REPUBLIC OF TÜRKİYE
MINISTRY OF INDUSTRY
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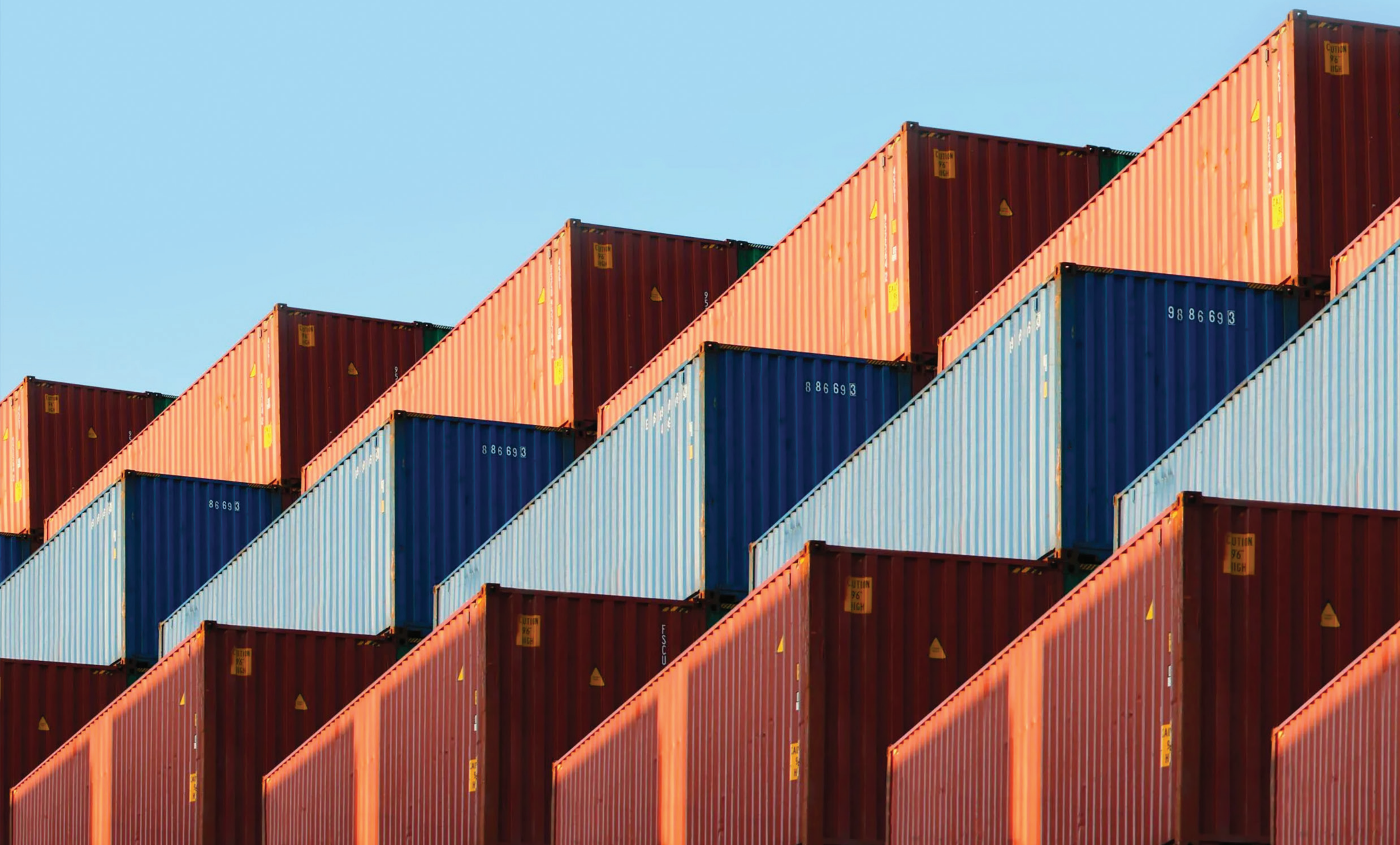
İZMİR
DEVELOPMENT
AGENCY

CURRENT SITUATION ANALYSIS AND
DEVELOPMENT PERSPECTIVE
OF THE PORTS OF İZMİR

CONCEPTUAL BACKGROUND



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RESENTATION

Dating back to 3000 BC, the story of the Port of İzmir continued with İzmir's transformation into a city of ports and trade, becoming more significant day by day with the impact of the economic developments in Europe in the 17th century on the Eastern Mediterranean trade. As the rapid economic developments in Europe since the 17th century started to show its effects on the Eastern Mediterranean trade, which revived the trade at the port, İzmir turned into one of the major trade centers of the Eastern Mediterranean as of the 17th century. After gaining momentum throughout this period, trade activities continued to increase in the 18th and 19th centuries. The Industrial Revolution that began in Great Britain in the second half of the 18th century had a positive impact on İzmir's trade. The main reason behind this development was the status of the Western Anatolia region as a good source of raw materials, and a market that is close to Europe. In the 19th century, Europeans' interest in Western Anatolia increased, ushering in an era of rapid development for İzmir and its ports. Construction of the first modern pier at the port was completed by the French in the same century. Additionally, the İzmir-Aydın and İzmir-Kasaba railways built by the British in Western Anatolia strengthened the connection of the Port of İzmir with its hinterland, boosting the port's domestic and foreign trade activities in the process. While trade activities remained active until World War I, they were then interrupted due to the port being shut down to trade during the war. However, after the end of the war and liberation of İzmir from the Greek occupation on September 9, 1922, the port and the trade activities in the city were revived with a rapid recovery achieved in line with the liberal policies adopted in the early years of the Republic. By 1929, İzmir and the Port of İzmir were among Türkiye's most crucial foreign trade centers. With the TCDD Port of İzmir, which started its activities in its current location in 1959, İzmir had Türkiye's second-highest cargo volume in the 1980s, and the port city alone handled 43 percent of Türkiye's cargo in the 1990s. With the increase in ports in the 2000s, İzmir has now become one of the key maritime clusters of Türkiye and the Mediterranean.

> ***Maritime transport and port services play a key role in the sustaibale development of İzmir, which carries out approximately 83 percent of its exports exceeding $12 billon with its 16 ports in the Aegean, a region that houses 22 different ports along with coastal zones.***

Below are the goals of the "Current Situation Analysis and Development Perspective of the Ports of İzmir" study, which was prepared as part of the Result-Oriented Program for Marine Economy (ROPME) started by our agency in 2020:

- Emphasizing the significance of maritime transport for İzmir's future,
- Identifying İzmir's existing maritime transport and port services infrastructure,
- Identifying current global trends,
- Offering an inclusive and applicable growth perspective for the ports of İzmir

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CHAPTER 1.

Adventure of İzmir's Development in Maritime Transport

İzmir's seas and maritime connections have always been the decisive factors throughout its historical development. Ancient cities, including Pergamon, Ephesus, Teos, Milet, Priene, Aspendos and Olympos, all lost their military and economic power upon losing their ports. However, whether under the Hellenic civilization, the Roman Empire, the Byzantine Empire, the Ottoman Empire or the Republic, İzmir has always managed to serve as one of the region's major settlement and trade centers.

In ancient and medieval times, İzmir always competed with other ports in Western Anatolia, such as Foça, Ayasoluğ, which replaced Ephesus after the rise of sea levels, Kuşadası (Scala Nuova) and Balat (Miletus)[1]. For both İzmir and its neighboring ports, commercial development was subject to various times and conditions. In the short period when Istanbul was under the control of the Byzantine Empire and ruled by the Latins (1204-61), İzmir experienced a revival as Byzantines developed İzmir as a culture and trade hub with the help of the Genoese[2]. However, the control of the region by the Aydın and Menteşe Turkish beyliks in the following centuries caused İzmir's commercial advantage to shift to Kuşadası and Balat ports, resulting in partial erosion of its strong position under Byzantine rule.

After coming under the rule of the Ottoman Empire in the 15th century, İzmir could not show remarkable development as a port city in the 15th and 16th centuries despite the conquest of Rhodes, which made the southern sea routes safer, and other conquests that opened up the ports of the Eastern Mediterranean to Ottoman trade. During this period, the city's population was still under 5000[3]. However, in the 17th century, Westerners looking for products and markets to replace the spice trade on the shores of the Levant found not only potential customers for cotton and wool for their newly developing industries and textile products in Western Anatolia, but also a port where they could demonstrate their commercial abilities in Izmir[4]. Resembling a small town until the 17th century, İzmir then became the Ottoman Empire's gateway to the world thanks to the developments in this period and its advantageous geographical location. Foreign travelers and diplomats who came to the Ottoman lands and visited İzmir during this period described İzmir as Levant's most renowned and critical city for land and sea trade, claiming that it was the most suitable port for commercial goods going from Asia to Europe, and vice versa. As the trailblazers of the trade revolution in the 17th century, the Dutch, the English and the French discovered, developed and utilized the city and its port, referring to it as an absolute gem[5].

1 Goffman, Daniel, "İzmir ve Levanten Dünya (İzmir and the Levantine World) (1150-1650)", History Foundation Yurt Publishing House, 2nd Edition, September 2000, p.4-6

2 Goffman, Daniell, "17. Yüzyıl Öncesi İzmir (İzmir Before the 17th Century)", Üç İzmir (Three İzmirs), YKY İstanbul, 1992, p. 74-76

3 Zeki Arıkan, Zeki, "15.-16. Yüzyıllarda İzmir (İzmir in the 15th and 16th Centuries)" Üç İzmir (Three İzmirs), YKY İstanbul,1992, p.15-16

4 IBID, p.43

5 Goffman, Daniel, "İzmir ve Levanten Dünya (İzmir and the Levantine World) (1150-1650)", History Foundation Yurt Publishing House, 2nd Edition, September 2000, p.43

Effects of modernization spreading rapidly around the world in the 19th century, especially in Europe, the use of steamships that were able to cross the great oceans, and the use of trains running on coal and operating on railways with multiple wagons all affected İzmir's maritime transport as well as the Port of İzmir itself. There were no complete highways connecting the city with its neighbors up until mid-19th century. Commute in the city was made mostly by camels, and also horses and carriages, through the Caravan Bridge over the Kemer Stream. Despite fertile and rich lands and an abundance of products, the primitive roads that had to be endured to bring these products to the market hindered the development of trade. In the post (menzil) system, which offered horse exchange and accommodation in inns built to accommodate frequent breaks, caravans were frequently attacked by bandits on the way or most of the goods were spoiled on village roads before arriving at the port due to long travel times. Accordingly, railways were the biggest requirement for bringing much-needed modern production relations and economic and social welfare to Western Anatolia, and especially to İzmir[6].

