D.T1.2.3 WORK PAPER

Analysis of market potentials for rail freight transport Emilia-Romagna Region

Version 3.0
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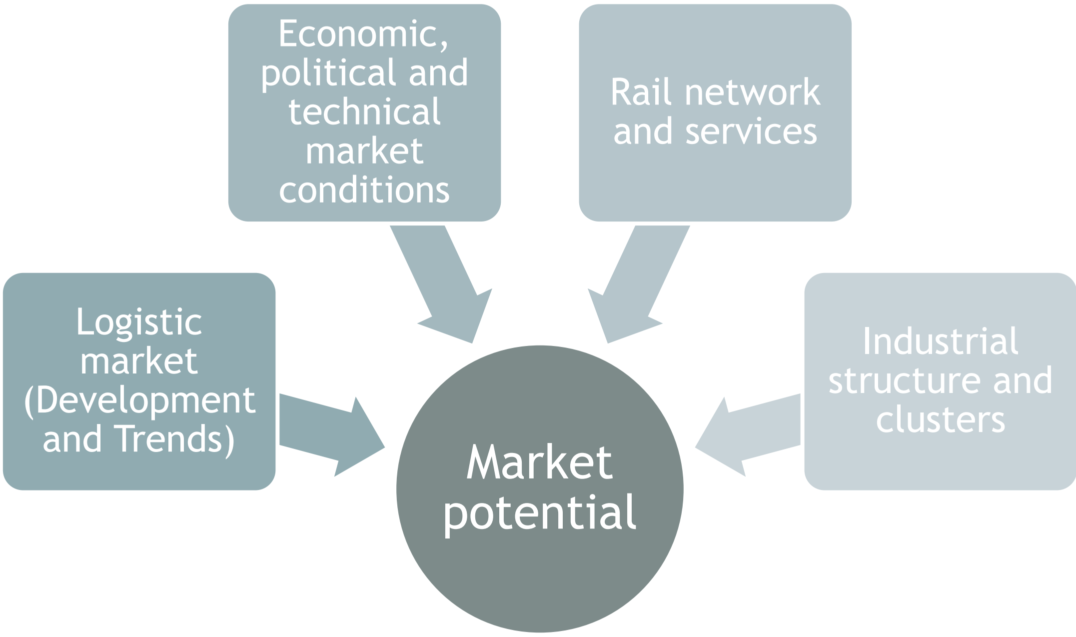
1. Introduction

The deliverable "Analysis of market potentials for rail freight transport" (D.T1.2.3) is based on the deliverable "Methodology for analysis of market potentials for rail freight transport" (D.T1.2.1) and the realised online training for the implementation of the market potential analysis (D.T1.2.2). The work paper analyses the regional market potential for rail freight services in Emilia-Romagna Region.

Market potential is the total demand for a product or service in a given business environment. For that it is very important to calculate the market potential and the actual value before a product or service can be implemented. Determining the main market potentials for regional rail freight transport and services is quite complex and goes beyond analysing only the market itself (the potential customers). The analysis shall help to find out the potential to shift goods transport from road to rail.
The following figure shall illustrate the impact of various factors on the market potential:



2. Status quo Analysis of Market Potential

2.1. Analysis of regional rail network and services

As described in D.T1.1.3 the regional rail infrastructure network of Emilia Romagna region is managed by two Infrastructure Operators (RFI – Rete Ferroviaria Italiana, national operator, and FER – Ferrovie Emilia-Romagna, regional operator). More in detail (Figure 1), the share of network managed by RFI is 1,315 km long while the remaining part is composed by 364 km of single-line tracks and is under the responsibility of the regional operator FER, in compliance with specific service and program contracts.

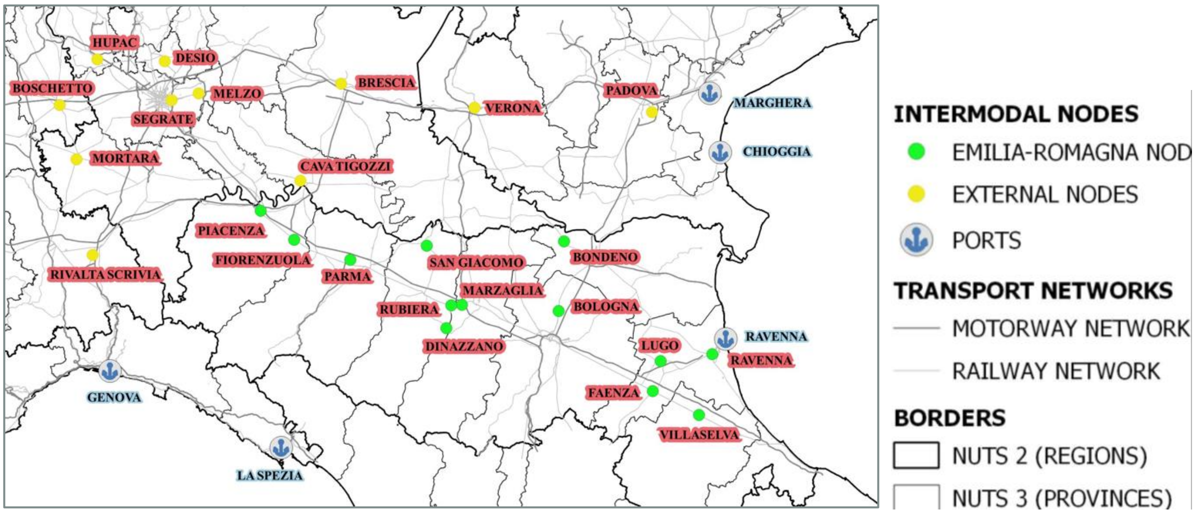


Figure 1 - Emilia-Romagna intermodal nodes (in green) and other relevant extra-regional nodes (in yellow)

The operative RFI railway lines in Emilia Romagna are mainly electrified (1,229 km) and can be classified in Fundamental lines (748 km), complementary lines (397 km) and node lines (170 km). 61% of the lines are double track (804 km), so the total length of RFI's tracks in the region is 2,119 km. Concerning the 364 km of lines managed by FER, only 138 km are electrified.

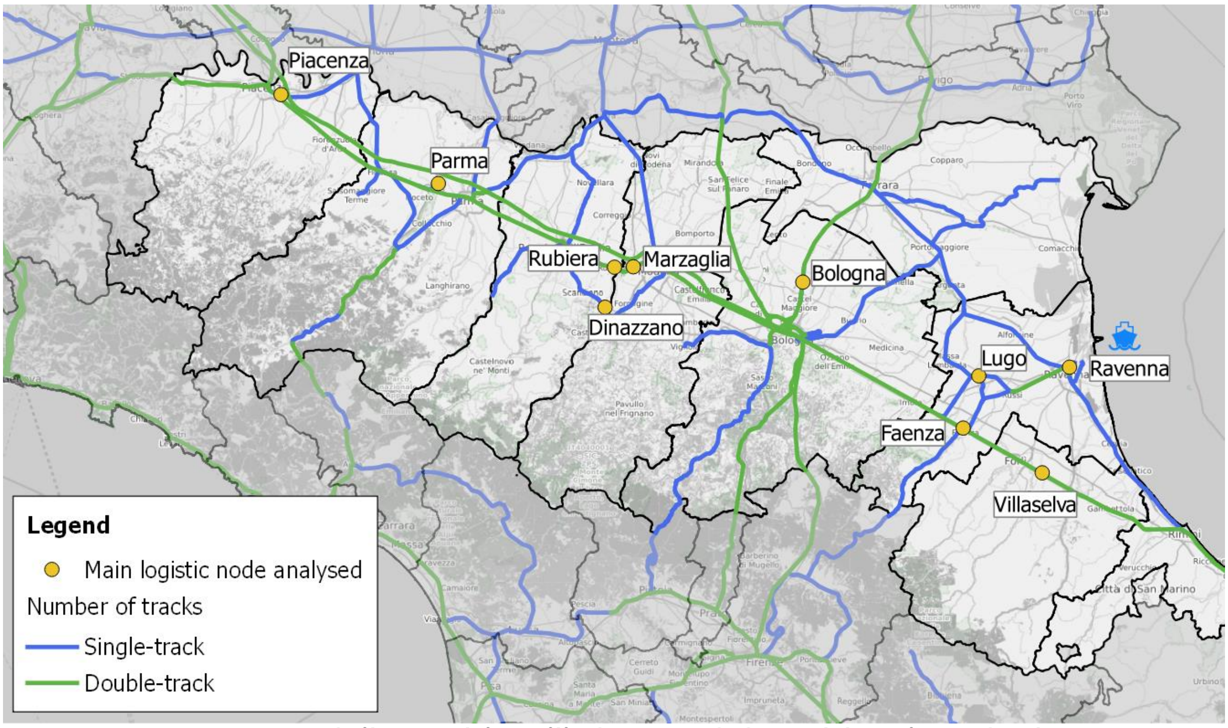


Figure 2 – *Rail network in Emilia-Romagna. RER-ITL elaboration on RFI data*

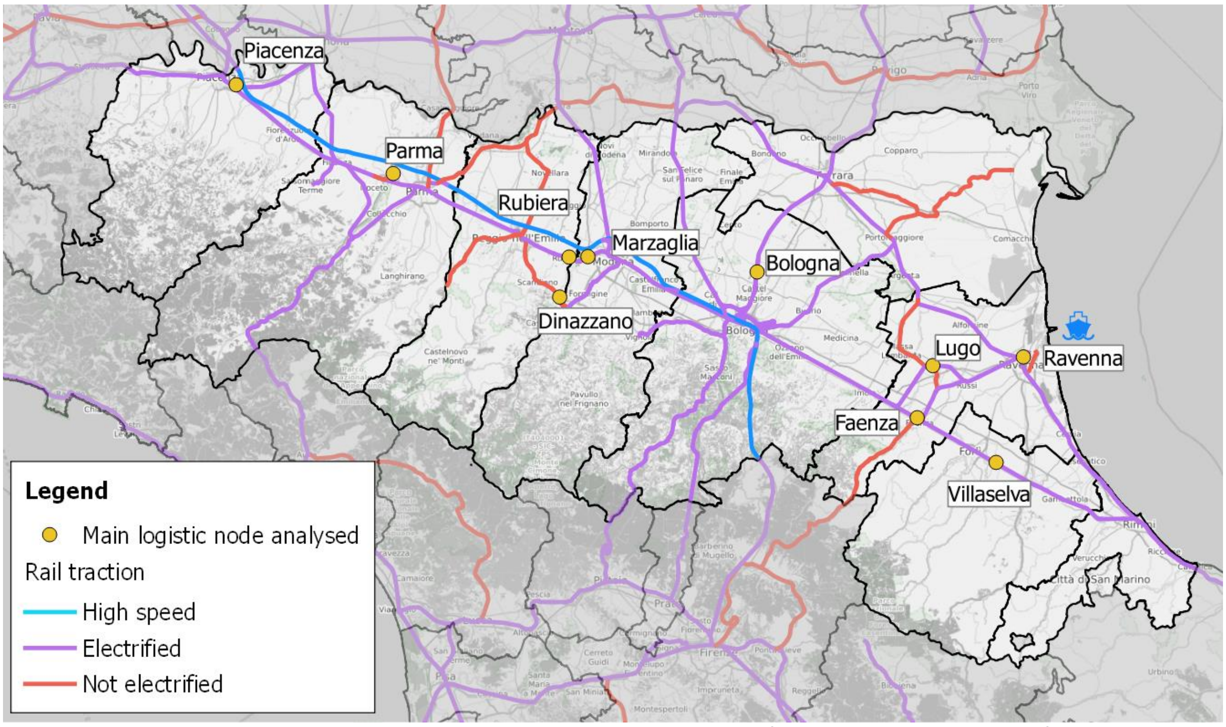


Figure 3 - *Trans-European Network – Transport (TEN-T) corridors. RER-ITL elaboration on RFI data*

In 2018 the rail freight nodes of the Emilia-Romagna region handled about 20 million tons of goods. The National Infrastructure Manager (RFI) confirms that the average number of trains operated by regional nodes is 89 trains/day, which corresponds to approximately 34,000 trains/year (RFI data, 2015).

The table below illustrates the services of the main regional intermodal nodes:

Table 1 - Characteristics of regional intermodal nodes. Source: RER

	Intermodal maritime	Combined road-rail transport	Traditional	Rail Port Db
Villa Selva		X		
Terminal Piacenza		X		
Bologna freight village	X	X	X	
Parma freight village		X	X	X
Dinazzano Po	X		X	X
Rubiera	X			
Lugo		X	X	
Ravenna	X		X	
Faenza		X		

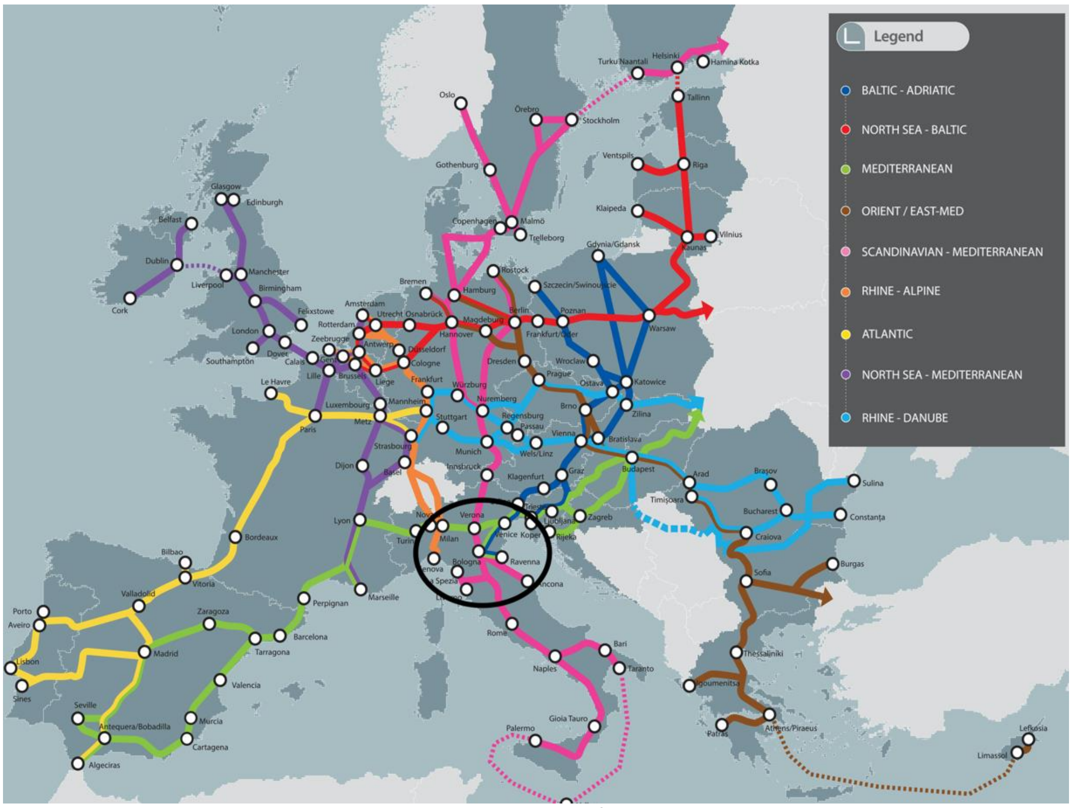


Figure 4 - *Trans-European Network - Transport (TEN-T) corridors. Source: Trans-European Transport Network website*

Within the nine corridors making up the Trans-European Network – Transport (TEN-T), four of these cross Italy and three of these cross the Emilia Romagna territory (Figure 4). These are the Baltic Adriatic Corridor (BAC), the Scandinavian-Mediterranean (SCAN-MED) and the Mediterranean (MED). In the Figure below. a focus on TEN-T corridors crossing Emilia-Romagna region is shown.

