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Connecting air and rail to improve the tourist destination accessibility: the case of Malpensa airport

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Abstract

The paper analyses airports as strategical nodes of passenger transfers and the various modes of transport that define airport accessibility. Using the methodological approach of transport geography, this work underlines the strategic importance of the air-rail connection in order to improve airport accessibility. The attention is focused on the specific situation of Malpensa airport (Italy), considering its position along a European transport corridor (Rhine-Alpine) and its current integration with rail. In this regard, the paper presents the project of the new railway between Terminal 2 and the Simplon line, intended to improve the link with the existing (national and international) railway system. The final goal is to highlight the possible future scenario after the realization of the new railway, considering the positive effects on tourist destination accessibility. The analysis shows that the air-rail link is the best modal choice for long-distance passengers in order to access the tourist destinations located within the airport's catchment area. The methodology used to analyse the project can be proposed for educational aims and to perform similar investigations in other airports.

Keywords: Airports Accessibility, Air-Rail Connection, Catchment Area, Malpensa Airport, Tourist Destination Accessibility

1. Introduction

Addressing the themes of passenger transfer by plane, modal combination and the relationship between transport and territories necessarily requires the analytical and interpretative support of geographical discipline and, in particular, of transport geography.

According to Rodrigue et al. (2006), transport geography is a sub-discipline of geography interested in movements of freight, people and information. It aims to link spatial constraints and attributes with the origin, destination, extent, nature and the purpose of movements. Within this mainstream vision, transport geography should analyse the cross interactions between "spaces" and "transports"; this is relevant from the local to the global level. In other words, transport geographers should analyse how the milieu places constraints on transports and how transports affect the milieu they serve or go through (Dobruszkes, 2012). This means

that transport geography examines the movement of people, goods and information within or across different regions. The analysis of flows between regions implies the use of the so-called network approach (Black, 2003).

Therefore, it is possible to identify three core dimensions of transport geography: flows, nodes/locations and networks (Hesse and Rodrigue, 2004). Nevertheless, transport geography also studies the different modes of transportation such as road, rail, aviation and ships.

This work focuses the attention on airports as strategical nodes of passenger transfers but also on the network infrastructure and the transportation modes that define the airport accessibility. The first part of the paper presents a brief review of the literature on the concept of accessibility. Using the methodological approach of transport geography, the study underlines the strategic importance of the air-rail connection in order to improve the airport accessibility. The second part of the article examines the case of Malpensa airport, considering its position along a European transport corridor (Rhine-Alpine) and its current integration with other transport modes. In particular, the study focuses on the air-rail link to improve the tourist destination accessibility, illustrating the project that plans to connect Terminal 2 and the Simplon line. The study shows how the new infrastructure is of absolute importance for the hub function of Malpensa airport and how the new railway can affect tourist destination accessibility. The methodology used to analyse the project can be proposed for educational aims, as well as to undertake similar studies in other airport catchment areas.

2. Airports accessibility

Accessibility has been defined in several ways in the literature and thus has taken on a variety of meanings (Geurs and van Wee, 2004). These include well-known definitions such as the potential of opportunities for interaction (Hansen, 1959), the ease of reaching any land-use activity from a location using a particular transport system (Dalvi and Martin, 1976), and the benefits provided by a transportation/land-use system (Ben-Akiva and Lerman, 1979).

The term accessibility is composed of the words “access” and “ability”, thus meaning the ability to access, where “access” is the act of approaching something. The word is derived from the Latin *accedere* that means “to come” or “to arrive”. Therefore, it concerns the ease of reaching destinations or activities (El-Geneidy and Levinson, 2006).

It is possible to underline that accessibility involves a combination of two elements: location on a surface relative to suitable destinations and the characteristics of the transport network or networks linking points on that surface (Vickerman, 1974). Therefore, accessibility refers to the ease of reaching (and interacting with) destinations and activities distributed in space. The role of transport networks and related services is to allow people and goods to move between different points (characterized by some activities) in space, in other words, to provide accessibility (de Stasio et al., 2011). This means that accessibility should relate to the role of the land-use and transport systems in society, which will give individuals the opportunity to participate in activities in di erent locations. Focusing on passenger transport, it is possible to define accessibility as the extent to which land-use and transport systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport mode(s) (Geurs and van Wee, 2004). For these reasons, accessibility has long been a central issue in transport geography (Gutiérrez et al., 1996; Geurs and van Wee, 2004; Yang et al., 2016).

In particular, this paper considers the accessibility of airports that represent strategical transport nodes linking passengers to destinations. The connection of airports with settlement units on a local and regional scale constitutes a research problem focused on access to air travel (Kołoś et al., 2012). This aspect has been investigated since the 1970s when scholars began to analyse the travellers’ modal choice in order to reach the airport (Gosling, 2008). On the other hand, airport accessibility is a strategic element driving the air passenger market (Hsu and Wu, 1997).

A personal air travel trip is a transport chain. Firstly, the traveller starts from the origin (e.g. home) to the departure airport by road or railroad. Afterwards, the traveller goes to the desti-

nation airport by plane and reaches the final destination by road or railroad again. The travel convenience depends on the surface transportation infrastructure as well as the flight network. A better convenience corresponds to better accessibility from the origin to the destination (Yang et al., 2016). Based on the spatial separation concept, the travel convenience from origin to departure airport by road or railroad is defined as airport landside accessibility, while the travel convenience from departure airport to the destination airport is defined as the flight accessibility (Yang et al., 2016). In fact, as highlighted by the European Commission (2010), factors influencing airport accessibility can be subdivided into two categories: an "airside" which mainly reflects the service quality offered at airports (airline fares, frequencies and the number of destinations served) and a "landside" which mainly comprises airport ground accessibility. In this paper, the attention is focused on the airport landside accessibility.

Air travel has become one of the major modes of transportation in the last few decades. This substantial amount of air passenger growth is producing high pressure on ground networks connected to airports (Pasha and Hickman, 2017). Airport landside accessibility is a strategic element of the aviation sector. An airport with good airside infrastructures cannot be fully used if landside accessibility is inadequate. Better ground access to the airport is an important part of the competitive position of airports and airlines. Most major European cities have recognized this and provided adequate ground accessibility (Community Observatory on Airport Capacity, 2013). This implies that the latter is becoming a crucial tool for airports in attracting passengers. Airports have to work hard to retain both airlines and passengers. Therefore, they have to improve airside operations, but also have to enhance landside access to retain or increase their competitive position (Community Observatory on Airport Capacity, 2013).