All the merchants in İzmir were aware that a functioning connection between Western Anatolia and İzmir would significantly boost trade and their profits. However, railways were beyond the financial and technical capabilities of the Ottoman Empire, as their financial situation in particular was gradually deteriorating. In 1855, an English merchant from İzmir named Robert Wilkin and his four partners requested an official concession to build the "Ottoman Railway from İzmir to Aydın." After an agreement was reached with the Ottoman Empire, the construction works of the railway were started in 1857, and the 133-km railway between İzmir and Aydın was put into operation upon its completion in 1866[7].

As expected, the railway increased the production in Western Anatolia as well as the tax revenue of the Ottoman Empire. Soon, İzmir followed Istanbul in highest customs revenue, accounting for 12 percent of the Ottoman Empire's total customs revenue at the time[8].

In the same period, the shoaling of the port, the corresponding inability of next-generation ships to visit the port, loading processes being carried out with rafts from the ships anchored in the open before they could approach the shoreline, the increasing need for functioning and quality piers, and the city's trade suffering from all these factors made it a necessity to construct modern ports and piers. On November 18, 1867, within the same period as the commencement of railway operations, the Ottoman Empire started constructing modern port and piers upon reaching an agreement with three engineers of English origin; J. Charnaud, A.Barker and G.Guarracino.[9] With the construction of the pier, the city's economy was revived, significantly increasing the arrivals and departures of large-volume ships and rapidly developing foreign trade in the process. For instance, while 1,295 ships with a total carrying capacity of 443,340 metric tons arrived at the port in 1863, these numbers increased to 1,814,486 metric tons and 2,495 ships in 1895. Within thirty years, there has been an increase of 95 percent in the number of ships arriving at the Port of İzmir, and an increase of 304 percent in tonnage. This is also a result of the developments in the global maritime industry.

Most of the ships that came to İzmir in the middle of the century were sailing ships. However, steamships began to replace sailing ships towards the end of the century. It is safe to say that the Port of İzmir supported the modernization of the Ottoman Empire with the ships it was able to serve thanks to its modern piers and port, and with the Mediterranean maritime trade in which it plays a key role.[10]

By the 19th century, both the disintegration and collapse of the Ottoman Empire and the global depression experienced due to World War I were making their presence felt. At the time of the war, the Port of İzmir was the country's second most critical port.[11]

In the early days of the Republic, the significance of the Port of İzmir increased in line with the emphasis on maritime investments, the nationalization of the Port of İzmir, the influence of the İzmir Economy Congress, and the revival of Turkish maritime and maritime trade. With the TCDD Port of İzmir, which was put into service in 1959, İzmir continued to be one of the key trade hubs, as its share in Türkiye's foreign trade increased up to 43 percent until the mid-90s.

At the beginning of the planned economy period in our country, the goal was to develop a "Heavy Industry Zone" in the Aliağa district located to the north of İzmir in line with the First Development Plan targets covering the years 1963-1967, which resulted in a more industrial-intensive region starting from the 1970s, replacing the region's previous production pattern that was mostly based on agriculture. Tüpraş İzmir Refinery, which was among the first petrochemical facilities of our country, was put into operation in 1972, followed by Petkim İzmir Refinery in 1984. In 1986, operations at the Mechanical and Chemical Industry Corporation Scrap Steel Processing Facilities were commenced, as the region's heavy industry production was further reinforced with fertilizer, paper, cellulose and chemical facilities, and especially petrochemical and iron and steel facilities. With the industrialization in Aliağa, dock constructions were started in line with the needs of industrial facilities, and maritime transport became increasingly important. The first dock for industrial facilities in Aliağa was opened in 1977 by Ege Fertilizer in the Nemrut Bay (TCS İzmir Branch, 2012:17). This was followed by the commissioning of Ege Steel, Habaş, Batıçim, İzmir Iron and Steel, Petrol Ofisi (POAŞ), Petkim, Tüpraş, Akdeniz Chemical Nemport, Total Oil and Alpet docks. The Nemrut Port Cluster was formed as an alternative port cluster, especially for cargoes that the TCDD Port of İzmir could not serve due to the shifting of renewal works to the newer docks in the Nemrut Bay. Over time, the ports here were visited by shipowners such as Maersk, MSC, Arkas, CMA CMG, Hapag-Lloyd and Hamburg Süd[12].

With the establishment of major industrial organizations, such as Tüpraş and Petkim, the rate of industrialization in the region started to accelerate. This also required the development of new dock and port structures.

To serve this end, the first private port operator in the region (NEMPORT) started its operations in 2009. Then came the establishment of new ports in Nemrut Bay for serving general cargo, bulk cargo and container cargo.

With ports that host 16 of the 22 ports serving in the Aegean, serve all types of cargo, and handle a total cargo volume of 80 million metric tons, İzmir alone accounts for 16 percent of the total cargo and 15 percent of the container cargo in Türkiye. Its ports in the Nemrut Bay form a major maritime base, described as "Europe's 2nd fastest growing port cluster."

6 19. Yüzyılda Ege'de Demiryolu Devrimi (The Railroad Revolution in the Aegean in the 19th Century)", Demiryolu ve Kalkınma Dergisi (Railroads and Development Magazine), v.5/12, July 2021, p.27-28

7 Kurmuş, Osman, "Emperyalizmin Türkiye'ye Girişi (Imperialism's Arrival in Türkiye)", Yordam Kitap Publishing House, 2nd Edition, 2012, p.99-111

8 Kurmuş, Osman, "Emperyalizmin Türkiye'ye Girişi (Imperialism's Arrival in Türkiye)", Yordam Kitap Publishing House, 2nd Edition, 2012, p.113

9 Kütükoğlu, Mübahat, "İzmir Rıhtımı İnşaatı ve İşletmesi İmtiyazı (Construction and Operation of İzmir's Quay)", İzmir Tarihinden Kesitler (Cross-Sections of İzmir's History), p.206-207.

10 Georgelin, Herve, Smyrna'nın Sonu: İzmir'de Kozmopolitizmden Milliyetçiliğe (The End of Smyrna: From Cosmopolitanism to Nationalisms), 2009, Birzamanlar Publishing House, p.54-59

11 Data from 1910 shows that Istanbul comes first with 16,215,000 metric tons, İzmir comes second with 2,990,000 metric tons, and Beirut comes third with 1,671,000 metric tons. These ports are followed by ports of Thessaloniki, Jaffa, Samsun, Tripolitania, Trabzon and Iskenderun, respectively.

12 TCS İzmir Branch (2012). Aegean and State of the Industry 2011. (Date of Access: 20.12.2021), (www.dtoizmir.org)

İzmir Caravan Bridge, No Date, Getty Research Institute

The bridge of Caravans at Smyrna, Gustave Dore, Engraving 1855

1.1. Ports of İzmir

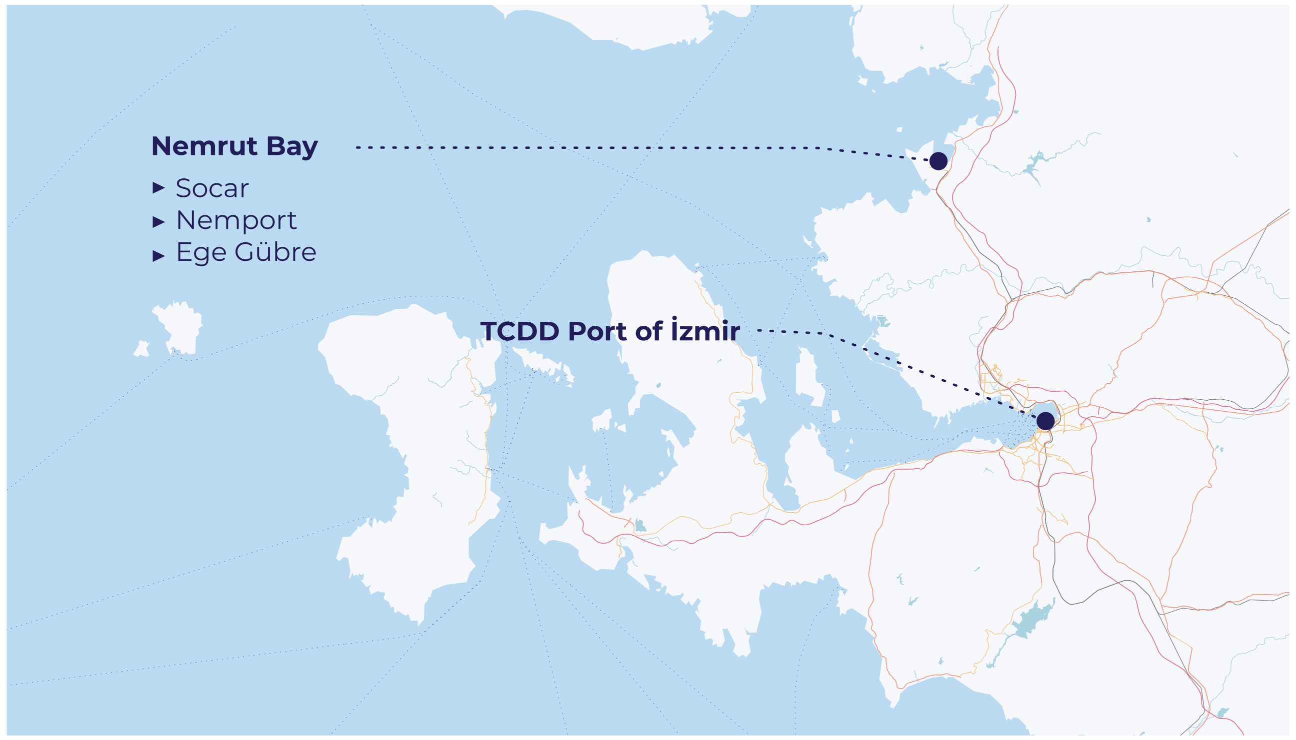
İzmir is one of the most developed regions of our country and the Aegean Region in terms of population, geographical location and basic socio-economic indicators. In İzmir, which is also the Aegean's maritime transport leader, the regional ports are distributed from the city center to the north and towards Çeşme in the Peninsula region.