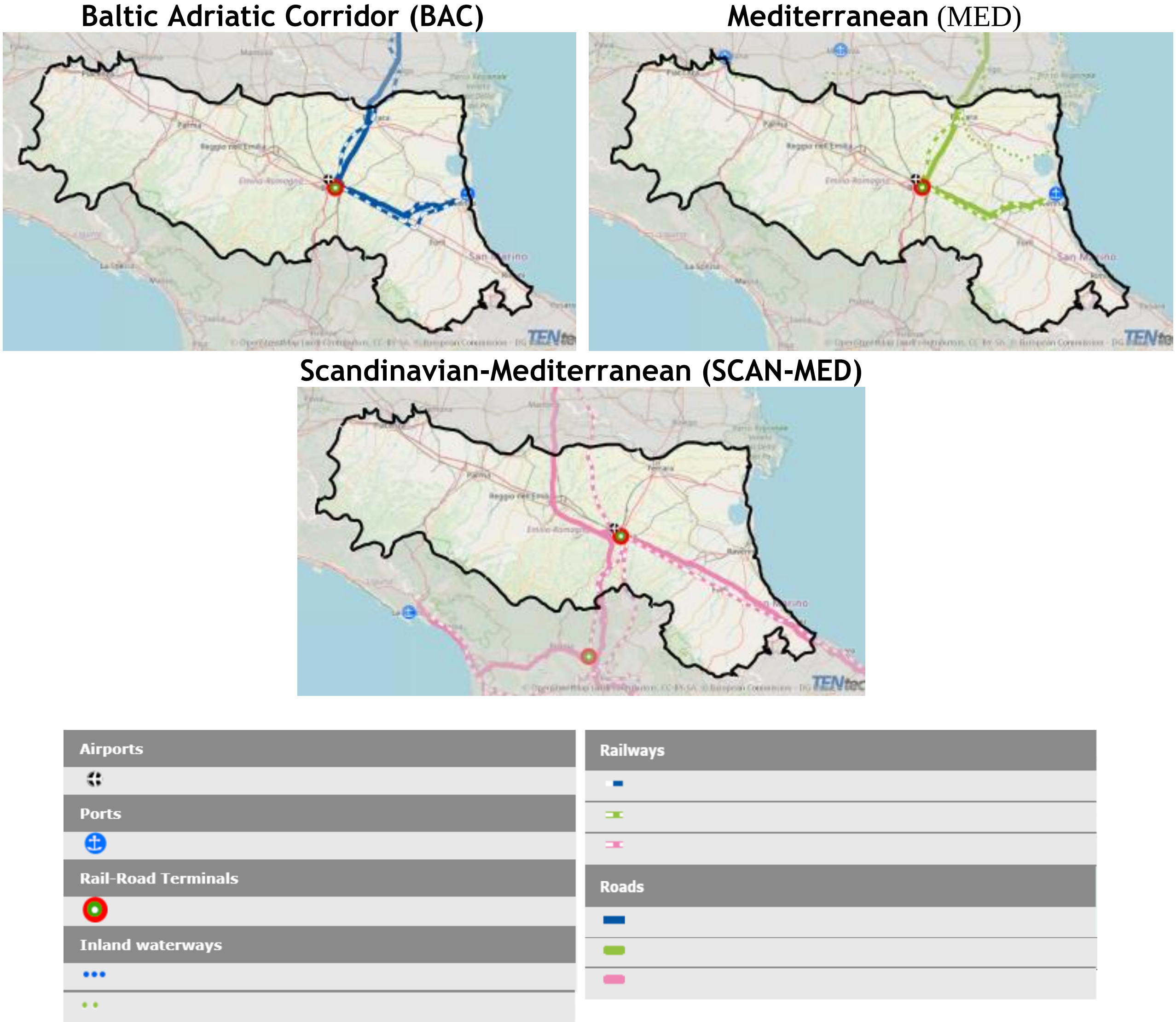


Figure 5 - Focus on *Trans-European Network - Transport (TEN-T) corridors crossing Emilia-Romagna region. Source: TenTec website*

2.2. Analysis of the logistic market (Development and Trends)

The rail/road modal split for regional freight transport is about 11%-89%, for domestic traffic, while for traffic originating in the region it is 14%-86%. This strong imbalance is for the most part innate to the characteristics of road transport, but some considerations are certainly necessary to evaluate what are the possibilities 1) to integrate the two modes using the system of regional intermodal nodes and 2) to attract greater volumes by rail for those categories of goods that are suitable for this mode of transport and that currently use road transport anyway.

The concept of accessibility is central in several scientific fields including transport planning, urban and spatial planning, and plays an important role in supporting policy and planning actions and decisions. Accessibility usually refers to the ease to reach services and/or opportunities, reflecting the extent of the interaction between the system of activities distributed in the territory and the transport systems that serves it. Land use and transport system are mutually and closely dependent; the characteristics and performance of the transport system determine whether it is accessible or easy to move from one place to another. Accessibility, in turn, strongly influences the location of

activities, and therefore the configuration of land use. A number of examples in the literature show that transport systems, on the one hand, are designed to meet the needs of the population and freight to reach opportunities distributed in space and time, and on the other hand they generate direct and indirect effects on the distribution of economic activities in a given area (Waddell, 1993[1]; Ibeas et al., 2013[2], O'Sullivan, 2000[3]; Pagliara and Wilson, 2010[4]). Accessibility is often measured by means of indicators, related not only to the performance of transport systems but also to the extent and quality of opportunities and services supplied in the nodes, strictly connected with individual factors and preferences (Geurs and van Wee, 2004[5]). These accessibility measures are easily interpretable and replicable, and are therefore widely adopted by researchers, transport planners and policy makers. The potential uses of these measures are manifold, because they synthetically capture the quality of the existing state of the transport system and reflect the potential or actual effects of any improvement or upgrade of the services (Bhat et al., 2000[6]); moreover they support the assessment of the impacts produced by alternative land use policies and the effectiveness of transport projects in relation to planning objectives and, finally, they provide useful information for policy makers to orient transport strategies and investments aimed at achieving specific objectives. With regard to intermodal freight transport and, specifically, accessibility to nodes, there is less work in the literature than for passenger transport (Larsson and Olsson, 2017[7]; Cartenì, 2014[8]; Lim and Thill, 2008[9]). In general, accessibility is assessed as a combination of time and opportunities offered at nodes (capacity, volumes, connections, etc...). Accessibility is therefore a key concept, also in the activities of this project, as it represents a fundamental element to promote intermodal transport and to highlight possible limits and barriers to its development. We have therefore decided to evaluate the accessibility of the regional intermodal nodes system, both by using simple time measures (travel time on the road network to access each single node) and by implementing more refined measures, which take into account the actual transport offer present in each single node (in terms of frequency and quality of connections).
As far as accessibility to nodes is concerned, the table below shows the isochronic accessibility maps of regional intermodal nodes considered in this study. The chromatic scale indicates time thresholds of accessibility from < 30' (green) to > 150' (brown). The travel time is estimated on the regional road network in low congestion conditions, from each "origin" of potential shipment, represented by all municipalities in the Region.

[1] Waddell, P., & Shukld, V. (1993). Manufacturing location in a polycentric urban area: a study in the composition and attractiveness of employment subcenters. *Urban Geography*, *14*(3), 277-296.

[2] Coppola, P., Ibeas, Á., dell'Olio, L., & Cordera, R. (2013). LUTI model for the metropolitan area of Santander. *Journal of Urban Planning and Development*, *139*(3), 153-165.

[3] O'Sullivan, D., Morrison, A., & Shearer, J. (2000). Using desktop GIS for the investigation of accessibility by public transport: an isochrone approach. *International Journal of Geographical Information Science*, *14*(1), 85-104.

[4] Pagliara, F., & Wilson, A. (2010). The state-of-the-art in building residential location models. In *Residential location choice* (pp. 1-20). Springer, Berlin, Heidelberg.

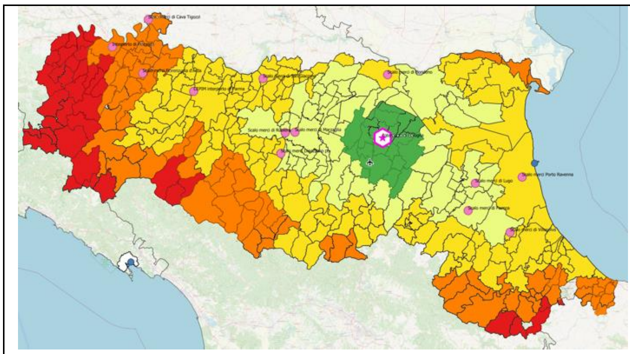
[5] Geurs, K. T., & Van Wee, B. (2004). Accessibility evaluation of land-use and transport strategies: review and research directions. *Journal of Transport geography*, *12*(2), 127-140.

[6] Bhat, C. R., Handy, S., Kockelman, K., Mahmassani, H. S., Chen, Q., & Weston, L. (2000). Accessibility measures: formulation considerations and current applications. *Work*, *7*, 4938-2.

[7] Larsson, A., & Olsson, J. (2017). Potentials and limitations for the use of accessibility measures for national transport policy goals in freight transport and logistics: Evidence from Västra Götaland County, Sweden. *Region*, *4*(1), 71-92.

[8] Cartenì, A. (2014). Accessibility indicators for freight transport terminals. *Arabian Journal for Science and Engineering*, *39*(11), 7647-7660.

[9] Lim, H., & Thill, J. C. (2008). Intermodal freight transportation and regional accessibility in the United States. *Environment and Planning A*, *40*(8), 2006-2025.



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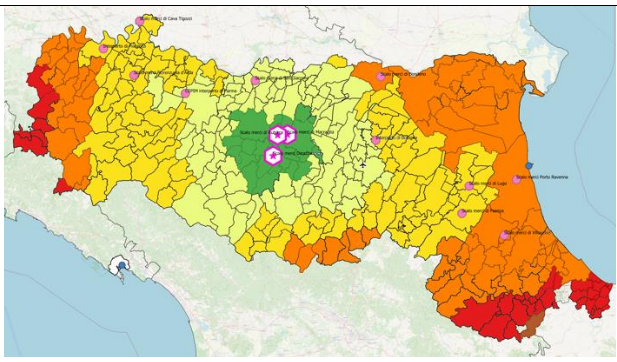

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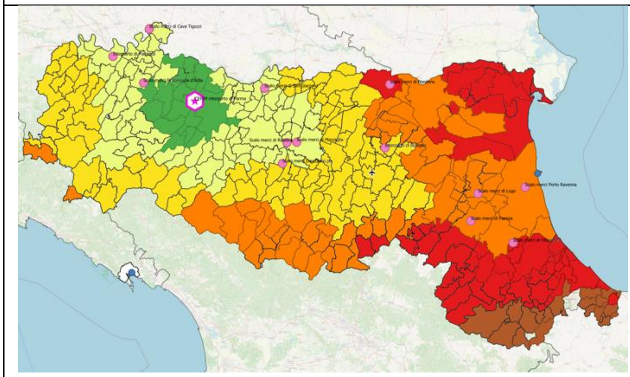

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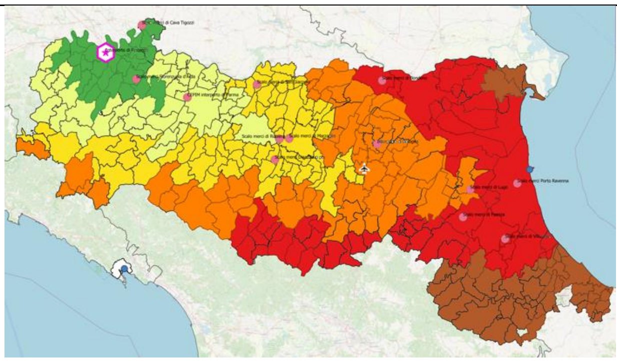

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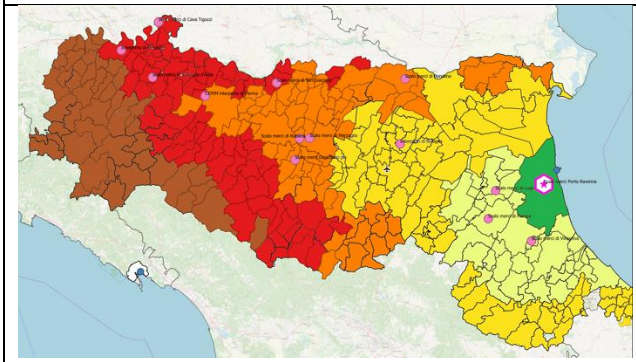

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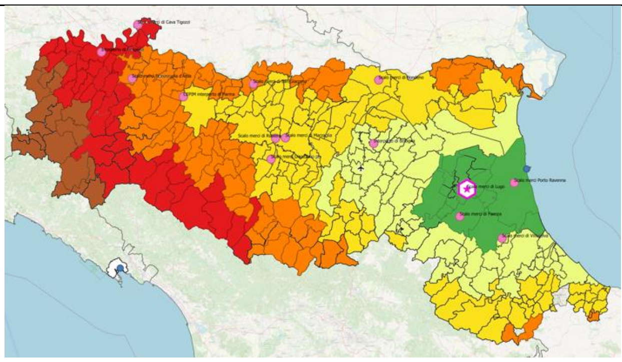

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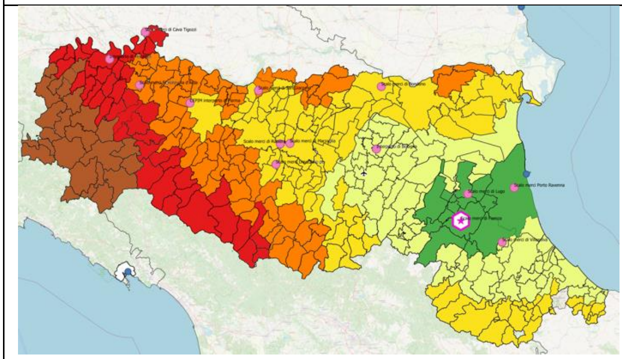

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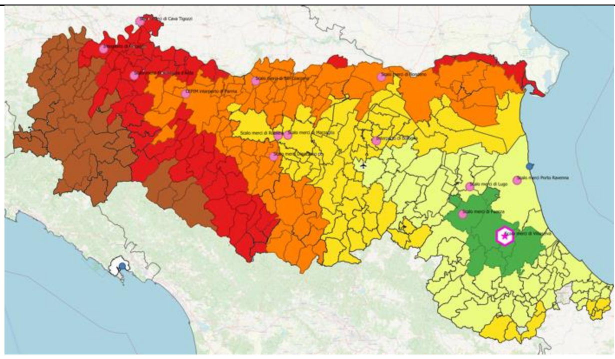

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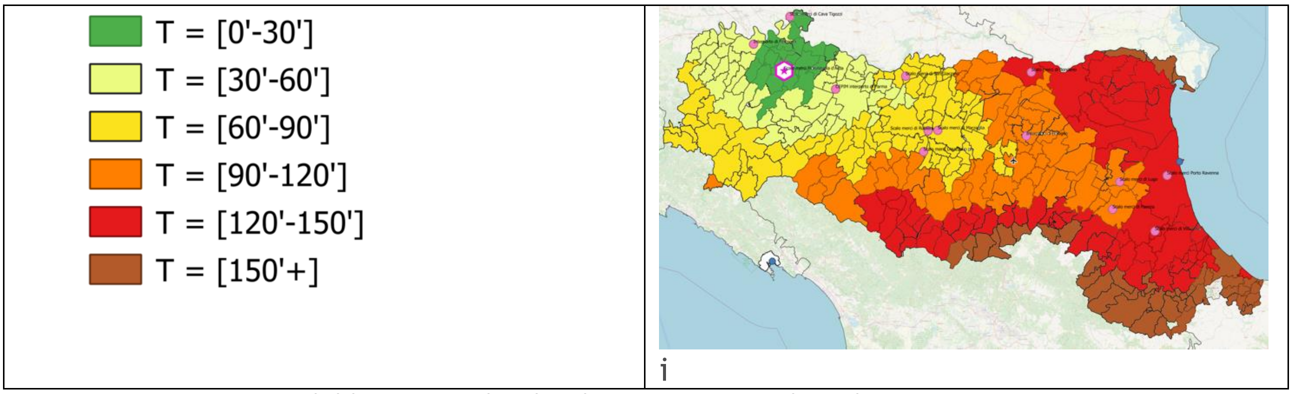


Figure 6 - *Road accessibility (travel time in minutes) for the regional inter-modal nodes: a) Bologna; b) Dinazzano-Rubiera-Marzaglia; c) Parma; d) Piacenza; e) Ravenna; f) Lugo; g) Faenza; h) Villaselva; i) Fiorenzuola*

The accessibility of intermodal nodes measured by road travel time only is certainly an important indicator of how accessible a node is from the territory and, therefore, potentially useful for intermodal transport. However, it should be noted that this aspect is exclusively related to the efficiency and quality of road connections and, therefore, not to how much an intermodal node can actually attract freight demand, which is also function of a) the services it offers and b) the number and quality of connections and therefore the markets potentially served.
With regard to the connections offered by each node, it is important to highlight and distinguish the quantity (frequency) of connections and the type of connection, i.e. the destination served. This last aspect in some way defines the quality of the connection itself, since connections with national or European transhipment ports and connections with strategic nodes at continental level represent elements that raise the quality and therefore the very attractiveness of the nodes.
The table below contains the number of connections (expressed in weekly frequency) and their type (distinction between connections to other national nodes, national ports, other EU nodes and EU ports) for intermodal nodes in the region. The data contained in the table have been obtained directly by contacting the node operators or from their websites.

