BEST PRACTICES EXCHANGE IN SEA–RAIL INTERMODALITY: A CASE STUDY OF THE PORTS OF İZMIR, TURKEY AND TRIESTE, ITALY

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ABSTRACT
Benchmarking and best practices derivation is a traditional and consolidated approach in transport planning. Less frequent is the use in the design of ports' masterplans and intermodality promotion in coastal cities, where the connection between the development of ports and local economy and the quality of the environment is stronger. Rail transport is essential for the development and efficiency of a port as it enhances economic importance and competitiveness. It also provides faster movement and higher port capacity, thus affecting the total throughput, which is a fundamental productivity measure of a seaport. This paper aims to depict a roadmap for the increase of rail modal share in ports' areas by identifying the most promising operational and infrastructural actions derived by recognized best practices. The case study described in the paper is about the exchange of best practices between the ports of Trieste and İzmir. For many years, İzmir has been an important container port in Turkey. However, its total throughput has decreased dramatically in recent years while its competitors, both in the Aegean and Marmara regions, have been developing their business rapidly. Considering that the owner and operator of the port are Turkish State Railways, the port of İzmir currently has quite a low rail share, which was less than 10% in 2021. This decrease is mainly due to an unsuitable infrastructure and poor coordination with the railway network. This paper exemplifies how it would be possible to increase the rail modal share of the port of İzmir by defining the necessary actions and redesigning the rail infrastructure. This can make the port of İzmir an effective alternative to solve the massive congestion problem of the Marmara region (Istanbul) ports, affected by morphologic barriers. Here, the port of Trieste will be the reference port as it has the highest rail share (50%) in Italy. Its current state and future targets will represent the best practice to increase the rail share in İzmir. Since almost half of the Turkish maritime freight directed to Europe is via Trieste, similar percentages on the Turkish side can strengthen the sea–rail intermodal connection between these port cities.
Keywords: sea–rail intermodality, port connectivity, railway terminal, port of Trieste, port of İzmir.

1 INTRODUCTION

Maritime transport has the highest mass carrying capacity and the lowest unit cost. This is the reason why the share of maritime transport in global trade is around 90% in volume and 70% in value. When the huge competition in seaborne trade is considered, being a *port city* is one of the most significant advantages. The *Global Cities Analysis* report published in 2019 by Oxford Economics, estimates the growth of 900 cities in the period 2020–2035. According to this, eight of the top ten cities expected to show the highest growth performance in the world were port cities [1].

In the European combined transport market, the use of intermodal load unit (ILU) shows a strong tendency toward containers, which account for about 62% of the whole market. The remaining market shares are almost equal between semi-trailers (21%) and swap bodies (17%) [2]. Thus, due to the attraction of container growing flows, it has become easier in the ports to organise efficient transport by rail only [3]. According to The European Commission White Paper, two alternatives to all-road freight transport are credible: rail transport and short-sea shipping (Fig. 1). In this context, Europe is considerably dependent on seaports.

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There are more than 300 active seaports in the continent; at least 130 can handle containers, of which around 40 have intercontinental container services [3].

In this paper, after getting fundamental information on maritime in Italy and Turkey, the focus is on one of the most important Italian ports to understand how to design an ideal sea–rail intermodal network. Having more than 50% rail modal share, the port of Trieste is one of the best case study in Europe. Moreover, it has also relevant maritime traffic with Turkey. After giving some more details about trade relations between those two countries, the ports of Trieste and İzmir, the last part will be clarifying what should be in İzmir to increase the rail share and be in connection with Trieste by sea–rail intermodality. Since Turkey (326 million t) and Italy (287 million t) are the top two countries in short sea shipping in Europe (Fig. 1).

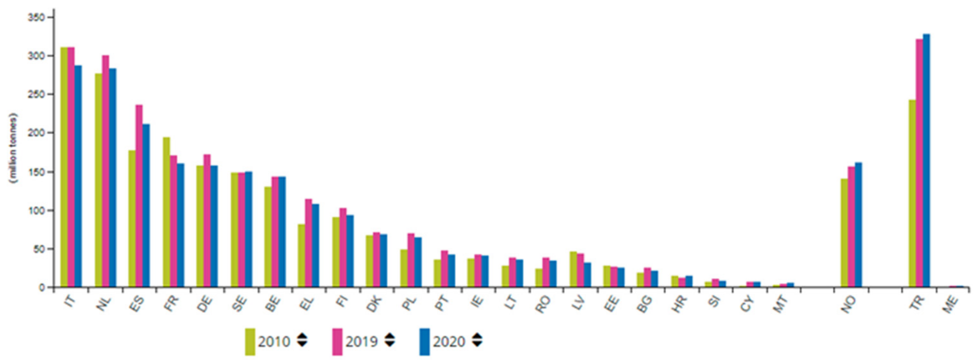


Figure 1: Short sea shipping of freight in million tons in Europe. (*Source: Eurostat.)*