- TCDD Port of İzmir (Konak)
- Ulusoy Çeşme Port (Çeşme),
- Port of Dikili (Dikili),
- Nemport Port (Aliağa),
- Socar Terminal (Aliağa),
- Ege Fertilizer Port (Aliağa),
- Batıliman (Aliağa),
- Petkim Port(Aliağa),

The İDÇ Port (Aliağa) comprises the region's main ports for serving bulk cargo, container cargo and Ro-Ro cargo. In Aliağa, nine terminals continue their activities mainly to meet their own needs without serving outside of their own operations; namely the Habaş Port, Ege Steel Port, Petrol Ofisi Port, Total Port, Alpet Port, Tüpraş Port, Milangaz Port, Impact Port and Ege Gaz Port.

With the increase in the types of cargo that can be transported by containers and the development of integrated transportation systems experienced around the world in the last two decades, the demand for container transport has increased significantly. Accordingly, container transport becoming available for some of the cargoes transported in general cargoes has led to a decrease in general cargo transport. This relationship between cargo groups and ship types has also affected the distribution of the global merchant ship fleet. Accordingly, the number of containers handled at ports of Türkiye has increased by 78 percent in the last ten years. The container terminals located within the borders of İzmir are shown in Figure 2.

FIGURE 1. Container Terminals in İzmir



he annual total berthing capacity of the three container terminals located in the Nemrut Bay in Aliağa is 1,984 ships, while this capacity is 1,577 ships at the TCDD Port of İzmir. On the other hand, the total container handling capacity of the container terminals in Aliağa is 1.5 million TEU, while this capacity is 1 million TEU at the TCDD Port of İzmir. This data shows that the four terminals serving container ships in İzmir have a total berthing capacity of 3,561 ships and a total container handling capacity of 2.6 million TEU[13].

Apart from İzmir, the Aegean Region has cruise terminals in Kuşadası (Aydın), Muğla (Bodrum) and Marmaris, and a cargo port in Milas (Güllük Port).

FIGURE 2. Ports and Hinterland of İzmir

While some of the ports operating in İzmir serve as multi-purpose ports, some are specialized according to the types of cargo handled. The analysis of terminals shows that a total of 26 terminals serve at the ports of İzmir, consisting of 4 containes, 9 bulk/general cargo, 11 liquid bulk cargo, 2 Ro-Ro and 3 passenger terminals.[14]

According to the "Türkiye's Ports Capacity Report" published by the Port Operators Association of Türkiye (TÜRKLİM) in 2019, the annual total berthing capacities (number of visits) at the bulk/general cargo ports of Aliağa, İzmir and Dikili are 3,866, 1,572 and 15, respectively, while the total berthing capacity is 5,589. Bulk/general cargo handling, on the other hand, is 22.7, 3.9 and 0.2 million metric tons, respectively, and 26.8 million metric tons in total.

13 TÜRKLİM, Türkiye's Ports Capacity Report, 2019

14 TÜRKLİM, Türkiye's Ports Capacity Report, 2019

1.2. The Last Ten Years of Maritime Transport in the Aegean and İzmir (2011-2020)[15]

While a total of 496 million metric tons of cargo were handled at all ports of Türkiye in 2020, 19 percent of this amount was handled at the ports of the Aegean Region, and 16 percent was handled at ports of İzmir.

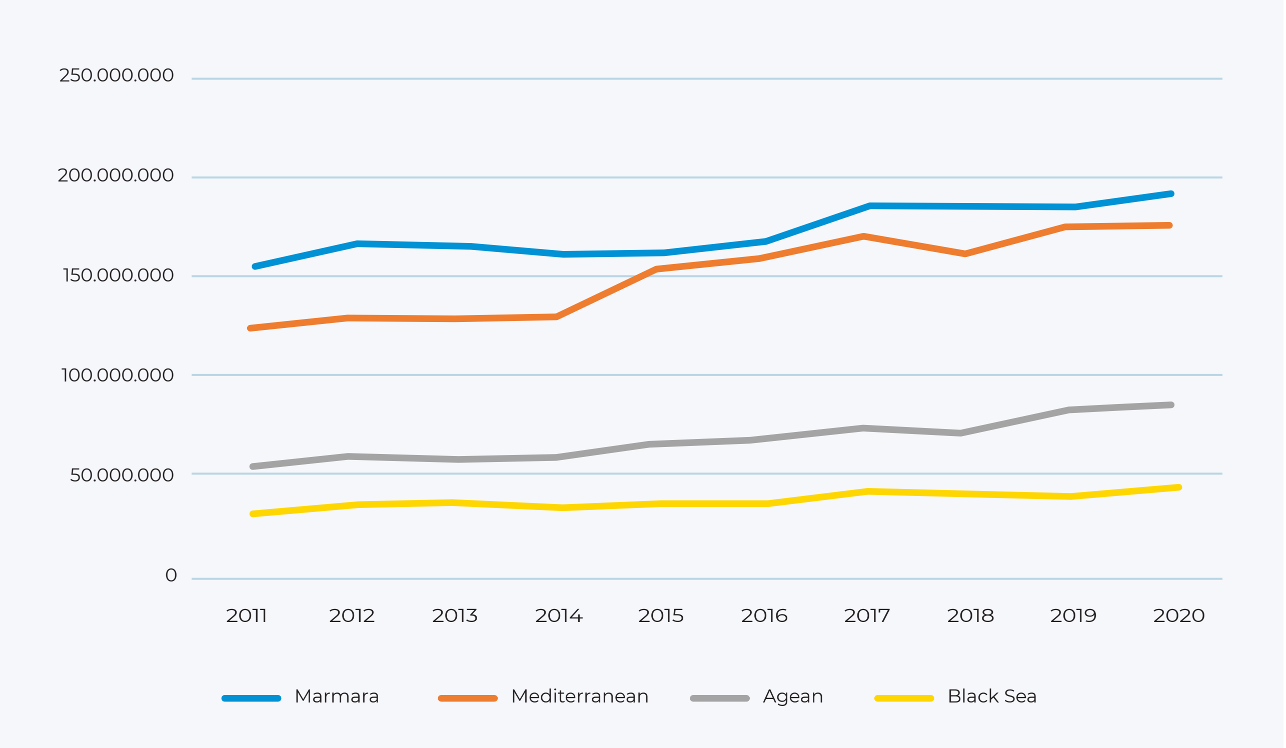
Annual development of cargoes in the 2011-2020 period shows that the Aegean Region has the fastest development rate, and the highest cargo increase across all regions with 4.7 percent.

TABLE 1. Regional Cargo Development, 2011-2020 (metric tons)

	Marmara	Mediterranean	Aegean	Black Sea	Total
2011	154,115,234	122,961,623	54,303,421	31,966,445	363,346,723
2012	165,808,652	128,262,908	58,680,870	34,673,802	387,426,232
2013	163,739,271	127,599,853	57,294,558	36,297,076	384,930,758
2014	159,856,938	128,568,843	59,565,203	35,129,635	383,120,619
2015	160,810,595	153,070,251	65,478,727	36,677,122	416,036,695
2016	166,553,197	158,551,034	67,819,303	37,277,628	430,201,162
2017	184,699,191	169,902,567	74,098,504	42,473,634	471,173,896
2018	185,186,598	160,652,426	72,281,772	42,032,764	460,153,560
2019	184,661,739	174,723,830	83,923,544	40,859,299	484,168,412
2020	191,203,199	175,560,233	85,889,153	43,990,066	496,642,651
2019-2020 YoY Change	3.5%	0.5%	2.3%	7.7%	2.6%
10-Year Change	2.2%	3.6%	4.7%	3.2%	3.2%

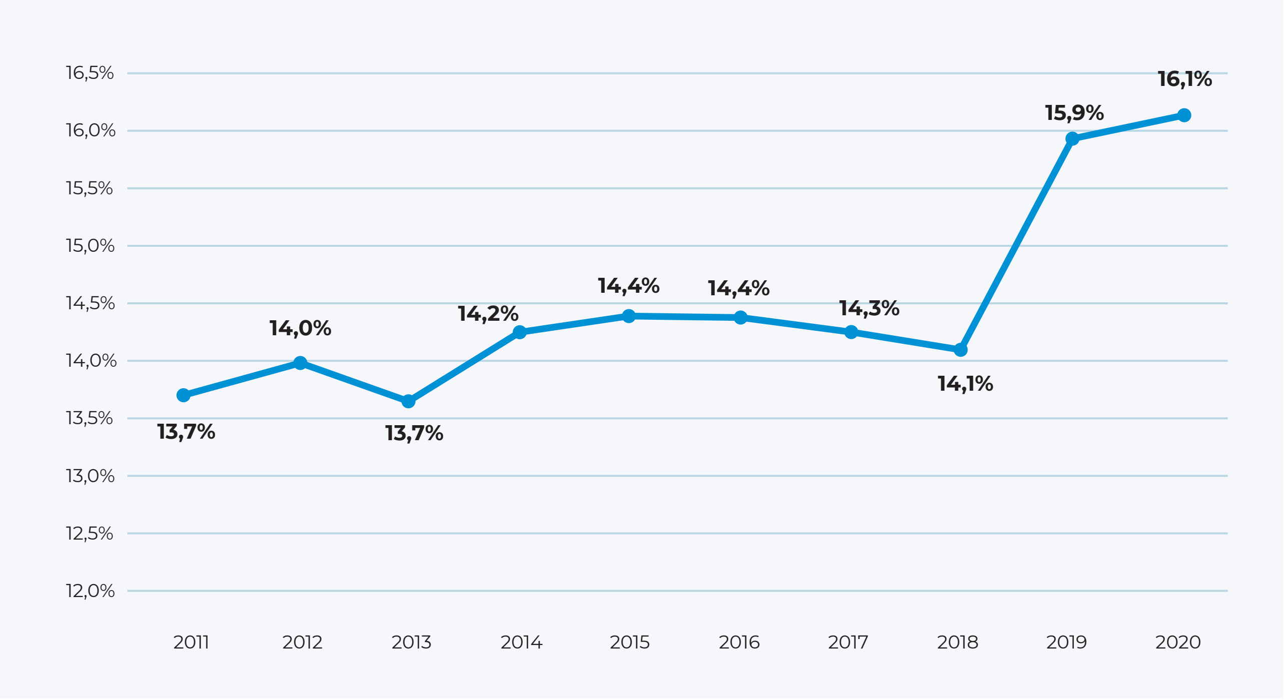
15 The data in this section has been obtained from the Ministry of Transport and Infrastructure, General Directorate of Maritime.