Table 2 - *Number and type of weekly connections operated in the regional intermodal nodes*

INTERMODAL NODE	National connections	EU connections	Connection with national port	Connection with EU port
PIACENZA	24	12	3	10
PARMA	16	2	0	6
DINAZZANO (MO-RE)	30	12	68	0
BO INTERPORTO	28	3	7	3
FAENZA	3	1	0	0
LUGO	3	3	1	0
RAVENNA	65	10	1	3
VILLA SELVA	3	5	0	0
FIORENZUOLA	7	0	3	0

As you can see, the vocations of the various nodes are very different. For example, there are nodes, such as the port of Ravenna, which are mainly dedicated to connections with other national nodes (in this case for the sorting of raw materials arriving in the port).

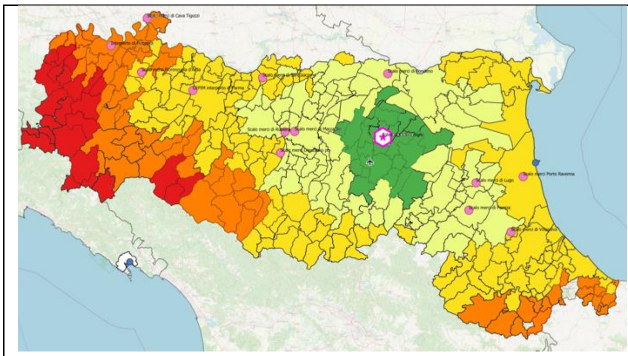
Other nodes, such as those of Dinazzano-Marzaglia-Rubiera (MO-RE) are oriented towards maritime inter-modality, with several weekly connections with national ports. Others, such as Piacenza, have a more balanced orientation towards various markets, with national and EU connections, port and inland nodes.
As can be seen, the regional nodes generate about 330 train pairs/week, which corresponds to about 34,000 trains/year expressed by the region (RFI data, 2015). The nodes that generate the greatest amount of traffic are Ravenna, Dinazzano, Bologna interporto, Parma and Piacenza, i.e. all the nodes connected to the lines with the highest capacity and with better performance in terms of infrastructure (gauge, weight and length module).
In order to express more comprehensively the attractiveness of an intermodal node, a measure has been developed, which takes into account not only the access time on the road (and therefore the accessibility already measured) but also the number and quality of connections. It is important to highlight the difference between a "measure" and an "indicator" of accessibility. The former is a measure associated with the ease of reaching a certain place, using a transport/service network; the latter is a function - more or less complex - of the measure.
The considered measure envisages the "correction" of access time through a mathematical transformation that weighs the services offered by the nodes considered. More in detail, given Ti the road access time of node i, ni the weekly connections offered by node i, the accessibility measure Ai is given by:

$$A_i = \frac{T_i}{1 + ln\left(1 + 2\frac{n_i}{\sum_{j=1}^{k} n_j}\right)}$$

Of course, the smaller the measure Ai is, the better the accessibility. The number of connections can be formulated by weighing up the connections with port nodes or abroad, for example:

$$n_i = n_{1i} + \beta_2 n_{2i} + \beta_3 n_{3i} + \beta_4 n_{4i}$$

The index has been calculated by weighing the connections in this way: national internal connection n1 with β1 = 1; internal EU connection n2 with β2 = 1.8; connection to national port n3, with β3 = 2; connection with EU port n4, with β4 = 2,5.
Applying the connectivity index changes the access times to nodes. Obviously the most significant reductions are for the nodes that present more weekly connections and above all connections of "value" (foreign destinations, ports, foreign ports). It is possible to represent this index by means of connectivity maps to be combined with temporal accessibility maps.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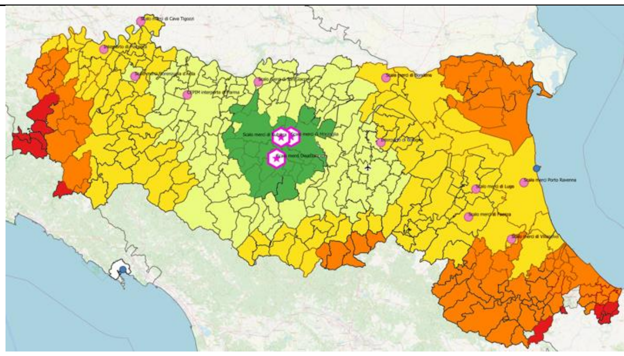
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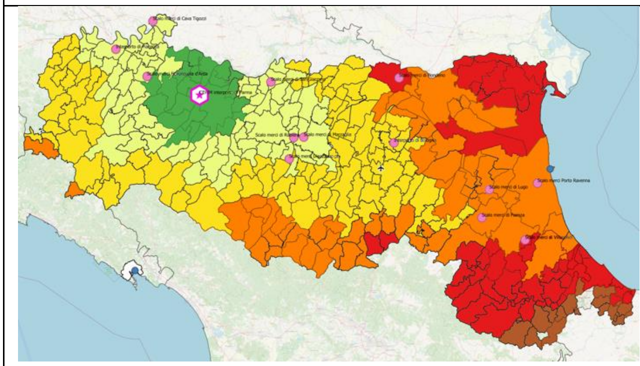
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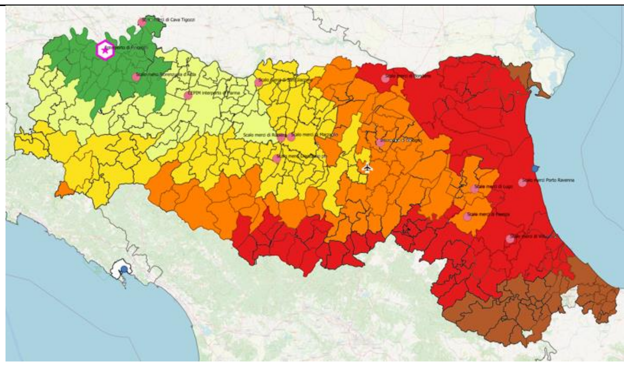
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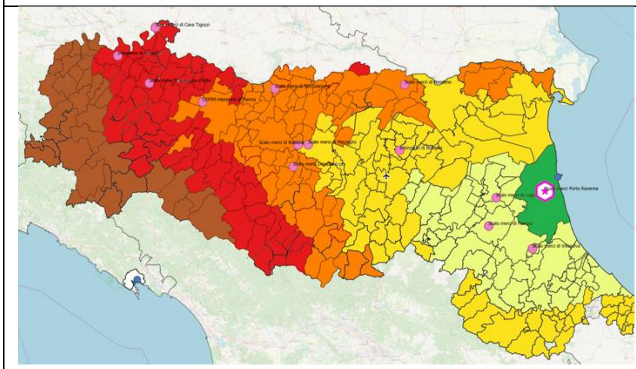
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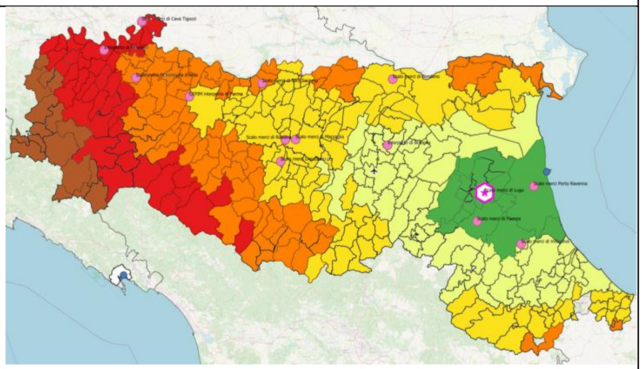
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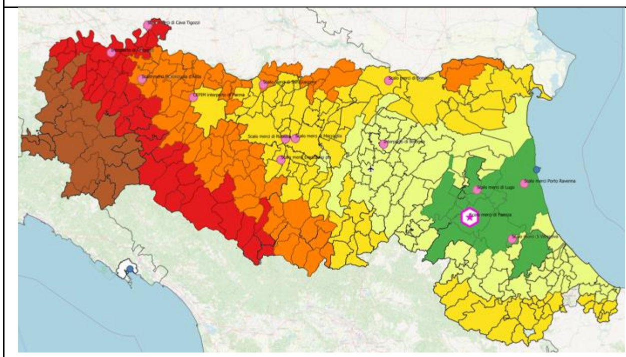
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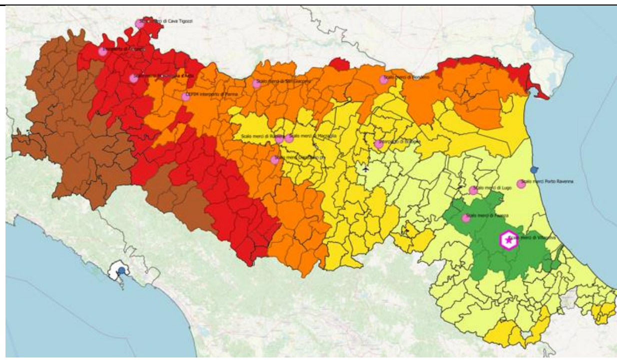
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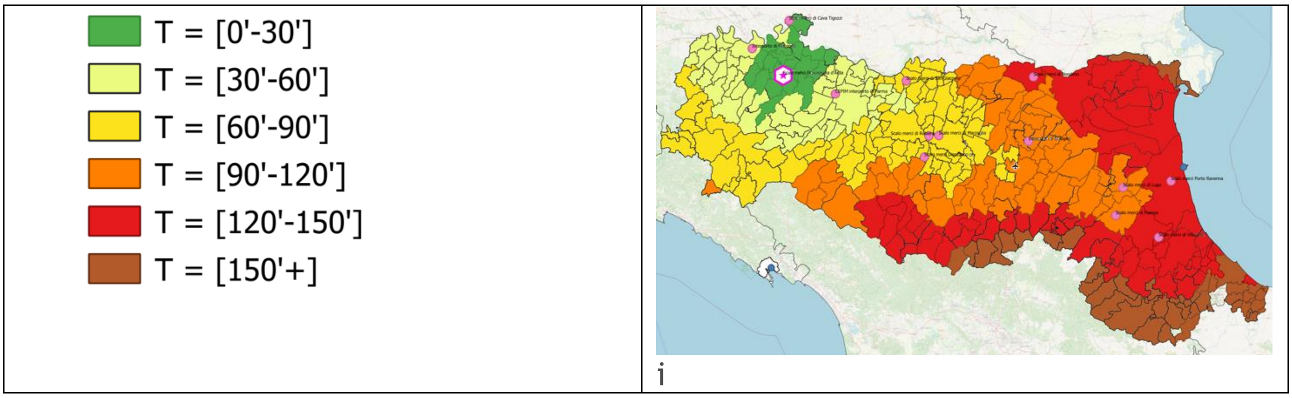


Figure 7 - Connectivity ("adjusted" travel time in minutes) for the regional inter-modal nodes: a) Bologna; b) Dinazzano-Rubiera-Marzaglia; c) Parma; d) Piacenza; e) Ravenna; f) Lugo; g) Faenza; h) Villaselva; i) Fiorenzuola

As can be seen even from a simple graphical comparison between Figure 4 and Figure 7, the nodes that present a better supply in terms of quantity (weekly frequency) and quality are also those that obtain a better "gain" in terms of connectivity. More in detail, the node that obtains the greatest benefit (and therefore has the greatest attractiveness compared to road accessibility alone) is that of Dinazzano (reduction in accessibility time of about 11%), followed by the port of Ravenna (reduction of 5.8%), Piacenza (4.7%). The other nodes achieve lower reductions.

The increase in connectivity generates a widening of the catchment area, i.e. the basin in which productive realities potentially attracted by nodes are located. The definition of the catchment area is important not only to assess the influence of a single node, but above all to analyse the possible competition between nodes, represented by the overlaps between the basins themselves. In the literature (Van den Heuvel et al., 2013[10]; Sirikilpanichkul and Ferreira, 2007[11]) a common value assumed to assess the limit within which a node is considered advantageously accessible by an economic activity located on the territory is 60' of access time by road. In this work, considering the characteristics of the territory and the assumptions underlying the accessibility indicator above described, a threshold of 90' is considered more suitable.

The Emilia-Romagna region is located in a wide production area, which includes a significant part of northern Italy, in particular the regions of Lombardia, Piemonte and Veneto. In these regions there are - in addition to a number of industries and activities that generate high turnovers and massive traffic of freight - some intermodal nodes that, due to their geographical location and the quality and intensity of the services offered, are potentially attractive even beyond the borders of the regions in which they are located. For this reason, some of these extra-regional nodes have been included in this analysis, with the aim of analysing situations of potential competitiveness between different regional intermodal infrastructure systems and to develop a tool to assess whether some potential demand shares are met by transport offers in extra-regional nodes which, despite being at distances potentially above the catchment limit, are able to attract traffic thanks to the quality and quantity of the supplied services.

The table below shows the extra regional nodes considered (in grey those of Lombardia, in purple those of Piemonte and in green those of Veneto). As it is possible to notice, many

[10] van den Heuvel, F. P., de Langen, P. W., van Donselaar, K. H., & Fransoo, J. C. (2013). Regional logistics land allocation policies: Stimulating spatial concentration of logistics firms. *Transport Policy*, *30*, 275-282.