2 TRADES IN MEDITERRANEAN AND POSITION OF ITALY AND TURKEY

South-east Asia and the Far East is the most crucial region regarding the number of connections [4]. Reaching the Mediterranean area from those regions, The Suez Canal plays a strategic role for global shipping as 9–10% of international trade uses it. The Mediterranean is a privileged transit route as it accounts for 27% of the 487 global liner services. This fact is also strongly affecting the ports around [5].

Turkey and Italy are important trade partners with high export and import values every year. According to 2021 data, Italy is the fourth country in export with around 11,473 million USD, while the fifth country in imports with 11,562 million USD. In the case of Italy, the trade volume between Italy and Turkey is around 17 million EUR, except for 2020, due to the pandemic restrictions.

In maritime transport between Italy and Turkey, should play an important role the port of Taranto, as one the main Turkish company, Yılport Holding, in 2020 signed a 49-year concession agreement with Port Authority of the Ionian Seaports. Taranto is the final node of the rail terminal of the Scandinavian–Mediterranean Corridor, connecting this corridor also to Valletta, Malta [6].

2.1 Overview of maritime and railway transportation in Italy

Italy is Europe's fourth largest economy and a founding member of the European Union. The country has a strong export structure and its global competitiveness, expertise superiority and innovation in significant sectors have created the *Made in Italy* brand [7]. Moreover, Italy is located in southcentral Europe, shaped as a peninsula into the Mediterranean Sea, with 7,500 km coastline [8].

Italian ports are more favourable than northern ports, especially considering navigation time from the Far East, which is about five days less than to northern range ports. The most important Italian ports (Fig. 2) can group as Ligurian ports (Genova, La Spezia, Savona, and Livorno), north Adriatic ports (Trieste, Ancona, Ravenna, and Venezia), Campanian ports (Napoli and Salerno), hub ports (Cagliari, Gioia Tauro and Taranto) and others, such as Civitavecchia, Bari, Trapani, Catania and Palermo [5]. Ligurian ports are the most convenient for Switzerland, while Adriatic ports for southern Germany and central-eastern Europe [4].

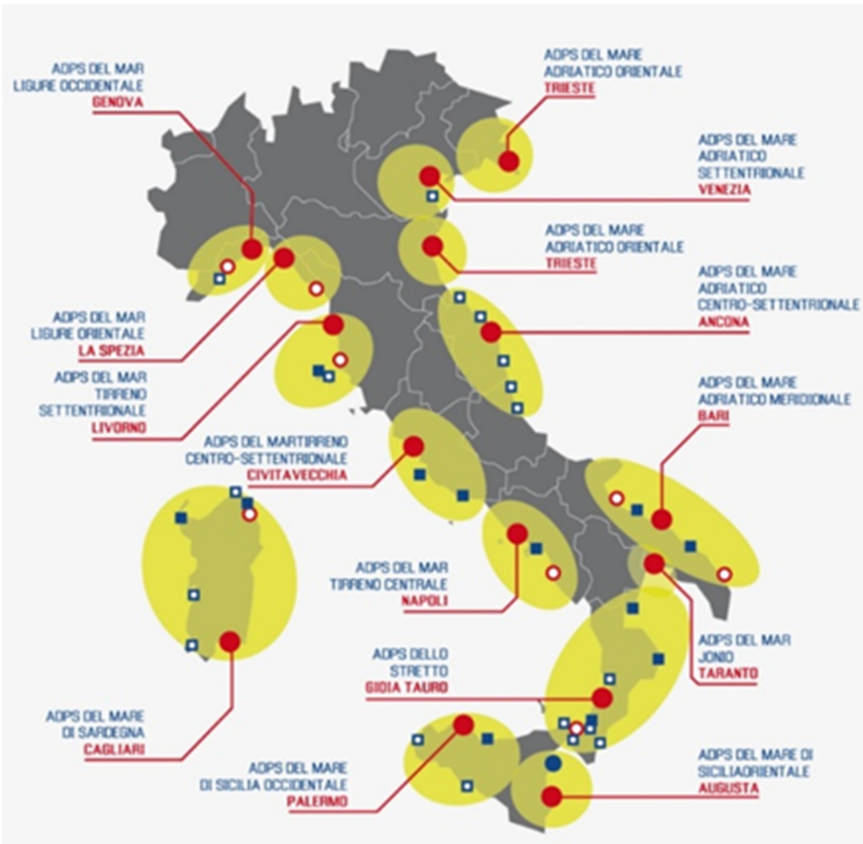


Figure 2: Italian port authorities.

