in the next section. First, emphasize the strategic marketing focus, i.e., the logic of the value creation process. As a guiding principle, an emphasis on the strategic focus ensures that digital content is offered within a coherent suite of courses at both undergraduate and graduate levels. Second, use open-source software. Many schools struggle to manage the cost of digital content, both in terms of software / platform cost and also personnel cost. Open-source software (e.g., R and Python) brings obvious cost savings, but an added benefit is compatibility with emerging standards in academia and industry. Third, emphasize coding as a hands-on skill in marketing analytics courses, and where appropriate, courses focusing on digital marketing, sales, and advertising methods. The basic conceptual understanding of problem-solving via application of insights from data is made transparent in code. Further, programming skills allow the worker to ask key questions of data without relying on a separate data team. Fourth, teach ethics, which embraces the question of "what is the right thing to do?" as benchmarked by moral and legal considerations. The focal issue of privacy rights with regard to personal data is increasingly important as a global concern and may make or break businesses that increasingly rely on digital data sources.

4 Curricular Recommendations

To aid in conceptualizing the constellation of challenges and skills described thus far, we describe three emerging roles for marketing professionals in the new digital economy. These roles not only vary in terms of career stage (early, middle, late) but also with respect to their focus on AI, digital advertising, omnichannel distribution, and ethics. The three marketing roles are: (1) Marketing Analyst, (2) Digital Strategist, and 3) Digital Transformer. These roles correspond respectively to the educational tiers of undergraduate, Master of Science, and MBA degrees. This comprehensive educational roadmap not only addresses the increasing complexity of marketing functions but also underscores the imperative integration of ethics in the era of digital transformation. Table 2 gives an overview of these three roles and the key skills

needed for each. We turn first to the undergraduate level and the role of marketing analyst.

Table 2 Educational framework for digital marketing roles: Undergraduate to MBA

		Undergraduate degree	Master of Science degree	MBA degree
	Role	Marketing analyst	Digital Strategist	Digital transformer
Key skills needed	Strategy	Digital advertising basics Mobile marketing Social media analytics	Omnichannel platform management Mobile marketing Customer analytics Marketing automation for customer management Social media analytics	Leading digital innovation Omnichannel platform management Customer analytics Digital advertising advanced Mobile marketing Social media analytics Ethics and privacy (philosophical basis of ethics, legal basis of ethics, bias) Privacy (legal basis of digital privacy, regulatory constraints by nationality)
	Analytical	Statistics basics Basic concepts in computer science Coding and programming languages Implementation of KPI measures in IT systems Basics of artificial intelligence Methods of machine learning	Statistics advanced Predictive vs. causal analytics Customer profiles and demand estimation Data-driven problem conceptualization, analysis, and solution Designing data input systems Advanced coding and programming Advanced Al	Statistics advanced Predictive vs. causal analytics Data-driven problem conceptualization, analysis, and solution Advanced programming paradigms and data team management Advanced Al
	Ethics		Ethics and privacy (legal basis of digital privacy, regulatory constraints by nationality)	Ethics and privacy (legal basis of digital privacy, regulatory constraints by nationality)

Role #1: Marketing analyst (Undergraduate degree)

A marketing analyst is an entry level position that embraces digitally based marketing functions that may be carried out by an employee with an undergraduate level education. The marketing analyst position demands an understanding of the basics of marketing strategy and digital advertising (including digital segmentation and personalization), a rudimentary knowledge of analytics, and coding.

The primary goals for educating toward this role are as follows. First, a focus on teaching digital advertising basics reflects the recognition that much of the current advertising function now operates by way of digitally automated auctions. Advertising buying is conducted using a digital dashboard, with ever-evolving interfaces and capabilities. To operate an advertising dashboard requires modest training and can be managed by new hires with an undergraduate degree. However, what is needed here is an understanding of how the advertising process fits within the overall marketing function (which rests on providing superior value to the target consumer). An undergraduate course that situates the advertising buying function within the larger context of marketing strategy is essential within the curriculum. Second, statistics and analytics are important at the undergraduate as MBA level. Moreover, tere is a growing need undergraduate education in marketing integrated with the computing science skills that embody the logic of coding (Lei et al., 2023).

Key skills needed

- Statistics basics (probability, regression)
- Basic concepts in computer science (algorithms, data type, syntax, semantics)
- Coding and programming languages (R, python)
- Implementation of KPI measures in IT systems
- Basics of artificial intelligence
- Methods of machine learning (supervised and unsupervised learning with Python, neural networks and deep learning, cluster analysis and dimension reduction, natural language processing).
- Digital advertising basics (segmentation, personalization, search engine optimization, bid strategies, creating audiences, launching ads, retargeting, managing owned, paid, and earned media)
- Mobile marketing (location-based and usage-based targeting)
- Social media analytics (sentiment analysis, campaign tracking)
- Ethics (philosophical basis of ethics, legal basis of ethics, sources of bias)

Role #2: digital Strategist (Master of Science degree)

A Digital Strategist is an early to mid-career managerial position in marketing that emphasizes analytics and digital integration within the broader marketing function of end-to-end value creation. The role requires an understanding of marketing strategy along with a particular focus on one or more facets of marketing tactical execution (product and service design, pricing, promotion, communication, distribution, brand design). The position demands detailed understanding of AI and analytics, with sufficient sophistication in coding and software design as to facilitate communication

(translation of technical concepts) between personnel within the firm at the executive level and the data management level.

Of key importance, this role embodies a generalist's savvy for understanding a wide range of challenges and finding data-driven solutions to those problems. A generalist knows a little bit about everything, and the basis for such knowledge may be an undergraduate degree that includes computer science, statistics, business, but also the humanities and social sciences, all of which are preparatory to the Master of Science degree where the deeper understanding of marketing strategy and analytics are realized. Further, this position demands a deep understanding of the entire value chain that spans customer acquisition to retention, with the ability to cross-connect, creatively integrate, and "mash up" initiatives. A Digital Strategist is a person with "range," advocated in a book of the same name: "As complexity increases – as technology spins the world into vaster webs of interconnected systems in which each individual only sees a small part – we also need more … people who start broad and embrace diverse experiences while they progress. People with range." (Epstein, 2019, p. 14). This role would need to translate between disparate ways of speaking and thinking, and filled by someone who understands brand purpose, customer relationship management, and the data dashboard that provides real-time feedback on performance in market.

Key skills needed

- Statistics advanced (probability, regression, dimension reduction, causation)
- Predictive vs. causal analytics
- Customer profiles and demand estimation (pricing)
- Data-driven problem conceptualization, analysis, and solution
- Designing data input systems
- Advanced coding and programming (R, python)
- Advanced AI (sourcing, design, implementation, customization, and management)
- Omnichannel platform management
- Mobile marketing (location-based and usage-based targeting)
- Customer analytics (customer profiles, customer journey, demand estimation)
- Marketing automation for customer management
- Social media analytics (sentiment analysis, campaign tracking)
- Ethics (philosophical basis of ethics, legal basis of ethics, sources of bias)
- Privacy (legal basis of digital privacy, regulatory constraints by nationality).

Role #3: digital Transformer (MBA degree)

The Digital Transformer is a role that encompasses more senior managerial positions that are typically held by those holding an MBA. This role is aspirational in that few MBA graduates could attain such a position upon graduation, but rather is a long-term career target. The position entails oversight of AI marketing initiatives within the broader context of marketing management or general management. The Digital Transformer has a working knowledge of the economic approach to statistics, but

also a working knowledge of how AI automates and accelerates the predictive and causal sides of the analytics equation. The role demands detailed understanding of AI and analytics, with sufficient sophistication in coding and software design as to interface between personnel at the executive level versus at the data management level. The core concept of this role was profiled as a "AI champion" in a recent book:

> The AI Marketing Champion will oversee all of your AI and machine-learning marketing initiatives, and functions as a translator between marketing and data science. This "marketing technologist" will not just understand data and marketing and be excited to about possibilities that AI machine-learning can create; they'll also have some technology in their background, including some agile-based software project management experience. (Venkatesan & Lecinski, 2021, p. 129).

The Digital Transformer role may increasingly find its way into C-suite positions in the coming years.

Perhaps the most pivotal skill demanded by this role is the ability to convert marketing problems into data analytic problems, which means understanding which data sources and which analytic methods are capable of providing actionable results, and which cannot. As such, critical thinking is essential, yet is one of the most difficult of skills to teach. This role includes working with data scientists in a supervisory capacity. An important aspect is an intuitive understanding of the marketing concept; the basic logic of value creation is not replaced by, but rather enhanced by, AI. Thus, training and expertise in the overall strategic envelope of marketing remains a key asset of any business leader. Training in marketing strategy is common at business schools today, but the next generation of marketing strategy courses will be infused with AI, not only as case examples but as part of the workflow that guides the strategic progression from specification of customer insight, to value proposition, to targeting, and to tactical execution.

Key skills needed

- Statistics advanced (probability, regression, dimension reduction, causation)
- Predictive vs. causal analytics
- Data-driven problem conceptualization, analysis, and solution
- Advanced programming paradigms and data team management
- Advanced AI (sourcing, design, implementation, customization, and management)
- Leading digital innovation (digital transformation in marketing, emerging business models, emerging technologies in marketing).
- Omnichannel platform management
- Customer analytics (customer profiles, customer journey, demand estimation)
- Digital advertising advanced (segmentation, personalization, two-sided platforms, creating audiences, designing and managing ads, key performance indicators)
- Mobile marketing (location-based and usage-based targeting)
- Social media analytics (sentiment analysis, campaign tracking)
- Ethics (philosophical basis of ethics, legal basis of ethics, sources of bias)
- Privacy (legal basis of digital privacy, regulatory constraints by nationality).

5 Conclusion

We have specified a general blueprint for educating the next generation of marketing leaders for the emerging digital economy. We foresee increasing needs for training in analytics and AI within the marketing function, conceptualized in terms of three key emerging roles: (1) Marketing Analyst, (2) Digital Strategist, and (3) Digital Transformer, which roughly correspond to the educational tiers of undergraduate, Master's of Science, and MBA, respectively.

For many businesses, a working knowledge of AI is increasingly important. At the same time, there is the concern that an overemphasis on AI may constrain innovation and competitive advantage over the long term. For the next decade or so, the primary benefit of AI will likely be for routine or incremental business processes. The competitive advantage of AI will almost certainly diminish as its use becomes universal. Although AI will increasingly play a powerful role in many business operations, it is essential to recognize the potential limitations of overemphasis. A source of competitive advantage at some point in the future may come from breaking with AI and creatively anticipating (via human intuition) what customers want beyond algorithms or by way of creating new processes to fuse AI and human intuition. To use a well-worn example, would an AI deployed a hundred years ago anticipate the automobile, or simply a faster horse? The key point is to recognize that the ideal business school curriculum demands a balance between skills in understanding digital technology versus skills in holistic problem-serving. In the end, true leadership embraces the courage to decide, sometimes, against the recommendation of an algorithm.

As we delve deeper into the educational recommendations presented in this chapter, it becomes imperative to explore how these strategies will reverberate within the academic realm and reshape the landscape of marketing practice. Our proposed curriculum adjustments and emphasis on critical skills respond not only to the evolving needs of future marketing professionals but also anticipate broader transformations within educational institutions and the business sphere.

The integration of digital competencies within academic curricula is poised to redefine the educational journey of aspiring marketers. By incorporating hands-on experiences, industry collaborations, and cutting-edge technologies, educational institutions can bridge the gap between theory and practice, equipping students with the agility required in the fast-paced digital landscape. This evolution will likely foster a new generation of marketing scholars and researchers, adept at navigating the complexities of the digital era and contributing innovative insights to the academic community.

Our recommendations extend beyond the classroom, offering a strategic roadmap for marketing practitioners to navigate the digital frontier. By aligning educational goals with real-world challenges, businesses can anticipate a workforce with enhanced capabilities in data-driven decision-making, ethical considerations, and adaptive strategies. The implementation of these recommendations holds the promise of elevating marketing practice, fostering innovation, and ensuring that professionals

are well-prepared to tackle the multifaceted demands of the contemporary business environment. In essence, our proposed educational framework is not merely a response to current challenges but a proactive initiative to shape the future of both marketing education and practice in the digital age.