3. Airports as intermodal nodes

In literature, we can find the terms "multimodality" and "inter-modality" to define a characteristic of a transport system that allows at least two different modes to be used in an integrated manner in a door-to-door transport chain (European Commission, 1997). Multi-modal or intermodal transport usually implies that one transport mode is used as the main mode for making the trip, while the other(s) is (are) used as access or egress mode(s) (de Stasio et al., 2011). In a broad sense, intermodal transport can be viewed as the transport of passengers by the use of several coordinated transport modes. In literature, we can find various definitions (NTUA, 2000; Eurocontrol, 2004):

- Characteristic of a trip which uses at least two different transport modes from origin to destination;
- Characteristic of a nodal point that allows transfer between at least two different transport modes.

Considering these definitions, we can see that all trips made by air have to be intermodal trips since all passengers have to go from their point of origin to the airport. Air transport is necessarily connected to other systems of transport, which permit the traveller to carry out his entire journey, from origin to destination (Bresciani, 1995). Therefore, air passengers are always involved in intermodal travels, where the intermediate node (airport) acts as a platform for mode transfer (Duarte Costa, 2012). According to Janic (2011), airports are defined as intermodal transport nodes, which enable air passengers to transfer from the airports' ground access modes to the air transport system, and *vice versa*. This underlines the essence of the airport as an intermodal node. Intermodality refers to the airport as the focal point of all transport activities, with a master/slave relationship to rail and road systems feeding the airport. It can involve a combination of (Picardi, 2003):

- Access to airports: local services between the airport and the neighbouring city (e.g. via train, metro or bus);
- Feeder services between the airport and the various parts of the surrounding region (mainly provided by high-speed train, train or bus);
- Complementary or alternative services between the airport and the centre of neighbouring regions.

Eurocontrol (2004) introduced the concept of "geographic intermodality" that is well linked to the conceptual background of transport geography. The role of an existing airport as a node of intermodal transport is partly exogenously determined by its geographical position. Several factors need to be considered when developing a multimodal node: the distance between the airport and the city centre and its localization relative to other large cities (Eurocontrol, 2004). In air transport, Eurocontrol (2004) distinguishes between intermodal travel in which one mode performs airport ground access from/to the near city centre and intermodal travel in which the airport is integrated with the regional or national network of other transport modes. This distinction generates the following two categories:

– Type 1 intermodality (airport ground access from the nearest urban area);
– Type 2 intermodality (integration of an airport in the regional or national transport networks).

Considering Type 1 intermodality, the airport ground access can be divided into different types (Eurocontrol, 2004):

– The bus is the most common type of collective transport to the airport. Connection to the airport by bus can be part of the city bus network but, in most cases, it is a dedicated service (express bus linking the airport to the city centre or regional bus linking the airport to other regional cities);
– High-speed dedicated or express train linking directly airport to the city central station;
– Light rail which is a kind of tramway that can link airports as a part of a city public light rail network or as a dedicated link from the airport to the city centre;
– Subway link is one of the most common types of rail connection to airports. The links are very popular for passengers but have some constraints due to the lack of space for luggage;
– Suburban railway integrating the airport in the suburban railway network and providing direct access to airports.

Type 2 intermodality requires airport integration in the transport network. This integration is generally provided with the rail network. Different airport railways allowing this integration are:

– Regional railway allowing the airport to be directly connected to the regional railway network;
– High-speed network allowing the airport to be directly connected to the (inter)national railway network.

In this work, both types of railways are considered, analysing the current situation and the future scenario of Malpensa airport ground accessibility and the connections with its catchment area.

These types of intermodality refer to collective transport. According to Eurocontrol (2004), transport modes can be considered as intermodal when they are collective, scheduled and when everybody can use them. For this reason, as far as passenger travel is concerned, we shall consider the connections to airports through public transport modes (rail, bus, subway, etc.). Air passengers can choose from a range of various transport modes to access the airport. The access modes can be subdivided into two categories: private (mainly car) and public transport (rail, coaches and busses) (European Commission, 2010). The exponential growth of air transport (since the nineties) has led to a significant increase in ground trips to airports with a significant share of private car use (Pasha and Hickman, 2017). This strong dependence on private cars has caused congestion on local road networks and greater levels of pollution from vehicle emissions (Button, 2003; Budd et al., 2011).

In order to reduce these environmental and economic impacts, public transport has received priority in almost every major airport worldwide. Public transportation offers one possible method of more efficiently moving the forecast number of future air travellers. Table 1 shows the public transport modes that may affect airport accessibility.

	Rail	Road
International	High-speed train, Intercity, Eurocity	Express coach
Long-distance	High-speed train, Intercity, Express train	Express coach
Regional	Regional express, regional interurban	Regional bus
Local	Subway, metro, tram, urban express (shuttle)	City bus, local bus, taxi

Table 1. The public transport modes to airports. Source: Author's elaboration from Duff (2003).

The literature indicates that the traditional public transport sector has missed much of the market opportunities created by the boom in air travel since deregulation. In many cases, there were no ground transport upgrades (in particular new public transport solutions) when new flights were added. Accordingly, most airport journeys by passengers are made by private car or taxi, and airport staff almost universally use cars rather than public transport (Barrett, 2003; Humphreys and Ison, 2005).To overcome this issue, an effective system of public transport connections has been developed, in some cases in the past or more recently in a widespread way (IARO, 2015).

4. Air-rail connections

Today the most important airports (those that handle a high number of passengers) have extensive public transportation access and the rail seems to be the main solution adopted for linking air terminals. Kaper (2004) explains that rail connection is recommendable for airports with more than 7 million passengers per year. Rail allows the handling of massive and concentrated flows to and from major airports, whereas buses are more suitable in the case of smaller airports or more spread-out population (smaller or more dispersed flows). Besides, the location of airports seems to increase the importance of public transport: larger distances appear to be better suited to railway-based solutions (Kołoś et al., 2012). Air transport is best interfaced with rail, which allows the timely and reliable movement of a large number of people in a more environmentally friendly way than roads (Picardi, 2003). A railway line through an airport is a modern and efficient way of feeding the latter and handling passenger flows. The introduction of public rail transport systems, which guarantee relatively rapid and reliable links, has started the most natural development of integration between airports and the neighbouring areas (Bresciani, 1995).