There are many rail connections in operation from Italian ports, mainly from Trieste, La Spezia, Genoa and Livorno. However, still, companies are using intermodal connections marginally. The 81% of companies prefer road connection, while 19% uses a road and railway combination. The lack of rail infrastructure connected to the ports is one of the reasons for this trend [5]. Trieste registered more than 50% rail modal share; La Spezia is around 33%. Only these ports have comparable rail share with north European ports (e.g., Hamburg). The leading Italian port regarding domestic rail connections is La Spezia; meanwhile Trieste is dominating for international connections [9].

2.2 Overview of maritime and railway transportation in Turkey

Turkey is a transcontinental country between Europe and Asia. The country is geographically a peninsula with 8,333 km coastline. The maritime transport milestone in Turkey is the Treaty of Lausanne, signed in 1923 and providing the right to cabotage. In addition, Montreux Convention, signed in 1936, gave the sovereign rights of Bosporus and Dardanelles.

Maritime transport is the leading mode having around 95% share in imports and 81% share in exports in 2019. Road transport share tends to decrease in export, in parallel with the increase in maritime transport and railway, which has a share of about 1% for both import and export.

Thirteen ports have rail link in Turkey (Fig. 3), namely Haydarpaşa, Derince, İzmir, Bandırma, Mersin, Samsun, İskenderun, Tekirdağ, Zonguldak, Yılport, Evyap, DP World Ports and Nemport. Among them, the Turkish State Railways (TCDD) own and operate Haydarpaşa and İzmir, meanwhile the others became private.

Figure 3: Ports and freight villages in Turkey with rail connections.

The 5,743,455 TEU handled in 2010, more than doubled in 2021 and became 11,759,484 TEU (464,405,662 t) in Turkish ports in 2021. Again, in 2021, the highest amounts of cargo handled in Turkish ports, almost 39 million t, on 62 million t, was to Italy. Considering container transport in 2021, Italy is the fourth country in container handling with 630,837 TEU after Greece, Israel and Egypt with more than 1 million TEU (General Directorate of Maritime Affairs of Turkey).

The current traffic level between the European and Asian sides causes enormous delays and difficulties for Istanbul. Unfortunately, there is an irregular port development in Turkey caused by the private port investments, considered a rapid response to container demand to compensate for the inadequate capacities of public ports. As a result, it can become detrimental to the efficient distribution of resources by causing overlapping investments [10].

Fig. 4 shows the amount of goods, which the Marmara, Aegean and Mediterranean Sea attracted between 1989 and 2016. There is a notable increase in the Marmara Sea comparing Aegean and Mediterranean ports. Turkey's busiest ports are concentrated around Istanbul and the Marmara Sea. Marmara is the region with the highest amount of cargo handled with 40% in 2020, followed by the Mediterranean region with 35% and the Aegean region with a

16% share. Therefore, it is vital to shift a part of this traffic to other ports of the country to support regional development [10].

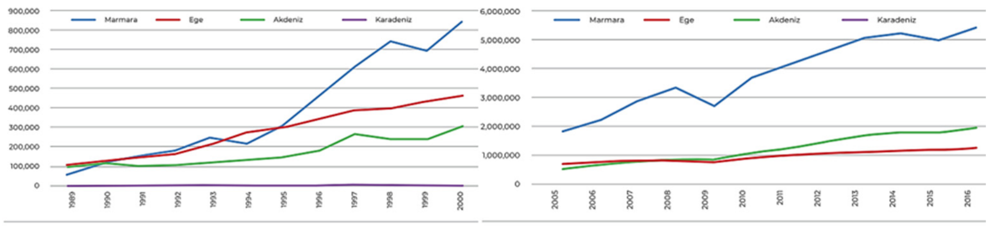


Figure 4: Container transport in Marmara (blue), Aegean (red) and Mediterranean (green) Sea in 1989–2000 and 2005–2016 (TEU) [10].