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Climate Change in Business School Curricula

Panagiotis Tzouvanas and Stavros A. Zenios

Abstract The current decade is considered a make-or-break decade for climate action. Business school curricula must adapt to the significant challenge of climate change risks and their effects on businesses. After a brief background on climate change, its origins, and its wide-ranging effects, we discuss major international policy initiatives. This leads to understanding how climate change shapes today's business environment through mitigation, adaptation, and transition demands and allows us to focus on what business schools should teach future industry leaders. We suggest that a module on the science of climate change and its effects on the environment and economic activity should be followed by a discussion of international agreements to combat climate change and then a discussion of national emissions targets, carbon taxes, emissions markets, and climate finance as critical new elements of the business landscape that business students must be well versed in. We discuss the modules for a broad curriculum on climate for business education, give more details on a potential course on climate finance that we have been teaching, and conclude with a short case study.

1 Introduction

The war in Ukraine, the 2019 pandemic, and, more recently, the COVID-global surge in inflation overshadowed the risks of accelerating climate change. But the fact is that 2020 tied as the warmest on record, with 2016 a short four years earlier.

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2023 set a new record. The current decade is considered a make-or-break decade for climate action. For the first time in 2022, Europe used more electricity from renewable sources than fossil fuels (WMO, 2022). Nevertheless, the United Nations World Meteorological Organization states Europe is the fastest-warming continent.[1] Sea surface temperatures reached new highs, accompanied by marine heatwaves, extreme heat, drought, wildfires, and glacier melts.

Our societies are increasingly concerned about environmental, social, and governance (ESG) factors. Such factors are playing an increasing role in decision-making, such as purchasing goods and services, investing our savings, regulating our businesses, etc. Investors, for example, incorporate ESG data into fundamental analysis and use it as a tool for activism. Adopting ESG practices creates value, defines corporate purpose, makes operational changes, and commits to transparency (Serafeim, 2020). Attention to ESG criteria makes companies more resilient to climate and other disruptive changes (Brunnermeier, 2021). From the ESG factors, E is directly linked to climate change.

In this chapter, we discuss how climate change shapes today's business environment and how it can impact Business Schools' curricula. We discuss what Business Schools should do to incorporate climate change into their syllabus and stop falling short in the fight against climate change (Financial Times, 2023). To do so, we first need to understand the potential topics that business school students should comprehend for their employment opportunities and future careers. We provide a brief background on climate change and the risks it creates and discuss the global initiatives for combating climate change. We then discuss the effects of climate change and the policy initiatives on the business environment and suggest what a Business School curriculum should cover. We finally discuss the topic of climate finance in more detail and conclude with a short case study.

2 Background to Climate Change Risks

The Science of Climate Change

The first thing Business Schools should do is to make the students deeply understand the problem of climate change and how it can affect, or already affects, diverse businesses globally. The curriculum should prepare future industry leaders to deal with these problems and provide solutions.

A mainstream definition of climate change is a shift in long-term temperature patterns and weather conditions. It is primarily driven by human activities, particularly the combustion of fossil fuels (such as coal and oil) and deforestation, which release greenhouse gas (GHG) into the atmosphere. These GHG, including carbon dioxide (CO_2), methane, and nitrous oxide, trap part of the incoming solar radiation,

[1] See https://news.un.org/en/story/2023/06/1137867.

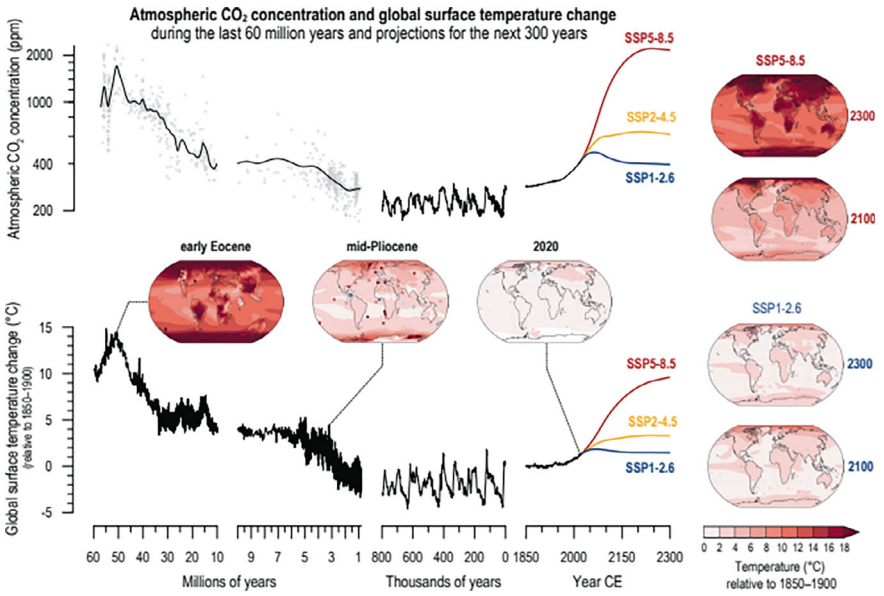

Fig. 1 Historical carbon dioxide concentration and temperature change (relative to 1850–1900). *Source* IPCC (2021)

which otherwise would have been reflected to space as outgoing longwave radiation, leading to global warming. Therefore, climate change has increased the global temperature, bringing about abrupt and frequent shifts in weather patterns (IPCC, 2014) .

Figure 1 shows that CO_2 and temperature follow a highly collinear relationship for millions of years. Changes in CO_2 cause an immediate change to the global temperature. Thus, the increasing CO_2 concentration in the atmosphere has increased the global temperature by approximately 1 °C compared to preindustrial levels. The physics that links CO_2 and global temperature was well understood in broad terms by Fourier in the early nineteenth century and demonstrated in the experiments of Irish physicist John Tyndall in 1859. However, the specific mechanisms can be complex, with non-linear feedback loops and tipping points that are still studied and, in many instances, debated, till the present day. Recognizing the destabilizing effects of feedback loops, governments and businesses are prompted to act.

The Risks of Climate Change

Climate change has significant effects on society, both chronic and acute. Over time, rising temperatures and altered rainfall affect agriculture, water resources, and human

well-being. Acute events such as hurricanes, floods, and heatwaves result in infrastructure damage, loss of life, and disruption of vital services. For instance, prolonged droughts contribute to water scarcity and crop failures, coastal areas become more susceptible to storm surges, and heat waves lead to illnesses, fatalities, and loss of productivity. These risks affect businesses and their bottom line (KPMG, 2021). We discuss the physical and transition risks of climate change.

Physical Risks

Physical risks relate to the material effects of climate change, some of which we are already experiencing. They include extreme weather events and natural disasters, impacting the economic, operational, credit, and market environment. They arise from the increased frequency and severity of climate and weather-related events that damage property and disrupt trade, such as heatwaves, flooding, rising sea levels, wildfires, droughts, and storms. For instance, heat waves lower productivity, and dust storms impact public health.

Physical risks can be acute or chronic. Acute risks have severe, short-term impacts, such as those arising from floods or hurricanes. These extreme weather events can lead to significant short- and medium-term costs for clean-up and redevelopment. Chronic risks have gradual, longer-term impacts, such as those from rising sea levels.

A striking example of acute physical risks affecting businesses is the case of Honda Automobile (Thailand) Co., Ltd in 2011. In November 2011, severe floods in Thailand put Honda's factories underwater. The company mentioned, "As the flooding in Thailand continues, several Honda suppliers in Asia currently are unable to maintain parts production, disrupting the flow of parts to our production operations in North America." Honda withdrew its earnings guidance for this financial year and reported a sharp fall in quarterly profit after the floods forced it to shut down a car factory. From that date onward, Honda endeavors to make operational decisions while carefully monitoring the situation with climate change. A striking example of chronic physical risk for operations is that of the US Air Force, which is facing the problem of potential recurrent flooding of air stripes that could reduce operational readiness, necessitating a move of military sites at high costs.[2]

Finally, there is indirect exposure to climate risks, such as those faced by the banking system as a business lender. While a bank may be immune to floods or rising sea levels, its borrowers are not. If borrowers experience a deterioration in the value of their assets because of climate risks and cannot repay their obligations, the banks are affected as well (Alogoskoufis et al., 2021).

[2] See more at: https://insideclimatenews.org/news/19112018/military-readiness-climate-change-risk-hurricane-heat-sea-level-rise-dangers-without-borders/.

Transition Risks

Transition risks arise from the transition to a low-carbon economy. Transition risks can arise through a sudden and disorderly adjustment to a low-carbon economy (e.g., abatement cost from climate policy, market preferences, and technology changes). Carbon-intensive industries (e.g., oil and gas, manufacturing, shipping) are more associated with transition risks than low carbon-intensive sectors (e.g., health care, education). Transition risks manifest themselves in different aspects of a business: policy risk, economic risk, market risk, reputational risk, technology risk, and litigation risk.

First, policy (also regulatory risk) is related to rapid changes in the political climate, which brings uncertainty to long-term investments. In the United States, for example, a previous administration was skeptical about climate change and increased investment in fossil fuels. Such actions may affect the economic value of some assets and make them more or less attractive to investors.

Second, the economic risk of climate change is closely tied to the mitigation risk. This risk includes the cost of changing business operations to decrease companies' carbon footprint.

Third, market risks emerge from changing consumer behavior and social norms, leading to changes in demand for products and services. For example, investment demand (for fossil fuel assets) is closely linked to substitution or changing consumer behavior (e.g., buying fewer avocados to prevent deforestation). Therefore, investor sentiment (e.g., reducing investments in oil car manufacturers) will impact the price of assets.

Fourth, reputational risks arise when companies suffer from association with high-carbon methods. Production and distribution, or environmental destruction, leads to falling demand and revenues and reduced attractiveness to potential customers, employees, and investors. Reputational risks may also arise in relation to a range of broader social and sustainability factors, such as using child labor. Financial services firms can find themselves suffering reputational (and financial) damage if they are seen to be supporting organizations and sectors that contribute to global warming.

Fifth, technology risks occur when new, lower-carbon (or other) technologies replace existing products and services. It may lead to the impairment or stranding of assets (assets that are losing their value) due to the transition to a low-carbon world. The transition towards a low-carbon world will bring about the substitution of a wide range of products and services. Supply chains will be affected (e.g., to reduce or remove non-recyclable food packaging).

Sixth, litigation risk stems from parties who suffer loss from the effects of climate change seeking compensation from those they hold responsible. For example, stakeholders may file lawsuits against companies that fail to disclose climate risks, such as the potential impact of climate change on business operations and supply chains. California's PG&E declared bankruptcy after being found liable for forest fires caused by exposed high-voltage lines in the extreme heat and dry season of the State. This was declared as "the first climate-change bankruptcy" by the *Wall Street Journal* in January 2019, but "probably not the last."

Dealing with Climate Change

Various policies and tools are developed to deal with the adverse effects of climate change. These policies are split into two major categories of mitigation and adaptation. The former focuses on halting climate change by human intervention to reduce emissions or enhance the sinks of greenhouse gases. The latter focuses on adaptation to the new reality through a process of adjustments to actual or expected climate and its effects in order to moderate harm or exploit opportunities. For example, by building resilient infrastructures designed to withstand the impacts of climate change or designing water management strategies to ensure the future availability of clean water. In close relation to adaptation strategies, there are various risk management tools to minimize the impact of climate change on the economy. For example, climate insurance instruments compensate for property damages from extreme weather events. Financial derivatives allow businesses to hedge climate change risk. For instance, climate (weather) derivatives compensate firms in the case of a climate change catastrophe or in the case of excessive energy costs due to climate change.

3 Global Climate Change Initiatives

We now turn to policies and the development of carbon markets aiming at mitigation and adaptation.

Climate Policies

Ongoing policy initiatives aim to stabilize carbon emissions, which is a Herculean task that could potentially destabilize countries' public finances (Dibley et al., 2021, Zenios, 2022, Mammetti & Zenios 2024). According to Stern (2007), tackling climate change considers four main actions: regulating emissions, incentivizing green investments, minimizing asymmetric information, and building an informative network for society.

The first initiative is the Intergovernmental Panel on Climate Change (IPCC), which was set up in 1988 as an international body for assessing climate change. The IPCC presents scientific, technical, and socio-economic information to understand the future risks arising from human-induced climate change. Its main contribution is to inform about potential impacts and provide options for adaptation and mitigation. In 1992, the treaty known as the United Nations Framework Convention on Climate Change (UNFCC) was signed with its main target to stabilize GHG at a harmless level to the environment. UNFCCC is the most serious attempt made against climate change. It established what is popularly known as COP—Committee of Parties—as

the supreme decision-making body of the Convention. The annual COP meetings serve to make the necessary decisions to promote the effective implementation of the Convention and review progress. Meetings of COP led to later actions such as the Kyoto Protocol (COP3) with the Clean Development Mechanism as Article 12, and the Paris Agreement (COP21).