As previously mentioned, it is important to highlight that there are different types of airport-rail connections (Figure 1). According to Bresciani (1995), these types differ considerably in constructive characteristics, in mode of travel and in the services offered. Summarizing, the types of air-rail links can vary from part of the underground system to fast-dedicated lines (shuttle trains) up to the regional links that form an extension of the suburban rail network. Generally, regional rail links are the most common type of connection (Kouwenhoven, 2008). The main reason for rail connections to airports is the need to bring passengers to (or from) the airport in order to allow them to begin (or end) their air journey (Givoni and Banister, 2007). The relationship between rail and air transport networks is usually based on the railway as a provider of access services to the airport. In this case, according to Givoni and Banister (2007), there is a simple co-operation between the two modes. This is the minimum level of integration that currently exists at many airports. The advantage of the railway as a means to access the airport is mainly twofold:

– It is a reliable and high capacity form of airport access that bypasses the road congestion problems;
– It contributes to a reduction in air pollution around airports when substituting car journeys to and from the airport.

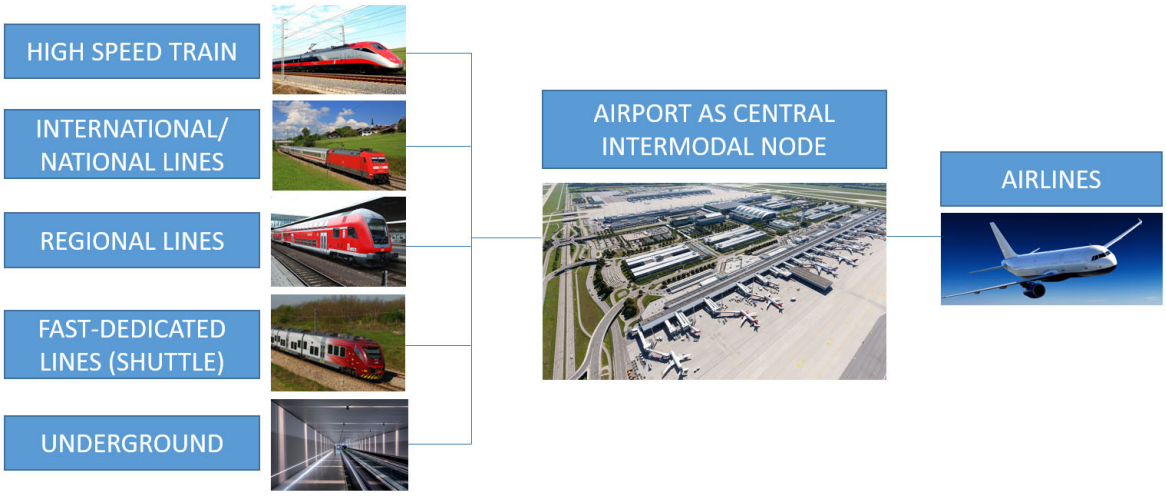

Figure 1. The air-rail combination. Source: Author's elaboration.

Both advantages have prompted the development of rail links to airports. According to Givoni and Banister (2007), a complete cooperation leads to an integration between rail and air transport services. In this case, the airlines and the rail service providers can both benefit from an additional demand of passengers and higher load factor (that means an increase in profits). This air and rail integration could lead to a rise in the number of international passengers using these intermodal services in the future. As a result, it will be possible to attract such passengers, as well as domestic tourists, and allow them to use the railway to explore destinations served by the railway network outside major cities (IATA, 2003). This would clearly have a positive impact on tourism.

Therefore, rail access is an important element in the mix of airport access modes, both for long-distance and short-distance access. It usually allows quick access, bypassing traffic jams found in many metropolitan areas and has quite a high capacity. Additionally, with many short-distance rail services, it offers a high number of frequencies, which is convenient to the passenger, as waiting times are reduced (European Commission, 2010).

The role of air-rail link is actually strategic because of the increase in congestion at major airports, but also considering the environmental impacts of air transport services. These reasons have led many airports (European ones in particular) to develop rail links (Buchanan and Partners, 1995; Neufville and Odoni, 2003; Givoni and Banister, 2007). Finally, it is possible to assert that the success or failure of the air-rail link is dependent on some factors. Kouwenhoven (2008) underlined that the following characteristics are important:

- Journey time advantage over other modes: this, along with journey time reliability of rail and/or competing modes, appears to be a very significant factor, as air passengers have high time values;
- Direct access to the city centre: avoiding the need to interchange;
- Size of the catchment area with direct rail access: direct services from the airport catchment are critical;
- Composition of airport passengers: particularly the proportion of business travellers (who are more likely to be prepared to pay for a premium, high-speed service) and local passengers (who are more likely to have a car available or be able to obtain a lift to or from the airport);
- Fare: there is clear evidence that air passengers are less price-sensitive than passengers that use other transport modes. However, there is an upper limit to what price can be charged.
- Terminal access: the importance of integrat-

ing the airport rail station/s into the airport terminal/s is widely recognized.

The following section illustrates the evolution of the rail system connected to Malpensa airport considering the impact of these factors.

5. Malpensa airport: passenger traffic and ground accessibility

Malpensa airport is the biggest airport in Northern Italy. It is located 50 km northwest of the city of Milano, in the Varese Province territory, near the boundary with Piedmont. The first civilian flights began in 1948, while the original airport structure was completed in 1962. The airport was equipped with a runway of 3,915 meters on the line of the existing one, plus a second parallel runway (located 805 meters further west) of 2,628 meters in length. The terminal was located between the two runways at the north end (the current Terminal 2) (Tadini, 2015a).

The resulting increase in traffic volumes led to the development of expansion projects defined in the early 70s that, however, did not pass to the operational phase. Malpensa's upgrade started in the mid-1980s. In 1987, the Italian Ministry of Transport approved the new development plan (the so-called "Malpensa 2000" project). Works began in 1990 including new buildings, but also technological and organizational improvements (Beria and Scholz, 2010). In 1993, the Christophersen Group included Malpensa 2000 in the Trans-European Network Transport (TEN-T) priority list, making it a primary gateway to southern Europe (Ulied et al., 2010).

This meant that the airport would become a pole of attraction for traffic (passengers and goods) originating elsewhere and sorted for the various final destinations, shaping itself as the fundamental pivot of a network of continental and intercontinental routes (Tadini, 2015a).

The official inauguration of Malpensa 2000 was held on October 25th 1998. The new Terminal 1 was opened and the existing international airport was developed into a modern hub and upgraded with increased runway capacity, a brand new passenger terminal, a new control tower, new aircraft parking areas (apron) and a new cargo centre (Ulied et al., 2010).

As a first consequence, the traffic increased exponentially in 1999, satisfying an increasing demand for international travels (Tadini, 2015a). Figure 2 shows the evolution of passenger flows from 1997 (the year before the opening of Malpensa 2000) until 2018.