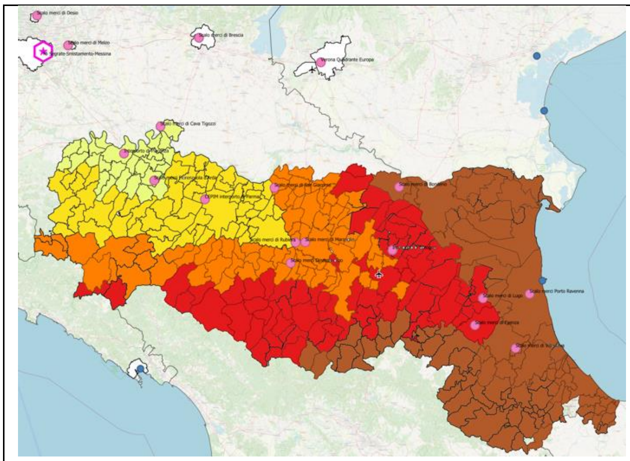
[11] Sirikijpanichkul, A., FERREIRA, L., & LUKSZO, Z. (2007). Optimizing the location of intermodal freight hubs: an overview of the agent based modelling approach. *Journal of Transportation Systems Engineering and Information Technology*, *7*(4), 71-81.

of these nodes have greater supply of services than the ones of the Emilia Romagna region, both in terms of frequency of weekly connections and in terms of "quality" of the destinations served (national and EU ports in particular).

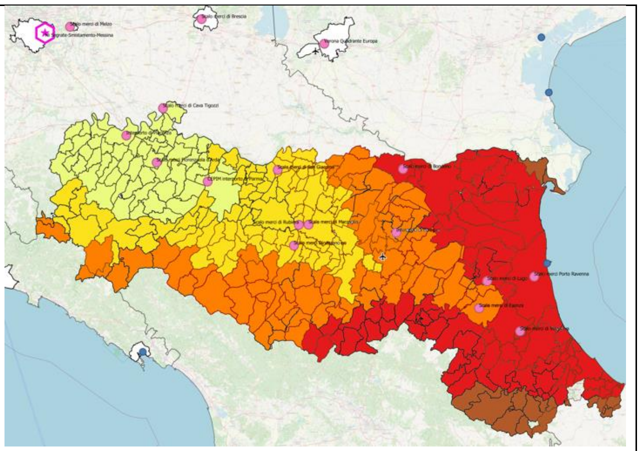
Table 3 - Number and type of weekly connections operated in the extra-regional intermodal nodes

INTERMODAL NODE	National connections	EU connections	Connection with national port	Connection with EU port
MORTARA	0	0	0	17
MILANO Segrate	32	81	35	65
BRESCIA	2	50	22	11
CREMONA	5	2	3	1
MELZO	16	51	25	15
DESIO	0	2	0	0
BUSTO ARSIZIO	28	75	0	114
NOVARA BOSCHETTO - CIM	14	107	0	59
RIVALTA	7	0	17	0
VERONA QE	10	94	21	77
PADOVA	31	23	42	33

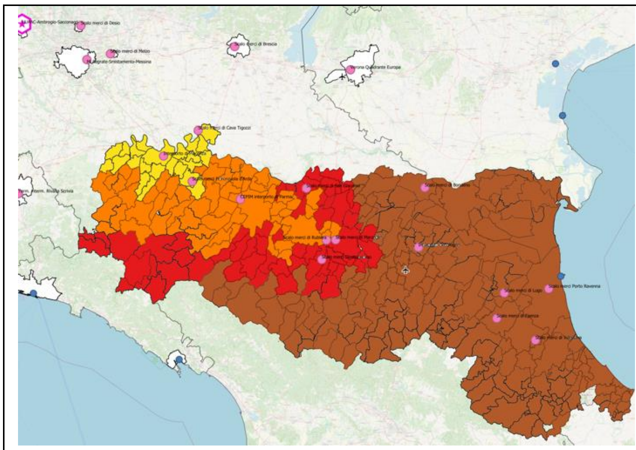
In the figure below, the accessibility maps of some of the extra-regional nodes considered in the analysis (Milano, Busto Arsizio and Verona QE) are reported. In the left column there are the accessibility maps based on the travel time only, while in the right one the accessibility maps based on the proposed connectivity indicator (i.e. the "adjusted" travel time) are shown.



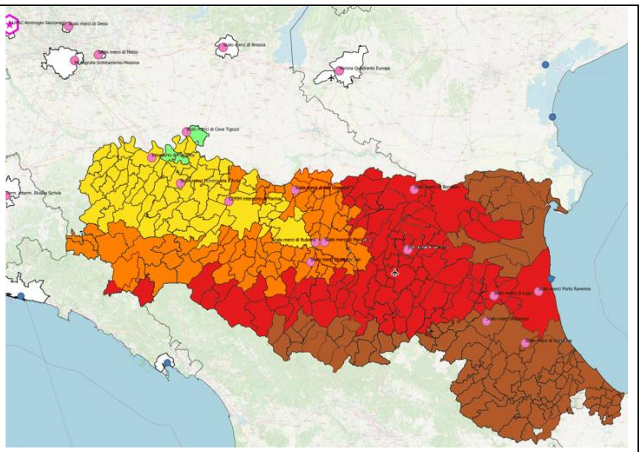
a (Milano Segrate – travel time)



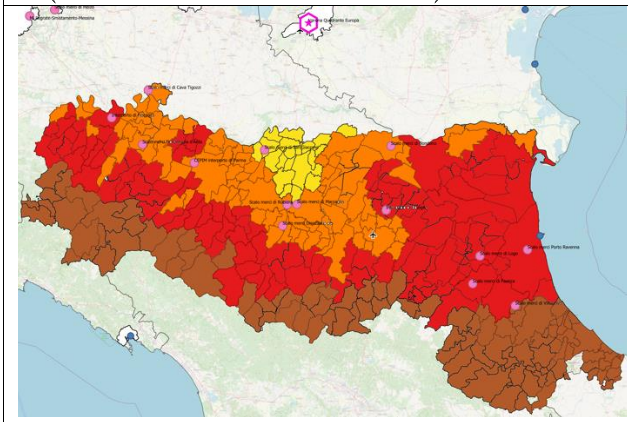
a (Milano Segrate – connectivity indicator)



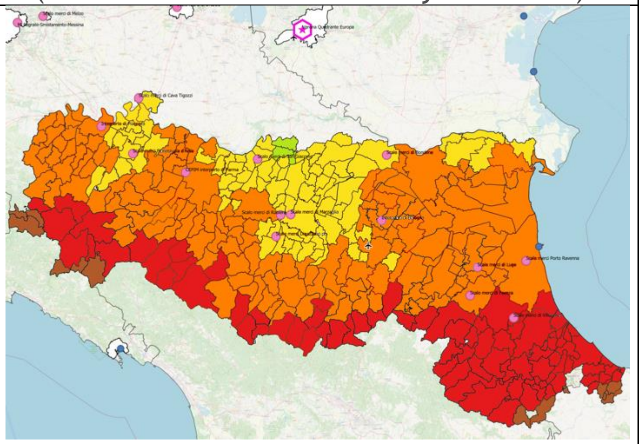
b (Busto Arsizio – travel time)



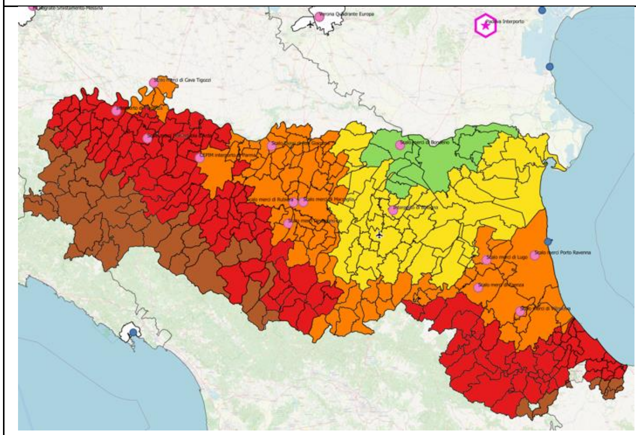
b (Busto Arsizio – connectivity indicator)



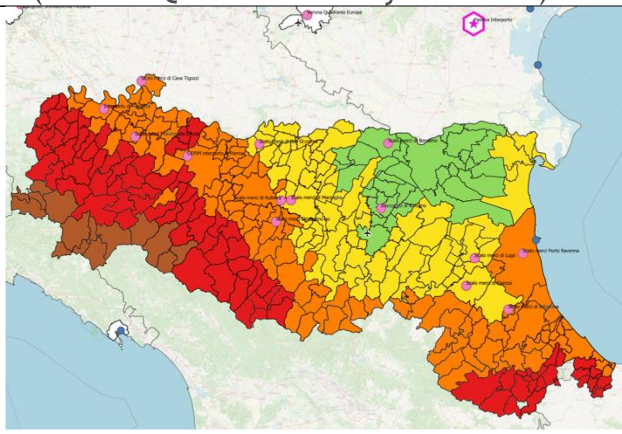
c (Verona QE – travel time)



c (Verona QE – connectivity indicator)



d (Padova – travel time)



d (Padova – connectivity indicator)

- T = [0'-30']
- T = [30'-60']
- T = [60'-90']
- T = [90'-120']
- T = [120'-150']
- T = [150'+]

Figure 8 - *Travel time and Connectivity ("adjusted" travel time in minutes) for some extra-regional inter-modal nodes: a) Milano Segrate; b) Busto Arsizio; c) Verona; d) Padova*

As can be seen, the catchment areas of the three nodes considered are remarkably extended when the accessibility is evaluated by means of the proposed indicator (and so not only with the mere travel time). It should be noted, in particular, that a number of municipalities in Emilia-Romagna which would normally be located above the access time limit, are instead fully within the catchment areas of the extra-regional nodes.

The links indicated in the previous tables are analysed below for each individual node and classified by type, according to the route and the border crossing involved.

O/D relationship between Austria and Italy:

Two railway paths are possible between Austria and Italy:

- Friuli Venezia Giulia region is crossed by as much as 43 train couples/week (through Villach – Tarvisio Coccau pass). Of those, nearly 46,5% originate/end within the same region, while 35% involve Veneto or Emilia Romagna regions and the remaining 18,5% involve Lombardia and Liguria. In Vienna it is located a connection between Rhine – Danube, North sea – Mediterranean and Orient – East Mediterranean TENT corridors.
- Trentino Alto Adige region is crossed by as much as 53 train couples/week heading Worgl in Austria through the Brenner pass (RO-LA)

O/D relationship between Belgium and Italy:

The relationship between Belgium and Italy has nearly as much as 140 train couples/week. Main intermodal platform in Belgium are located along the North Sea – Mediterranean TENT corridor: Anversa – Antwerp, Bruges – Zeebrugge, Charleroi, Gand, Genk. Connections are present with Atlantic, Rhine – Alpine and North Sea – Baltic TENT corridors.

- Relationship Charleroi – Gand – Zeebrugge = 52 train couples/week
- Relationship Charleroi – Zaventem – Mechelen – Antwerp = 60 train couples/week
- Relationship Charleroi – Liegi – Genk = 31 train couples/week

The path from Charleroi to Italy crosses Luxembourg – France (Metz, Strasbuorg, Epinal, Mulhouse) – Switzerland (Basilea or Geneve, going through a longer branch departing from Epinal).

Mulhouse is the linking node to Rhine – Alpine TENT corridor to which the main intermodal nodes in Italy belong:

- To reach Piemonte (Novara, Rivalta) and Liguria (Genova) regions, the **Sempione tunnel** is used (Briga - Domodossola) → **54 train couples/week**
- To reach Lombardia (Milan Segrate – Smistamento – Terminal Messina, Mortara, Busto Arsizio), the path crosses Zurich and the **San Gottardo base tunnel** to reach Bodio – Bellinzona and then either Varese or Chiasso by the railway path Mendrisio – Varese or Mendrisio - Chiasso – Como – Milano relationships respectively → **56 train couples/week**. This path is covered also to reach Verona QE, Padova (**23 train couples/week**), Bologna Interporto and Piacenza Interporto (**10 train couples/week**). Another path to link Veneto and Emilia Romagna region with Belgium is through the Brenner pass, but it is a time-expensive solution from our perspective.
- Through the San Gottardo base tunnel intermodal nodes in Piemonte could be reached as well along the railway path Locarno – Domodossola, a narrow-gauge line which would require a full transfer of the load

O/D relationship between China and Italy:
The San Gottardo base tunnel (Rhine – Alpine TENT Corridor) is used to direct the only weekly connection from Lombardia to China to other corridors linking the far East.

O/D relationship between Sweden – Danemark – Italy:
Padborg and Taulov (Denmark) and Malmoe (in Sweden) are located along the Scandinavian – Mediterranean TENT Corridor. 16 train couples/week linking Verona, Brescia and Busto Arsizio with platforms located in north European countries are likely routed through the Brenner pass.

O/D relationship between Spain - France – UK and Italy:
The Intermodal platforms involved in the France – Italy connection are mainly located along the North Sea – Mediterranean (French platforms), Scandinavian – Mediterranean and Mediterranean (Italian platforms) TENT Corridor. As much as 110 train couples/week are routed through the Frejus tunnel; on the Italian side of the relationship 84 connections are limited to Piemonte, 13 in Emilia Romagna and the remaining ones involve platforms in Lombardia region. From the French point of view, 30 couples train/week are a ROLA connection from Torino Orbassano to Aiton, 71 train couples/week head north (Arcis, Calais and the UK, Dourges, Parigi, Eppeville, Sillery), 6 train/couples/week head southbound towards Marsiglia and the remaining ones stop in Lyon
Additional 3 train couples/week transiting from Italy and Frejus tunnel to Lyon head Westbound towards Spain (Barcelona Morrot)

O/D relationship between Germany and Italy
From Centre and South Italy, Emilia Romagna, Veneto and Friuli Venezia Giulia regions and through the Brenner Pass

- Trains headed to platforms located along the Scandinavian – Mediterranean, Rhine – Danube and Rhine – Alpine TENT Corridors in Germany and the Netherlands → Brenner pass - Monaco – Ulma – Stoccarda Kornwestheim – Karlsruhe - Ludwigshafen am Rhein – Frankfurt – Bonn – Colonia Koln – Leverkusen – Wuppertal Dusseldorf Monchengladbach - Krefeld – Duisburg.

- Trains headed to platforms located in Germany along the Scandinavian – Mediterranean TENT Corridor → Brenner pass – Monaco Munich – Norimberga – Lipsia – Berlino – Rostock

- Trains headed to platforms located in either Germany or Danemark along the Scandinavian – Mediterranean TENT corridor → Brenner pass – Monaco Munich – Norinberga – Herne – Kassel - Hannover – Amburgo Hamburg – Lubecca - Kiel.

From Piemonte and Lombardia regions through the Sempione and the San Gottardo tunnel, respectively

- Trains headed to platforms located in Germany along the Rhine – Alpine, North Sea – Baltic, Scandinavian – Mediterranean TENT Corridors → Sempione pass - Singen – Friburgo Freiburg – Karlsruhe - Ludwigshafen – Francoforte Frankfurt – Colonia Koln – Kaldenkirchen – Krefeld - Duisburg – Hannover – Amburgo Hamburg – Lubecca

To summarize, the relationship between Germany and Italy is worth hundreds of train couples/week; the traffic is split between Brenner pass (39% of the traffic), Sempione pass (16% of the traffic) and San Gottardo tunnel (45% of the traffic).

O/D relationship between Luxembourg and Italy:
Traffic linking Italy and Luxembourg (located along the North Sea – Mediterranean TENT corridor) from Friuli Venezia Giulia and Lombardia cross the Alps at the Brenner pass (or at Villach – Tarvisio Coccau pass) and San Gottardo tunnel, respectively. Connections with Rhine – Danube and North Sea – Mediterranean TENT Corridors are needed to reach destination.