The Kyoto Protocol's main objective is to regulate a permissible limit of GHG. The Protocol had been negotiated since 1997 and was set in action in 2005. It requires ratification, and signed members ought to decrease their emissions by 5% below that in 1990. Similar to the Kyoto Protocol, Asia Pacific Partnership (APP, including Australia, Canada, China, India, Japan, Korea, United States) has attempted to meet goals for national air pollution reduction and climate change in a way that will not harm the growth and the sustainability of countries and firms.

The most recent and prominent attempt against climate change took place in Paris in December of 2015. The Paris Agreement is being ratified by 195 out of 197 countries and was put into force on November 2016. The agreement incorporates three main targets: (a) holding the world temperature increase below 2 °C (after the industrial revolution, the temperature has increased by almost 1 °C), (b) facilitating the adaptation of low GHG technologies with respect to the food production and (c) align finance flows with the target of climate-resilient development. To achieve this, Nationally Determined Contributions (NDCs) were determined as a central component of the Paris Agreement. These are country commitments to deal with climate change, including mitigation and adaptation efforts. In a similar vein, developed countries are committed to providing financial support to developing countries. The goal is to mobilize $100 billion annually by 2020 to support developing nations in their climate mitigation and adaptation efforts.

An equally important initiative is the United Nations Sustainable Goals. A blueprint to achieve a better and more sustainable future for all people globally by 2030 was designed by the United Nations in 2015. Seventeen sustainable development goals have been introduced and the goals came into effect on January 1, 2016. Goal 13 is about Climate Action. Without action, the populations of the poorest and most vulnerable countries are severely affected. The purpose of this goal is to strengthen resilience and adaptive capacity to climate-related disasters, to integrate climate change measures into policy and planning, to build knowledge and capacity to meet climate change, and to implement the UNFCCC.

Most recently, the highlight of the COP27 at Sharm el-Sheikh concluded with a historic decision with countries agreeing to establish a "loss and damage" fund to assist vulnerable nations affected by climate disasters. An Adaptation Agenda was announced, enhancing resilience for people living in the most climate-vulnerable communities by 2030.[3]

Unfortunately, in spite of the many initiatives, global CO_2 emissions keep on rising, except during the 2020 COVID-19 period. Recent work by the European Commission (2022) and data by the Global Carbon Project (2023) suggest that global

[3] See https://unfccc.int/news/cop27-reaches-breakthrough-agreement-on-new-loss-and-damage-fund-for-vulnerable-countries.

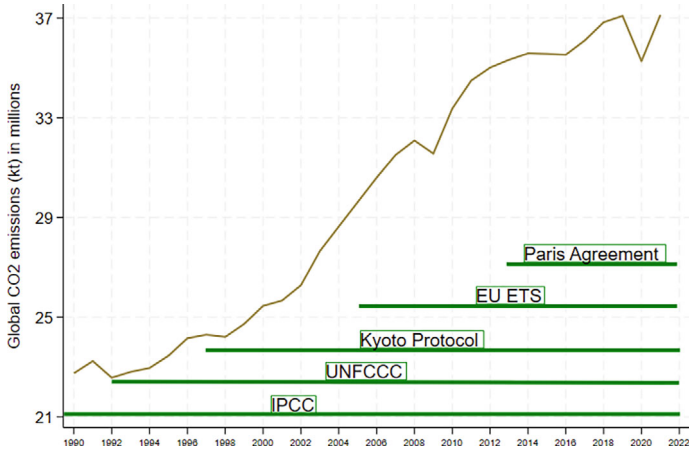

Fig. 2 Global CO_2 emissions over the years. *Source* Authors' calculations. Data from global carbon project (2023)

CO_2 emissions rebounded in 2021 after a temporary reduction during the COVID lockdown. There are some regional differences, but the CO_2 concentration in the atmosphere remains unalerted; see Fig. 2.

Carbon Markets and Taxes

In addition to the policy initiatives discussed above, carbon taxes and carbon trading markets have been developed over the years. As of today, there are 73 policies that control 22% of the total world's GHG. Figure 3 shows that the first policies started in 1990, when Poland and Finland introduced carbon tax. A milestone in this timeline is 2005 with the launching of the EU ETS (Emission Trading System). The EU ETS is a cap-and-trade mechanism aimed at reducing greenhouse gas emissions cost effectively. The scheme runs in four phases: Phase I (2005–2007) was a pilot 'learning by doing' preparation for the next phase with free allocation of emissions, Phase II (2008–2012) coincided with the first commitment period to reduce emissions, in Phase III (2013–2020) auctioning become the main method of emission allocation instead of the free allocation, and more industries were included, and Phase IV (2021–2030) set more ambitious targets and further reductions in free allocation. Other regions followed suit, such as California and Japan. In 2021, China, the largest emitting country, launched its own ETS.

Lastly, there are initiatives aiming to bring the banking and financial system to contribute towards combating climate-related risks and understanding the effects of these risks on financial stability. The Financial Stability Board created the Task Force on Climate-related Financial Disclosures (TCFD) to improve and increase

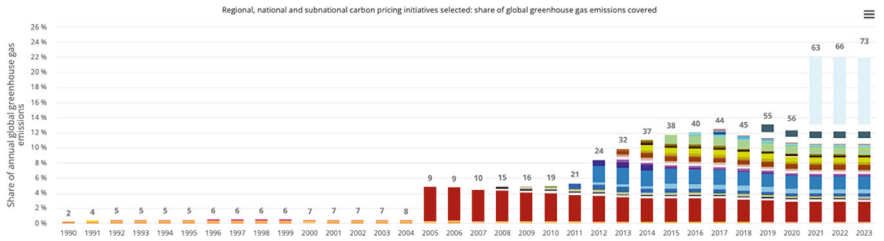

Fig. 3 Number of ETS & Carbon Taxes per year. *Source* World Bank (2023). https://carbonpricingdashboard.worldbank.org/map_data

the reporting of climate-related financial information. TCFD provides insights into the lending practices of banks, distinguishing between financing of green and brown activities, and so enabling us to monitor the destination of funds. The banking reporting spans three categories: risk identification, risk mapping, and risk measurement.[4]

Measuring climate change risk is key to mitigating its impact. There are several initiatives to measure the risk profile of countries and businesses, and those are not limited only to the banking sector (Alogoskoufis et al., 2021). For example, the Notre Dame country index ranks countries according to their readiness and adaptation to climate change. Yale's environmental performance index shows countries' proximity to their environmental goals. In terms of firms' climate risk quantification, several providers such as S&P Global, Refinitiv, Bloomberg, Carbon Disclosure Project, Sustainalytics, and others provide firms' environmental ratings.

4 Business and Climate Change

The Link Between Climate Change and Businesses

How is climate change linked to businesses? Figure 4 illustrates the two-way relationship between firms and climate change. Firms produce goods. The production process demands that firms use fossil fuels and other materials that emit GHG emissions. In turn, GHG emissions increase global temperatures and generate climate change, impacting firms. First, firms should decrease their GHG emissions as part of their climate transition to the greener era. Stakeholders such as governments or activist investors demand climate-friendly changes to firms' operations. This involves compliance costs that impact operations and profitability. In the opposite direction, firms are affected by physical climate change risks. For example, consider a firm

[4] See for example the ECB initiatives at: https://www.ecb.europa.eu/ecb/climate/html/index.en.html.

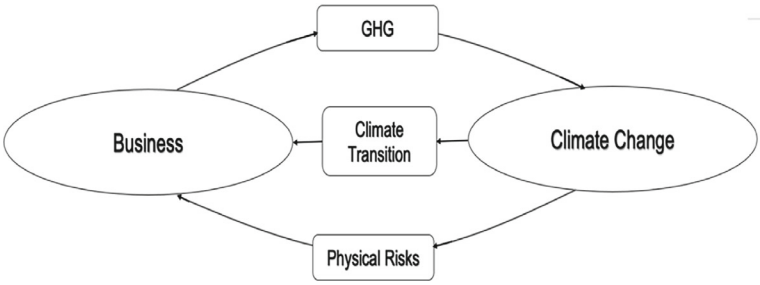

Fig. 4 Climate change and businesses. *Source* Authors' illustration

close to a coast. This firm must protect its operations from rising sea levels at potentially significant costs or move to another location. Consider, for instance, hotels on the Pacific islands, the Mediterranean coastline, or the US Air Force landing strips mentioned earlier. Businesses from different sectors are influenced differently by climate change risks. For example, climate risks should be treated with caution when comparing a tourism firm with a financial one or a healthcare provider. The exposure is quite different, both in terms of potential impacts and the mechanisms.

Businesses must act in the face of unprecedented uncertainty about climate policies. A prime example of the deep uncertainty surrounding the issues of climate change (Barnett et al., 2020) is how the US engineered, then withdrew from and then re-joined the Paris Agreement under different presidential administrations. There are *risks* for which the probabilities may be known, such as the frequency of floods or fires (even as they may increase and become more intense). There is *ambiguity* where outcomes may be known but their likelihood is not, such as knowing the effects of abiding or not with the Paris Agreement on GHG emissions, but we do not know how likely it is to meet these targets. And there are *misspecifications* with no consensus on data or models.

Businesses must deal with this complexity from two perspectives. We call them *passive* and *active*. By passive, we mean that a firm may be subjected to the effects of climate change, even if it may have very little to do with causing the problem, and it must be prepared to adapt. Think, for instance, of small olive farmer cooperatives on the Greek islands or fishermen in the Pacific; they contribute little to climate change, but they suffer severe consequences. By active, we mean that stakeholders require firms to act to mitigate climate change and lower their causal effects on the problem. Think, for instance, the cruise ships and airline industries. Of course, the distinction is blurred. For instance, carbon pricing in a firm's energy consumption calls for changes to the product mix and production processes and pricing strategies. But these changes lower the firm's carbon footprint, earn it goodwill with environmentally sensitive stakeholders, and mitigate climate change.

A Business School Curriculum on Climate Change

Businesses need to deal with the acute climate risks and prepare for the chronic climate risks. They also need to navigate the complex policy and regulatory environments to do their part in mitigating climate change. The training of future business leaders must adapt to the challenge of climate change.

Of course, issues like ESG (Environmental, Social, and Governance) have been a key concept in business education over the last several years. The consensus is that ESG issues must be taught horizontally, infusing several curriculum courses. Overall, this has been a topic where business schools have been quite responsive, although the effectiveness of ESG is debated. See Google trends that reveal *greenwashing* is getting more attention than ESG investing; see Fig. 5. Gorovaia and Makrominas (2024) use natural language processing to uncover a disparity between company CSR reports and firm compliance with environmental regulations.

We argue that *Climate Change* should enter the curriculum of business schools. From a limited search, we have identified several courses on climate finance (Columbia University, Essex, BI Norwegian Business School, EDHEC, Durham University and the University of Edinburgh, among others, including also the courses we recently introduced to our respective institutions, the University of Sussex and University of Cyprus; see also Roncalli (2023)). However, the issue of climate and businesses, in general, is only currently picking up steam. Eight of Europe's top business schools formed a network to collaborate and provide thought leadership to help present and future leaders deal with climate change.

What should such a course entail? Without giving a full course outline, we provide our approach when designing our courses (which are still evolving). The courses cater to business school students interested in managing operations, services, finance, and investments. Business ethics or strategy and leadership courses must also deal with the climate challenge, but their curriculum is beyond our scope.