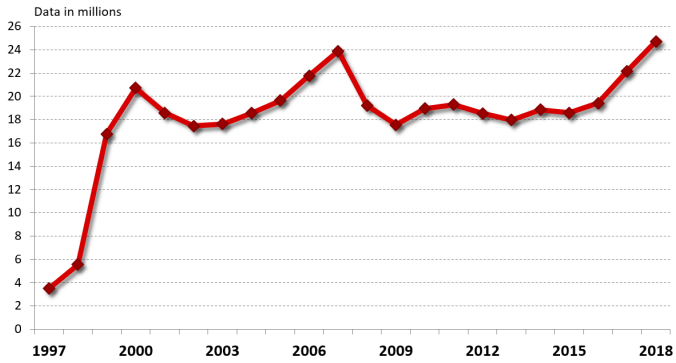

Figure 2. Malpensa airport passenger traffic.
Source: Author's elaboration of Assaeroporti data.

Currently, the airport is formed by Terminal 1 (divided into three sections, called "satellites") that handles intercontinental and international flights, by Terminal 2 (basically constituted by the old passenger terminal), that handles low-cost carriers and charter services and Cargo city, a section dedicated to freight services (Figure 3).

As depicted in Figures 3 and 4, the airport ground accessibility is provided by road and rail connections. Considering the current motorway network, it is possible to highlight that the SS 336 dir has connected the airport to the A8 highway (Milano-Varese) since 1962 and to the A4 highway (Milano-Torino) only since 2008 (Ferrario and Tadini, 2011). Road access has evolved over time allowing the closing of the ring between the two motorways.

However, the focus of this article is on public transport by rail connections.

Figure 3. Present Malpensa airport layout.
Source: Author's elaboration of Google Earth image.

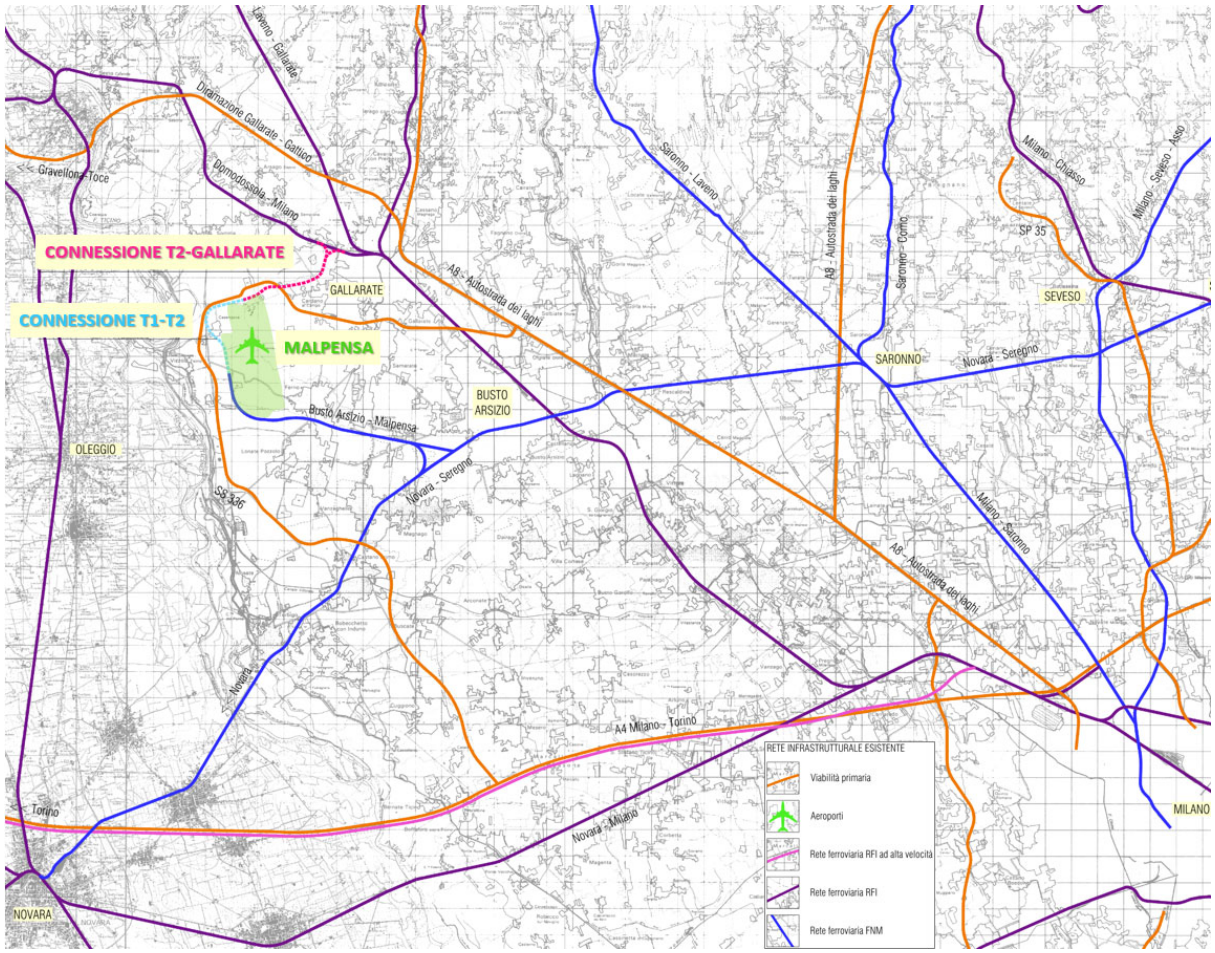

Figure 4. Malpensa airport ground accessibility. Source: Author's elaboration of Nord_Ing image (2018).

6. The current air-rail link of Malpensa airport

The integration of air and rail is particularly challenging, first due to costly long-term infrastructure investments as a prerequisite to connecting airports to the railway system (Grimme, 2007).

Currently the rail connection of the airport is the Busto Arsizio-Malpensa branch of the Saronno-Novara line (double-electrified track owned by Ferrovie Nord). In particular, through this railway network (Figure 5, in red) Terminal 1 and Terminal 2 are connected with the stations of Busto Arsizio, Novara and Milano (Bovisa, Cadorna, Garibaldi and Centrale).