FIGURE 3. Regional Cargo Development, 2011-2020 (metric tons)



The share of the ports of İzmir in the ports of Türkiye increased to 16 percent in 2020 with the commissioning of SOCAR Terminal in Aliağa in 2019. In the 2011-2018 period, this share was around 14 percent on average.

FIGURE 4. Share of the Ports of İzmir



Port authorities operating within the borders of İzmir are located in Aliağa, İzmir, Çeşme, Dikili and Foça. With 68.9 million metric tons handled in 2020, the Aliağa Port Authority handles the highest volume of cargo in all of İzmir. Aliağa is followed by İzmir with 9.4 million metric tons, Çeşme with 1.2 million metric tons, and Dikili with 498,000 metric tons. There was no cargo movement at the Foça Port Authority in 2020, as the region was more active in fishing and sportive maritime activities.

Analysis of the data in Table for 2019 and 2020 shows that the ports of İzmir have exceeded 80 million metric tons in total with an increase of 3.9 percent.

In 2020, the cargo handled at the ports of İzmir had a share of 93.2 percent in the Aegean region, and 16.1 percent in Türkiye.

Even though the ships increase in size in order to achieve economies of scale in global trade, which results in decreased number of ships visiting the ports in our country, the increase in cargo volume continues at full steam. In 2020, the number of ships docking at Aliağa ports was 5,356, while the number of ships docking at the TCDD Port of İzmir was 1,660. A total of 7,659 ships dock at the ports of İzmir, and these ships constitute 15.7 percent of the total number of ships docking at the ports of Türkiye.

TABLE 2.. Data from İzmir's Port Authorities (metric tons)

	2019	2020	2019-2020 YoY Change	10-Year Change
Aliağa Port Authority	65,799,062	68,946,001	4.8%	6.2%
İzmir Port Authority	9,226,482	9,390,012	1.8%	-1.1%
Çeşme Port Authority	1,553,848	1,236,404	-20.4%	3.1%
Dikili Port Authority	519,271	498,017	-4.1%	1.1%
Total of İzmir's Port Authorities	77,098,663	80,070,434	3.9%	4.9%
Total of Other Aegean Port Authorities	6,824,881	5,818,719	-14.7%	2.5%
Total of Aegean Port Authorities	83,923,544	85,889,153	2.3%	4.7%
Total of Türkiye's Port Authorities	484,168,412	496,642,651	2.6%	3.2%
Ports of İzmir - Share in the Aegean	91.9%	93.2%		
Ports of İzmir - Share in Türkiye	15.9%	16.1%		

TABLE 3. Number of Ships Docking at the Ports of İzmir

	2018	2019	2020
Aliağa	5,241	5,135	5,356
İzmir	2,047	1,551	1,660
Çeşme	2,098	1,946	522
Dikili	256	134	121
Total in İzmir	9,642	8,766	7,659
Türkiye	72,360	55,302	48,821
Share of İzmir	13.3%	15.9%	15.7%

While 11.6 million TEUs of cargo was handled at all container terminals across Türkiye in 2020, the share of the ports of İzmir was 15 percent with 1.7 million TEUs. While the average container development in Türkiye was 5.9 percent in the ten-year period between 2011 and 2020, this rate was 5 percent at the ports of İzmir.

While 74 percent of the containers handled at the ports of İzmir were handled at the TCEEGE, Nemport and Socar Terminal ports located in the Aliağa Nemrut Bay (1.3 million TEUs), the remaining 436,000 TEUs, adding up to 26 percent, were handled at the TCDD Port of İzmir. The need for infrastructure, superstructure and equipment modernization at the TCDD Port of İzmir has been causing a cargo shift to the ports of Aliağa since 2009. With the effect of this cargo shift, ports of Aliağa showed a significant cargo increase trend of 13% in the ten-year period between 2011 and 2020, while the continuation of the cargo loss at the TCDD Port of İzmir in the same period (4% on average) caused the region's total cargo development to remain below Türkiye's average. In the "Evaluation of the TCDD Port of İzmir (Alsancak) in terms of Regional Economy from Past to Present[16]" report, which was prepared under the coordination of our agency and completed in 2019, the real loss caused by the port's inability to receive the infrastructure and superstructure investments it needs in regional economy in line with decreasing port revenues was calculated at $2.6 billion. Considering potential positive externalities that may occur with the realization of the said investments, İzmir's loss in terms of foreign trade amounts to $29.5 billion.

TABLE 4. Development of Container Cargo in Türkiye (2011-2020, TEU)

	Marmara	Mediterranean	Aegean	Black Sea	Total
2011	4,107,835	1,317,904	1,049,634	48,133	6,523,506
2012	4,510,561	1,513,431	1,109,372	59,034	7,192,398
2013	4,963,615	1,731,399	1,149,618	55,305	7,899,937
2014	5,210,325	1,858,236	1,215,273	67,289	8,351,123
2015	5,007,726	1,834,986	1,230,025	73,663	8,146,400

16 The report is available at https://izka.org.tr/wp-content/uploads/pdf/liman-raporu.pdf .

	Marmara	Mediterranean	Aegean	Black Sea	Total
2016	5,419,372	1,953,697	1,322,747	66,161	8,761,976
2017	6,299,112	2,201,827	1,432,255	77,347	10,010,540
2018	6,843,524	2,365,581	1,555,613	79,282	10,844,000
2019	7,159,361	2,685,110	1,674,159	73,209	11,591,839
2020	7,034,054	2,768,691	1,711,906	112,001	11,626,651
2019-2020 YoY Change	-1.8%	3.1%	2.3%	53.0%	0.3%
10-Year Change	5.5%	7.7%	5.0%	8.8%	5.9%

TABLE 5. Development of Container Cargo at the Ports of İzmir (TEU)

	2019	2020	2019-2020 YoY Change	10-Year Change
Aliağa (TCEEGE, Nemport and Socar Terminal Ports)	1,132,480	1,275,521	12.6%	13.0%
TCDD Port of İzmir	541,679	436,386	-19.4%	-4.2%
Total in İzmir/Aegean	1,674,159	1,711,906	2.3%	5.0%
Total in Türkiye	11,591,839	11,626,651	0.3%	5.9%
Ports of İzmir - Share in Türkiye	14.4%	14.7%		

In 2020, services were carried out to European ports (Trieste/Italy, Sète/France and Chios/Greece) from Ro-Ro lines connected to İzmir, the port of Çeşme and the TCDD Port of İzmir. With a total of 56,700 transports, the Trieste lines were by far the busiest line, followed by the Sète and Chios lines. The share of the ports of İzmir in Türkiye's total Ro-Ro transports in 2020 was 12.4 percent for incoming vehicles, and 10.9 percent for outgoing vehicles.

TABLE 6. Ro-Ro Transport by Lines (vehicles)

Lines	2018		2019		2020	
	Incoming	Outgoing	Incoming	Outgoing	Incoming	Outgoing
Çeşme-Trieste	24,640	29,493	28,148	30,121	30,095	26,739
Çeşme-Sète	3,517	3,715	5,855	7,100	0	1,079
Çeşme-Chios	0	0	250	841	142	545
TCDD Port of İzmir-Trieste	1,877	3,139	0	0	0	0
TCDD Port of İzmir-Sète	7,079	6,899	0	0	0	0
Total in İzmir	37,113	43,246	34,253	38,062	30,237	28,363
Türkiye	255,691	327,869	270,034	321,700	244,797	259,955
Share of İzmir	14.5%	13.2%	12.7%	11.8%	12.4%	10.9%

Automobile transports connected to İzmir were carried out from the TCDD Port of İzmir. While a total of 15,500 new vehicles were handled at the port in 2020, 14,400 of these vehicles were exports. The ratio of outgoing vehicles loaded at the TCDD Port of İzmir in 2020 to the total loaded outgoing vehicles in Türkiye was 1.5 percent.

TABLE 7. Automobile Transports Connected to İzmir (vehicles)

	2018		2019		2020	
	Incoming	Outgoing	Incoming	Outgoing	Incoming	Outgoing
TCDD Port of İzmir	547	18,203	342	11,036	1,101	14,464
Türkiye	438,163	1,340,362	270,427	1,264,238	476,649	958,462
Share of İzmir	0.1%	1.4%	0.1%	0.9%	0.2%	1.5%

Even though the ports of İzmir broke a new record by reaching a total of 557,000 cruise passengers in 2012 (with a share of 26.6 percent in Türkiye), cruise tourism in Türkiye started to decline due to the developments in the country and other circumstances. While 2,300,000 passengers visited our country in 2013, this number decreased to 213,000 in 2018. The COVID-19 pandemic that started in Wuhan, China at the end of 2019 quickly took the world by storm, negatively affecting the demand in many industries and stopping cruise tourism in line with travel bans. Only 1,824 cruise passengers visited our country in 2020.

TABLE 8. Cruise Tourism Development at the Ports of İzmir (passengers)

	TCDD Port of İzmir	Port of Dikili	Total in İzmir	Türkiye	Share of İzmir
2011	493,533	17,281	510,814	2,190,098	23.3%
2012	552,714	4,574	557,288	2,098,381	26.6%
2013	486,913	7,565	494,478	2,259,053	21.9%
2014	257,233	7,796	265,029	1,792,298	14.8%
2015	241,666	8,317	249,983	1,888,522	13.2%
2016	27,619	3,998	31,617	626,840	5.0%
2017	9,172	99	9,271	306,485	3.0%
2018	0	103	103	213,771	0.0%
2019	0	776	776	300,896	0.3%
2020	0	0	0	1,824	0.0%

CHAPTER 2.