The course targets five learning objectives:

1. Develop a systematic and comprehensive understanding of advanced knowledge on the key concepts, theories, and principles of climate change, climate risks, climate finance and accounting, supply chains, and business operations.
2. Demonstrate a conceptual and practical understanding of the effects of climate change on operations and supply chain management. This would include such

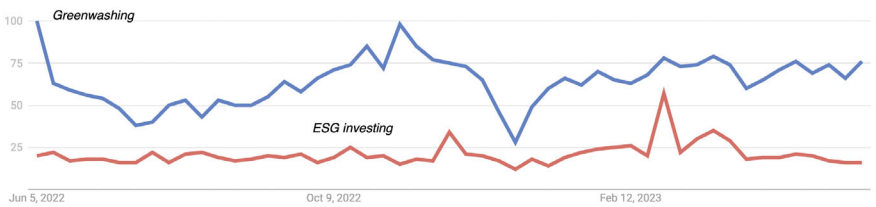

Fig. 5 Google trends: greenwashing and ESG. *Source* Google trends (2023)

topics as carbon neutrality initiatives and innovative business models that reduce carbon emissions, technological solutions, trade-offs, tensions, and synergies among operations and supply chains stakeholders, what are the barriers and what facilitates climate-related practices in operations and supply chains, performance evaluation and carbon neutrality practices in processes, services and products, and supply chains.
3. An understanding of the broader policy and regulatory landscape to encourage firms to achieve carbon neutrality from both a national and an international perspective.
4. Develop skills to critically analyze and interpret qualitative and quantitative data, prepare reports, and convey ideas, information, problems, and solutions to specialist and non-specialist audiences while using various communication skills.
5. Demonstrate knowledge and understanding of a range of research-based approaches and practical skills to explore complex concepts both systematically and creatively, reflecting an awareness of the wide range of issues related to climate finance as it is an emerging field of study.

Below, we present some topics that may be included, but not limited to, in such a course:

1. Introduction to climate change: Focus on the science of climate change, discuss IPCC reports, illustrate the greenhouse effect, and understand the relationship between CO_2 and temperature.
2. The role of ESG: Give an overview of sustainability in the business environment by discussing the broad theme of social and governance issues, with a particular focus on the environmental component. Examples can be drawn from the corporate social responsibility literature and how it has evolved over the years.
3. Climate-related risks: Categorize climate change risks (transition and physical) and how these risks impact society and companies.
4. Climate change initiatives: Demystify the alphabet soup of policy initiatives that have been developed to battle climate change (IPCC, COP, carbon taxes, ETS, TCFD, etc.).
5. Climate finance: The role of finance in battling climate change, with a focus on pricing climate risks and green financing. We discuss further this topic below in Sect. 5.
6. Sustainability accounting: Frameworks and methodologies for measuring, assessing, and reporting GHG emissions, carbon footprints, and climate-related risks. For example, *Corporate Climate Accounting* provides guidelines to calculate and report emissions.
7. Climate change and business operations: How climate change can disrupt the production process and productivity. This can lead to increased costs and potential revenue losses. Businesses must mitigate and adapt to the new environment by taking a proactive approach. This includes transitioning to renewable energy sources, improving energy efficiency, and creating green branding.

8. Climate change and supply chains: Supply chains and climate change have a two-way relationship. Most anthropogenic GHG come from supply chain emissions, but climate change also disrupts supply chains via extreme weather conditions. Businesses need to adapt, innovate, and build resilience to ensure the continuity of their supplies (see, for instance, Sect. 6.2).
9. Climate risk management: How firms can deal with climate change risks, such as with climate derivatives, climate change insurance, and geographical diversification of assets.
10. Climate change case study: Examine real-world companies. See, as an example, Sect. 6 below, where we consider how Unilever is scrutinized for its actions on climate change.
11. Green Innovation: Development and application of new ideas and products that have positive environmental impacts.
12. Stakeholder Engagement: Active participation and collaboration of various stakeholders to design, implement, and monitor climate-related financial projects.

5 Climate Finance

> To achieve our climate goals, every company, every financial firm, every bank, insurer and investor will need to change. Countries need to manage the increasing impacts of climate change on their citizens' lives, and they need the funding to do it. (Mobilise Finance in COP26, 2021)

It has been recognised that finance can be a potent tool to battle climate change. The two-way relationship between climate change and finance is the emerging field of "Climate Finance". Climate finance refers to the financial resources provided to support activities and projects to aid with mitigating and adapting to climate change. Finance can affect climate change. Examples can be (i) green products and services offered by financial institutions (e.g., green bonds), which firms can finance their zero carbon projects, (ii) regulatory initiatives to fight climate change by establishing an upper limit to carbon emissions thanks to carbon markets, and (iii) this causes the need to create a new type of companies, the so-called clean- or green-tech. But also, climate change affects finance. Climate change can deplete labor productivity, reduce food production, and cause uncertainty for firms by reducing potential cash flows (Dell et al., 2014).

One focus of the climate finance module is on how companies can obtain the funding they need and to change their operations. The primary approach is through debt, while equity plays a secondary role. Firms can either issue a bond or take a loan to finance a green project. These new financial products are called green bonds and green loans, respectively. Green bonds/loans are instruments where the proceeds will be used only to finance or refinance green-eligible projects. The design of a green bond/loan is similar to that of a non-green instrument, with one crucial exception: the proceeds from the issuance will be used for green projects. Such projects may

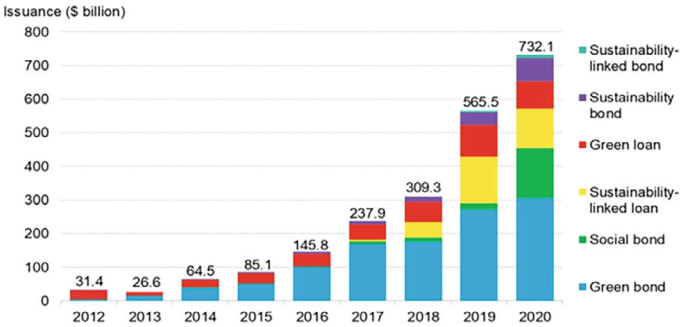

Fig. 6 Sustainable project funding. *Source* Bloomberg (2020)

be related to energy efficiency, sustainable use of land and sustainable agriculture, terrestrial and aquatic biodiversity protection, electric transportation, and sustainable water and wastewater management. According to Bloomberg (2020), the sustainable debt issuance exceeded $730 billion in 2020. Despite the COVID-19 pandemic, it hit another record in 2020, with $732 billion issued, a 29% increase from 2019. As shown in Fig. 6, green bonds are the primary source of financing sustainable projects, reaching $300 billion in 2020, while green loans are coming fourth with a value of around $100 billion.

The main disadvantage of these new asset classes is that some companies might use them for greenwashing. Greenwashing conveys a false impression or provides misleading information about how a company's products are more environmentally friendly. To avoid this issue, Green Bond/Loan Principles have been developed. There are four main components that firms should satisfy to get a certified green instrument. First, the use of proceeds should be directed to green projects. Second, a process for project evaluation and selection should be in place so the firm can communicate to investors the project's progress. Third, the management of proceeds to update the proceeds account. Finally, reporting with firms listing the projects to which proceeds have been allocated and a brief description of the projects, the amounts allocated, and their expected impacts.

Another topic is that of public finance. The complex interaction between public finance and climate change illustrated in Fig. 7 provides a high-level schematic of the complex interactions between climate and sovereign debt. Literature suggests that climate change risks could destabilize countries' public finances (Dibley et al., 2021). While this figure relates to the specific public finance problem, the overall flow of effects transposes to other areas. However, the specifics differ and require different approaches to those used for sovereign debt (Zenios, 2024). A course on climate finance can teach these complex interactions and help students develop the necessary analytical understanding.

In the context of climate finance, a comprehensive approach would be to (i) understand the pricing effects of climate change on the financial markets, (ii) the role of financial sources including public and private finance, (iii) explore the possibility of

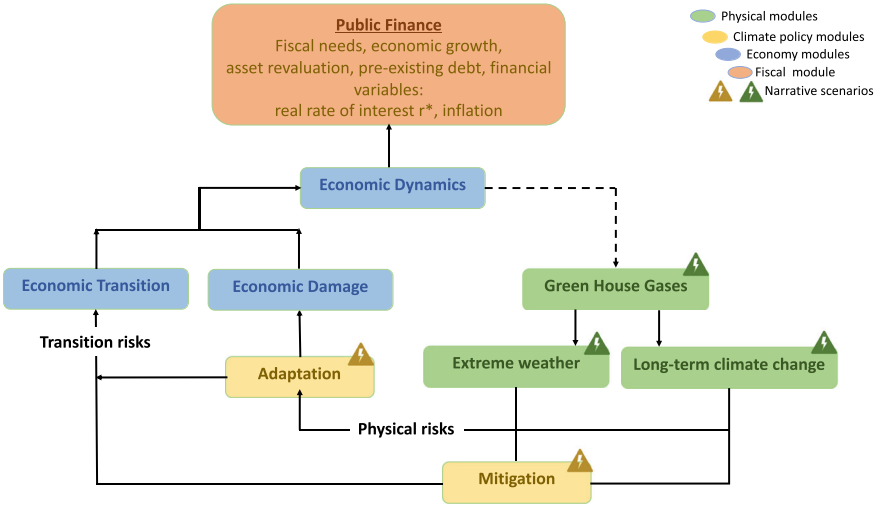

Fig. 7 Public finance. *Source* Zenios (2022)

public–private partnerships to gather funds to fight climate change,[5] (iv) the development of innovative financial mechanisms such as carbon markets and green bonds, and (v) the role of accelerators, incubators and project preparation facilities to support climate finance projects.

6 Case Study: Climate Actions at Unilever

Real-world examples can bridge theory with practice, and we conclude our chapter with the example of Unilever. Unilever was established in 1929 in the UK and is one of the world's largest consumer goods companies. They operate in more than 190 countries, their products are used by 3.4 billion people daily, and the company's turnover was € 60.1 billion in 2022. The company set a clear pathway to zero emissions in their operations by 2030 and net zero emissions across their value chain by 2039.

To understand the case study, we must be aware of the differences among GHG emissions. The GHG Protocol corporate standard classifies a company's GHG emissions in three scopes: Scope 1 refers to direct GHG emissions by the company, Scope 2 refers to indirect GHG emissions from the consumption of purchased energy (electricity, heat, steam, etc.), and Scope 3 refers to other indirect GHG emissions (not included in Scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions (extraction and production of purchased

[5] See, for example EU missions' projects for the adaptation to climate change: https://climate-adapt.eea.europa.eu/en/mission/the-mission/mission-projects.

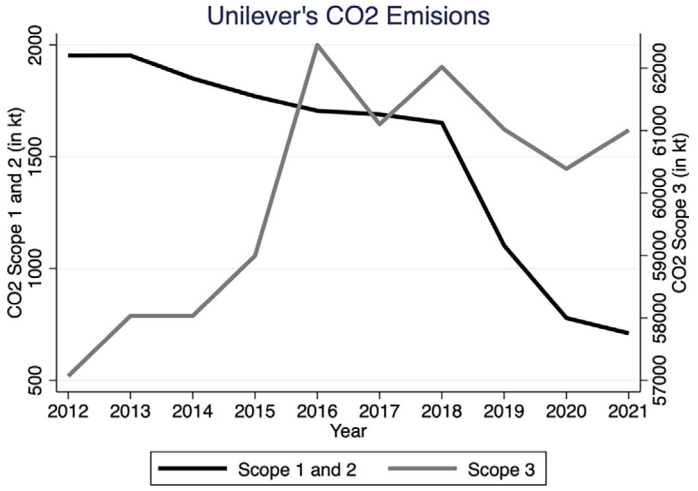

Fig. 8 Unilever's emissions. *Source* Authors' estimations. Data from Refinitiv (2023)

materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities, outsourced activities, and waste disposal).

The key takeaways from this case study are the following: Unilever set a zero emissions target in their operations by 2030 and net zero emissions across their value chain by 2039. Unilever has made significant progress, with a 68% reduction in greenhouse gas (GHG) emissions from factories, research laboratories, and warehouses since 2015 (as shown in Fig. 8 for the case of Scope 1 and 2 emissions). They have focused on converting to renewable electricity, improving energy efficiency, and increasing renewable thermal energy. Unilever also recognizes the importance of addressing emissions throughout their value chain, working closely with suppliers to reduce their carbon footprint (Scope 3). They have launched the Unilever Supplier Climate Programme to accelerate decarbonization across supply chains as Scope 3 emissions have increased in the last 10 years.

Zero Emissions in Operations by 2030

GHG emissions from their operations are relatively small at 2% of the value chain emissions in scope of our net zero target. However, they have the greatest influence and form a key part of our net zero roadmap. In 2022, emissions from factories, research laboratories, and warehouses (Scope 1 and 2) reduced by 68%, versus 2015. This puts them on track to achieve their interim target of a 70% GHG reduction by 2025. Their progress has been driven by converting to renewable electricity and energy and improving energy efficiency.

In 2022, 93% of their electricity was from renewable sources, an increase of 7% since 2021. They also include renewable electricity generated at their factories, such as the electricity from their combined heat and power plants (CHPs) and on-site solar installations.