Italy is one of the first trade partners of Turkish ports and Turkey is the same for Italian ports, especially for port of Trieste. In this context, shifting some Turkish freight from Trieste to İzmir port in TEUs and using railways already connected with the hinterland serves this purpose. While freight transport by road over the years cannot shift to railway, it continues to take the least share, 4% in total and 1% international in 2020. International rail links by land are Bulgaria, Greece, Georgia, Armenia, Iran and Syria. Links with Armenia and Syria do not provide service in the current situation. There are several difficulties concerning international rail freight transportation mainly related to modernization works/constructions and security problems at the eastern border.

3 THE PORT OF TRIESTE

Trieste is a port city in north-eastern Italy and towards the end of a narrow strip of Italian territory lying between the Adriatic Sea, Slovenia and Croatia [11].

The port area is about 2.3 million m^2 (about 1.8 million m^2 of free zones). The length of the docks is 12 km with 58 berths. The maximum depth of water is 18 m. The total length of internal rail track is 70 km connected to the national and international network, aiming to serve shunting and/or assembling freight trains directly in the terminals. The port is in operation 24 hours/day, 365 days/year. The port operator is Adriafer Srl, company setup by the Trieste Port Authority. It is the only operator allowed at moving wagons and trains and organize the rail operations within the port. The Alpe Adria Spa is a multimodal transport operator that coordinates road, rail and sea carriers to organize and handle intermodal and combined transportation. The company runs a wide network of links between north-east Italy and central/eastern Europe. It has strongly developed in intermodal container transport and combined road–rail transport (Ro-La) [12], [13].

The port of Trieste is having the advantages of the special regime of free zones and a natural water depth up to 18 meters and ease of access for vessels. Intense road and rail links, regular ocean transportation services to/from China, India and the Far East takes competitive advantage in serving the markets of central and eastern Europe by saving more than 2,200 miles (more than four days sailing at 20 knots): Suez–Trieste distance is 1,300 miles, while Suez–north European ports distance is about 3,500 miles [13].

In 1719, the Austrian Emperor Carlo VI established The Free Port of Trieste. The 1947 Paris Peace Treaty and the Memorandum of London in 1954 gave an extra-territorial status and created the Free Port of Trieste's regime. Since then, customers can benefit from special conditions for import, export and transit operations, fiscal regime and customs procedures.

An EU Free Zone is not comparable to Trieste's Free Port because its regime is born from an international Treaty signed before the EU's existence. Thus, many of Trieste's Free Port benefits are not available in the EU Free zones [14]. Examples are free access granted to ships, trains and trucks of all flags, preferential maritime duties not chargable by Italian taxes, no time limit for freight storage, no customs formalities and duties, low harbour duties, simplified transit and custom systems in transit to outside of Italy; permitted free manipulation of goods (packaging, repackaging, labelling, sampling, eliminating brands, etc.) [15]. Foreign rail carriers can operate in the port of Trieste without limitations and non-EU trucks can be driven inside the Free Port area freely. If directed to a foreign country, they can reach the border (e.g. Austria or Slovenia) with a temporary permit. For instance, due to the limited number of annual transit permits provided to Turkey by the Italian government, the Trieste free status is a key attraction for Turkish operators as trucks are not subject to national quota restrictions [16].

Main terminals are Pier VII (TMT) which is a container terminal with the deepest natural draft of the Mediterranean Sea (18 m at the berth). Most of the traffic is currently concentrated at this terminal. On the five rail tracks of 600 m each, operate three rail-mounted stacking cranes able to work on up to five trains simultaneously. Pier VI (EMT) with drafts 9–10 m. The terminal has four rail tracks. The primary Ro-Ro connections leave from Pier VI of Trieste heading to Pendik and Ambarlı operated by EKOL. Pier V (SAMER/DFDS) is the main Ro-Ro terminal that can host three vessels simultaneously with a 12 m natural draft. It includes a renovated section devoted to rail operations featuring a rail-mounted stacking crane able to operate on four 310 m long tracks. This is the terminal with most of the Turkish freight traffic. Among other operators, SAMER is a specialist in ISU transport [11], [14].

Figure 5: Structure of the port of Trieste [11].

The port of Trieste is in connection with to the national railway line, thus to the TEN-T networks, through the following nodes (Fig. 6): Campo Marzio, Servola and Aquilinia [11]. Concerning shunting operation in the terminals, trains have normally two sections because of the tracks' limited length (550 m). These two parts join again using the shunting locos on one of the 750 m long six tracks after waiting on dedicated sidings. Currently, two locomotives and two Zephyr vehicles are available for this shunting operation [12].

Connected to the Brennero railway line through Tarvisio and located close to rail lines directed to Ljubljana and Zagreb, Trieste stands out 52% of the full containers passing by train in 2017, while it was 30% in 2016 for 8,911 trains in 2019, according to AdriaFer data.