The construction of the airport rail line began in February 1998 and it was activated in May 1999. The service was initially provided by a shuttle train (called Malpensa Express) connecting Terminal 1 to and from Milano Cadorna. Within a few years (2010), a further connection with Milano Centrale (using the interchange of Milano Nord Bovisa) was added, followed in 2011 by the extension of the services to and from Switzerland, linking the airport to the Canton Ticino rail network (via Luino). These two direct connections are currently active along with indirect ones: regional services from Busto Arsizio station and long-distance from Milano Centrale station.

The station at Terminal 1 was built with four platforms and the extension was safeguarded, considering the possibility of lengthening the railway to the North in order to provide wider connections (IARO, 2015). The project to extend the rail link (3.6 km) to Terminal 2 began in 2010.

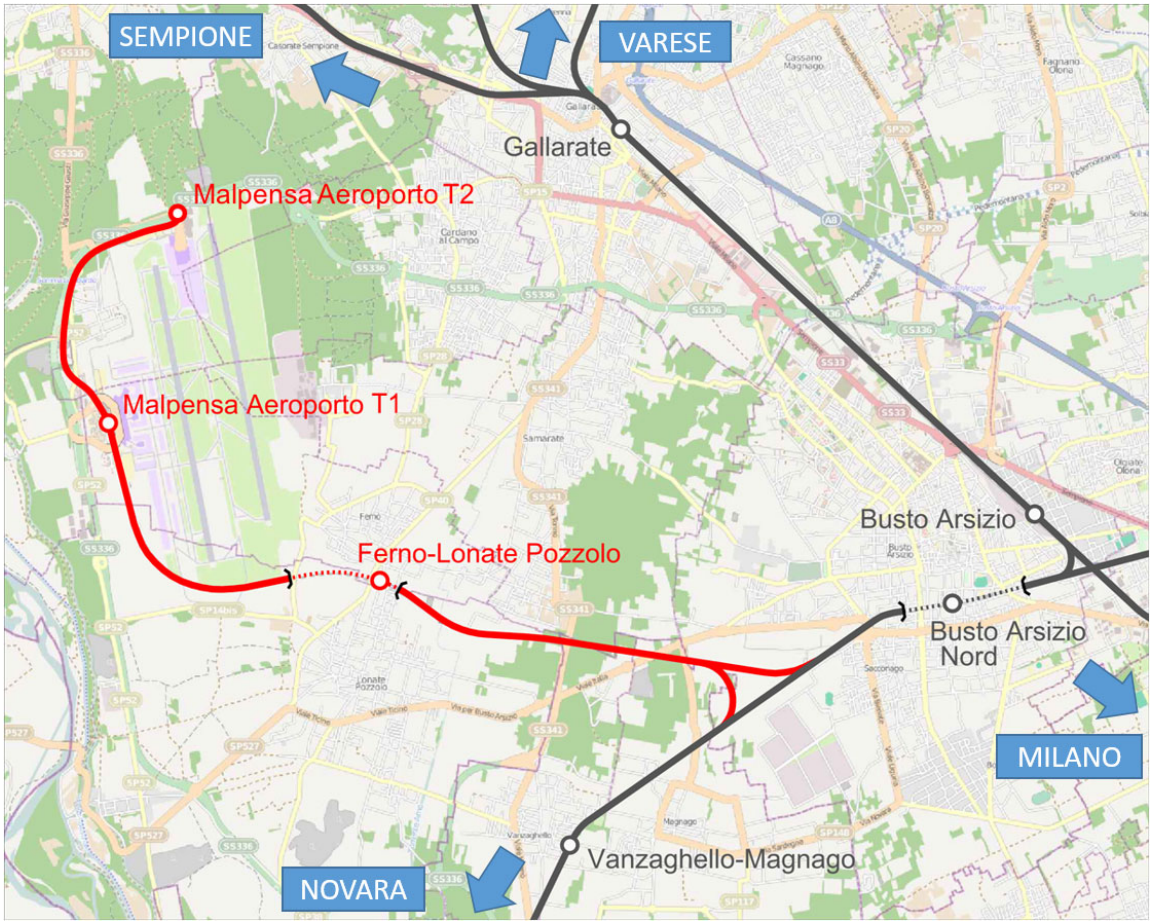

Figure 5. The current rail link of Malpensa airport. Source: Author's elaboration from Wikimedia Commons.

Funding for the €115 million extension is shared between the national government, the regional government and SEA, with a contribution (€23 million) from the European Union under the Trans-European Networks (TEN-T) program (IARO, 2015).

The development of airport rail access is a priority in the program Connecting Europe Facility, which is detailed by EU Regulation No. 1315/2013. With this document, the EU highlights as strategic the inclusion of the core airports (such as Malpensa) within the system of priority transport corridors (Baccelli et al., 2017). In the new European transport framework (defined at the end of 2013), the railway interconnection of Malpensa airport represents a strategic objective along the Rhine-Alpine corridor (which is one of the nine main European corridors). Besides, the national programming has indicated Malpensa as a strategic node and intercontinental gate within the National Plan of the airports (2015). The new rail link between Terminal 1 and Terminal 2 opened in December 2016.

The success of rail as an access mode to the airport is best measured as the share of passengers using rail to/from the airport (Givoni and Banister, 2007). Table 2 shows the evolution in passengers' means of access to Malpensa airport over the last three years, derived from customer satisfaction surveys (SEA, 2019). The results indicated a drop in the use of public road transport (down 10% across airport, down 50% at Terminal 2) in favour of private road transport (from 64% to 72%), while the use of rail transport to and from Malpensa increased in Terminal 2 (from 13% to 15%) as a consequence of the new rail connection with Terminal 1.

	Malpensa T1			Malpensa T2		
Transport mode	**2018**	**2017**	**2016**	**2018**	**2017**	**2016**
Collective transport by road	13%	17%	15%	12%	19%	23%
Rail transport	15%	18%	18%	15%	14%	13%
Private road transport	72%	66%	64%	72%	66%	64%
Other	1%	1%	0	1%	1%	0
Sample	2.659	2.423	2.321	1.015	1.124	1.010

Table 2. Mode of ground transport used by passengers to reach Malpensa airport. Source: SEA data (2019).

The rail transport share is growing but it turns out to still be low. However, the decline in public transport (due to the drastic reduction in road transport) and the parallel increase in private road transport is worrying. In the long run, it will be necessary to check whether there is a tendency to replace collective road traffic with rail transport.