Decarbonizing the energy they use to generate heat is critical in the next phase of their strategy to achieve the 2030 operational emissions goal, including 100% renewable thermal energy. In 2022, over a third of their thermal energy came from renewable sources. Their factories achieved a full year of production without direct coal (primarily used to generate thermal energy). One of the ways they accomplished this was by using biomass.

Improving energy efficiency is another key part of the decarbonization roadmap. In 2022, their factories reduced absolute operational energy consumption by 4% versus 2021. In 2022, they invested €37 million in capital expenditure projects through the Clean Technology Fund. These projects were mainly focused on renewable energy and resource efficiency, and it is estimated that they will reduce GHG emissions by 88,000 tonnes across the lifecycle of the projects.

Net Zero Emissions Across the Value Chain by 2039

Most of their carbon footprint lies in the value chain: from raw materials and the emissions from transporting ingredients to factories and then getting finished products to the customers. Every decision about what goes into their products and how they're made is an opportunity to reduce climate impact. Working with suppliers to reduce their carbon footprint is at the heart of Unilever's approach.

They aim to reach net zero emissions covering Scope 1, 2, and 3 emissions by 2039. That means they will radically reduce the GHG impact of their products—from raw materials, manufacturing, logistics, and distribution—including the freezers that keep ice creams cold in store, targeting emissions from aerosols, and disposing of waste products and packaging.

In 2022, GHG emissions in the scope of net zero targets increased by 2% versus 2021. Their progress in reducing GHG emissions from operations, packaging, logistics, and retail emissions was offset by an increase in emissions from raw materials and ingredients and an increase in direct consumer use emissions.

Raw materials and ingredients represent the most significant proportion of their GHG emissions at 59%. As these emissions are outside their control, they collaborate closely with suppliers. In 2021, they launched the Unilever Supplier Climate Programme, which aims to accelerate the decarbonization of their shared supply chains across raw materials, ingredients, and packaging materials.

Unilever is targeting 300 priority suppliers for this program. In 2022, they ran a pilot with 35 raw material suppliers of varying sizes and climate maturities, covering a range of industries and geographies. Suppliers participating in the pilot were able to build their climate knowledge and develop expert capabilities to calculate and share their GHG emissions data.

7 Conclusion

There is currently a broad consensus among policymakers and scientists of various disciplines on the risks of climate change. However, the economic consequences of many of the associated complex risks need to be fully quantified. This limitation should not stop us from including these unquantified, poorly understood, and often deeply uncertain risks in economic evaluations and decision-making processes. This argument was elaborated recently in *Nature* by Rising et al. (2022), and it is the approach we follow in our own (ongoing) work on climate risks for managing sovereign debt. In this short chapter, we argued that business schools have an essential role in spreading the study of climate change risks in their curricula, focusing particularly on business operations.

This chapter underscores the profound impact of climate change on businesses, emphasizing both physical and transition risks, the development of carbon markets, and the uncertainties surrounding various climate policies, including the Kyoto Protocol and the Paris Agreement. Business schools must integrate climate change into their curricula, and we have outlined a business school curriculum on climate change, underlying key learning objectives and topics. We also delved into a detailed exploration of the scope and importance of climate finance in addressing climate change. Finally, this chapter concludes by examining how Unilever adapted its operations in response to the challenges posed by climate change risks.

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Pedagogical Lessons from the Pandemic

Joelle Saad-Lessler and Kevin Ryan

Abstract This study conducts a survey of students and faculty at an undergraduate school of business to identify which pedagogical tools were effective in supporting student learning during and after the pandemic. Comparing student perspectives with those of faculty suggests that faculty should continue to record classes, hold remote office hours, utilize experiential learning techniques, increase their use of polling and student-to-student teaching in the classroom and reduce their reliance on remote teaching. Survey results also indicate that faculty have been more available to students outside the classroom via remote office hours compared with pre-pandemic times. This is a welcome change that should be celebrated and encouraged.

1 Introduction

The onset of Covid forced teachers to adopt Emergency Remote Teaching (ERT) practices. All faculty, some with prior experience with online teaching, most with none, had to deliver content via zoom to students who were similarly unprepared for this new mode of delivery. University IT departments quickly created tutorials on how to set up equipment, and some even conveyed advice on online teaching techniques, such as the use of chat rooms and breakout rooms. Now that the pandemic has passed, some faculty would like to forget the whole episode and go back to the way they used to teach face-to-face. Because of the rushed adoption of remote teaching, many equate ERT with Online Learning and Teaching (OLT) and are loathe to adopt digital learning tools in a face-to-face classroom setting. It would be a shame to discontinue the use of digital tools that proved effective from a pedagogical perspective during the pandemic, just because of their association with ERT.

In this study, we survey faculty and students at an undergraduate school of business and ask them which tools worked well for them and which were unhelpful from a

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pedagogical point of view. We compare students' answers with those of faculty to zero in on instances where students see things differently from the faculty.

Finally, we evaluate the extent that faculty have changed their behavior with respect to students since the pandemic by asking both faculty and students who were at the school before the pandemic about faculty-student interactions outside the classroom. Again, we look for commonalities and differences in perspectives between students and faculty. Results of our study will inform a set of best practices that can be shared with faculty going forward.

2 Literature Review

Prior to the COVID-19 pandemic, an extensive literature evaluated pedagogical tools and methodologies that professors could utilize to enhance student learning in higher education. Particularly, teacher and student readiness, performance, and satisfaction were analyzed against the backdrop of technology adoption. Bond et al. (2020)'s review demonstrated that online learning and face-to-face education were becoming increasingly integrated with one another and proposed different methods for fostering student engagement. Furthering this discussion, Nortvig et al. (2018)'s literature review on e-learning examined factors that affect students' and teachers' learning experiences, outcomes, and engagement and highlighted the significance of proper teacher training for mutual gratification in higher education classrooms. In addition to research on the impact of digitalization on instructors and learners, different pedagogical approaches and tools, including flipped classrooms (Lundin et al., 2018), social media tools (Chawinga, 2017; Hamadi et al., 2021; Wooten, 2020), and online lecture recordings (Morris et al., 2019) revealed how technology could enhance instruction.

The role of digitalization in higher education has also been assessed in business courses and schools. In their study, Gupta et al. (2020) examined the impact of different variables on successful adoption of digitalization by business schools and found that students' and teachers' competence had the strongest impact on adoption. Various tools, such as flipped classrooms (Das et al., 2019) and recorded lectures (Nyer, 2019) were also analyzed in business higher education settings.

The onset of the COVID-19 pandemic demanded an abrupt shift to online education and widespread adoption of technology. Throughout the pandemic, educator and learner perspectives were evaluated to understand the obstacles and opportunities associated with Emergency Remote Teaching (ERT). Several studies assessed teacher readiness for online learning and their efficacy in a virtual learning setting by surveying faculty. Scherer et al. (2021) conducted a survey of educators from 64 countries, aimed at identifying teachers' online teaching preparedness. Damşa et al. (2021) studied the notion of teacher agency in the context of online emergency education, relying on a survey of university teachers asking about their experiences and challenges during the first month of teaching remotely due to the COVID-19 lockdown. Marek et al. (2021) conducted a survey to explore the experiences of higher

education faculty who converted classes to distance learning during the COVID-19 pandemic. Correspondingly, other studies researched learners' viewpoints by surveying students to gauge how they fared with ERT (Daniels et al., 2021; Patricia, 2020). These studies were focused on ERT because of its widespread adoption during the pandemic.

Once the pandemic abated and institutions began returning in-person, studies advanced to discover what lessons could be drawn from the experience with ERT, and what aspects of Online Learning and Teaching (OLT) and digital learning can be applied in the classroom post-COVID. Ashour et al. (2021) surveyed administrators and professors at three universities in the UAE to evaluate whether remote teaching would be here to stay. They predicted that many of the takeaways during the period of forced adoption of distance education will be used by universities to enhance and expand online learning provisions. Rapanta et al. (2021) conveyed that ERT's forced integration of technologies in higher education will advance pedagogical innovation, particularly starting with course design and interactive learning environments. They also anticipated that teachers will use a variety of instructional methods that emphasize flexibility, empowerment, professionalization, and strategic decision making in order to accommodate different learning styles and ways of student engagement post-COVID. Sharma and Alvi (2021) evaluated and compared learning aspects pre- and post-pandemic such as flexibility, content quality, and instructor's responsiveness in Indian undergraduate engineering students. They found that blended learning methods are perceived better than web assisted e-learning by students.

A few post-COVID studies take stock of both student and instructor reflections; this paper aims to add to this academic discourse. Chen et al. (2022) provide a holistic overview of students' and instructors' experiences of online courses at a Canadian university and determine that both teachers and students have a greater need for flexibility in the post-COVID higher education level. Notably, they find that students overwhelmingly want access to recorded live lectures. Benito et al. (2021) also analyze satisfaction levels of students and faculty following the return to in-person classes. They look at universities in Turkey, India, and Costa Rica and find that post-COVID learning experiences in higher education can be enhanced with integration of technological components, particularly with access to learning materials in a digital form and flexibility in the physical attendance to lectures.

In summary, there is a large literature on how technology could enhance pedagogy pre pandemic, and a growing literature on what lessons can be drawn from the pandemic to further improve instruction. Our work contributes further to this literature, focusing specifically on undergraduate business programs. We identify practical pedagogical methods (both digital and face-to-face) that have worked and those that have not in a post-COVID American undergraduate business school setting, without committing to the adoption of digital technology in the classroom, or to online teaching methods. The aim is to identify what works so we can help faculty use our findings to improve the way they deliver content to their students. We hypothesize that faculty and students will agree that some teaching tools that were used when instruction was fully online were not effective and should no longer be used. We also

hypothesize that some teaching tools will be viewed favorably by one group but not by the other. We hope to learn the most from these areas of disagreement.

3 Methodology and Data Description

Using a Qualtrics anonymous survey, we ask faculty and students at a U.S. undergraduate school of business which tools worked well for them, and which tools were not effective from a pedagogical point of view. The students were encouraged to participate via in-class visits and through membership in a university subject pool, while faculty were sent the survey via email. The student body profile is similar to that of other U.S. undergraduate institutions, with a slightly lower fraction of females and members of under-represented communities.

The list of tools we inquired about includes recording classes, polling, breakout rooms/ group work within the classroom, chat rooms,[1] remote office hours, experiential learning techniques, student-to-student teaching and remote teaching. Students could indicate more than one answer, and they could write in other methods that are not on the list provided. For each teaching tool identified as ineffective, students are asked to indicate whether this is because the tool is inherently ineffective, or it is used incorrectly. We compare students' answers with those of faculty to identify teaching tools that both students and faculty agree are helpful or unhelpful. We also zero in on instances where students see things differently from the faculty. Results of our study will inform a set of best practices that can be shared with faculty going forward.

Another aspect of the study evaluates how instruction and the availability of faculty outside the classroom has been affected by the pandemic. Reports abound of faculty complaining about being overworked and burned out. Based on our own experience, as well as ad-hoc testimonials from fellow faculty members, we hypothesize that faculty have made themselves more available to their students, likely through the use of email or online office hours. If true, this is potentially a boon to students and would help increase faculty-student interactions outside the classroom. We survey students who were enrolled in the fall of 2019 and ask them whether faculty have become more or less available outside the classroom—and the role of online office hours in helping achieve that. This set of questions is similarly asked of faculty. Again, we look for commonalities and differences in perspectives between students and faculty.

[1] When we launched the survey, this referred to the chat room feature in zoom. This may not have been clear and could be interpreted as referring to discussion boards. Similarly, student-to-student teaching could be confused with group work in the classroom or to situations where a student is invited to lecture on a particular topic.

Table 1 Student body composition

First year	358	58%
Second year	114	19%
Third year	69	11%
Fourth year or more	75	12%

Student Survey

The anonymous student survey was completed by 618 School of Business students, and they represented all major undergraduate programs: marketing innovation and analytics, finance, economics, accounting and analytics, information systems, management, quantitative finance, business and technology as well as business undecided. The vast majority of responding students were in their first year. The survey also included responses from second, third, and fourth-year students, as well as three students who are in their fifth year, earning an accelerated master's degree (see Table 1).