Figure 6: Railway infrastructure at port of Trieste: shunting area (green) and Campo Marzio station (RFI) (blue). *(Source: AdriaFer.)*

In the case of Ro-Ro traffic, the Turkey strategic relationship with Trieste created in the last decades represent the Mediterranean's busiest Motorway of the Sea. The mean value of sea distance is around 50% of land distance [17]. In 2020, approximately 60% of the Ro-Ro traffic of Trieste is linking Pendik, Yalova, Ambarlı, Mersin and Çeşme.

According to Torbianelli [18], during the early 1990s, when there was the Yugoslavian crisis in Balkan countries, Trieste–Istanbul relations became critical to maintaining the traffic. Considering the difficulties of motorway transportation passing through Serbia and Croatia, the maritime route got primary importance to prevent war [18].

In 2021, the port of Trieste ranked first among Italian ports for total throughput with about 55.4 million t. By looking at Fig. 7, the growing trend of port of Trieste is evident, in both t and TEUs. This trend requires upgrades, especially in the fields of capacity. Network's ability to withstand traffic increases of 15–20% each year is a challenging issue, makes mandatory planning infrastructural upgrades and uses the potential of new technologies and communication systems to optimise the use of existing infrastructures [19].

When growing intermodal demand concerned, the port faces several challenges related to efficiency and connections. Namely, upgrade of the railway infrastructures, optimizing existing infrastructures through ICT tools, and working with the other ports [5]. The railway traffic of the port has grown significantly and the traffic demand will keep growing in the following years according to the trend. Thus, the principal investments in infrastructures aim at increasing the total capacity for handling goods, with particular focus on railway capacity and intermodality [19].

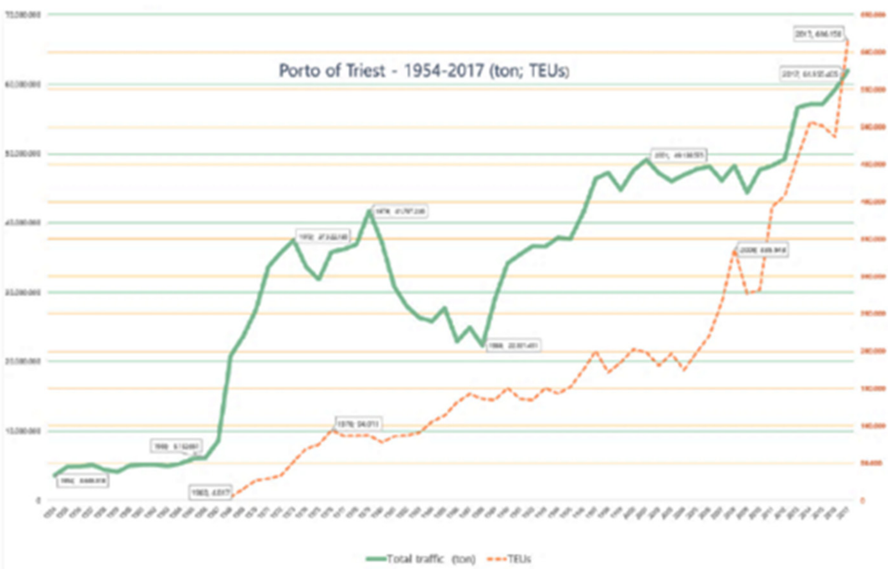


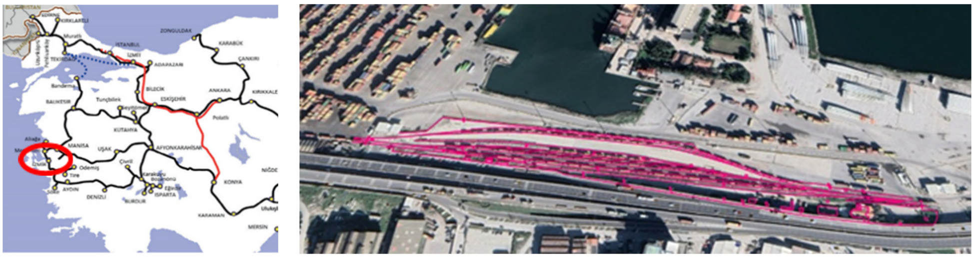
Figure 7: Traffic at port of Trieste 1954–2017 [20].