O/D relationship between Netherlands and Italy:
Connections between Italy and the Netherlands (Geleen and Rotterdam mainly) cross the Alps at the Brenner pass (traffic originated/directed to Emilia Romagna and Veneto regions, along the Scandinavian – Mediterranean and North Sea – Baltic TENT corridors, whose connection is in Hannover) or either the Sempione pass or the San Gottardo tunnel when originated/directed to Piemonte, Liguria, Lombardia regions (Rhine – Alpine TENT Corridor).
To summarize, the traffic of nearly 200 train couples/week linking Italy and the Netherlands splits between Brenner pass (36% of the traffic), Sempione pass (19% of the traffic), and the San Gottardo tunnel (45% of the traffic).
O/D relationship between Hungary - Romania – Czech Republic – Poland and Italy:
Connections between Italy and Eastern Europe sum up to nearly as much as 30 train couples/week from Emilia Romagna and Friuli Venezia Giulia regions along the Mediterranean and Baltic – Adriatic TENT Corridors. The most likely pass to be adopted is the one located in Villach – Tarvisio Coccau for the traffic towards Czech Republic and Poland (35% of the total) and Villa Opicina pass for the traffic towards Hungary and Romania (65% of the total)

O/D relationship between Switzerland and Italy:
Along the Rhine – Alpine TENT Corridor are located the four platforms of Zurigo Zurich, Schafisheim, Aarau, Basilea Basel (as much as 70 train couples/week) which are somehow linked to Italy. Traffic is routed through the San Gottardo tunnel (or – less likely – Sempione pass).

The following table shows the supply from each considered region (Emilia – Romagna, with its logistic system, and the competing extra-regional logistic systems of Lombardia, Veneto and Piemonte) expressed in train pairs / week, divided by border crossing points and traffic corridor.

Table 4 - *Rail supply for each considered region, expressed in couples of trains / week, grouped for border crossing and traffic corridor*

Border crossing	Veneto - FVG - TAA	Emilia Romagna	Lombardia	Piemonte	Other	TOT traffic
Villa Opicina	**Hungary - Italy: 14 train couples/week.** TENT connections = Mediterran., Baltic - Adriatic, Rhine - Danube, North Sea - Baltic Austria - Italy (2nd best option for 20 train couples/week connection from/to FVG.	**Romania - Italy: 2 train couples/week.** TENT connections = Mediterran., Baltic - Adriatic, Rhine - Danube, North Sea - Baltic				**14 f/t HUNGARY + 2 f/t ROMANIA** **= 16 train coupl./week** **CAPACITY = 15 train couples/DAY.**
Villach	**Austria - Italy = 23 train couples/week** 20 from/to FVG (46% traffic) + 3 from/to Veneto (7% traffic) (best option). TENT connections = Baltic - Adriatic, Rhine - Danube, North sea - Mediterran. and Orient - East Mediterran. **Czech Republic - Italy: 5 train couples/week.** TENT connections = Mediterran., Baltic - Adriatic, Rhine -	**Austria - Italy = 6 train couples/week** from/to Emilia Romagna (13% traffic) (best option). TENT connections = Baltic - Adriatic, Rhine - Danube, North sea - Mediterran. and Orient - East Mediterran. **Poland - Italy: 6 train couples/week.** TENT connections = Mediterran., Baltic - Adriatic, Rhine -	**Austria - Italy = 4 train couples/week** from/to Lombardia (9% traffic) (best option). TENT connections = Baltic - Adriatic, Rhine - Danube, North sea - Mediterran. and Orient - East Mediterran.		**Austria - Italy = 10 train couples/week** from/to other regions. TENT connections = Baltic - Adriatic, Rhine - Danube, North sea - Mediterran. and Orient - East Mediterran.	**43 f/t AUSTRIA + 5 f/t CZ. REP + 6 f/t POLAND** **= 54 train coupl./week** **CAPACITY = 40 train couples/DAY, 10 of which for international service.**

	Danube, North Sea - Baltic Luxembourg - Italy = 29 train couples/week from FVG (2nd best option). TENT connections = North Sea - Mediterran., Rhine - Danube.	Danube, North Sea - Baltic				
Brenner	**Austria - Italy = 53 train couples/week** from TAA **Denmark - Italy = 8 train couples/week** from Veneto. TENT Connections = Scandinavian - Mediterran., Rhine - Danube, Orient - East Med, North Sea - Baltic **Germany - Italy = 209 train couples/week** 150 from/to Veneto (23% of the total) + 59 from FVG (9% of the total) TENT connections = Scandinavian - Mediterran., Rhine - Danube and Rhine - Alpine **Luxembourg - Italy = 29 train couples/week** from Friuli Venezia Giulia (best option).	**Germany - Italy = 16 train couples/week** from/to Emilia Romagna (3% of the total). TENT connections = Scandinavian - Mediterran., Rhine - Danube and Rhine - Alpine	**Sweden - Denmark - Italy = 8 train couples/week.** TENT Connections = Scandinavian - Mediterran., Rhine - Danube, Orient - East Med, North Sea - Baltic		**Germany - Italy = 26 train coupl./week** from/to other regions (4% of the total). TENT connections = Scandinavian - Mediterran., Rhine - Danube and Rhine - Alpine	**53 f/t AUSTRIA + 16 f/t SWEDEN & DENMARK + 29 f/t LUXEMB + 251 f/t GERMANY + 74 f/t NETHERL.** ――― **= 423 connections coupl./week** *NB = Since there is no information on intermediate stops, this is the number of* ***connections****.* *The number of trains is lower since wagons are grouped at the pass so that the number of incoming convoys is lower than the number of outcoming.*

	TENT connections = North Sea - Mediterran., Rhine - Danube. **Netherlands - Italy = 46 train couples/week** from/to Veneto (22,5% of the total). TENT connections = Scandinavian - Mediterran., North Sea - Baltic	**Netherlands - Italy = 12 train couples/week** from/to Emilia Romagna (6% of the total). TENT connections = Scandinavian - Mediterran., North Sea - Baltic			**Netherlands - Italy = 16 train coupl./week** from/to other regions (8% of the total). TENT connections = Scandinavian - Mediterran., North Sea - Baltic	**CAPACITY = 135 train couples/DAY**
San Gottardo	**Switzerland - Italy = 15 train couples/week** (21% of traffic) TENT Connections = Rhine - Alpine, North Sea - Med, Mediterran. **Belgium - Italy = 23 train couples/week** 21 from/to Veneto (17% of the total) and 2 from/to FVG (2% of the total). TENT connections = Rhine - Alpine, North sea - Mediterran. and North Sea - Baltic	**Switzerland - Italy = 10 train couples/week** (14% of traffic) TENT Connections = Rhine - Alpine, North Sea - Med, Mediterran. **Belgium - Italy = 10 train couples/week** from/to Emilia Romagna (8% of the total). TENT connections = Rhine - Alpine, North sea - Mediterran. and North Sea - Baltic	**Switzerland - Italy = 15 train couples/week** (21% of traffic) TENT Connections = Rhine - Alpine, North Sea - Med, Mediterran. **Belgium - Italy = 36 train couples/week** from/to Lombardia (29% of the total). TENT connections = Rhine - Alpine, North sea - Mediterran. and North Sea - Baltic **China - Italy = 1 train/week.** TENT Connections = Rhine - Alpine, Orient - East Mediterran., Rhine - Danube		**Switzerland - Italy = 31 train couples/week** (44% of traffic) TENT Connections = Rhine - Alpine, North Sea - Med, Mediterran.	**71 f/t SWITZERL.** + **69 f/t BELGIUM** + **1 f/t CHINA** + **4 f/t LUXEMB.** + **292 f/t GERMANY** + **92 f/t NETHERL.** ________ **= 529 connection couples/week** *NB = Since there is no information on intermediate stops, this is the number of **connections**.* *The number of trains is lower since wagons are grouped at the pass so that the number of*

			Germany - Italy = 292 train couples/week From/to Lombardia (45% of the total) TENT connections = Scandinavian - Mediterran., Rhine - Danube and Rhine - Alpine **Luxembourg - Italy = 4 train couples/week.** TENT connections = North Sea - Mediterranean, Rhine - Danube. **Netherlands - Italy = 92 train couples/week** (45% of the total) TENT Connections = Rhine - Alpine, North Sea - Med, North Sea - Baltic.			*incoming convoys is lower than the number of outcoming.* **CAPACITY = 100 train couples/DAY**
Sempione	Switzerland - Italy = (2nd best option)	Switzerland - Italy = (2nd best option)	Switzerland - Italy = (2nd best option)	**Belgium - Italy = 54 train couples/week** from/to Piemonte (44% of the total) TENT connections = Rhine - Alpine, North sea - Mediterran. and North Sea - Baltic **Germany - Italy = 102 train couples/week** 87		**54 f/t BELGIUM + 102 f/t GERMANY + 39 f/t NETHERL.** ——— **=195 connection couples/week** *NB = Since there is no information on intermediate stops, this is the number of* ***connections.*** *The number of trains is lower since*

				from/to Piemonte (13,5% of the total) and 15 from/to Liguria (2,5% of the total). TENT connections = Scandinavian - Mediterran., Rhine - Danube and Rhine - Alpine **Netherlands - Italy = 39 train couples/week** from/to Piemonte (19% of the total traffic). TENT Connections = Rhine - Alpine, North Sea - Med, North Sea - Baltic.		*wagons are grouped at the pass so that the number of incoming convoys is lower than the number of outcoming.* **CAPACITY = 30 train couples/DAY**
Frejus		**France - Italy = 18 train couples/week.** (16,5% of the total). TENT connections = North Sea - Mediterran., Scandinavian - Mediterran., Rhine - Alpine, Mediterran.	**France - Italy = 8 train couples/week.** (7% of the total) TENT connections = North Sea - Mediterranean, Scandinavian - Mediterranean, Rhine - Alpine, Mediterranean. **Spain - Italy = 3 train couples/week.** TENT connections = North Sea - Mediterranean, Scandinavian - Mediterranean,	**France - Italy = 84 train couples/week.** (76,5% of the total). TENT connections = North Sea - Mediterranean, Scandinavian - Mediterranean, Rhine - Alpine, Mediterranean. **UK - Italy =**		**110 f/t FRANCE + 3 f/t SPAIN + 3 f/t UK** **= 116 train couples/week** **CAPACITY = 43 train couples/DAY**

			Rhine – Alpine, Mediterranean.	**3 train couples/week.** TENT connections = North Sea - Mediterranean, Scandinavian – Mediterranean, Rhine – Alpine, Mediterranean.		

The database of intermodal freight relationships on railway infrastructure at both national and EU levels highlights some aspects worth consideration in the process of design of regional and national freight transport planning:

- Due to its shape, north-south displacements are prevailing against east-west displacements which are actually possible only in the northern part of Italy while in the centre-south the presence of the Appennines and the short distances make the railway transport not viable from the financial point of view.
- Italian nodes are peripheral with reference to the extension of TENT Corridors; thus, opportunities and interchanges are reduced in number. Nevertheless, four out of nine TENT corridors involve the Italian territory: of those only one extends its branches towards the Southern Italy, and two corridors link the main harbours of Geneva, Trieste, La Spezia, Livorno, Venice Marghera and Ravenna to the rest of Europe. On the other hand, unfortunately, vessel traffic in the Mediterranean basin is not so relevant in size if compared to Northern Sea and, what is more, it is scattered so that relevant and stable o/d connection from/to Italy are difficult to be sustainable.
- The economic performance of Italy and Emilia Romagna region is not always compatible with railway freight transportation as far as dimension of the final product, just-in-time delivery, and valuable/fragile items are involved. In addition to that, the average size of firms within Emilia Romagna is not a booster of railway intermodal freight transport.
- Connections between Italy and the rest of Europe are mainly present in those regions which have one or more national borders towards foreign countries (such as Friuli Venezia Giulia, Veneto, Trentino, Lombardia, Piemonte). Traffic originating in inland regions should therefore combine a reduced number of international connections with frequent national feeder connections towards consolidation hubs, same-size and feeder platform to guarantee an adequate, connected and integrated supply of infrastructures (stock areas) within a coherent and effective framework.

The table below shows the performance of each node which has been appointed importance in the context of the REIF project. The performance measure for each region is the sum of the contribution of each platform withint the target region involved. The performance weight modifies the simplest accessibility measure (travel time) by imposing increased importance to international connections and O/D relationships involving sea shipping from ports. Thus, a target node will become more attractive based on the number and value of its connections so that freight operators will perceive it less impacting road displacements to reach the platform and time losses due to transhipment operation.

Table 5 - Equivalent connections index and weights for the considered nodes.

INTERMODAL PLATFORM	PERFORMANCE WEIGHT	REGION	REGIONAL PERFORM.	N° of O/D relations national	N° of O/D relation abroad	N° of port relations national	N° of port relation abroad
PIACENZA INTERPORTO	0,0232	EMILIA ROMAGNA	0,16	16	6	3	6
FIORENZUOLA	0,0047			9	0	3	0
PARMA INTERPORTO	0,0109			12	2	0	2
DINAZZANO - MARZAGLIA - RUBIERA	0,0591			13	6	10	0
BOLOGNA INTERPORTO	0,0173			12	4	4	2
GUASTALLA	0,0022			0	0	1	0
BONDENO	0,0002			1	0	0	0
FAENZA	0,0011			3	1	0	0
LUGO	0,0079			3	8	1	0
PORTO DI RAVENNA	0,0294			22	16	2	4
VILLA SELVA	0,0038			2	4	0	0
MORTARA	0,0134	LOMBARDIA	0,41	0	0	0	6
MILANO SEGRATE - SMISTAMENTO	0,1303			9	18	6	16
BRESCIA	0,0524			1	4	10	4
CREMONA	0,0054			8	4	6	2
MELZO	0,0619			8	22	6	3
DESIO	0,0011			0	2	0	0
BUSTO ARSIZIO	0,1409			8	21	0	15
NOVARA BOSCHETTO - CIM	0,1125	PIEMONTE	0,13	10	25	0	12
RIVALTA SCRIVIA	0,0129			4	0	4	0
VERONA QUADRANTE EUROPA	0,1310	VENETO	0,21	6	29	8	15
PADOVA INTERPORTO	0,0755			14	7	10	9
PORTO DI GENOVA	0,0406	LIGURIA	0,09	19	8	0	2
PORTO DI LA SPEZIA	0,0535			22	8	0	2
PORTO DI LIVORNO	0,0088	TOSCANA	0,01	14	0	0	0

The results of the table clearly show that many medium-small platforms, built to cover the whole territory of a region, which at the same time lack connections to national hubs and foreign destination is not sufficient to guarantee positive performance to the intermodal freight traffic at the regional level. Emilia Romagna region is indeed endowed with infrastructure to provide accessibility to railway infrastructures to all provices (and this is testified by the maps which represent the road accessibility of each regional platform under average uncongested traffic scenarios). Neverthess, the performance at the regional level is uncomparably lower than Lombardia; in addition Veneto and Piemonte score roughly the same result but with a reduced number of relevant platforms within the Emilia Romagna catchment area (two platforms each) thanks to their higher/more valuable connection basket.