Students were asked to mark from a list of pedagogical tools which ones they felt were effective in supporting student learning. This list included recording classes, polling, breakout rooms/ group work within the classroom, chat rooms, remote office hours, experiential learning techniques, student-to-student teaching and remote teaching. Students could indicate more than one answer. Students were also asked to mark from the same list which tools they felt were not effective at supporting student learning. Again, students could choose more than one answer.

The survey also looked at how faculty-student interactions outside the classroom changed compared with before the pandemic. For that portion of the survey, only students who were at the school before the onset of the pandemic should have answered. The sample included 75 students who identified as being in their senior year or being in their fifth year in an accelerated master's program, which means they were first year students in fall 2019.

Faculty Survey

Thirty-one School of Business faculty participated in the anonymous survey and they represented all major graduate and undergraduate programs; marketing, finance, economics, accounting, information systems, management, financial engineering, and data analytics. The average years of teaching experience was eighteen and varied from one to forty-six years. Participating faculty included tenured, tenure track, and non-tenure track faculty with an average of five classes taught per year.

Approximately half of the faculty who responded had experience teaching remotely before the pandemic. In addition to the traditional on-campus offerings, the School of Business offers graduate courses in both an online and "hybrid" format; courses with a combination of on-campus and online students.

4 Results

Effective Pedagogies—Student View

Results of the student survey are displayed in Table 2. Students identified the following as the top three effective teaching tools for supporting student learning:

Recording classes
Remote office hours
Experiential learning.

Student-to-student teaching and polling were also identified as being effective. The fraction of students who listed all these tools as effective was higher than the fraction who listed them as ineffective. When asked to list additional teaching techniques and tools they would like to see used in the classroom, students listed more interactive teaching methods and game-based learning (Kahoot was specifically mentioned).

The following teaching tools had a higher percentage of students indicating they were ineffective than effective for supporting student learning:

Remote teaching (listed by 43% of the responding students compared with 27% who thought this was an effective method of instruction)
Chat rooms.

Students seemed split on the use of Breakout rooms and group work within the classroom, with 39% indicating these are not effective, while 38% felt they were effective tools in the classroom.

In addition to the tools listed, students identified a lecture format where the instructor reads off presentation slides as another ineffective approach.

For each teaching tool they identified as ineffective, students were asked to indicate whether they felt this was because the tool was inherently ineffective, or it was used incorrectly. For this follow-up question, more students identified the following as being inherently ineffective, rather than being used ineffectively: polling, breakout

Table 2 Student assessment of teaching tools

	Effective (%)	Not effective (%)
Recording classes	74	11
Polling	39	24
Breakout rooms/group work within the classroom	38	39
Chat room	19	37
Remote office hours	57	10
Experiential learning	49	10
Student-to-student teaching	40	24
Remote teaching (zoom/WebCt/teams etc.)	27	43

Table 3 Reason tool was ineffective

	Inherently ineffective tool (%)	Used incorrectly (%)
Recording classes	17	23
Polling	26	12
Breakout rooms/group work within the classroom	29	22
Chat room	30	17
Remote office hours	11	11
Experiential learning	10	11
Student-to-student teaching	20	16
Remote teaching (zoom/WebCt/teams etc.)	31	18
Other tool you identified	7	6

rooms/group work in the classroom, chat rooms, remote teaching and student-to-student teaching (see Table 3). On the other hand, students who felt that recording classes was an ineffective tool were more likely to feel that way because the tool was used incorrectly.

Faculty-Student Interactions—Student View

Student responses to questions about interactions with faculty outside the classroom pre and post Covid are in Table 4. Among the respondents, 37% felt that professors were more available since the pandemic. This agrees with faculty observations (see next section). The majority (87%) of the respondents are just as likely or more likely to interact with faculty outside the classroom since the pandemic and 49% indicate they are more likely to attend virtual office hours (approximately 24% are less likely to attend in-person office hours since the pandemic). Among respondents who indicated that faculty availability has increased since the pandemic, 79% stated that they were more likely to attend virtual office hours. This implies that the increased availability of faculty outside the classroom is directly attributable to the use of virtual office hours.

Effective Teaching Tools—Faculty View

Results of the faculty survey indicate that during the pandemic, there was a significant increase in the number of faculty who recorded classes, and who used polling, breakout rooms, chat rooms and remote teaching (see Table 5). There was also an increase in the number of faculty who made use of teacher-to-teacher training

Table 4 Student-faculty interactions

	Stayed the same	Increased	Decreased
How has the availability of professors outside the classroom changed since the pandemic	51%	37%	7%
	Just as likely	More likely	Less likely
Are you more or less likely to interact with faculty outside the classroom since the pandemic	68%	19%	8%
Are you more or less likely to attend in-person office hours since the pandemic	57%	13%	24%
Are you more or less likely to attend virtual office hours since the pandemic	40%	49%	5%

sessions. The use of remote office hours did not change and the prevalence of experiential learning declined. Other tools used during the pandemic included online assignment submission, online discussion forums, talking sessions outside of office hours and the use of the whiteboard feature in Zoom to write lecture notes and subsequentially posting these notes on the Canvas course website. The increased use of online cloud-based storage tools and websites used to post and distribute course related documents also provided another layer of connection during the pandemic.

Post pandemic, the recording of classes increased further, as did the use of polling and remote teaching. Moreover, there was an increased incidence of remote office hours and experiential learning in the classroom. On the other hand, the use of breakout rooms and chat rooms plummeted. Faculty identified the following teaching tools as the most effective to support student learning (see Table 6):

Table 5 Faculty use of teaching tools over time

Teaching tools used	Pre-pandemic	During pandemic	Post pandemic
Recording classes	14	17	22
Polling	8	12	13
Breakout rooms/group work within the classroom	10	19	15
Chat room	5	15	4
Remote office hours	16	16	21
Experiential learning	12	5	10
Student-to-student teaching	4	4	4
Teacher-to-teacher training	0	4	3
Remote teaching (zoom/WebCt/teams etc.)	14	19	20

Table 6 Faculty-identified effectiveness of teaching tools to support student learning

Teaching tools used	Effective (%)	No-longer effective
Recording classes	58	16
Polling	26	16
Breakout rooms/group work within the classroom	42	13
Chat room	13	16
Remote office hours	48	3
Experiential learning	39	3
Student-to-student teaching	6	3
Teacher-to-teacher training	3	13
Remote teaching (zoom/WebCt/teams etc.)	52	13

Recording classes
Remote teaching (using Zoom lectures)
Remote office hours
The use of breakout rooms and group work within the classroom
Experiential learning.

For each of these, more faculty felt these tools were effective in the classroom than those who felt their usefulness has waned. On the other hand, more faculty identified chat rooms and teacher-to-teacher training as no longer effective compared with those who still felt these were effective tools.

It is interesting to note that remote office hours, remote teaching, and the recording of classes continued to be used by faculty after the return of students to campus. All three techniques are used, for example, to assist students who are quarantining after COVID.

Faculty-Student Interactions—Faculty View

Faculty indicated, compared to pre-pandemic semesters, that online interaction with students (e.g., remote office hours) remains an important way to connect with students (see Table 7). Moreover, 42% of faculty indicated an increase in their availability to students on demand.

Table 7 Faculty interactions with students compared to pre-pandemic

	Virtual (%)	In-person (%)	On-demand (%)
Decrease	16	24	8
No change	16	52	50
Increase	68	24	42

Table 8 Time Faculty spent with Students

	Stayed the Same (%)	Increased (%)	Decreased (%)
Amount of time faculty make themselves available to students	39	45	29
Student attendance to in-person office hours	58	13	58
Student attendance to virtual office hours	3	42	13

The result of both on-campus and online interaction has resulted in an increase in the amount of time faculty are available to meet with students (see Table 8). However, most faculty note that at in-person (on campus) office hours has stayed the same or decreased compared to to pre-pandemic semesters.

On the other hand, most faculty report an increase in attendance in virtual (online) office hours. A comparison of faculty and student perspectives based upon the survey results are presented in the next section.

5 Discussion of Results

Students and faculty have different views on the impact of the continued recording of class lectures as an effective tool to support student learning (see Table 9). Both groups identified class recordings as the most effective tool to enhance student learning during the pandemic. However, with the return of students to campus, faculty listed class recordings as the number one tool no longer helpful to student learning. While the recording of classes was viewed as most effective by students, it was also listed by students as the tool most often used incorrectly by faculty.

Opinions on the use of breakout rooms and group work in the classroom also differed between students and faculty, with the latter exhibiting confidence in the effectiveness of these tools for furthering student learning, while students were evenly split between those who agreed and those who found these tools ineffective.

In another important difference between student and faculty perspectives, students identified remote teaching as the number one most ineffective tool to enhance student learning. In fact, it was also cited as the most inherently ineffective tool, making it clear it is not redeemable. By contrast, the faculty listed remote teaching as the second most effective tool (after the recording of classes).

A majority of students and faculty agreed that experiential learning and polling are effective, and that chat rooms are ineffective, but the relative difference in opinions (an indicator of conviction) was more pronounced among students. Faculty exhibited an under-appreciation of the potential for using student-to-student teaching in the classroom compared with how students felt.

Based upon survey results, students value recorded lectures, virtual office hours, experiential learning, polling and student-to-student teaching. Faculty question the

Table 9 Students vs Faculty evaluation of teaching tools

Teaching tools used	Students			Faculty		
	Effective (%)	No longer effective (%)	Diff (%)	Effective (%)	No longer effective (%)	Diff (%)
Recording classes	74	11	63	58%	16	42
Polling	39	24	15	26%	16	10
Breakout rooms/group work within the classroom	38	39	− 1	42%	13	29
Chat room	19	37	− 18	13%	16	− 3
Remote office hours	57	10	47	48%	3	45
Experiential learning	49	10	39	39%	3	36
Student-to-student teaching	40	24	16	6%	3	3
Remote teaching (zoom/ WebCt/teams etc.)	27	43	− 16	52%	13	39

continued benefit of recorded lectures and underestimate the importance of student-to-student teaching. They also overestimate the usefulness of remote teaching and breakout rooms and group work in the classroom relative to students.

The majority of faculty and students indicated that attendance in virtual office hours increased post pandemic. Moreover, 45% of faculty and 37% of students agreed that faculty availability outside of class increased post-pandemic—perhaps a direct result of the increased use of remote office hours. This is a welcome development because it increases faculty-student interactions within a flexible construct for faculty.

We speculate that faculty's lack of enthusiasm about class recordings stems from a feeling that the process is burdensome, and faculty feel stretched thin due to the increasing expectation that they make themselves readily available when students need them. This may also explain faculty loyalty to remote teaching because it gives them a bit of a break from all the extra work. If this is part of the reason for the difference in attitudes, it suggests that the added faculty burdens need to be considered when asking them to take on additional responsibilities.

Continued Integration of Technology for Effective Student Learning: Opportunities and Challenges

The benefits of recorded lectures for students include the ability to reexamine important lecture topics and to assist those unable to attend class due to illness or an excused absence (e.g., athletic conflict). Advantages to professors include facilitating teacher-to-teacher training and course coordination and sequencing of topics across multiple sections. The recordings can serve as a guideline for lecture pacing and appropriate level of coverage for each topic in courses taught by multiple professors.

The possible impact of class recordings on in-class attendance is a concern. One solution is to make recordings available only to students who have attended the lecture

or have an excused absence. Alternatively, faculty could take attendance regularly and make in-class attendance a part of the grade.

Another concern is that recording class sessions can be onerous for faculty to set up. Moreover, the recording process should not hinder the natural teaching style of the professor. For example, the professor should not be required to stand in one area of the room but should be able to walk around the room to interact with students. This will require recording technology which is easy to use and can record the lecture and interaction from anywhere in the classroom. The recording equipment should focus on the professor to maintain student privacy. This will require significant investments in upgrading classrooms to make sure recordings can be launched seamlessly and easily and can capture sound and movement throughout the classroom. The recording of labs and recitations, which typically involve hands-on exercises, will pose unique challenges. Lab and recitation recordings may be supplemented with follow-up Zoom meetings between students and teaching assistants.

To enhance office hours, faculty should consider providing remote access (e.g., Zoom link) to their existing in-person office hours. If this complicates the logistics of office hours, faculty can divide their office hours into an on-campus period and an online period. They could also adopt in-person office hours and be on-call via email at certain times. This recommendation does not entail any challenges, other than an added expectation that faculty make themselves available to students outside the classroom for more time.

Finally, faculty should receive training on the increased use of experiential learning techniques, student-to-student teaching within the classroom and enhancing the use of polling to increase student engagement.