Current Global Trends in Maritime Transport

Today, we are able to classify the trends and agendas that directly or indirectly affect the maritime industry as follows:

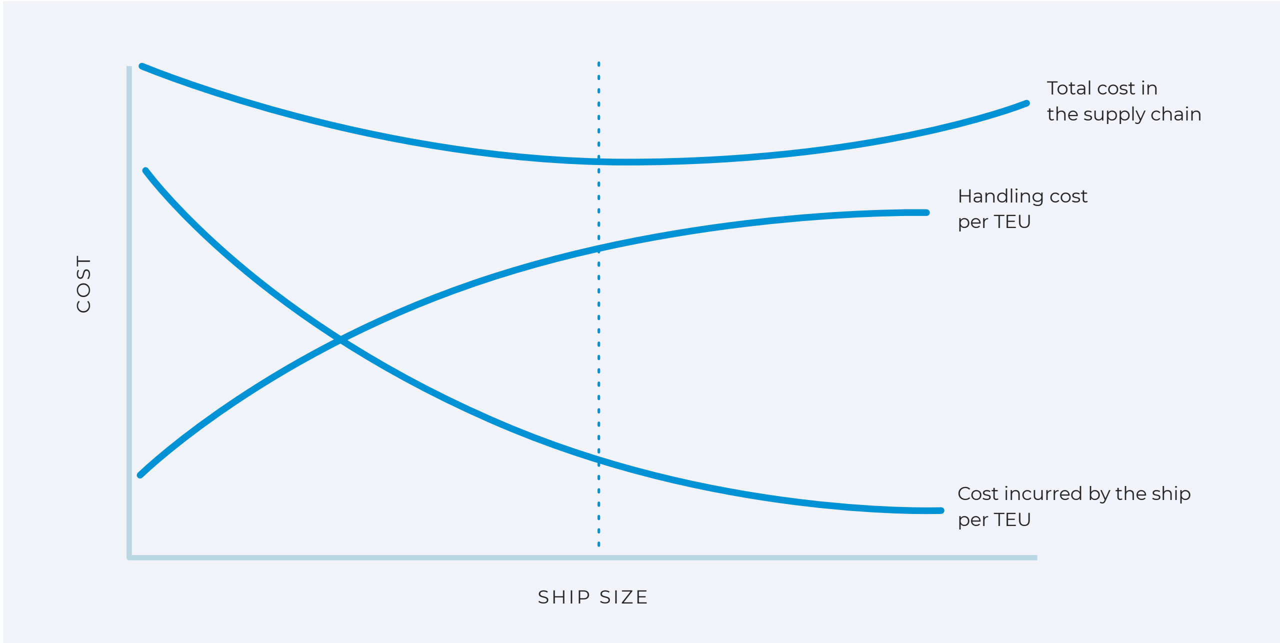
- Increasing Ship Sizes
- Global Risks and Opportunities
- China's Belt and Road Initiative
- Digitization and Disruptive Technologies
- Port Automation (Smart Ports)
- Port 4.0 Practices
- Developments in Sustainability and Environmental Protection
- Northern Sea Route

2.1. Increasing Ship Sizes

Global trade of goods increases every year. Even though recent developments with periodic effects such as the 2008 global financial crisis or the Covid-19 pandemic led to a ripple effect on global trade, the overall trend still points to an increase. Increases in global trade of goods increase the amount of transported cargo, lead ship operators to search for economies of scale in transports, and all these factors contribute to the continuous increase in ship sizes. Even though increased ship sizes create certain advantages for ship operators, this situation poses new challenges for ports and other members of the supply chain.

As the ship size increases, the cost for each TEU of container carried by the ship decreases. However, as the density of the cargo on the ship increases, the handling costs of the ports and therefore the transport costs of a container in the supply chain begin to increase. At this point, serving ship sizes that minimize all costs becomes a requirement. As of March 2021, the longest (LOA) ships in the fleet of ships operating in global maritime trade are container ships.

FIGURE 5. Relation of Ship Size and Cargo Transport Costs [17]



The container ship HMM Algeciras, received from South Korean shipyards to start operation in 2020, has a length of 400 meters and a width of 61 meters, while the maximum (fully loaded) water depth is 16,5 meters. The ship's theoretical container carrying capacity is 23,964 TEU. While TI-class oil tankers stand out with a capacity of 441,000 DWT, a length of 380 meters, a width of 68 meters and a draft of 24.5 meters, Valemax-class ships with a length of over 360 meters and 400,000 DWT serve with a draft of 23 meters for bulk cargo carriers. As for cruise ships, Oasis-class ships provide service with a length of more than 360 meters, despite their low drafts.

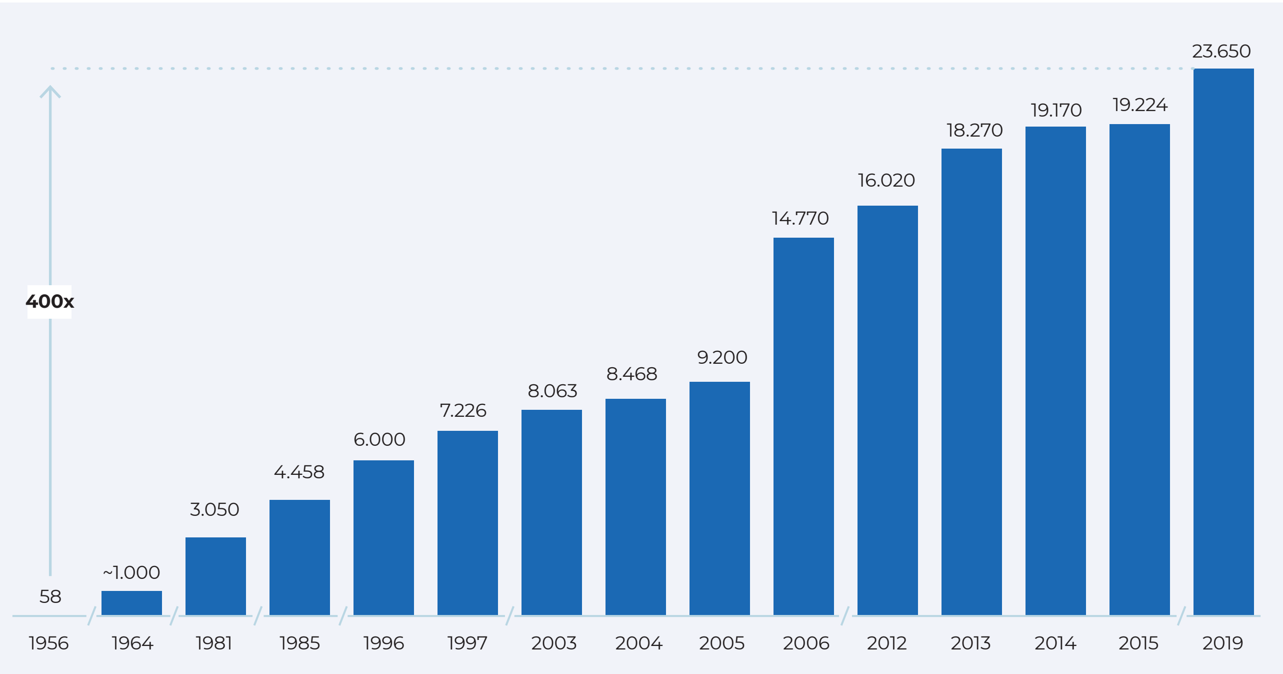
17 OECD/ITF/Jansson ve Sheerson, 1982

TABLE 9. Largest Ships of Each Ship Type

Ship Type	Name/Class	LOA (m)	Width (m)	DWT (Deadweight Tonnage)	Water Depth (Draft-m)	Date of Construction
Container	HMM Algeciras	400	61	232,283	16.5	2020
Oil tanker	TI-class Supertanker	380	68	441,893	24.5	2002
Bulk Cargo	Valemax	362	65	400,000	23.0	2011
Cruise Tourism	Oasis-class	362	61	15,000	9.3	2009

The negative effects of increasing ship sizes are mostly observed in container transport. In fact, the 400-meter-long Ever Given ship, which got stuck in the Suez Canal in March 2021, blocked the canal for six days, disrupted the ship traffic on the Asia-Europe main trade route, and caused a convoy of more than 370 ships. This development fueled the discussions of ship sizes around the world[18].

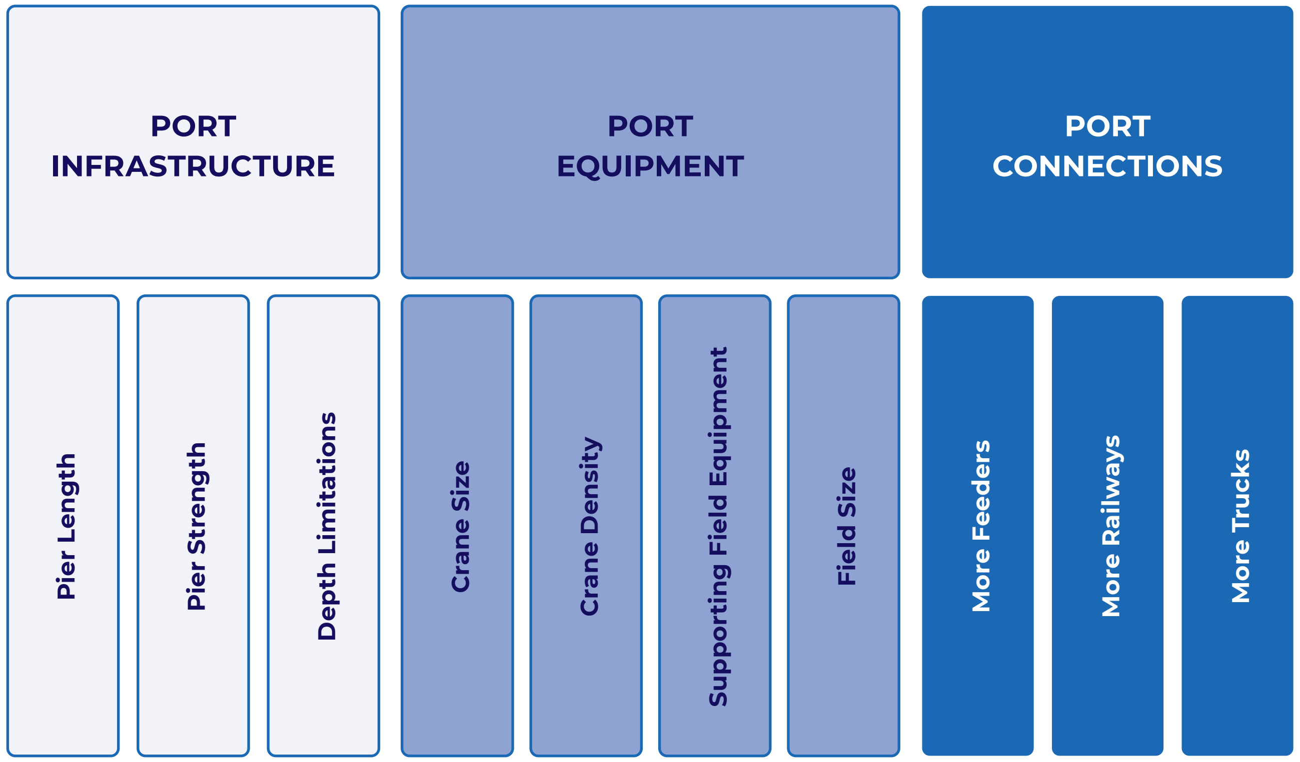
FIGURE 6. Development in Container Ship Capacities



The negative effects of increasing ship sizes on ports and supply chains are not limited to port equipment. Most of the time, these ships cause other ships to stay at the ports for longer periods of time. This increases cargo transit time in the supply chain and delays cargo deliveries.