No study or analysis has shown a solid correlation between any characteristics of rail service to the airport and market share in airport ground transport (SEA, 2019). Some correspondences may be identified, with the preference for rail transport increasing in cases of long trips and when the travellers are non-residents. The importance of direct rail services stems from the need to offer competitive travel times against other modes. Thus, the attractiveness of the rail service to passengers, as a substitute for the collective road transport and car, depends on high frequency of service and on reductions in the total travel time (Wardman, 2001; Givoni and Bannister, 2007). However, even if it is not possible to establish unequivocal correlations between the availability of service, travel time, cost, frequency, comfort and reliability of service and the success of the mean of transport, these factors are undoubtedly crucial to the modal choice (SEA, 2019).

With regard to the quality and quantity of Malpensa's direct rail links, the Malpensa Express offer currently consists of 146 daily round-trips connections (of which 68 to/from Milano Central Station and 48 to/from Milano Cadorna Station) implying an overall frequency of four trains per hour (SEA, 2019). The maximum journey time (43 minutes from Cadorna and 57 minutes from Central Station) is adequate and competitive in terms of international standards. The ticket cost is 13€ (compared with 10€ for the Malpensa Shuttle bus). All the routes will operate with new rolling stock designed specifically for airport service, with good services and high levels of comfort.

The rail accessibility to Malpensa airport has registered a significant improvement following the realization in December 2016 of the connection between Terminal 1 and Terminal 2 (Figure 5). This extension of the line has made it possible to significantly expand the potential catchment area, and thus to find more competitive rail services in travel times and cost-effective compared to other modes of transport to get to Terminal 2, which handles over 7 million passengers per year (Baccelli et al., 2017; SEA, 2019).

7. The projected evolution of Malpensa air-rail link and its impact on tourist destination accessibility

The aim of this paper is to illustrate the current situation of the Malpensa air-rail link and the northern rail connection project in order to underline the possible future scenario after the realization of the new railway and its effects on tourist destination accessibility.

As highlighted in the previous paragraph, at the beginning of 2020, the two airport terminals were interconnected with the railway system only from the South via the Ferrovie Nord line (Figure 5). The northern part is currently the missing link. Its implementation will permit the complete intermodal connection (air-rail) along a European corridor.

According to Givoni and Banister (2007), when planning railway connections to airports,

one element is crucial: the position of the airport station on the railway network. In order to be effective in providing a good alternative to other modes on access journeys to the airport, the rail station must offer direct and high-frequency services to different destinations. This could be achieved if the airport station is on a main line (i.e. a railway line on a major transport corridor) and all the trains running through its stop (Givoni and Banister, 2007). As stated before, Malpensa airport is strategically located on the Rhine-Alpine Corridor and the implementation of the northern rail access represents its functional completion (Corradi, 2018).

The new connection ensures optimal integration and interoperability among different means of transport (air-rail). Moreover, it completes the missing link of a railway network section by connecting the Simplon-Milano and Bellinzona-Luino-Sesto Calende lines from the North with Malpensa airport (EU Commission, 2015). In this way, the possible access to the airport from the Swiss border would be realized through two routes: Brig-Gallarate via Simplon tunnel, central Switzerland-Bellinzona-Gallarate via Luino-Gottardo (FerrovieNord, 2018) (Figure 4). The third route of connection is still operative from 2018, after the activation of the Arcisate-Stabio line. With this solution, it became possible to connect Malpensa (from the south via Busto Arsizio) with the Canton Ticino (Lugano, Mendrisio) but also with the areas of Varese and Como.

According to Corradi (2018), the main needs addressed by the project are to provide railway connections to all Malpensa operational areas and to convert the airport railway stations into "passing through" stations (instead of terminal stations), to insert the airport as a strategic node on long-haul railway services (Figure 4).

The history of the extension project dates back to 2003 with the first track hypothesis developed by RFI. More recently, SEA and Ferrovie Nord, coordinated by Regione Lombardia, have been engaged (since 2014) in the planning of the link extension starting from Terminal 2 towards the North, in the direction of the Simplon line (Baccelli et al., 2017). In April 2015, these stakeholders received EU funding for the design of the new railway connection. The final project was presented in January 2018 and submitted to environmental impact assessment in March 2018. The realization of this new rail link would generate environmental issues: in particular, considering that the area is inside the Ticino Valley Regional Natural Park. However, the response of the assessment was positive. In December 2019, the final approval by Regione Lombardia was issued. The expected time for work is 3 years. Therefore, the realization of the work (which will cost 211 million euros) will not end before 2024. The planned line is an electrified double track and has a length of about 4,7 km (Figure 6). The path develops partly underground (artificial tunnel and natural gallery, more than 50% of total) and in part in the open-air (trench and embankment) (FerrovieNord, 2018). The connection of Malpensa airport with the RFI line has its origin in correspondence with the Terminal 2 station. It continues up to the Simplon line but, at a certain point, the new link is divided into two branches of interconnection with crossroads (Figure 6). Towards Gallarate the line is underground, while towards the West (Sesto Calende) there is a grade-level intersection to interconnect the RFI line (FerrovieNord, 2018).

The peculiarity of the project is to provide a second rail access, directly from the RFI network (Milano-Domodossola line), since the current access is only from the South via the FerrovieNord network. The closure of the Malpensa "railway circle" (through the north link towards Gallarate) will enable the airport to serve the Milano metropolitan area both via Bovisa/Saronno (the actual link) and via Rho/Gallarate (Terminal 2 will be the first airport stop) (Corradi, 2018). In order to be effective, this connection link cannot ignore the quadrupling of the Rho-Gallarate line. A planned intervention, but still to be realized, which will require the inclusion of new tracks in a heavily urbanized territory.

The new northern rail link and other infrastructure interventions could improve existing connections or make new and more effective connectivity solutions not only for airport passengers but also for commuters in the area, realizing the heterogeneity of the traffic and mobility demand (Baccelli et al., 2017).