Partly as a result of this study and in response to student requests, faculty in our school have been encouraged to record classes using zoom with screen sharing. Faculty are given lapel microphones to use to capture sound as they move around the classroom and Bluetooth enabled tablets to write on in lieu of writing on the board. The class recordings do not include live video of the classroom to maintain student privacy. A number of faculty at the university already record their lectures in this fashion (including one of the authors of this study) and have not encountered issues.

6 Conclusion

This study set out to uncover which pedagogical tools were effective during the pandemic and should continue to be used—not quickly forgotten along with the bad memories associated with the pandemic. We surveyed students and faculty and found that class recordings, holding remote office hours (in addition to in-person office hours) and experiential learning techniques are effective tools that we should strive to keep using in a face-to-face setting. We discussed some challenges with adopting these tools and made suggestions for dealing with these challenges. Moreover, faculty should increase their use of polling and student-to-student teaching in the classroom. Though faculty have developed some level of mastery teaching remotely, students

were consistently unhappy with remote teaching, leading us to recommend that face-to-face instruction should be prioritized as much as possible.

Our survey also found that faculty-student interactions outside the classroom increased, mostly through the use of online office hours. Although the increased availability of faculty may contribute to faculty burnout, its benefit to students is one way the pandemic experience may not have been all bad. As the saying goes: every cloud has a silver lining.

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Sense of Presence in Digital Learning Environments: Experiences from the COVID-19 Era

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Abstract With the onset of the COVID-19 pandemic higher education institutions relying on traditional teaching methods were forced to transfer their teaching to exclusively digital settings. This study investigates how the absence of any physical presence affects students' satisfaction in digital learning contexts. Based on the Community of Inquiry (CoI) framework, students' sense of presence is conceptualized in terms of learning from the content, interacting with instructor and feeling socially present as part of a particular class. The study was conducted on three cohorts of postgraduate programs that were taught exclusively digitally. Results indicate that social presence is the most important predictor of student satisfaction, followed by teaching presence which has also significant effects. Cognitive presence exhibited a weaker effect on students' satisfaction. Methodologically, the research contributes to the validation of the CoI framework and instruments at the program level. The findings demonstrate the importance of maintaining the students' social sense of belonging in the digital learning context and the instructors' responsibility to create the appropriate learning climate through their instructional methods.

1 Introduction

Digital transformation of teaching and learning has been accelerated by the COVID-19 pandemic in almost all levels of educational practice. The pandemic has led universities worldwide to unexpected operational changes, as they were forced to transit the educational experience from a classroom environment to an exclusively online learning environment. According to the global survey by UNESCO (2021), the pandemic affected 220 million higher education students who were disrupted in 2020 by university closures. The findings of the Global Survey on the Impact of COVID-19 on Higher Education conducted by the International Association of Universities (Marironi et al., 2020) in April 2020 revealed that in 67% of the cases

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classroom teaching was replaced with distance teaching and learning, while in 24% of the cases, teaching was suspended to prepare and develop distance teaching methods. According to the analytical report (Farnell et al., 2021) about European universities' teaching and learning practices during the pandemic, 74.6% conducted teaching via live-streamed lectures, 44.5% sent presentations to students, 32.1% sent recorded lectures in the form of video, and 20.6% sent recorded lectures in the form of audio.

It is obvious that the pandemic has significantly affected and reshaped the way teaching is delivered in higher education globally. Classroom-based education has been replaced by distance digital education in the form of synchronous, asynchronous or blended learning. Despite the difficulties, it has also offered a unique opportunity for the reconstruction of educational programs to fulfil the online educational needs. The pandemic has also triggered a collective reflection on how universities design and deliver their educational products and services in the present and which alternative actions could be taken in the future to be more effective. As distance digital education gained students, professors' and universities' interest, one fundamental question that needs to be answered is how online programs will become more effective (Arbaugh, 2018).

While a variety of factors affecting digital learning effectiveness have been researched extensively, digital learning is also significantly affected by a sense of class belonging. Maintaining a sense of belonging in the absence of a physical classroom is a controversial issue for online education environments. Online classroom teaching as a type of educational transaction is characterized by three essential elements that are expressed as three types of presence (Garrison et al., 2000). Teaching presence, social presence and cognitive presence describe the elements that affect relationships among online course participants, instructors and learners, and how these factors could be related to the success of online educational environments and the development of critical thinking.

The Community of Inquiry framework (CoI) constitutes a conceptual basis to study online educational experiences (Garrison et al., 2000). The CoI framework consists of three basic elements such as cognitive presence, social presence and teaching presence for the creation and design of meaningful educational experiences. A better understanding of the digital distance educational approaches and experiences, and of how effective they are could provide insights into how to improve their design and delivery to maximize students' outcomes.

Although the association of CoI presences and course outcomes may constitute a challenging research focus (Maddrell et al., 2017), there is a lack of empirical research in this area. Furthermore, this association has been empirically examined almost exclusively in separate courses instead of the basis of the whole program. This study adopts the CoI framework to understand and explore the effects of students' sense of presence on students' outcomes in the context of whole digital distance educational programs in higher education. To achieve the above purpose, the CoI instrument was adapted, to explore student perceptions of the three CoI factors (teaching, social, cognitive presence) and their association with students' satisfaction in digital distance postgraduate programs during the unexpected transition from face-to-face to fully online learning environment.

2 Sense of Presence in Digital Distance Higher Education

Information technology offers various possibilities for digital distance education. Educational environments can be described by their synchronicity and modularity (Ebner & Gegenfurtner, 2019). According to Ebner and Gegenfurtner (2019), "synchronous learning environments enable simultaneous and direct interaction, while asynchronous learning environments afford temporally delayed and indirect interaction". The benefits of digital education include flexibility for students regarding participation, convenience, and customizability to students' needs (Richardson et al., 2017). In the case of online MBA studies, the possibility of online communication makes these online programs more appealing to older students because of their work and family obligations (Arbaugh, 2002). Lack of face-to-face interactions between classroom participants remains a major concern of digital learning (Francescucci & Rohani, 2018). That is the reason why there are several studies regarding the effectiveness of distance learning and the learning outcomes of online classrooms. Some studies find differences in the effectiveness of digital compared to face-to-face learning environments, while other studies argue that there are no significant differences between these different environments (Sarker & Nicholson, 2005).

Student satisfaction from the educational transaction and their learning experience has been researched extensively in recent years for higher education provided digitally both within formal programs or lifelong learning (Alaulamie, 2014; Arbaugh, 2008; Garrison et al., 2010; Giannousi & Kioumourtzoglou, 2016; Joo et al., 2011; Piccoli et al., 2001). The more established model for understanding the shaping of the educational experience in students and teachers likewise is the Community of Inquiry (CoI) framework introduced by Garrison et al. (2000). In this framework, inquiry and community are the central elements as proposed by Dewey (1933) who argues that student individual development requires a community context to be achieved (Swan et al., 2009). As these elements describe the role of teachers and students during the educational process, their interaction is the key factor for a successful educational experience within the community.

Cognitive presence describes the extent to which the participants of a community of inquiry can communicate effectively during distance learning sessions and extract meaningful knowledge. Cognitive presence is vital for the development of critical thinking, and this is the reason that makes the analysis of this presence, so important for both face-to-face educational as well as online environments where participants communicate remotely (Garrison et al., 2000). According to Garrison et al. (2001) and the Practical Inquiry Model, developed by Dewey (1933), cognitive presence comprises four phases: triggering event, exploration event, integration event and resolution event.

Social presence describes the ability of participants to preserve their characteristics and interact with each other like in real life. It also relates to their ability in the Community of Inquiry to project their personal characteristics into the community,

thereby presenting themselves to the other participants as "real people". The social presence element is also important for the educational experience as a support for cognitive presence, because it indirectly facilitates the process of critical thinking development during the educational process within the community of learners. Nevertheless, social presence contributes directly to the success of learner education, when the interaction between the participants is vital for the success of the educational process (Garrison et al., 2000). Garrison and Arbaugh (2007) argue that social presence comprises affective expression, open communication and group cohesion. They indicate that social presence is increased through student interaction and collaboration and that social presence is necessary for cognitive presence development.

Teaching presence refers to the teacher's responsibilities within any Community Inquiry. The first responsibility is the design of the educational experience, from the selection and presentation of course content to the development of learning activities and assessments. The second responsibility is the facilitation of the experience, which could be shared among the participants, especially in higher education. Teaching presence is a means to support and enhance the social and cognitive presence in order to achieve the desired learning purposes (Garrison et al., 2000). Teaching presence is manifest through instructional design and organization, facilitating discourse and direct instruction (Garrison & Arbaugh, 2007).

Empirical research based on the CoI framework has mainly focused on the development and validation of the CoI instrument (Arbaugh, 2008), the association of CoI elements with student outcomes, and the relationships among CoI presences. The association of CoI presences with course outcomes was examined in previous studies (e.g. Alaulamie, 2014; Arbaugh, 2008; Garrison et al., 2010; Giannousi & Kioumourtzoglou, 2016; Joo et al., 2011;) and the findings revealed that CoI elements (cognitive, social, teaching) could predict students' outcomes. Almost all the studies were conducted in online settings, regarding one or more online courses, on one or more programs with different characteristics, instructors or lessons.

Student satisfaction forms the basis for ensuring digital learning success and effectiveness (Piccoli et al., 2001; Sun et al., 2008). Satisfaction constitutes an affective measure of students' attitude and fulfillment of learning expectations and needs from an educational experience. As a course outcome, satisfaction is affected by the sense of presence. Other studies have focused on the examination of the presences' construct separately (Arbaugh & Hwang, 2006; Garrison & Cleveland-Innes, 2005; Richardson & Swan, 2003). Stenbom (2018) found in his review that teaching presence has a positive effect on social presence and both teaching and social presences have a positive influence on cognitive presence. Garrison et al. (2010) found that teaching presence directly affected cognitive presence and is associated with social presence. He also found a mediating effect of social presence on cognitive presence. Based on Garrison's et al. findings, the mediation effects of each CoI element on the effects of each of the others on student satisfaction were examined in the present research.

The evaluation of educational experiences using CoI has been empirically tested in higher education settings almost exclusively at the course level. There is very limited research on the effects of CoI constructs at the program level and only at the doctoral level (Kumar & Ritzhaupt, 2014). Hence, there is value in exploring and validating the capacity of the CoI instrument to predict overall student satisfaction at the program level and in particular in postgraduate programs where exclusively digital teaching models are more widely used. This research exploits the unique conditions created by the pandemic offering an exclusively digital teaching and learning context where the effects of CoI constructs on student satisfaction can be examined.

The present study explores the effects of a sense of presence on student satisfaction in three postgraduate programs in a business and technology university. It researches three postgraduate programs in the areas of business and technology. The student populations in the study (2020–2022) were a unique respondent group as they had not experienced throughout their studies any face-to-face teaching or physical class interaction. Such unique conditions allowed us the effects of the sense of presence of students' learning experience and satisfaction in the absence of any physical contact. In our study, the sense of *presence* is *exclusively digital*.

3 Research Methodology

Research Context, Participants, and Instruments

The research was conducted at a higher education institution specializing in economics, business and technology studies and specifically in the Management Science and Technology (MST) Masters programs during the academic year 2019–2020. Students are graduates of Greek or foreign universities and are divided in full or part-time classes, based on whether they are employed or not. The MST Department employs about 45 professors and instructors, common for the three Master programs. It is worth noting that by law there was no previous digital distance educational experience for both students and faculty. The digital transition was an abrupt change for all higher education stakeholders.

From the total sample of 100 participants, 51 of them were females and 49 were males. Also, 53 of the participants were between 26 and 29 years old, 22 were between 22 and 25 years old, 16 between 30 and 35 years old, and the remaining 9 students were over 35 years old. As for the academic diplomas of the participants, about 86 of the participants had an undergraduate degree and only 14 of them had already a Master's degree. For 48% of the students, their learning score at the time of the survey was above 8.5 on a scale from 0 to 10.

The instruments used in the online survey consisted of three parts: (i) demographics (gender, age, education level), (ii) Community of Inquiry (34 items), and (iii) Satisfaction (12 items). The three presences of the Community of Inquiry were tested through the CoI framework survey instrument developed by Arbaugh et al.