There are also challenges related to shunting operation, such as the not automated marshalling yard causing delays and posing higher risks to safety due to potential human errors, require renovation and optimisation [12], [19]. However, upgrading infrastructure is a long-term goal that expected to be completed within 5–10 years. Meanwhile, the port of Trieste aims to use IT solutions to increase the railway capacity by making administrative operations faster and automated [19]. In this context, the Global Project (2018–2025) Trieste RailPort, co-funded by the CEF Programme, consists of strengthening and adapting to significantly increasing trend the traffic at the port, which aims to further growth from about 10,000 up to 20,000 trains/year [20].

4 THE PORT OF İZMIR

İzmir is an old city at the west shore of Anatolia Peninsula and it was always an important port city (Fig. 8). Recently, it has been an important container port in Turkey for many years, owned and operated by the railway infrastructure manager TCDD. The capacity is 1,025,000 TEU, 4.6 million t of general cargo and dry bulk and 372,000 Ro-Ro vehicles per year. The depth of the water is 10–12 m at the approach channel and 6–11.5 m at the berths. Moreover, there is a difference of 2 cm between the designed depth and the existing depth due to shallowness. [2], [21], [22]. The distances by rail from İzmir to its hinterland are: 884 km to Istanbul, 824 km to Ankara, 1,167 km to Edirne, 133 km to Aydın, 67 km to Manisa and 264 km to Denizli.

In recent years, its total throughput has decreased dramatically after 2008 financial crises while its competitors, both in the Aegean and Marmara Region, have been developing their business rapidly. It could not recover its business after 2008 because of several factors mainly related to congestion, growing vessels sizes and new competitors [2], [21], [22]. In 2008, the port of İzmir reached the 891,701 TEU container throughput and it was the highest container handling port in Turkey. This number decreased over the years and had dropped to 517,376 TEU in 2021.



(a) (b)

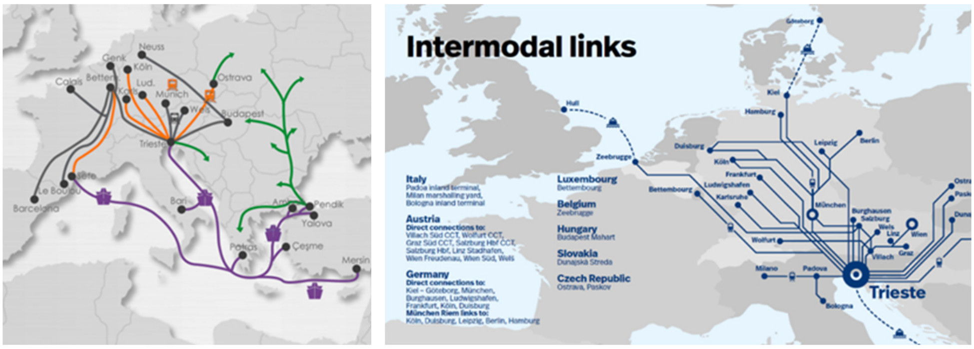
Figure 8: (a) Rail network in the West of Turkey; and (b) Satellite image and existing rail infrastructure of port of İzmir. *(Source: TCDD.)*

There are several reasons for this loss but mainly related to the draft problem, its position in the city and connectivity of the port. The approach channel and berth depths are not adequate for the entry of big vessels. Moreover, the port located in the city centre that affects its connections quite negatively since the primary mode of transport is the road. According to 2021 data, port of İzmir had a 9.29% rail share (12.77% unloading 5.87% loading) in total 9,215,988 t and 53,549 wagons. The rail share was 18.74% in 2016 and this decrease is due to infrastructure and poor coordination of the railway network. The most significant impact is that the processing and delivery of cargo through the railway is highly inefficient due to delays, which affects the punctuality and the cost. Also, most of the port equipment has completed their economic life. The automation system, modernized in 2013, is a quite old equipment, incompatible with more modern automation systems [23]. Another reason is the privatization process caused, which brings the port of İzmir to face a severe cargo loss due to the inability to make the needed investments. This process took ten years until removed from privatization program but caused delays in dredging works as well as the ageing superstructure elements, then shifting the new investments to Marmara Sea [2].

5 SEA–RAIL TERMINAL DESIGN FOR PORT OF İZMIR

The rail terminal's general structure has transhipment tracks under a rail crane. The transhipment track is a rail track served by handling equipment. There are also waiting and driving tracks. If there is no space in transhipment, tracks or trains need to wait for departure to the existing intermodal network (Fig. 9). The driving track connect them to the network and the transfer points for yard trucks are at the side of transhipment tracks (Fig. 10) [24].