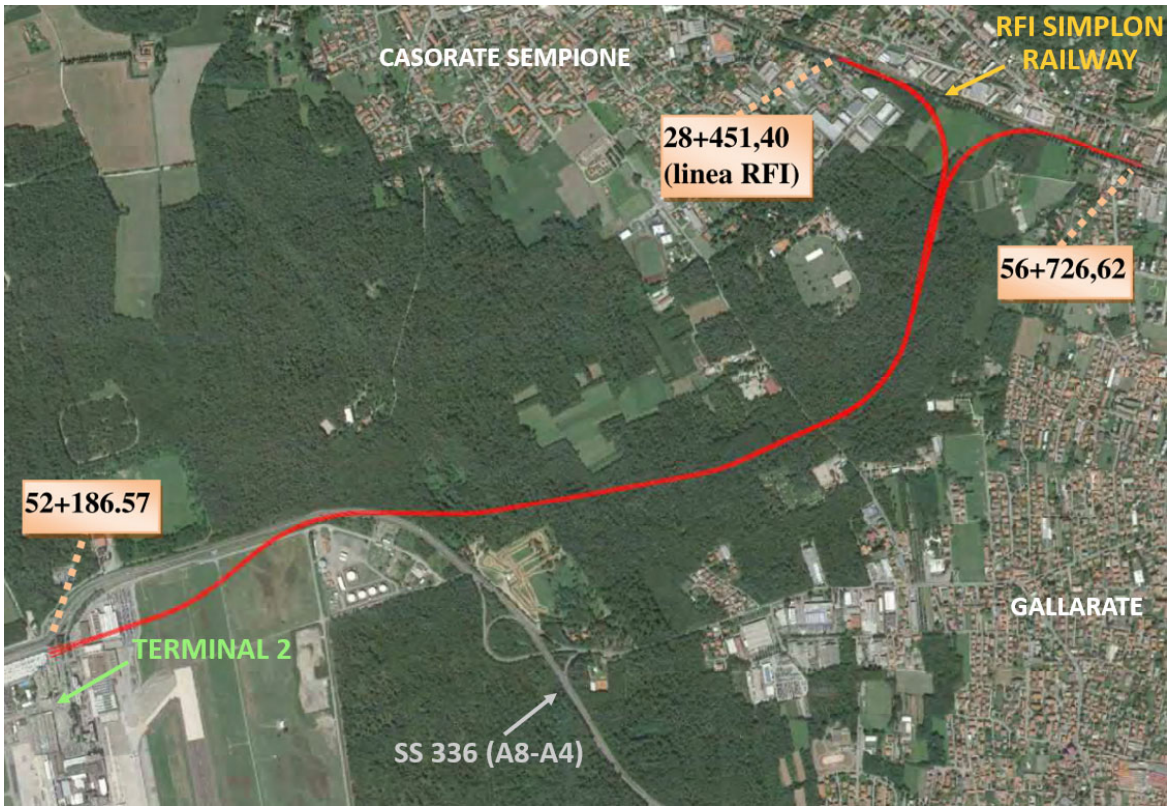

Figure 6. The projected north rail link. Source: Author's elaboration from FerrovieNord (2018).

In the long term, the northern link will increase the capacity, usability and competitiveness of the existing rail and air transport infrastructure. Furthermore, it will encourage a modal shift from road to rail (EU Commission, 2015). In this regard, in 2018 the Malpensa Express transported 3 million travellers (an annual record). SEA and FerrovieNord intend to achieve (by 2025) a 30% growth of the share of passengers who are currently using the train as a link to and from Malpensa airport. Therefore, the new northern link will enable Malpensa to expand its catchment area with sustainable transport alternatives (Corradi, 2018).

Currently, the railway system and its services make the Trans-padana corridor, North-eastern Piedmont and western Lombardy reachable in a short time. In particular, as Figure 7 points out, within the 90-minute journey from Malpensa it is possible to reach traditionally developed tourist destinations such as the Cusio and Verbano area, Lugano Lake, Como Lake, Milano and other less established but still relevant places like Brianza, Pavese and Novarese (Ferrario and Tadini, 2011). Moreover, Figure 7 shows how the 90-minute isochron line appears deformed especially along the high-speed lines. The most easily accessible tourist destinations from Malpensa airport fall within the territories belonging to the following areas: the provinces of Como, Lecco, Lodi, Milano, Monza-Brianza, Novara, Varese, Novara, Pavia, Varese, Verbano-Cusio-Ossola and, in addition, the districts of Lugano and Mendrisio in Canton Ticino (Switzerland). The tourist activity of these territories appears relevant (Table 3) considering the significant flows attracted by the hotel industry (11.7 million arrivals and more than 22.5 million overnight stays) and the availability of beds (about 143,000).

Tourist destinations located inside the Malpensa catchment area could improve their attractiveness through an enhancement in rail connection that makes them accessible more easily and quickly.