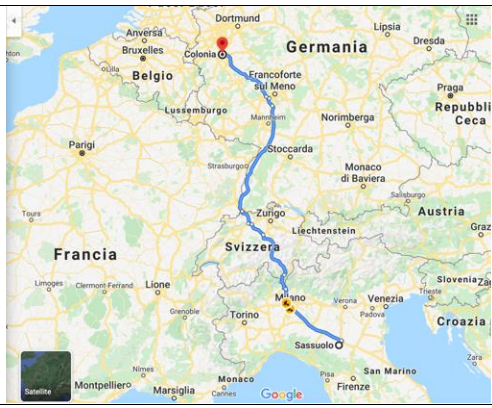
2.3. Analysis of the economic, political and technical market conditions

The Regional Integrated Transport Plan (PRIT2025) aims at rebalancing towards new forms of collective and non-motorized mobility both in urban and extra-urban areas for increasing the accessibility of the territory. More efficient and sustainable systems of modal integration and co-modality for passengers and freights will be promoted, innovating and empowering the local public transport – on passenger mobility side – and fostering the modal shift towards railway for freight transportation, through a better inter-modal integration, a focused system of market-based measures and acting on the rules of the system governance.
As far as the freight transport is concerned, the goal to 2025 is to increase the modal share of rail freight transport by +30%, with a minimum modal share of 13%.
The optimization of modal integration means a pivotal role of railway stations in the organization of services. In particular, the whole railway infrastructure must become the central node of urban and extra-urban mobility and therefore road transport should play the role of adductor to the railway system.
On the basis of what has been highlighted above, the region is orienting investments in order to improve the competitiveness of the logistic system referring to the main intermodal nodes, with the aim of increasing the supply of services able to satisfy the export demands of the regional productive activities. In this sense, apart from the investments already planned and described in the deliverable D.T1.1.3, the most recent investments agreed with the National network operator (RFI) include an important project to extend the railway node of the port of Ravenna. In that railway node (both for inter-modal and conventional / solid bulks) 3 million and 500 thousand tons of goods moved (26.5 in total) travel by rail, for more than 7 thousand trains / year, a constant growth in demand for transport by rail, to and from the port area, and an increase in the movement of goods at the railway station. Funding of around €47 million has been allocated for the strengthening of the freight yard, which will be used for strategic projects in order to improve the intermodal transport offer and connections to strategic markets.
The modal split is the result of a series of balances between multiple determinants of choice, essentially linked to economic, technical and regulatory aspects. In the case of freight transport, the prevalence of the modal share by road, for goods that could potentially also be suitable for rail transport, is largely due to the greater flexibility and economic advantage of this mode of transport. However, in many cases - especially over

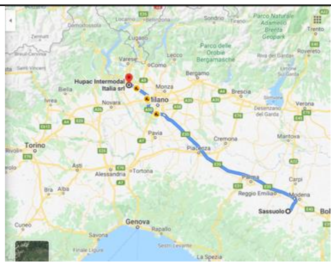
long distances - the modal imbalance in favour of road is often due to the difficulty of modal integration or the lack of rail transport services. Below are some examples of case studies illustrating how technical and contextual conditions can influence the modal choice.

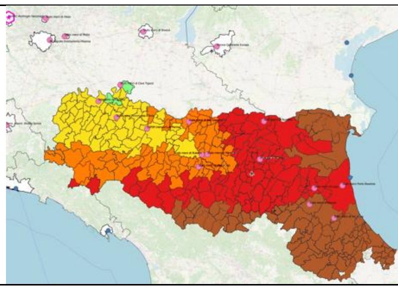
Case study #1

Suppose we have to ship an intermodal transport unit (semi-trailer) of tiles (20 tons) from the Sassuolo ceramics cluster to Koln (Germany). The all-road distance is 1,020 km and the average travel time is about 14h 20’. The current legal limits on driving schedules require drivers to stop for 45' every 4h and 30' of driving. Then, after 9 hours of driving, another 9 hours of rest. In this case, considering only one driver, the mandatory pauses lead to a travel time of 25 hours.



As regards costs, the Italian Ministry of Transport periodically releases the minimum cost per kilometre for road haulage, including all the necessary fixed and variable cost items. For distance classes of over 500 km (as in this case) the minimum cost is 1,227 €/km. This results in a cost on the route in question of € 1,251. It should be pointed out that in reality it is possible to find cost values on the market that are lower than the minimum costs usually applied by road haulage companies (on average 20% less). In order to reduce the time, it is possible to employ two drivers: in this case the cost increases by about 33%, while the travel time is reduced by 7h and 30'.



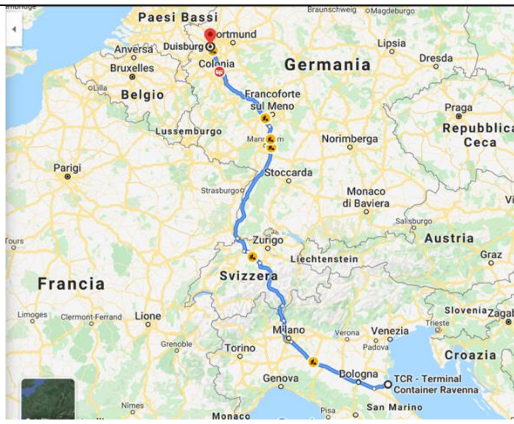


If we consider intermodal transport, then the freight intermodal node of Busto Arsizio, outside the Emilia-Romagna region, offers 17 terns/week for Cologne, with C50 gauge profile. The distance is 800 km; average freight train speed: 60 km/h, resulting in a travel time of 13 hours and 20 minutes. The average travel time for the road section from Sassuolo to the Busto Arsizio terminal node is approximately 2 hours, with arrival time at least 2 hours minimum in advance of the scheduled departure time of the train for load acceptance and handling. Suppose we add a final leg, from the arrival node to the destination, of about 30' of travel. The total time is therefore 17 hours and 50 minutes.

These times are calculated considering the absence of delays at the Alpine passes. It should be considered that, unfortunately, the transit through the Alpine crossing involves in most cases delays even in the order of a few hours. From analysis and research conducted with logistics operators, it is possible to estimate an average rail cost, including handling costs at nodes, of 0.045 € / ton-km. For a shipment of 20 tons and for the route in question the rail cost is therefore equal to € 720, to which must be added the road costs for the first and last section (about € 770). The total cost of this transport solution is therefore about 1500 €. From an economic point of view, road transport with a single driver is more advantageous, albeit only slightly so. If two drivers are considered then the costs are broadly comparable. As far as time is concerned, the two solutions are similar, even if the time for rail transport has been calculated in the absence of delays and above all depends on the frequency of the services offered (in this case very high). It is actually the high supply of services and connections that makes this node very attractive for large areas of the Emilia-Romagna region (see figure).

- Case study #2

Suppose we have to ship a 40" container from the port of Ravenna to Duisburg (Germany). The all-road distance is 1,184 km and the average travel time is about 16h 50’. The current legal limits on driving schedules require drivers to stop for 45' every 4h and 30' of driving. Then, after 9 hours of driving, another 9 hours of rest. In this case, considering only one driver, the mandatory pauses lead to a travel time of 27 hours and 20’. As regards costs, the Italian Ministry of Transport periodically releases the minimum cost per kilometre for road haulage, including all the necessary fixed and variable cost items. For distance classes of over 500 km (as in this case) the minimum cost is 1,227 €/km. This results in a cost on the route in question of € 1,453. It should be pointed out that in reality it is possible to find cost values on the market that are lower than the minimum costs usually applied by road haulage companies (on average 20% less). In order to reduce the time, it is possible to employ two drivers: in this case the cost increases by about 33%, while the travel time is reduced by 7h and 30'.



The intermodal solution involves the use of a direct rail link from the port of Ravenna to Duisburg. The connection is operated by Contship and has a frequency of 3 trains per week. The distance is 990 km, from the timetable we have for example departure at 16:00 on Monday and arrival at 06:00 on Friday. The total travel time is therefore 3 days and 10 hours. The average rail cost, also in this case derived from research and analysis carried out directly at the operators, is 0,030 € / ton-km; the total cost for 20 tons of goods in containers is therefore 653 €.

In 2009, 2013 and 2019 the Region adopted measures to face the reduction in rail traffic caused by the economic crisis and to prevent its further erosion. The objective was to stimulate the growth of rail freight transport by encouraging new traffic (i.e. additional to those already carried out) on existing and new traffic relationships, thus reducing the number of heavy vehicles on the road network, with obvious benefits in terms of environmental impacts, congestion and safety. Following the valuable outcomes of this first experience (3 million euro of annual contributions for each year in the period 2010-2011-2012 and traffic growth from 11,28 mln tons of freight by rail in 2009 to almost 16 tons in 2014), in 2013 the Region approved a new law on incentives for rail freight transport (Regional Law 10/2014). The total budget was EUR 800,000/ year for 2014-2015-2016 and the rail freight traffic has grown to around 20 million tonnes in 2019. In the same year the region reaffirmed this commitment, with a new law and new incentives (€1 million per year for the years 2020-21-22). The data concerning the financed connections, show a remarkable reactivity for those types of goods and relationships already consolidated in the region, such as solid bulk and clayey raw materials from the port of Ravenna to the production district of ceramics, steel materials and little intermodal traffic. The funding limits, which cover only the routes travelled on the regional territory (for a maximum of 120 km), make this initiative useful essentially to stimulate the modal shift of goods suitable for rail transport (large weights and/or volumes and low unit values) even on short routes, with an undeniable positive effect on the environment and reducing congestion on the road network. On the other hand, the effect on intermodal traffic (exports to ports and other national or foreign nodes) is not particularly influential, given the small amount of the route financed.

2.4. Analysis of the industrial structure and clusters (potential customers)

Emilia-Romagna has a highly specialized production system, consisting of 424 thousand companies, mainly SMEs, 50 thousand of which operate in the manufacturing macro-sector.
The region boasts some of the top Italian brands belonging to different sectors, and these are:

- Automotive (Ferrari, Lamborghini, Ducati and Maserati are some examples)
- Food (Barilla, Parmigiano Reggiano, Segafredo, prosciutto di Parma, etc.)
- Packaging (IMA, Marchesini Group, TetraPak)
- Fashion (Max Mara, Yoox, etc.)
- Tiles district (Florim, Marazzi, etc.)
- Wellbeing (Technogym)
- Health (Rizzoli Ortopedia, Cefla, etc.)

More specifically, regional specializations are detailed in the following list (source: Art-ER, Ervet)

1. **AGRO-FOOD**
    - Meat and dairy products. Dairy mainly located in the municipalities of Collecchio, Parma, Bologna and Reggio Emilia; province of Modena is also relevant. Meat production mainly in the municipalities of Forlì- Cesena and

Parma, followed by Modena; then Cesena, Langhirano (PR), Santa Sofia (FC), Castelnuovo Rangone (MO), Felino (PR) and Reggio Emilia.

- Agricultural machinery - the provinces of Modena and Reggio Emilia (the Po Valley area); Machinery for the food industry - mainly the province of Parma, followed by the municipalities of Lugo, Cento, Carpi and Anzola.
- Bakery and farinaceous products, almost all the cities in the following order: Parma, Bologna, Ravenna, Modena, Ferrara, Rimini, Forlì, Reggio Emilia and Cesena.

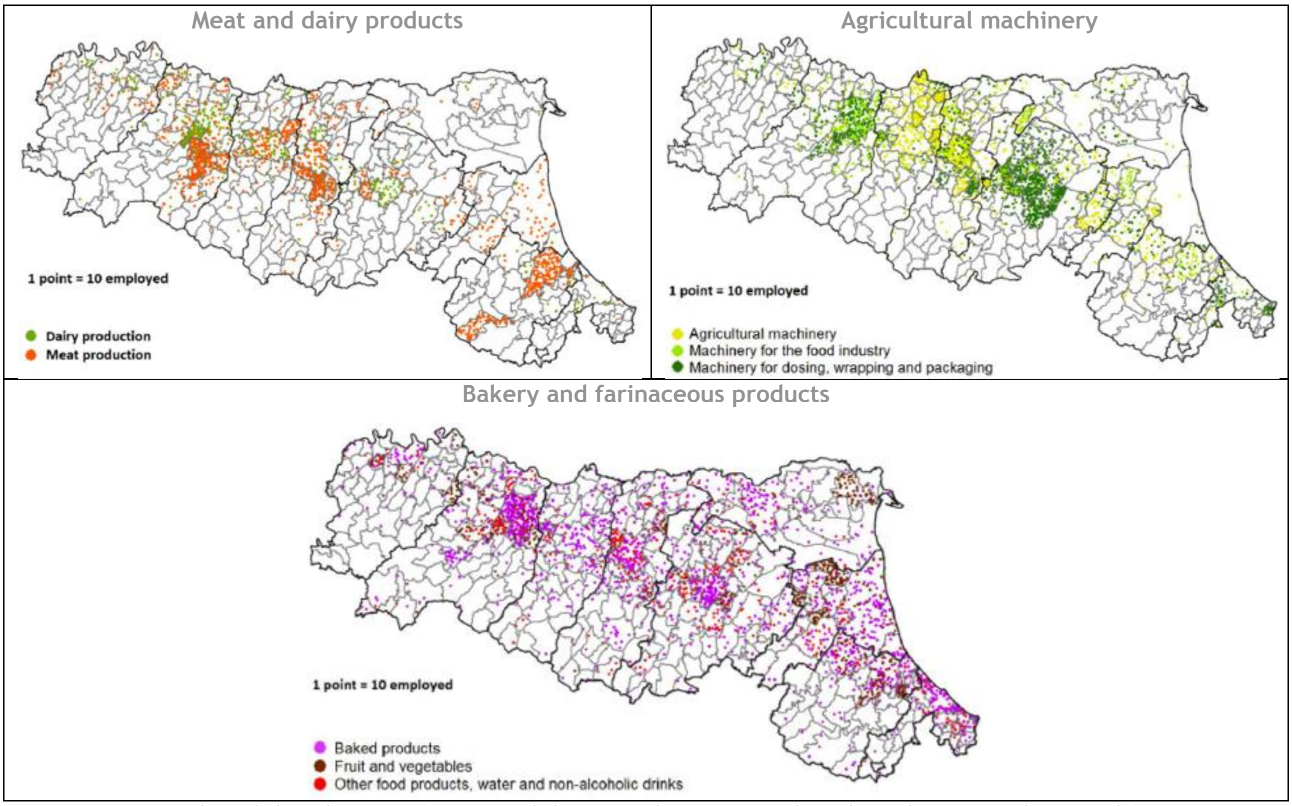


Figure 9 – Employed distribution of Meat and dairy products, Agricultural machinery, Bakery and farinaceous products. Source: Art-ER, Ervet (2018)

2. **HOUSING & CONSTRUCTION**
   - Ceramic products, high concentration in the ceramics district, between the provinces of Modena and Reggio Emilia (municipalities of Sassuolo, Fiorano, Castellarano, Casalgrande, Castelvetro, Rubiera), followed by the municipalities of Imola (in province of Bologna) and Faenza (province of Ravenna).
   - Furniture and wooden products, larger concentration in the Forlì, Rimini and Imola areas. Upholstered furniture district in the area of Forlì.