(2008). The instrument's reliability and validity have been tested in previous studies (Arbaugh et al., 2008; Shea & Bidjerano, 2009; Swan et al., 2008). The instrument consisted of 9 social presence items, 12 cognitive presence items, and 13 teaching presence items. No further analysis of presences categories was performed. Student satisfaction items were used by Arbaugh (2018). From the 12 initial items of Arbaugh's satisfaction instrument, two items were excluded, because they refer to students' willingness to take online lessons and they did not meet the surveys' scope to explore the forced transition to distance learning environments. All survey items were rephrased and adapted to meet the needs of the survey according to the research context. A 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) was utilized and the instrument was translated into Greek, which is the participants' native language. The final survey instrument was evaluated by experts to make sure that translations expressed the same question with the initial English phrase.

To examine the effects of the sense of presence on student satisfaction, the following research questions and related hypotheses were formed:

RQ1. Does the sense of presence (teaching, social, cognitive presence) affect student satisfaction in exclusively digital higher education?

H1a: Teaching presence has a positive influence on student satisfaction in exclusively digital higher education.

H1b: Social presence has a positive influence on student satisfaction in exclusively digital higher education.

H1c: Cognitive presence has a positive influence on student satisfaction in exclusively digital higher education.

H1d: Teaching, social and cognitive presences have a positive influence on student satisfaction in exclusively digital higher education.

RQ2. What are the indirect effects of sense of presence (teaching, social, cognitive presence) on student satisfaction in exclusively digital higher education?

H2a: Social Presence mediates Teaching Presence and student satisfaction relationship in *exclusively higher digital education.*

H2b: Cognitive Presence mediates Teaching Presence and student satisfaction relationship in exclusively higher digital education.

H2c: Cognitive Presence mediates Social Presence and student satisfaction relationship in exclusively higher digital education.

RQ3. Are there any direct or indirect associations among teaching, cognitive and social presence in exclusively digital higher education?

H3a: Teaching presence positively influences social presence in exclusively higher digital education.

H3b: Teaching presence positively influences cognitive presence in exclusively higher digital education.

H4: There are mediation effects of each type of presence on the relationship between the two others in exclusively higher digital education.

Data Collection and Analysis

Data was collected through a survey administration where the questionnaire was created on the Microsoft Forms platform and it was distributed through e-mail. After 20 days, a reminder e-mail was sent to the targeted population. The online questionnaire consisted of three parts: (i) demographic and background questions (gender, age, cohort, working condition, diploma level, courses platform ease of use), (ii) questions on students' perceptions of the sense of presence based on the community of inquiry, and (iii) questions on students' satisfaction. Collected responses were statistically analyzed, using the IBM SPSS 25 software. Data are ordinal, as responses of a 5-point Likert scale. The internal consistency of the instrument was examined by Cronbach's alpha reliability. Three items were reversed, in order to avoid the negative effect on the alpha coefficient. Calculated values ranged from 0.801 to 0.929 and exceeded the cut-off limit of 0.7, as suggested by several researchers in Peterson's metanalysis (Peterson, 1994). Because of the initial high Cronbach's alpha, no items were deleted from the model. Of course, both the CoI framework instrument and student satisfaction scale validity and reliability have been also proved by research in different contexts.

Results

There were no missing values, no responses were excluded. In order to exclude univariate outliers, the standardized z scores were calculated. Skewness per item does not exceed an absolute value of 2 and kurtosis per item does not exceed an absolute value of 5. As a result, data is supposed to be normally distributed. No multicollinearity was found in the data as the values of the tolerance and VIF were found within the range of the acceptable values (tolerance value of more than 0.10 and VIF value of below 10).

The mean scores of teaching, social and cognitive presences were found to range from 3.30, 3.14 and 3.50 respectively as shown in Table 1. Teaching presence got a positive response, with means values between 3 and 3.58 and a total mean of 3.3. Skewness values are negative, but for most of the items, its values are between 0 and -1. Considering social presence, mean values were from 2.67 to 3.46 and the total scale mean was 3.14. Skewness values for most of the responses are negative with values between 0 and -1. Cognitive presence items mean values were calculated from 3.14 to 3.88 and the total scale mean was 3.49. Student satisfaction items mean values were between 2.67 and 3.33, while total scale mean score was 3.02. Data distribution could be considered normal because the absolute skewness for every variable is less than 3 and the absolute kurtosis is less than 10 (Pardisa et al., 2017).

Pearson's correlation analysis was used to determine whether the sense of presence has a positive association with student satisfaction (RQ1). Results indicated that all

Table 1 Mean, std. deviation and Cronbach' alpha

Variables	Items	Mean	Std. Deviation	Cronbach' alpha
Teaching presence	13	3.31	0.59035	0.894
Social presence	9	3.14	0.68304	0.867
Cognitive presence	12	3.50	0.58218	0.888
Student satisfaction	10	3.02	0.85647	0.929

independent variables (teaching, social and cognitive presence) are positively correlated with student satisfaction, with Pearson Correlation coefficients 0.521, 0.553 and 0.446 respectively, at a significance level of 0.01 (two-tailed) (Table 2). So, hypotheses H1a, H1b and H1c are accepted. The three types of presence cumulatively have a positive correlation with student satisfaction with a Pearson correlation coefficient of 0.586 and a significance level of $p < 0.01$ (two-tailed). Therefore, H1d is accepted. These results indicate that participants with a high perception of teaching, social and cognitive presence were highly satisfied with the digital learning experience. The cognitive presence's positive association with student satisfaction was somewhat lower compared to teaching and social presence.

To assess the predictive capability of the three types of presence for student satisfaction, a backward multiple regression analysis was performed (Table 3). Cognitive presence was found to have an insignificant predictive effect (beta coef. = -0.011, sig. = 0.927 > 0.05). Both teaching presence (beta coef. = 0.326, sig. = 0.009 < 0.05) and social presence (beta coef. = 0.389, sig. = 0.000 < 0.05) were found to have a statistically significant effect on student satisfaction. Overall, teaching and social presence can predict 37.9% of student satisfaction ($R^2 = 0.379$).

Table 2 Pearson' correlation coefficients

	Student satisfaction	Teaching presence	Social presence
Teaching presence	0.521		
Social presence	0.553	0.525	
Cognitive presence	0.446	0.740	0.558

Table 3 Multiple regression

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	Beta	Std. Error	Beta		
1 (Constant)	− 0.027	0.412		− 0.066	0.947
Teaching presence	0.462	0.136	0.318	3.389	0.001
Social presence	0.484	0.118	0.386	4.107	0.000

Indirect effects of each presence on the relationship between each of the other two with student satisfaction (RQ2) have been only observed for the mediation of the teaching presence to student satisfaction relationship by social presence. Mediation effects have been examined using the Sobel test (Sobel, 1982). This test comprises a significant indicator for indirect effects in datasets similar to our own. The test yielded similar results to those obtained through partial correlations of regression analysis ($z = 3.409, p = 0.0006516$), where social presence was found to mediate the relationship between teaching presence and satisfaction with a coefficient equal to 0.372, while cognitive correlation is − 0.009. Obviously, social presence has a significant role in the relationships between the CoI framework and student satisfaction. Therefore, hypothesis H2a is supported, while hypotheses H2b and H2c are rejected.

Each of the three types of presence is positively correlated with the other two (RQ3). All correlations are above $r = 0.5$ (Cohen, 1988) with the strongest correlation found between teaching and cognitive presence ($r = 0.740$). Teaching to social presence and social to cognitive presence have similar levels of correlation ($r = 0.525$ and $r = 0.558$ respectively, all at $p < 0.01$). Therefore, both hypotheses H3a and H3b are supported. Furthermore, social presence has significant mediation effects of teaching on cognitive presence ($z = 2.739$, $p = 0.006162$). Therefore, hypothesis H4 is supported.

4 Discussion

Starting with the descriptives, the mean scores of the CoI presences were at levels less than 4 implying future improvements can be made for the creation of the community of inquiry. On the contrary, in Kumar and Ritzhaupt's study (2014) the findings indicated that the three mean scores of the CoI presences were above 4. According to Matthews et al. (2013) mean scores of the CoI presences less than 3.75, or slightly less than 4, indicate a trend of an ineffective learning community. In this study, the lowest mean emerged for the social presence showing that the students' views of their experience in the purely digital setting in terms of their sense of belonging, collaboration and interaction with others was at low levels. Similarly, the average scores of teaching presence highlight that the digital Masters programs did not stimulate the students' feeling of their design and organization by giving instructions on courses' topics and learning activities, the existence of discourse facilitation and helpful and timely feedback. Cognitive presence mean score were slightly higher than the other two but not at the accepted levels demonstrating that the students' puzzlement, information exchange and the connection and application of the ideas should be improved in the purely digital programs that were examined in this study.

Overall the CoI model of presence explains 37.9% of student satisfaction in our study. The findings indicate that teaching and social presence were significantly associated with students' satisfaction and social presence was the most significant predictor of student satisfaction. In a study by Joo et al. (2011) social presence was not found a significant predictor of students' satisfaction. Student satisfaction seems

to rely on the sense of belonging in a class, which is mainly enhanced by social and teaching presences. So, it is important for future online program design, that instructors develop common and more efficient communication methods to attract students' interest and make them feel that they still belong to a class.

Cognitive presence was found to be an insignificant predictor of the dependent variable. Contrary to this, other researchers (Alaulamie, 2014; Giannoussi & Kioumourtzoglou, 2016; Joo et al., 2011) found that cognitive presence was a better predictor of students' satisfaction, compared to teaching and social presence. Students' sense of puzzlement, information exchange and connection and application of ideas did not affect student satisfaction. This finding corroborates Arbaugh's (2008) findings.

Concerning the direct or indirect associations among teaching, cognitive and social presence in exclusively digital higher education, the findings indicated that social presence was significantly correlated with teaching and cognitive presence, as was expected based on the previous studies (Garrison et al., 2010; Shea & Bidjerano, 2009). Also, similar to Joo et al. (2011) and Garrison et al. (2010), mediation effects testing showed that social presence mediated the relationship between teaching and cognitive presence. This could be explained by the fact that during online courses, students need to enhance their feeling of belonging to a class. So, it is indicated that in the future, the design of online programs should promote student's reflection and online discourse to enhance cognitive presence. Furthermore, teaching presence has a major role in course facilitation, structure and organization. Results of the present study regarding teaching presence's correlation with social and cognitive presence, agree with previous studies that emphasized the importance of teaching presence on the effective delivery of online courses (Arbaugh & Hwang, 2006; Garrison et al., 2010). Also, Alaulamie (2014), who studied the application of the CoI framework on fully online programs, found medium positive correlations between the three presences. Teaching presence proved to directly affect both social and cognitive presence and significantly predict student satisfaction. Based on this finding, faculty should start to be trained and guided to offer more valuable facilitation and direction to students based on the CoI framework.

5 Conclusion, Limitations and Further Research

This study's findings showed that the community of inquiry framework could be a valuable guide for future online educational programs design and delivery in the context of a fully online program, instead of separate online courses. This is aligned with Alaulamie's (2014) and Kumar and Ritzhaupt's studies (2014) which highlighted that the CoI framework could be a useful tool for the evaluation of online programs, despite the initial scope of the CoI framework on individual online courses. The high correlation among the three presences implied that programs' different aspects should be redesigned to achieve positive results. This means that the educational programs should aim to increase students' participation, through the selection

of appropriate online tools. Finally, teaching methods should urge students to participate in online sessions for "class belonging" feeling to be stronger and students to be more satisfied.

The CoI framework could help teachers and instructors to offer more valuable courses. Based on the study's findings for students to be satisfied with online courses and to participate in future programs, they should feel that they belong in a community of inquiry. This feeling can be developed and increased when students feel that they contribute to a common goal and they are valuable members of a team, so the above suggestions hopefully could help instructors to provide qualitative and meaningful courses to their future students.

Teaching and social presences were significantly associated with students' satisfaction while cognitive presence was not associated with students' satisfaction. The study is unique in terms of two issues: (1) it is conducted at the level of programs rather than individual courses, and (2) the students had no experience with classroom-based education and hence their satisfaction was dependent exclusively on digital educational experience. Despite the useful insights, there are various future research opportunities, as fully online master programs continue to be increased. Future studies should examine larger samples to support the generalization of the findings. Furthermore, as participants' age was between 22 and 29 years old, similar research should be addressed in master programs with older students. It is also suggested a further examination of the effects of different categories of subjects on various course outcomes including learning achievement. Also, other researchers should redesign and empirically test the CoI and satisfaction instruments, in order to better address the basis of whole online programs, instead of separate courses.

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