When a container ship calls to port and moors at the quay, containers onboard are subject to unloading and storage at the port until their forward by rail or road. The containers are unloaded into the marshalling area and wait to move to the storage areas or trucks for the transfer to the multimodal terminal by trucks to the intermodal terminal or directly to the hinterland [24], [25]. The number of transhipment tracks determines the maximum number of trains that can stay in the handling yard simultaneously. The operational capacity of shunting locomotives determines the number of operated trains. The connected railway marshalling station determines the shunting capacity [26]. The preferred access to terminal is organised from both ends; however, many terminals have dead-end tracks, such as Trieste and İzmir [27]. The capacity of a station defines as the maximum number of trains the station can process and perform, such as stops, overtaking manoeuvres and exit the station [26].



(a) (b)

Figure 9: (a) Intermodal connections of the port of Trieste [11]; and (b) Intermodal links of a major shipping company working between Turkey and Trieste. *(Source: EKOL.)*

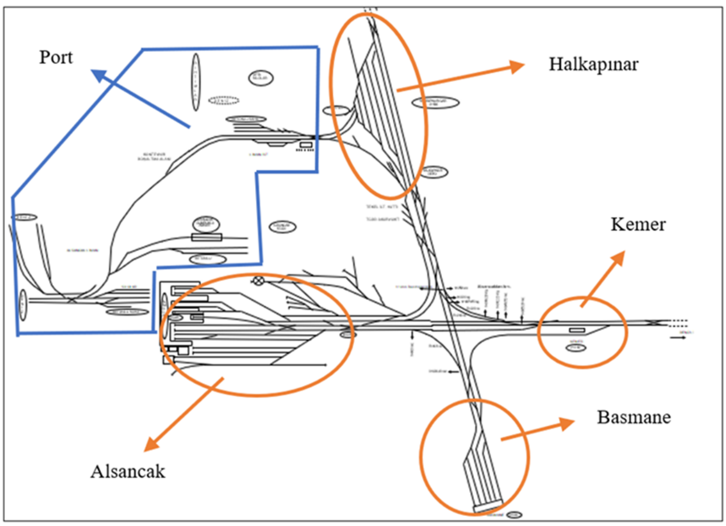


Figure 10: The existing rail infrastructure of port of İzmir and closest stations (Alsancak, Basmane, Halkapınar and Kemer). *(Source: TCDD.)*

The development of container sea–rail intermodal transport of port of İzmir is relatively backward comparing to its competitors (Fig. 11). This part of the paper will address a case study for designing a new rail terminal to increase the port's rail share, thus improving sea–rail intermodality. The design proposal includes analytical calculation, according to the transport requirements of the port, to estimate the design parameters: number of transhipment tracks and cranes and the traffic flow inside the rail terminal [24], [28].

The rail terminal capacity is 1,025,000 TEU/year. Aiming at 50% rail share, the total throughput requirement of the rail terminal is 512,500 TEU/year. Table 1 indicates the

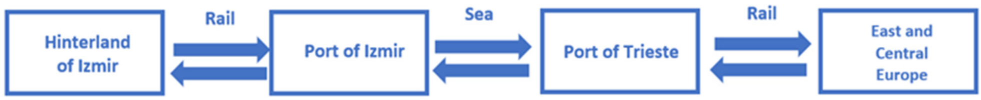


Figure 11: The suggested transportation model.

Table 1: Formulas and constant parameters for determining the values of design parameters.

Notations	Description
$Avan$	Effective handling capacity of a crane per hour $Avan = Tvan \times \eta T$
CV	Transport requirement in the number of containers (van) $CV = \frac{CTEU}{TEUf}$
Cea	The number of cranes required (design parameter) $Cea = \frac{CV \times Fp}{Avan \times Wd \times Wy}$
YHC	Handling capacity of cranes per year $YHC = Avan \times Wd \times Wy \times Cea$
DHC	The number of loading and unloading containers per day $DHC = \frac{CV \times Fp}{Wy}$
THC	Handling capacity of a crane per day $THC = Avan \times Wd$
Chf	The average number of handlings per container $Chf = DL + \{(1 - DL) \times 2\}$
$Trteu$	The loading capacity per train (TEU) $Trteu = NR \times 2(TEU)$
$Trvan$	The loading capacity per train in the number containers $Travn = \frac{Trteu}{TEUf}$
$Trhc$	The handling capacity of a crane (in TEU) per hour $Trhc = TEUf \times Avan$
$Trht$	Loading and unloading time per train by a crane $Trht = Trteu / Trhc$
$Trtot$	Total service time per train by a crane $Trtot = Trht + Trot$
$Ddtn$	The number of trains per day that arrive at the rail terminal $Ddtn = \frac{DHC}{Trvan}$
Dtn	The number of assigned trains per day per track $Dtn = \frac{Wd}{Trtot}$
$Dntn$	The required number of transshipment tracks (design parameter) $Dntn = \frac{Ddtn}{Dtn}$
Ct	Theoretical cycle time of the crane
$Tvan$	The handling capacity of the crane per hour $(1/C_t)$
ηT	The utilization of the crane
Wy	The number of workdays per year
Wd	Working hours per day
$TEUf$	TEU factor to convert the number of containers to TEU
$CTEU$	Transport requirement per year (TEU)
Fp	Peak factor
DL	Ratio of the direct transportation
NR	The average number of wagons per train
$Trot$	Time for the locomotive operations