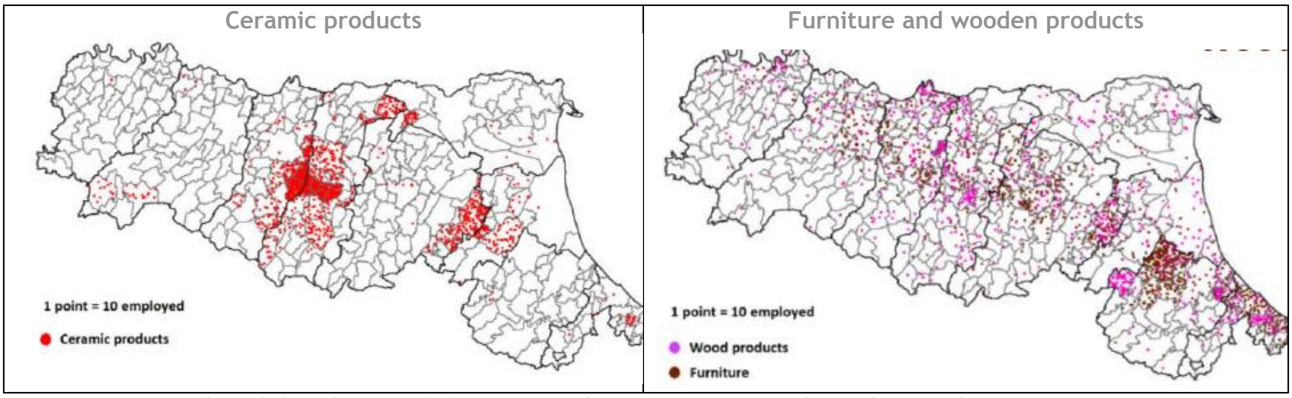


Figure 10 - Employed distribution of Ceramic products, Furniture and wooden products. Source: Art-ER, Ervet (2018 data)

3. **MECHANICAL ENGINEERING**
    - Automotive: the automotive division has made Emilia-Romagna world famous as the “Motor Valley”. Renowned brands have achieved the highest levels when it comes to quality, luxury and performance, thanks also to a widespread system of excellent suppliers and the innovation ecosystem. The transport vehicles sector shows a higher concentration of employees in the provinces of Modena and Bologna.
    - Engines and hydraulic components
    - Lifting and handling equipment
    - Boating
    - Packaging: the packaging division is an important regional specialization composed of design, manufacturing and trade of machinery, plants, apparatus and equipment in general for packing, packaging and refilling, in addition to design services, labelling, distribution and sales. The highest concentration of people employed is in the provinces of Bologna, Parma and Modena. Other districts in the sector are present also in the provinces of Reggio Emilia and Rimini.

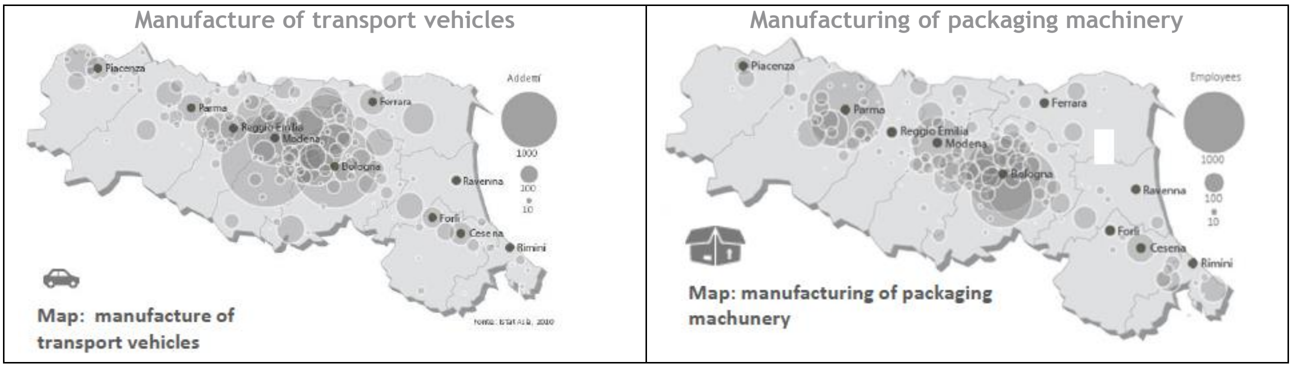


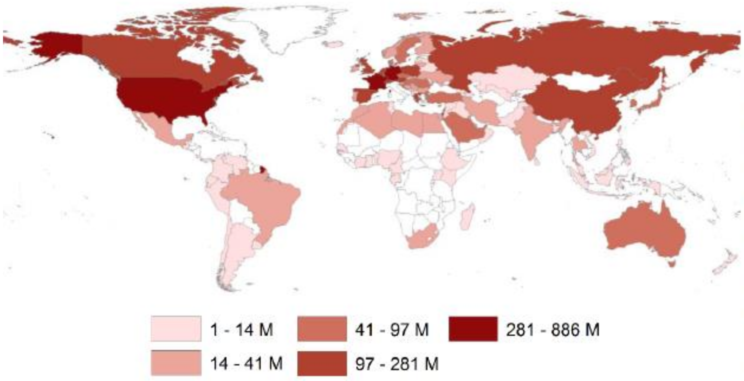
Figure 11 - Employed distribution of Manufacture of transport vehicles, Manufacturing of packaging machinery. Source: Art-ER, Ervet

4. **FASHION**
    - Footwear and leather goods
    - Textile and wearing apparel
5. **HEALTH CARE**
    - Biomedical
    - Pharmaceutical Products

6. CULTURE & CREATIVITY

- Creative, Arts and Entertainment Activities
- Media and Cultural Industry

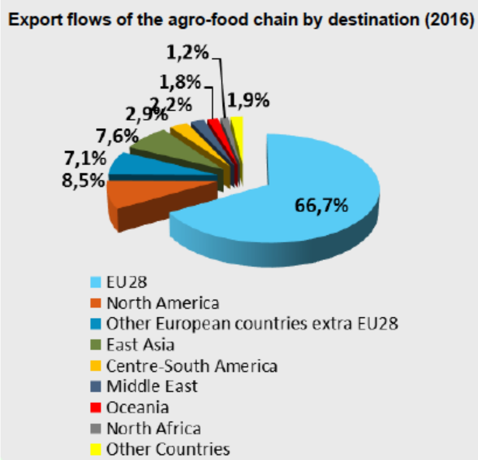
The regional housing sector is strongly export oriented with a balance of trade of more than 4 billion euros (5.6 exports minus 1.6 imports). There is a strong specialization in the ceramic sector (94% of the national total if we consider ceramics for building).



TOP 15 COUNTRIES	VARIATION 2008-18
France	6%
USA	39%
Germany	38%
UK	52%
Switzerland	14%
Belgium	13%
Spain	8%
Russia	-41%
Canada	38%
China	396%
Netherlands	24%
Austria	-28%
Poland	17%
Greece	-53%
Israel	160%

Figure 12 - Export data of regional housing sector (2018). Source: Art-ER, Ervet

In 2016 exports from the agro-food value chain in our region amounted to 7 billion Euros, 16.4% of the national total. The agro food sectors represent 12.6% of total exports from Emilia Romagna.
Emilia-Romagna mainly exports to the EU28 area which makes up over 68% of total exports from the cluster, followed by North America (8.5%), East Asia (7.6%) and Other European Countries extra EU28.



The top 15 importing countries in 2016 and variations in % terms compared with 2008

Country	Export 2016 (Euro)	Var.% (2016-2008)
Germany	1.235.663.143	16,9%
France	973.035.524	31,3%
USA	491.399.883	31,8%
UK	440.573.180	19,7%
Spain	314.167.326	16,8%
Netherlands	198.597.106	44,9%
Austria	190.171.681	25,8%
Switherland	172.868.506	52,1%
Belgium	166.946.637	34,6%
Greece	143.019.903	-18,0%
Japan	141.860.438	46,1%
Poland	137.956.500	27,7%
Sweden	130.410.209	52,3%
Denmark	106.469.805	26,8%
Canada	105.607.374	28,7%
World	**7.047.349.307**	**33,0%**

Figure 13 - Export data of regional agro-food sector (2016 data). Source: Art-ER, Ervet

The mechanical engineering sector is strongly export oriented (exports more than double of the imports). Balance of trade (2019) of more than 19.7 billion euros (exports minus imports). The whole mechanical engineering chain showed a growth of +30% in the period 2008-19, fully recovering the 2009 global financial crisis.

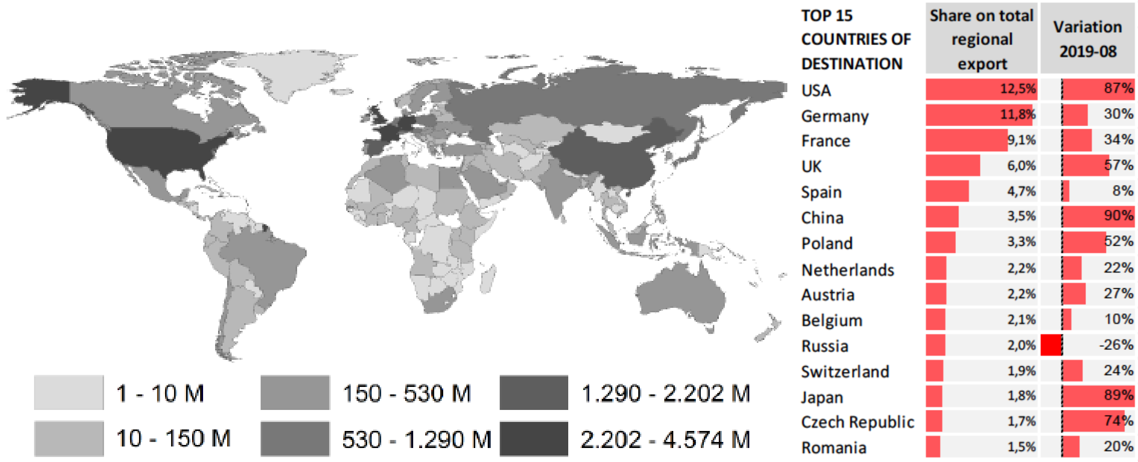


Figure 14 - Export data of regional mechanical engineering sector (2019 data). Source: Art-ER, Ervet

The values of exports (in millions of euros – 2018 data, source: Italian National Institute of Statistic (ISTAT) and local Chambers of Commerce) by individual provinces, and the related market shares by geographical area are shown in the tables below:

Table 6 - Export (in million Euros) by Emilia-Romagna provinces.

Province and activities	Tot export (mln €)
Modena	**12.956**
Machines and mechanical products	3.838
Automotive	3.343
Food industry	1.331
Textile industry	628
Biomedical	377
Ceramics and tiles	2.255
Other	1.186
Parma	**6.769**
Machines and mechanical products	2.606
Food industry	1.584
Pharmaceutical and chemical	1.516
Ceramics and tiles	332
Textile industry and leather	338
Other	393
Piacenza	**5.236**

Machines and mechanical products	2.652
Textile industry	1.315
Food industry	418
Chemical products	369
Other	482
Reggio Emilia	**10.722**
Machines and mechanical products	5.719
Food industry	619
Ceramics and tiles	1.092
Textile industry	704
Electronic	926
Other	1.662
Bologna	**14.547**
Machines and mechanical products	6.221
Textile industry	1.625
Automotive	2.480
Food industry	573
Electronic/electric	1.533
Chemical products	627
Other	1.488
Ferrara	**2.571**
Machines and mechanical products	780
Chemical products	758
Food industry	394
Other	639
Ravenna	**4.394**
Machines and mechanical products	879
Steel industry products	807
Chemical products	972
Food industry	722
Electronic/electric	448
Other	566
Forlì/Cesena + Rimini	**6.269**
Machines and mechanical products	1.279

Textile and leather industry	1.122
Steel industry products	677
Boats (shipyards)	545
Furnishings	652
Other	1.994

Table 7 - Export (main geographical areas) by Emilia-Romagna provinces.

Provinces and main geographical areas of export	% Export
Modena	
EU(28)	55,10%
USA	12,90%
Asia	12,10%
Other european	6,90%
Parma	
EU(28)	69,10%
Asia	12,73%
Usa	7,43%
Africa	4,06%
South America	3,86%
Piacenza	
EU(28)	65,70%
Asia	17,60%
Other european	11,70%
USA	4,50%
Reggio Emilia	
EU(28)	63,30%
Asia	10,70%
USA	9%
Other european	6,80%
Bologna	
EU(28)	51,20%
Asia	18,20%
USA	12,50%
Other european	8,60%
South America	4%
Ferrara	

EU(28)	58,80%
USA	17,60%
Asia	10,20%
Other european	6,40%
Ravenna	
EU(28)	65,50%
Asia	11,90%
Other european	7,90%
USA	6%
South America	3,40%
Forlì/Cesena + Rimini	
EU(28)	56,80%
Asia	14,90%
Other european	9,90%
USA	8,50%

The ceramics production cluster, located within the provinces of Modena and Reggio Emilia (Figure 15), is one of the most important in the region and constitutes an interesting element of study for the aspects covered by the project. In 2017 exports to Europe (EU28) amounted to approximately 189 million sqm, for a value of 2.651 million euros (source: Confindustria Ceramica). To the USA the figure is 53 million sqm and 872 million euros; to Asia 40.5 million sqm and 557 million euros.

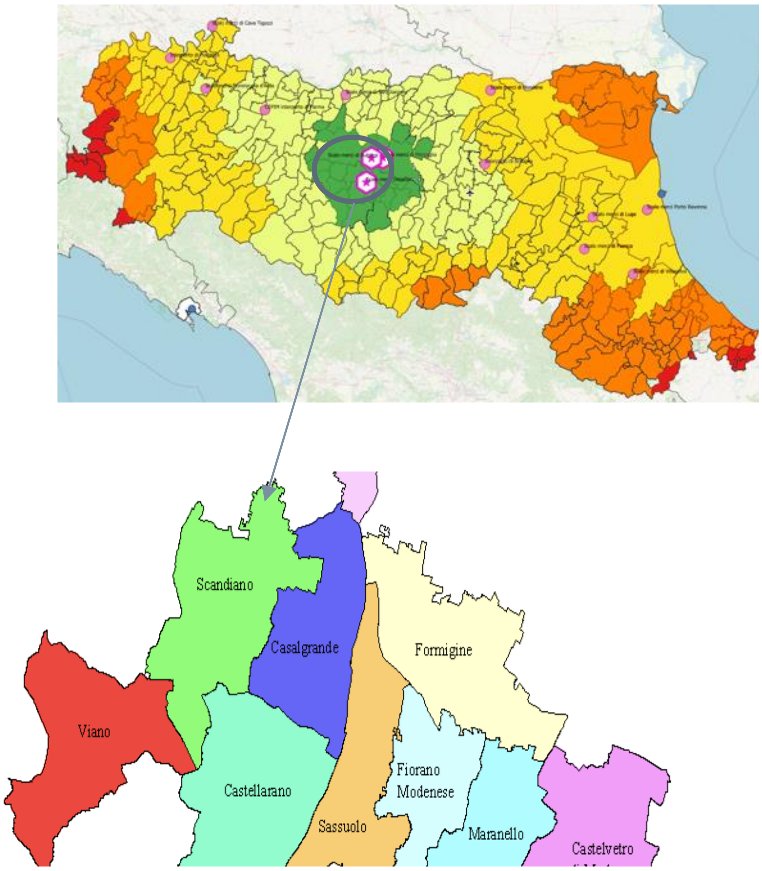


Figure 15 - *Ceramic production cluster*

Assuming an average weight of ceramic products of between 20 and 30 kg/sqm (i.e. 25 kg/sqm), the total amount of material exported to the EU is equal to: 4,722 million tons (towards USA about 1,320 million tons and towards Asia about 1 million tons).
Given the average load of an articulated lorry (20 tons), supposing to carry all the goods exported by road, a quantity of truck journeys to the EU of 236,250 vehicles/year would be necessary. On the other hand, assuming a complete modal shift by train, imagining to arrange the shipments in UTI, about 157,500 wagons/year would be necessary to satisfy this amount of rail transport demand. Alternatively, supposing trains departing from E/R, considering the line modules and the maximum weight limits at the border crossings, the estimated required supply would be about 9,000 trains/year (corresponding approximately to the current total yearly rail supply from the RER nodes).
The most recent figure (source: Confindustria ceramica) is that 24% of the total supply chain (raw materials supply + product distribution) is by rail. Clearly, most of this 24% concerns the supply of clays (mainly from the port of Ravenna and Germany, arriving at the intermodal node in Dinazzano, MO-RE nodes).
In 2018, regional nodes handled a total of 20.7 million tons, of which an average of 8-10% tiles and 25-27% sand and clay raw materials. It can therefore be estimated that 1.8-2 million tons of tiles were handled. That is, part of the export to the USA and Asia (from ports) and part of the EU export.
The main criticalities of the regional infrastructure system at the service of this productive cluster can be identified in: lack of "valuable" connections from the regional nodes to the EU reference basins and/or to the European ports; atomization of the nodes on the territory, useful for specific vocations (e.g. Dinazzano for incoming raw materials), perfect for reducing generalized costs of first/last mile access but narrowing the

opportunities of growth, as there are too many "small" nodes that cannot supply significant capacities. Connections from Rubiera (MO-RE node) to the ports of La Spezia, Livorno and Genoa are relevant but not sufficient, an increase intermodal shares to ports for non-EU exports is therefore necessary.