18 https://economictimes.indiatimes.com/small-biz/trade/exports/insights/why-the-worlds-container-ships-grew-so-big/articleshow/81771092.cms

FIGURE 7. Potential Effects of Increasing Ship Sizes on Ports and Supply Chains[19]



he impact of increasing ship sizes on ports can be examined under three categories:

- **Impact on infrastructure:** Construction of longer, stronger, more resilient and deeper piers,
- **Impact on port equipment:** The requirement for larger and more powerful cranes, the increase in the number of cranes assigned to a ship for faster completion of ship operations at the pier, the increase in internal transport equipment and stowage equipment for these cranes,
- **Impact on port back area connections:** The increase in the number of feeder services in parallel with the increase in cargoes, the requirement for infrastructure and equipment such as new train lines, and the increase in traffic density on the access roads to the port due to the increasing truck traffic.

Even though high-capacity ships reduce the costs of shipowners, they force other parties in the industry, and especially port operators, to make new investments. Examination of the period after years 2004 and 2005, which saw a general increase in ship sizes, shows that ports could not rapidly adapt to increasing ship sizes due to high equipment costs and the current level of technology, which in turn created challenges for competition between ports.

19 Roijals, 2015

2.2. Global Risks and Opportunities

The "2021 Global Risk Report" published by the World Economic Forum (WEF) at the beginning of 2021 offers an extensive explanation of global risks. The report identifies the biggest risk for the industry as the COVID-19 pandemic, which started in 2019, continued in 2020, and is expected to continue well into 2021 with efforts for supply and administration of vaccination. Increase in global risk approach and expectations due to the COVID-19 pandemic, economic recession, increasing poverty, climate crisis and environmental threats, digitalization and technological inclusion are some of the other major risks included in the report.

The risks that have the potential to adversely affect maritime transport and port services can be mainly associated with economic risks. These risks are:

- ▸ The "asset bubble" crisis in developed economies (housing, investment assets and mutual funds in developed economies gradually being cut off from the real economy)
- Collapse of globally critical industries (collapse of key industrial organizations in the supply chains)
- Debt crisis in developed economies (increasing public and real sector debts, especially in developed and developing economies)
- Failure to stabilize prices (inflation and deflation as a result of uncontrollable price increases and/or decreases of goods and services)
- Spillover to informal economy (growth of the informal economy around the world, fraud, organized crime, and expansion of illicit financial flows)
- Long-term economic stagnation (economic stagnation caused by the demand shock arising from the COVID-19 pandemic, near-zero and slow economic growth that can last for years)
- Severe demand shock (severe demand for the most vital goods in the global supply chain, i.e. food, energy, metals, minerals and chemicals)

As the most critical component of global trade and supply chain, maritime transport is very much subject to these risks, and will eventually either develop or stagnate depending on production and demand.

Even though 2020 data shows no dramatic contraction in maritime transport, and especially in container cargo, macro risk perspectives must be considered for development scenarios of almost all scales[20].

It should be noted that the COVID-19 outbreak, which started in China in December 2019 and was declared a pandemic by the World Health Organization (WHO) on March 11, 2020, continues to be effective around the world in 2021. In order to examine the effects of the pandemic on global trade and goods processes and better understand its economic complications, making evaluations based on maritime transport and ports may prove to be useful.

The pandemic process has brought maritime transport to the fore due to its critical role in ensuring the continuity of global trade and supply chain. Many international organizations around the world have called for the protection of port workers and ship crews, and for ports to remain open.

Adverse economic conditions worsened in 2020 due to the pandemic, causing a 4.1 percent decrease in international maritime trade. While the growth momentum slowed down in 2019, pressure on international maritime transport continued in 2020. Along with these developments, the increasing size of the ships in container transport and the increasing supply capacity continue to cause concern. Experience with ships and ports indicates that container ship sizes are likely at their peak. However, instead of ports, carriers are the ones benefiting from economies of scale in line with increasing ship sizes. According to the data, a 1 percent increase in the average ship size means a 0.52 percent decrease in the ship's duration of stay at the port per container. This situation puts a lot of pressure on ports (UNCTAD, 2020).

Mainline carriers have implemented a number of measures and adjustments in 2020 to deal with low demand arising from the pandemic and the relevant restrictions. Examples include periodic suspension of certain services, discontinuation of planned services and reviewing of transfers. Combined with new capacity management and cost reduction strategies, these practices enabled a good performance in freight rates in 2020 despite the pandemic. Issues prevalent before the pandemic, such as sustainability, decarbonization and control of ship pollution, continued to stay relevant (UNCTAD, 2020).

Another major development in 2021 was the normalization brought along with the start of vaccination. The normalization process allowed gradual recovery of demand. The inability of the supply chains to keep up with this increase, which has been a significant force for the recovery of trade, the deficiencies in the raw materials used for production such as metals, the container crisis, and the link between production and consumption prevented full recovery in the developing maritime trade. Price increases in certain product groups were also effective in this period of vaccination and normalization.

The COVID-19 pandemic has once again revealed the importance of rapid adaptation, manageable scaling and flexibility in maritime transport as in all industries. UNCTAD underlines the major changes with local effects in the post-pandemic period:

- A paradigm shift that prioritizes risk management and building resilience,
- Rapid change in globalization models and supply chains,
- New consumer spending and behavior,
- Stronger position of digitalization and dematerialization,
- Significant increase in the use of electronic commerce documents,
- Higher importance of standards and interoperability,
- Emphasis on cyber security and increasing cyber-attacks,
- Adaptation to the post-pandemic business environment and greater interest in potential business opportunities,
- The need for systematic and coordinated policy responses at the global scale.

In the light of these changes, it is imperative for the post-pandemic period that (1) tensions and restrictions are eliminated from trade, (2) globalization is restructured by means such as switching to multiple supply methods rather than close-range supply, (3) supply chains are made more resilient by promoting technology and digitalization, (4) data is used for monitoring and policy responses, (5) agile and resilient systems are implemented, and (6) efforts are continued for sustainability, adaptation to climate change and building resilience (UNCTAD, 2020).

20 http://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2021.pdf

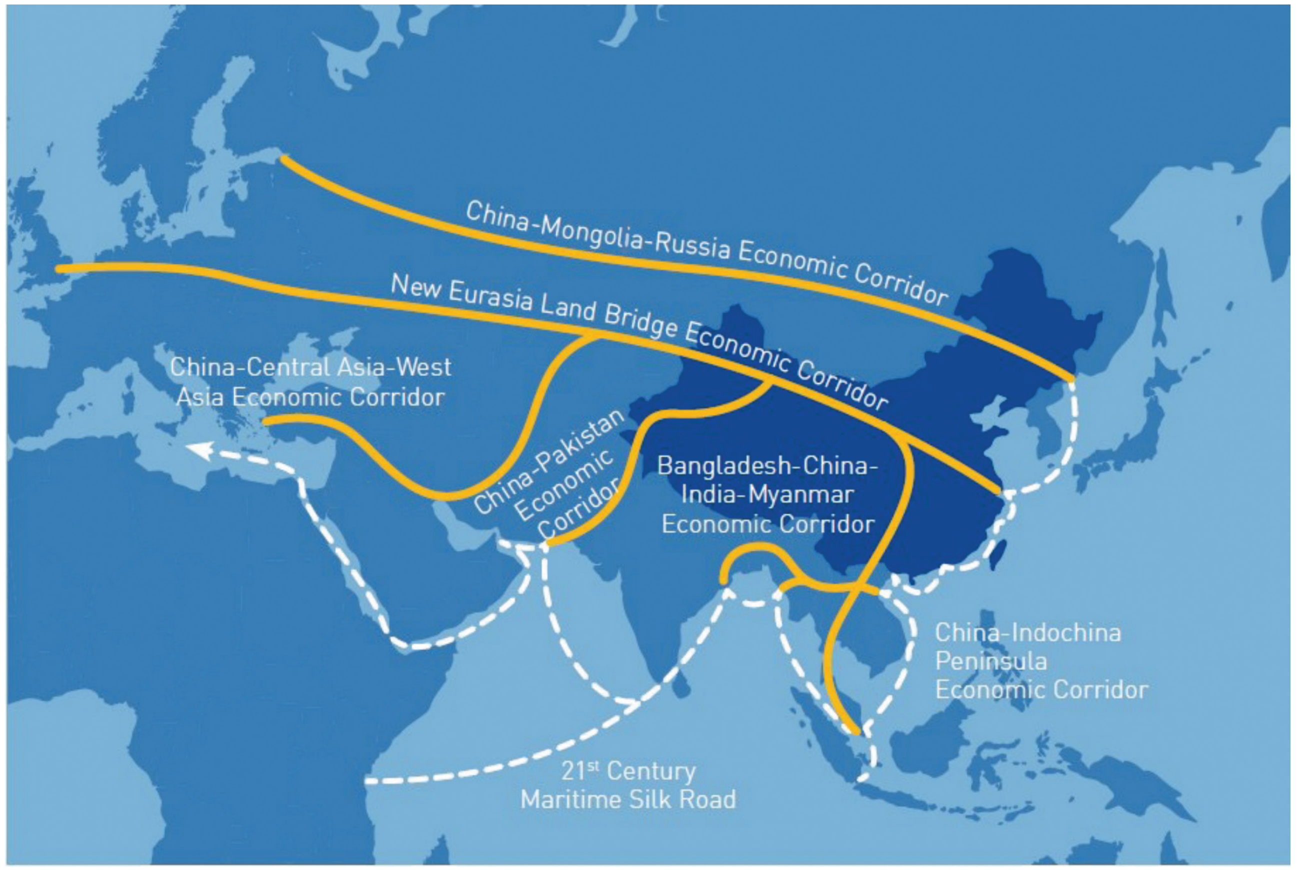
2.3. China's Belt and Road Initiative

Dynamics of the Far East-Europe sea route, which is one of the main trade routes of the world, remained more or less the same for about 500 years since the age of discovery[21] with European countries having the upper hand on the route. However, things started to change with the initiative that China officially announced in 2013. China's global Belt and Road Initiative aims for international integration through energy networks, telecommunications and transportation networks. The project is expected to be completed in 2049, the 100th anniversary of its establishment, as a visionary project that will solidify China's position in the global economy and politics[22].