Table 2: Input values of constant parameters [25].

Notations	Input values
Ct	82.3 s
$Tvan$	43.5 TEU/h
ηT	0.45
Wy	365 day/year
Wd	24 h/day
$TEUf$	1.48
$CTEU$	512,500 TEU/year
Fp	1.25
DL	0.6
NR	20

Table 3: Design parameters of the rail terminal.

Notations	Output values
Cea	3 cranes
YHC	517,716 TEU/year
DHC	1,186 TEU/day
$Ddtn$	44 trains/day
Dtn	10 trains/day/track
$Dntn$	5 tracks

numerical formulas for estimating the values of design parameters. Table 2 includes the input values of constant parameters. Table 3 summarise the numerical results and Fig. 12 the layout of the transhipment terminal. According to this analytical approach, the rail terminal needs a

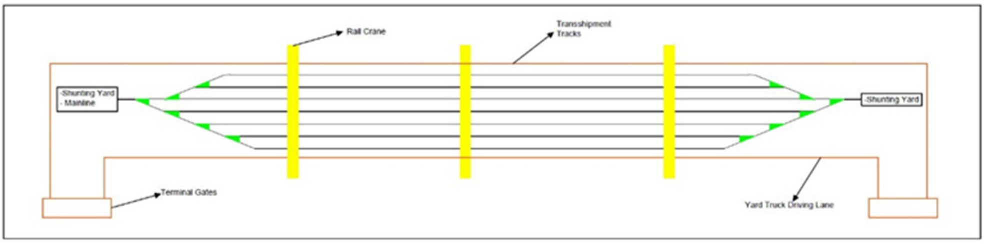


Figure 12: The layout of proposed sea–rail intermodal terminal for port of İzmir.

minimum of three rail cranes and five transhipment tracks to meet the planned capacity and performance. Two more transhipment tracks would allow at possible future growth of the handling requirement and holding. There are two gates for yard trucks to enter and, because of insufficient areas for standard 750 m tracks, the designed layout composed of 550 m tracks.

According to the TCDD network data, the capacity of Halkapınar-İzmir port is 40 double trains with double track, signalized at 3 km distance, the capacity of Basmane-Kemer stations is 40 double trains with single track, signalized at 1 km distance.

6 CONCLUSIONS

This paper underlined how important sea–rail intermodality is for countries with peninsular morphology, like Turkey and Italy. Nevertheless, looking at the rail modal shares in sea–rail intermodality, it is self-evident that Turkey needs to invest in the rail connections of the ports. Analysing port of Trieste was also crucial for several reasons. First, it is the port with the highest rail share in Italy and has been highly invested for this purpose. Secondly, it receives the highest amount of Turkish maritime freight, mainly directed to Europe. Almost all of them is coming from the Marmara. Moreover, almost all the freight is arriving at the Marmara ports by road. The suggested solution in this study is receiving containers from port of Trieste and then directed to the hinterland by rail from the rail terminal of port of İzmir and vice versa. With realizing this target, trade between ports of İzmir and Trieste is affordable with 50% by rail from both sides. Because a rail modal share under 10% is not acceptable for TCDD.

To increase the rail modal share of port of İzmir, the aim was to achieve the rail terminal dimensioning by an analytical approach. Consequently, constructing a rail terminal with three rail gantry cranes and seven transhipment tracks will make it possible to have a 50% rail share. For further research, the capacity of storage and parking areas, shunting and station capacity of closest stations to reach hinterland (e.g., Halkapınar and Basmane) as well as the technology of gantry cranes need to be determined because these factors also influence rail performance and are difficult to reverse.

Finally, the reason of planned investments for port of Trieste was its rapidly increasing demand. In contrast, the necessary investments in port of İzmir are due to its dramatic cargo loss.

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