The tables in the following summarising the rail suitability of the main production chains and types of goods produced in the Emilia Romagna region are reported below.

Table 8 - Rail suitability of main production chains and types of goods

Goods (for regions)	High rail freight suitability	
	yes	no
ceramic products, tiles and clay raw materials	x	
furniture		x*
agricultural products and cereals	x	
meat and dairy products		x
food industry products		x*
footwear, leather goods, textile products		x
Machinery, engines, automotive industry products, lifting equipment, boats, agricultural machines		x*
biomedical and pharmaceutical products		x

(*) partly suitable

Table 9 - Rail suitability of Loading Units

Loading units (for ports and inter-modal nodes)	High rail freight suitability	
	yes	no
containers	x	
semi-trailers	x	
swap-bodies	x	

Table 10 - Rail suitability of industries

Industries/companies (for regions only)	High rail freight suitability	
	yes	no
Ceramic industry	x	
Food industry		x*
Automotive industry		x

Packaging and mechanic industry		x*
Fashion industry		x
Health care industry		x
Furniture and wooden products industry		x*

(*) partly suitable

On the basis of the assessments made in paragraph 2.2, the analysis of the data contained in the origin/destination matrices of the traffic models of the Lombardia and Emilia-Romagna regions shows that extra-regional nodes attract a significant share of freight traffic (heavy vehicles). In particular, the matrix of Lombardia shows that from a large part of the territory of Emilia-Romagna (excluding the provinces of Piacenza, Parma, Reggio Emilia and Modena) there is an average flow of about 240 heavy vehicles/day to the nodes of Milan, Melzo, Busto Arsizio, Mortara and Brescia. These are intermodal flows, directed to extra-regional platforms, which could potentially be oriented towards the nodes of the Emilia-Romagna region. In confirmation of this, as can be seen from Table 12, the daily flow of goods vehicles from all regional origins to the nodes of Emilia-Romagna is about 540 heavy vehicles/day, slightly more than double that expressed by only part of the region to the nodes of Lombardia.

The situation is much clear and can be easily understood by analysing the tables below, which are an elaboration of the authors from the O/D road freight matrices of Lombardia and Emilia Romagna regions.

Table 11 - O/D freight vehicles matrix (source: Lombardia region - traffic model https://www.dati.lombardia.it), values in heavy vehicles/day

DESTINATION ⇒ ORIGIN ⇓	BUSTO ARSIZIO	MELZO	MILANO SEGRATE + SMISTAMENTO	MORTARA	BRESCIA	MALPENSA AIRPORT	LINATE AIRPORT
PIACENZA AREA	19,79	10,94	13,59	3,29	3,99	9,89	0,48
OTHER EMILIA ROMAGNA AREAS	94,46	53,22	63,58	16,14	13,89	37,89	1,21

Table 12 - O/D freight vehicles matrix (source: Emilia-Romagna traffic model) values in heavy vehicles/day

ORIGIN ⇒	ALL EMILIA ROMAGNA
DESTINATION ⇓	N° HEAVY VEHICLES > 11 T
Bentivoglio (Bo Interporto)	9,00
Bondeno	37,67
Casalgrande (Dinazzano)	28,00
Faenza	47,33
Fiorenzuola d'Arda	16,33

Fontevivo (Parma Interporto)	30,00
Forlimpopoli (Villa Selva)	8,00
Guastalla	7,67
Lugo	6,00
Modena	153,67
Piacenza	183,33
Rubiera	14,67
TOT	**541,67**

Table 13 - O/D freight vehicles matrix (source: Emilia-Romagna traffic model) values in heavy vehicles/day

ORIGIN		**ALL EMILIA ROMAGNA**
DESTINATION		**N° HEAVY VEHICLES > 11 T**
Lombardia	A1 Milano	272,67
	A21 Brescia	144,67
	Cremona	85,00
	Lodi - Codogno	38,00
	Mantova	48,33
Veneto	A22 Verona - Brennero	180,33
	Padova	159,67
	Rovigo - Adria	16,00
	Venezia	171,67
Liguria	Genova - La Spezia	111,00
Piemonte	Piemonte	232,67
Centre - South Italy	Abetone	3,00
	Aulla	3,00
	E45	55,00
	Firenze	348,00
	Pesaro - San Sepolcro	338,33
	Pistoia - Pracchia	2,67
Totale complessivo		2210,00

One of the reasons for the Emilia-Romagna low performance despite good road accessibility and platform numerosity is the location of intermodal platforms with reference to the main road axes. In addition, some platforms are located along secondary railway routes which are often under-developed from the infrastructure point of view, with low capacity and often single-track and/or train-module limits. Just to name a few examples, the platform of Dinazzano - which is origin and destination to ceramics industries in the Modena district – is located along a single-track railway lines; platforms in Guastalla and Bondeno have scarce accessibility both from road and railway points of view. In addition, while secondary railway lines are less congested, main lines and their nodes are heavy congested at certain times of the day or all over the day; therefore, the supply is limited from the lack of connections and available time slots. On the positive side, the widespreading adoption of high-speed trains to some o/d connections (only on high-speed network) can have a positive impact on the supply and henceforth attractivity of regional nodes.

As measure of the regional potential market of the regional logistic nodes, the number of companies and the revenues that are located in their catchment area are shown. The catchment area is made by the municipalities of the region whose adjusted travel time on the road network to access each single node is lower than the threshold of 90', that has been identified as the limit within which a node is considered advantageously accessible by an economic activity (paragraph 2.2). In the table, only the production chains and type of goods that are identified as suitable, even partially, for the rail freight market has been considered.
Due to the overlap of the catchment area of nodes, a municipality can be included in more than one catchment. This is the reason why the sum of the number of companies and the revenues for a regional sector can be exceed regional values.
For example, almost 100% of companies and revenues of ceramics and tiles sector is located to the catchment area of Dinazzano-Marzaglia-Rubiera nodes (MO-RE), due to their strategic position with regards of the ceramic cluster. At the same time, high proportions are noted even for the catchment of Bologna Interporto node.

Table 14 - Number of Companies and revenues of the regional sectors of specialisation within the catchment area of the main regional logistic nodes estimated with the "adjusted" travel time (connectivity index). Revenues are expressed in millions of euros.

Node's Catchment		Agrofood	Chemical and plastic products	Ceramics and tiles	Wood and furniture	Machines and mechanical products
Piacenza	Number of companies	1.149	556	194	384	5.142
	%	64%	53%	79%	46%	58%
	Revenue	14.928	4.101	3.399	964	35.548
	%	59%	49%	76%	40%	57%
Parma	Number of companies	1.346	736	213	490	6.572
	%	74%	70%	86%	58%	75%
	Revenue	16.697	5.533	3.846	1.149	45.653
	%	66%	66%	86%	47%	73%
Dinazzano-Marzaglia-Rubiera	Number of companies	1.630	946	241	681	8.073
	%	90%	89%	98%	81%	92%
	Revenue	21.964	7.435	4.307	1.959	54.449
	%	86%	88%	96%	80%	87%
Bologna	Number of companies	1.475	972	232	741	7.975
	%	82%	92%	94%	88%	91%
	Revenue	20.489	7.647	4.268	2.016	54.019
	%	81%	91%	95%	83%	87%
Lugo	Number of companies	1.194	872	222	685	7.103
	%	66%	82%	90%	81%	81%
	Revenue	18.234	6.400	4.284	1.906	48.077
	%	72%	76%	95%	78%	77%
Villaselva	Number of companies	852	632	136	520	5.128
	%	47%	60%	55%	62%	58%
	Revenue	13.291	5.035	2.114	1.639	38.425
	%	52%	60%	47%	67%	62%
Tot. Number of companies in sectors of specialisation of Emilia-Romagna		1809	1058	247	842	8802
Tot. Revenue of companies in sectors of specialisation of Emilia-Romagna		25.411	8.427	4.488	2.433	62.367

3. Summary and recommendation

The analysis of the potential market was carried out by focusing on the supply of rail transport at the nodes of the regional logistics system, with particular attention to its accessibility and quality of supply. This aspect was simulated thanks to the use of a connectivity measure that "weighs" the value and frequency of connections offered by the nodes in the region compared to those offered by extra-regional nodes (in particular those in Lombardy, Veneto and Piedmont).

- The economic performance of Italy and Emilia Romagna region is not always suitable with railway freight transportation supply, as far as dimension limits of the final product, just-in-time delivery, and valuable/fragile/perishable items are involved. In addition to that, the average size of firms within Emilia Romagna is not a booster of railway intermodal freight transport
- Due to its shape, north-south displacements are prevailing against east-west displacements which are actually possible only in the northern part of Italy while in the centre-south the presence of the Appennines and the short distances make the railway transport not viable from the financial point of view.
- The Emilia-Romagna region has a logistics system rich in intermodal platforms, the use and development of which is often limited by sub-optimal accessibility, particularly in terms of connections offered in terms of quality and quantity;
- This last aspect is highlighted by the accessibility measure used in this work (par. 2.2), which shows a high attractiveness of the extra-regional logistic system (Lombardia, Veneto and Piemonte) compared to that of Emilia-Romagna. This element is also confirmed by the analysis of o/d matrices (traffic models of Emilia-Romagna and Lombardia);
- The differences that have emerged make an interregional policy approach aimed at cooperation between nodes, rather than competition, plausible. The potential freight demand basin generated by the Emilia-Romagna region is in fact such, in terms of volumes and values, as to generate massive traffic. Such traffic can find, for specific categories of goods with good rail suitability, a natural outcome towards intermodal transport if the combination of the generalized cost of access to the nodes (monetary costs and time) and the value of the connections offered is such as to minimize the disadvantages connected to this modal strategy.
- Italian nodes are peripheral with reference to the extension of TEN-T Corridors; thus, opportunities and interchanges are reduced in number. Nevertheless, four out of nine TEN-T corridors involve the Italian territory: of those only one extends its branches towards the Southern Italy, and two corridors link the main harbours of Geneva, Trieste, La Spezia, Livorno, Venice and Ravenna to the rest of Europe. This confirms the need to strengthen connections in order to integrate the regional logistics system more efficiently into the TEN-T network. On the other hand, unfortunately, vessel traffic in the Mediterranean basin is not so relevant in size if compared to Northern Sea and, what is more, it is scattered so that relevant and stable o/d connection from/to Italy are difficult to be sustainable.
- Connections between Italy and the rest of Europe are mainly present in those regions which have one or more national border crossings towards foreign countries (such as Friuli Venezia Giulia, Veneto, Trentino, Lombardia, Piemonte). Traffic originating in inland regions should therefore combine a reduced number of international connections with frequent national feeder connections towards

consolidation hubs, same-size and feeder platform to guarantee an adequate, connected and integrated supply of infrastructures (stock areas) within a coherent and effective framework.

- As a final consideration, it is necessary to highlight that all evaluations made on the accessibility of intermodal nodes are based on the measure developed in this work. This measure is based on the "correction" of the road access time to each freight node by means of a simply mathematical function that takes into account the actual supply of services present in it and their "value" (both in terms of frequency and destination), by means of a system of weights. Of course, the results obtained can significantly change if the function itself is modified, or if the system of weights considered changes, i.e. if the relative value of a type of connection is modified compared to the others. A possible modification of the function may take in account even the type of good moved at the nodes.

Annex

The rail freight potential market could be analyzed by means of a two-step approach, i.e. considering the interaction between demand and supply. The demand, on one side, is drawn by the characteristics and structure of the industrial clusters, the market and logistic development and trends and the surrounding framework of regulations and economic/political conditions; the supply, on the other side, is given by the transportation systems opportunities (infrastructures and services) available in the considered area.
If we focus in detail on the transport supply system, the first thing we need to highlight is the factors that determine the modal choice in the freight market:
1) characteristics of goods (bulky, liquid/solid, fragile, perishable, heavy, high/low unit value...)
2) attributes of the service requested, closely related to the characteristics of the relevant market (intermediate or final)
3) types of cargo and shipments (frequency, distance, unit quantities shipped, packaging...)
4) generalised cost (combination of time and monetary costs, including any transhipments, for the actual transport chain)
5) specific aspects related to the shipper's preference for a certain mode of transport (green logistic)

Following the diagram in the figure below, the components of the supply subsystem are represented by:
1) rail (intermodal) freight supply system. This component contains the set of networks (arcs and nodes) and services (links, interchange and handling services at nodes, additional services);
2) service level, accessibility and performance. These elements characterise the overall quality of the service offer and the actual possibility to access it;
3) rail suitability. This is a qualitative indicator that expresses the orientation of a certain type of goods towards the rail transport mode (in terms of the matching between the attributes of the service offered and the required performance thresholds, in particular with regard to safety, security, perishability, fragility, the need for particular timing or flexibility of service).
These components are fully interconnected: the potential rail freight market cannot in fact be defined only by the suitability of a certain freight to this transport system, but necessarily also by the accessibility to these services (i.e. to intermodal railway nodes) and above all by the presence of connections considered advantageous (in terms of frequency and type).

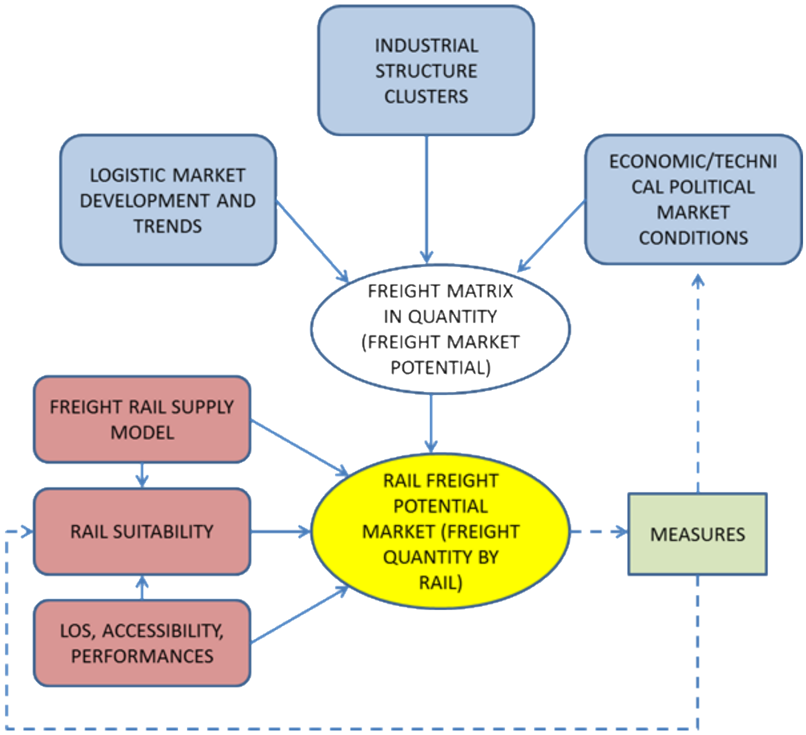


Figure 16 - Two-step approach of analysing (rail) freight potential market; Source: ITL