The initiative aims to strengthen global connections in five key areas:

- Interstate agreements,
- Establishment of a logistics network,
- Establishment of trade and investment relations through bilateral agreements (RCEP, etc.),
- Financial integration, and,
- Cultural change.

FIGURE 8. Routes in China's Belt and Road Initiative[23]



21 https://www.globalresearch.ca/back-in-the-great-game-the-revenge-of-eurasian-land-powers/5657042?fbclid=IwAR2uMfIctR78jiUAg6rTFk5rwp6O3ZTy8g5RK3F-LvXwInpDISqbe9Phiyk

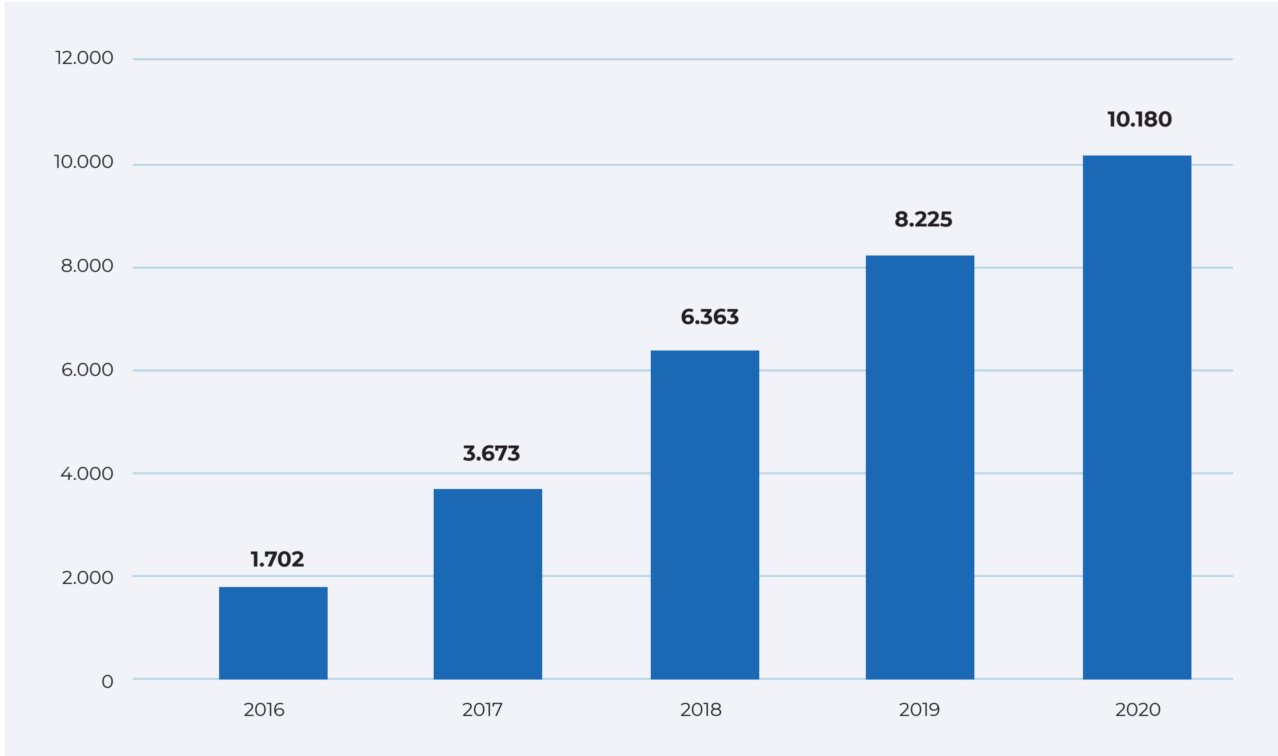
22 https://www.weforum.org/agenda/2018/12/what-you-need-to-know-one-belt-one-road/

23 https://www.scmp.com/economy/china-economy/article/3111052/china-debt-beijing-may-cut-belt-and-road-lending-due-domestic

As of 2020, 70 countries have been involved in the initiative within the seven years since the announcement of the project. Currently, 4.6 billion people (61 percent of the world population) are in the sphere of influence of this initiative. As of 2013, the initiative has enabled commercial contributions of $1 trillion, 171 agreements, and 19 projects worth $80 billion[24].

The increase in railway transports of the "Belt" is particularly striking. According to the data from the Chinese Ministry of Commerce, as of 2020, more than 14,000 rail services have been organized to 50 cities in 15 EU countries since 2013. The number of trains operating in 2018 alone reached 6,363 with an increase of 72 percent. In 2020, more than 10,000 block trains operated on the route.

FIGURE 9. Development in the Number of Train Services on the New Silk Road[25]



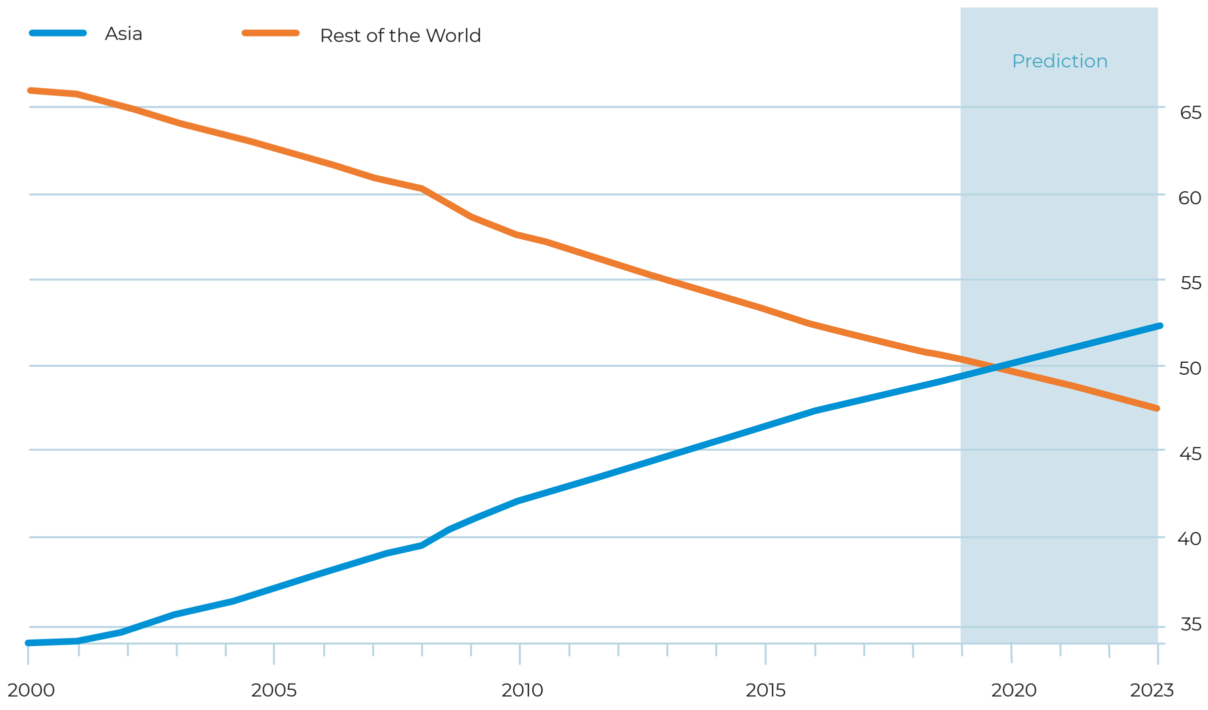
Even though the Baku-Tbilisi-Kars (BTK) railway, which became operational in October 2017 as part of this initiative, is officially included in the Middle Corridor located between Türkiye and the Iron Silk Road, there are still investments to be made. This is especially the case for integration with EU railways. The BTK Railway project is a major step towards connecting China to Europe via Central Asia and Türkiye.

The 12-day travel time between the project area and the Far East-Europe encourages the transport of time-sensitive cargoes by rail rather than by sea. Accordingly, it can be said that maritime transport will continue to benefit from economies of scale, even in case of short- and medium-term risks for maritime transport and port services.

24 Interview with Zafer Engin, DHL Shanghai Head of Value-Added Services (2021).

25 https://www.linkedin.com/pulse/rail-silk-road-2018-statistics-bartosz-miszkiewicz/

FIGURE 10. Comparison of Asia's GDP with Other Economies[26]



Since 2013, 42 ports in 34 countries have become part of the "Maritime Silk Road." After acquiring ports in Greece, Türkiye and Spain, Chinese subsidiaries started taking interest in Italian ports (Trieste and Genoa) in the Central Mediterranean in 2018, demonstrating China's emphasis on the Mediterranean region[27]. Greece's Piraeus Port, operated by COSCO Shipping Company which is one of the China's key shipowners, handled 5.5 million TEU of cargo in 2020, becoming the 2nd busiest port in the Mediterranean after Spain's Valencia Port, 6th busiest port in Europe and 40th busiest port in the world. As the fastest growing port in the world with a development of over 200 percent between 2007 and 2020, the port of Piraeus aims to become the largest and most critical container port in the Mediterranean by reaching a capacity of 10 million TEU in the near future.

26 https://www.ft.com/content/520cb6f6-2958-11e9-a5ab-ff8ef2b976c7?fbclid=IwAR2G_uXjhRNKRv-jCt6DZ0Je3FRlvtU49vrDxv_MdfiGg-1T5Bi1iGeQWFw

27 HE Haralambides (2019) China's Belt & Road Initiative: Connecting maritime transport flows for trade-driven prosperity, multilateralism and global peace.