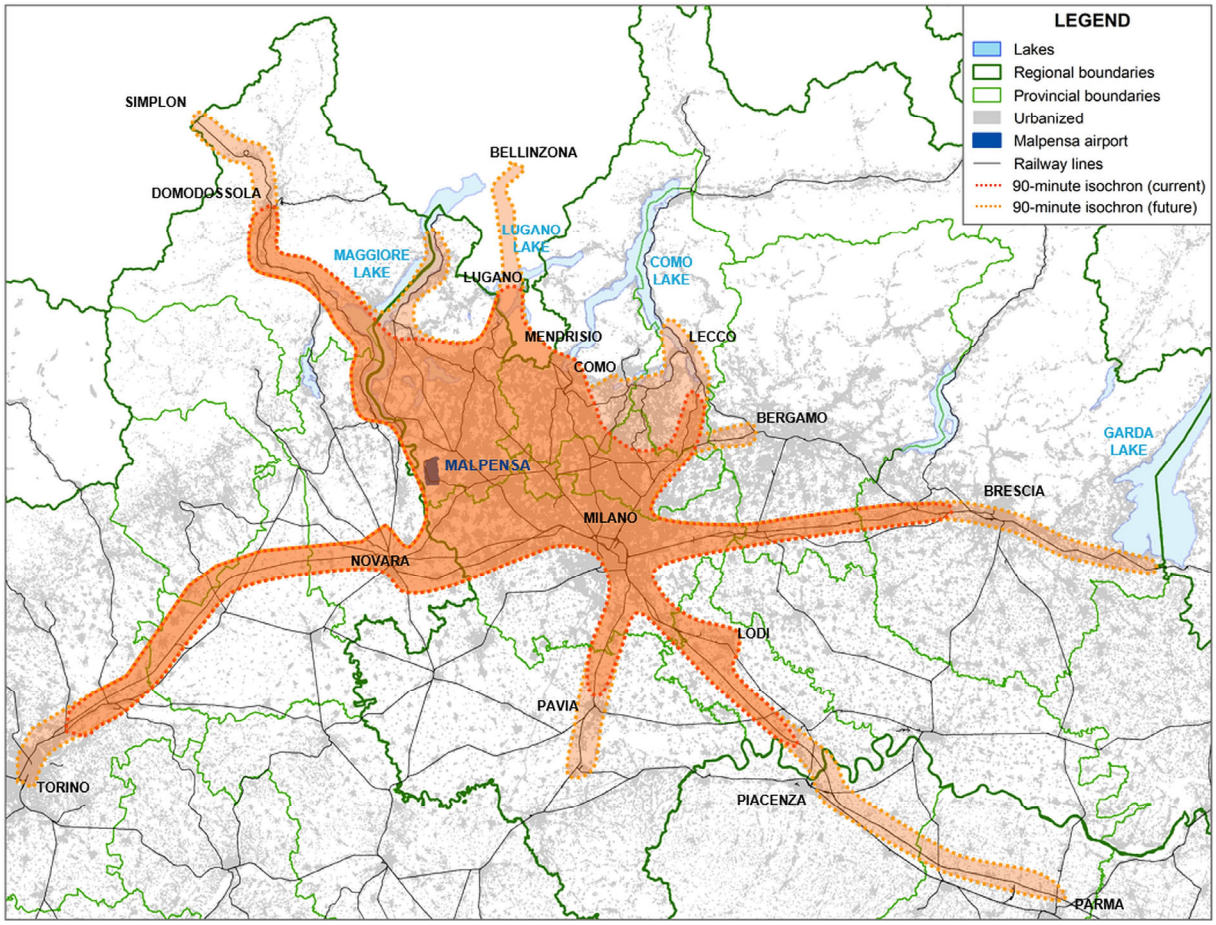

Figure 7. Malpensa catchment area within a 90 minute railway journey (current and future).
Source: Author's elaboration based on Ferrovia Regionale Tilo, Trenord and Trenitalia timetables[1].

Territories	Arrivals	Overnight stays	Number of beds
Lugano (CH)	487.950	922.634	6.309
Mendrisio (CH)	58.677	102.371	1.261
Como	999.580	2.184.678	14.325
Lecco	154.586	338.286	3.022
Lodi	132.863	191.351	1.603
Milano	6.986.694	13.427.962	74.958
Monza-Brianza	504.005	833.156	5.837
Novara	358.351	765.260	6.550
Pavia	179.007	333.340	3.868
Varese	1.248.639	1.877.191	12.654
Verbano-Cusio-Ossola	595.066	1.610.850	12.841
Total catchment area	11.705.418	22.587.079	143.228

Table 3. Tourism activity in the Malpensa catchment area (2018).
Source: Author's processing on data from Osservatorio del Turismo (O-Tour) – Università della Svizzera Italiana, Annuario Statistico Regionale della Lombardia and Osservatorio Turistico Regionale del Piemonte[2].

[1] This map was created with ESRI ArcGis software, using the cartographic bases provided by Regione Piemonte, Regione Lombardia, Regione Emilia-Romagna, Regione Veneto and Provincia Autonoma di Trento. Future isochrones are estimated on the basis of the expected travel times (estimated).
[2] The Table shows only the hotel industry data in order to allow international comparisons.

The new northern rail link would also allow this improvement, reducing the journey times for the localities already connected today and allowing the connection with other destinations currently too far in terms of accessibility. In detail, as the isochron line in Figure 7 shows, the future improvements of destination accessibility lies towards the north (Simplon, Maggiore Lake, Canton Ticino, Como Lake and Lecco Lake) but also towards the south (passing through Milano) in the Oltrepò Pavese direction and then along the high-speed lines (Torino, Brescia, Garda Lake and Verona, Parma). Consequently, the result would be to increase the attractiveness of the tourist destinations of the catchment area (in future enlarged) in particular to foreign (or long-distance) tourists.

8. Conclusions

The realization of the northern rail access to Malpensa is not only an important completion of the regional network but also a widening of the airport influence area. In fact, it allows an optimization of the service types, a redistribution of the loads on the various network arcs and an increase in connected destinations (FerrovieNord, 2018). The planned link railway represents a strategic element for an intercontinental node that serves a large catchment area in northern Italy. It will improve the airport rail accessibility and will consent a better interconnection for many touristic destinations that are inside the catchment area.

According to Poon (1993), air accessibility is a key factor in the success or development of a tourist destination. This applies to the attraction of flows of leisure and business tourism. In the light of the changing mobility needs, the possibility of rapid and reliable travel for passengers, guaranteed by the proximity to the main airports, can be considered an increasingly important factor of competitiveness as well as a determining element in the definition of territorial tourist performance (De Rosa, 2002). In order to understand the impact on the tourist competitiveness of a region, it is necessary to analyse the characteristics of the services offered by airport facilities (Hassan, 2000). Therefore, both the strategic importance of the equipment of airport structures clearly emerges along with the importance of their integration into the territorial infrastructural system. The development of an adequate system of infrastructural connections makes it possible to better serve the airport's neighbouring territories and better connect it to the tourist destinations that fall into its catchment area (Tadini, 2015b). For these reasons, the attention of this paper has focused on rail accessibility and on its changes resulting from the connection project from the North.

In conclusion, the new northern rail link and other infrastructure interventions (*in primis* the new two tracks of the Rho-Gallarate line) could improve existing connections or make new and more effective linking solutions for airport passengers directed to/coming from relevant destinations that attract many tourists every year. This can be achieved if a network of rail services enhancing the Malpensa connectivity with its catchment area were established, both local and international. The railway services that can be activated to improve the tourist destination accessibility are listed below (Baccelli et al., 2017; Ferrovie dello Stato, 2019):

- Regio express (from/to Canton Ticino and Como area, improving service);
- High-speed train connecting Malpensa with Verona, Padova, Venezia, Bologna and Roma (new links beyond the "traditional" catchment area);
- Interregional line (a new "pedemontana" connection Novara-Bergamo passing through Malpensa);
- Suburban lines (possible elongation up to Malpensa of two existing suburban lines);
- Express service (from/to Milano, increasing frequency and reducing transit times).

The recent growth in the number of passengers handled at Malpensa draws more attention to efficient and sustainable solutions of mobility, such as rail transport. The railway is (now and in the coming years) the best modal choice for long-distance passengers in order to access the tourist destinations connected to airports.

However, the current use of rail as airport accessibility mode is still low (a 15% share), due to the strong tendency to use the road. The project of the new northern link has a dual objective: the enlargement of the airport's catchment area and the improved efficiency of connections with the currently served areas (and tourist destinations). This should allow greater use of the train for airport accessibility (resulting in an increase in the railway modal share).

Finally, we underline that the analysis of the Malpensa northern link project can be proposed to carry out similar studies in other airport catchment areas but also for educational aims. In particular, for geographical didactics, it represents an example of the implementation of European corridor objectives, the strategic importance of air-rail link, the sustainability of intermodal passenger transport, as well as the airport's catchment area expansion through railway.

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