2.4. Digitization and Disruptive Technologies[28]

Maritime and port services are areas where disruptive technologies and digitization can be utilized as resources in both adapting and accelerating the development of the sector. Accordingly, the necessity of working in harmony with other stakeholders in the supply chain of maritime and port administration and going beyond traditional business methods and tools are the main factors behind the recent pressure, especially the one created by disruptive technologies. Applications that can be defined specifically for supply chains, ship and port administration as part of digitization and disruptive technologies can be classified as follows:

TABLE 10. Digitization and Disruptive Technologies

Supply Chain Applications
▸ Blockchain platforms
▸ Port information platforms
▸ Supply chain management
▸ Cyber security
▸ Internet of Things
Ship Management Practices
▸ Container monitoring/tracking
▸ IoT platform on deck
Port and Terminal Management Applications
▸ Smart lighting
▸ Equipment monitoring
▸ Remote equipment control
▸ Automation

The applications specified in Table 10 and their effects on the industry are briefly explained below.

Blockchain Platforms: Maritime transport operations consist of document-intensive processes that require physical transfer and control of documents and create additional time and costs. In recent years, the implementation of pilot applications that enable the tracking and transfer of these documents in the electronic environment with blockchain technologies and the provision of security in the processes have allowed for savings in time and effort, and accelerated the operations[29]. As these supply chain technologies become widespread, ports will need to adapt to this process in order to be efficient and competitive. The following formations are examples of these applications in the maritime industry:

- T-Mining-Port of Antwerp, 2017
- Maersk-IBM, 2018 (TradeLens)
- Agility-Maersk-IBM, 2018
- PIL-PSA-IBM-Chongqing (China)-Singapore, 2018
- MTI-Agility Science, 2017
- EY-Maersk-Microsoft-Guardtime MS Amlin-XL Cat- lin, 2017
- SMFG-SMBC-JRI-Mitsui&Co-MOL-MSI-IBM, 2017
- HMM-Samsung SDS, 2017
- CargoX, 2018
- CMA CGM-Cosco-OOCL-Evergreen-Yang Ming-DP World-Hutchison Ports-PSA-Shanghai International Port-CargoSmart, 2018

Port Information Platforms: Ports are complex and dynamic structures requiring multidirectional and multidimensional communication. Port information platforms enable the sharing of real-time data between parties. Data is usually shared using mobile technologies, cloud technologies and map-based

28 Masaharu Shinohara, Study on Digitization and Disruptive Technologies (Big Data, IoT, Blockchain, AI, etc.) in Port Operations (2019). IAPH.

29 https://www.tradelens.com/

applications (Cartographic). In these systems, port operators are at the core of the platforms as both the main data provider and the system administrator. Port information platforms are among the innovation areas for infrastructural technologies at ports. An example of these systems is the "Smart Port Logistics" system developed by SAP in 2016 and used by the Hamburg Port Authority. With smart solutions for traffic and goods flow, the Hamburg Port Authority aimed to boost the port's efficiency. The system combines the economic and ecological features of the port in three sub-sectors; traffic flows, infrastructure and goods flows. The establishment of an inter-modal port traffic center housing maritime, rail and road transport formed the basis for the networking of the traffic flow. Providing optimal data capture and rapid sharing of information and enabling logistics managers, carriers and agents to choose the most efficient means of transport for their goods, this intelligent network serves for smooth, efficient transport and flow of goods at the Port of Hamburg[30] .

Supply Chain Management: Containers are transported via various modes of transport (sea, rail and road) throughout the supply chain. Tracking systems covering the entire chain allow for increased visibility and traceability of the supply chain. An example of these systems is the Indian-based DMIC Trust-NEC Joint Venture (2016). The company aims to provide freighters and freight operators with logistics visualization services that enable them to perform real-time searches based on accurate location information, showing the location of containers transported by rail or road between Delhi and Mumbai. These efforts, which will contribute significantly to shortening delivery times, reducing inventory levels and improving the accuracy of production plans, includes RFID tagging of containers loaded and unloaded at the ports of Mumbai, installation of scanners/printers at locations such as port entrances and exits, toll booths on the highway between Delhi and Mumbai, and internal container warehouses where customs inspections and cargo reloads are carried out, and real-time collection of the location information with a cloud-based logistics visualization system[31].

Cyber Security: The increasing use of digital data in the maritime industry and the increase in internet dependency have brought along certain cyber security risks. Accordingly, the ports have started to take precautions. The most renowned example of these precautions is the Cyber Security Operations Center (CSOC), which was established at the port of Los Angeles in 2014. In 2020, the port implemented a multi-year collaboration agreement to design and operate a Port Cyber Resilience Center (CRC) to help protect its supply chain from cyber breaches. The agreement aims to improve the port's cybersecurity readiness and enhance communication of threats and cooperation within the supply chain ecosystem[32].

Internet of Things Development Initiatives: Various platforms have been established around the world in order to develop and monitor technologies related to maritime and port services, and some port authorities even provided direct financial and institutional support to these platforms. Examples include the Smart Port Challenge (2017) financed by the port authority in Singapore, and the BlockLab (2017) application developed in collaboration with the port and municipality. In the six-month practice in Singapore, start-ups and corporate firms were brought together to solve the problems identified in maritime, and an acceleration program was put in place[33]. BlockLab was launched with four innovation projects to create new solutions for the energy market. The goal is to accelerate the energy transformation with offshore wind power, the heat network of the Rotterdam port area, energy trade and the safe use of smart meters. With the formed committee, four of the twenty proposals were selected to receive funding for the

30 https://www.hamburg-port-authority.de/en/hpa-360/smartport

31 https://www.nec.com/en/press/201604/global_20160427_01.html

32 https://www.securitymagazine.com/articles/94172-port-of-los-angeles-to-secure-its-supply-chain-with-a-cyber-resilience-center

33 https://www.mpa.gov.sg/web/portal/home/maritime-companies/research-development/pier71/Smart-Port-Challenge

building of a prototype, with a plan to approve support for at least two of them.[34]

Container Monitoring / Tracking Systems: Containers can be remotely monitored with GPS (global positioning system), GSM (global system for mobile communications), and RFID (radio frequency identification) technologies. In addition to the location, it is also possible to monitor the container temperature (for refrigerated containers) both in road and maritime transport. The existence of such a system at ports provides significantly more efficiency. This minimizes potential errors in the regular checks performed by the port workers. A good example is the Remote Container Management application implemented by Maersk and Ericsson in 2016. With this cooperation, vital statistics of Maersk's fleet, such as temperature, location and power supply, can be transmitted via satellite. With the analysis of the information uploaded to the cloud at the central office, the need for human control of the containers is reduced, and more efficiency and speed is provided as well as security for the port workers.[35]

IoT Platform on Deck: Ship performance monitoring technologies increase the efficiency of ship operations. Ship-related data (navigation, machinery, etc.) are transferred to the data center on land in real time for analysis. An example of this application is the "Onboard IoT Platform" developed in 2018 by a consortium of technology companies from Japan and Norway (NYK-MTI-NTT-NTT DATA). Aiming to provide remote management and distribution from land offices, this system enables the collection, monitoring and sharing of comprehensive data between the ship and the shore. The data includes information on the operational status and performance of offshore ships [36].

Smart Lighting: Smart lighting technology is widely used in buildings, at home and on the streets. This technology enables dynamic dimming and remote access. The implementation of these technologies at port areas and on roads not only saves energy, but also increases employee and visitor safety. Examples include the "Dynamic Real-Time Lighting" system used at the Noatum Container Terminal in Valencia, Spain since 2015 (Ingenieria de Aplicaciones Energeticas SLU), and the "Intelligent Street Lighting" system used at the Port of Moerdijk in the Netherlands since 2018 (TVILIGHT-Dynniq Moerdijk).

FIGURE 11. Port of Noatum (Spain) Dynamic Lighting System[37]

34 https://www.blocklab.nl/four-energy-innovation-projects-launched/

35 https://internetofbusiness.com/maersk-ericsson-iot-success/

36 https://safety4sea.com/japanese-partners-test-next-generation-iot-platform/

37 https://www.valenciaport.com/en/the-sea-terminals-project-designs-a-dynamic-real-time-lighting-system-for-port-terminals/

The system in Valencia has enabled the smart and efficient management and reduction of energy consumption in lighting. According to the results, the estimated savings of the system can reach approximately 80 percent of the current energy consumption and costs, with the savings enabling returns of less than two years[38].

With the goal of reducing its operational costs, the Port of Moerdijk has also switched to smart lighting technology to illuminate an industrial zone of more than 2,600 hectares. With connected and sensor-based exterior lighting, the port's energy consumption has been reduced, safety has been increased for employees and visitors, and port sustainability has been improved. The combination of new LED lamps with dynamic dimming and remote control options was considered to be an optimal investment by port authorities[39].

Equipment Monitoring: KSensors mounted on the container handling equipment allow for the collection of key performance data, such as temperature changes and vibrations in the equipment. This data is analyzed in real time at monitoring centers, which ensures timely maintenance of port equipment. Examples include the "Equipment Monitoring" system used at the Port of Cartagena in Colombia since 2016 (IBM Cartagena), and the "Equipment Monitoring" system used at the DP World container terminal in London since 2017 (Equipment Monitoring, CHS Engineering Services-DP World London).

At the strategically located Port of Cartagena, located at the entrance of the Panama Canal, engine temperature, engine speed and working hours have been monitored for many years in order to increase efficiency and reduce maintenance costs. The implemented digital monitoring system has allowed real-time data and the ability to take immediate action. With the application, real-time data has been provided about the status and operation of more than 50 cranes and 180 trucks, increasing the efficiency and productivity of the fleet.[40]

Remote Equipment Control [41]: Equipment used in container handling can be controlled remotely. This enables operators to work in a safe and ergonomic office environment, increasing employee safety and job satisfaction in the process. An operator can use different equipment at different times, thus increasing occupational safety and operator productivity. Examples include the remote access applications developed by Siemens and ABB. With the help of the newest camera zoom technologies, the operator is able to work in a comfortable and safe environment, and perform the necessary actions to initiate the process and control the automatic movements.

FIGURE 12. Remote Crane Control Operator[42]

38 https://www.valenciaport.com/en/noatum-runs-real-time-dynamic-lighting-system-tests-in-its-valencia-terminal/

39 https://tvilight.com/tvilight-and-dynniq-strengthen-partnership-supply-intelligent-street-lighting-to-port-of-moerdijk/

40 https://www.ibm.com/blogs/internet-of-things/iot-shipping-lines/

41 In our country, this technology is used by the DP World Yarımca terminal.

42 https://w3.siemens.com/mcms/mc-solutions/en/mechanical-engineering/crane-solutions/remote-control-system/pages/remote-control-operation-system.aspx

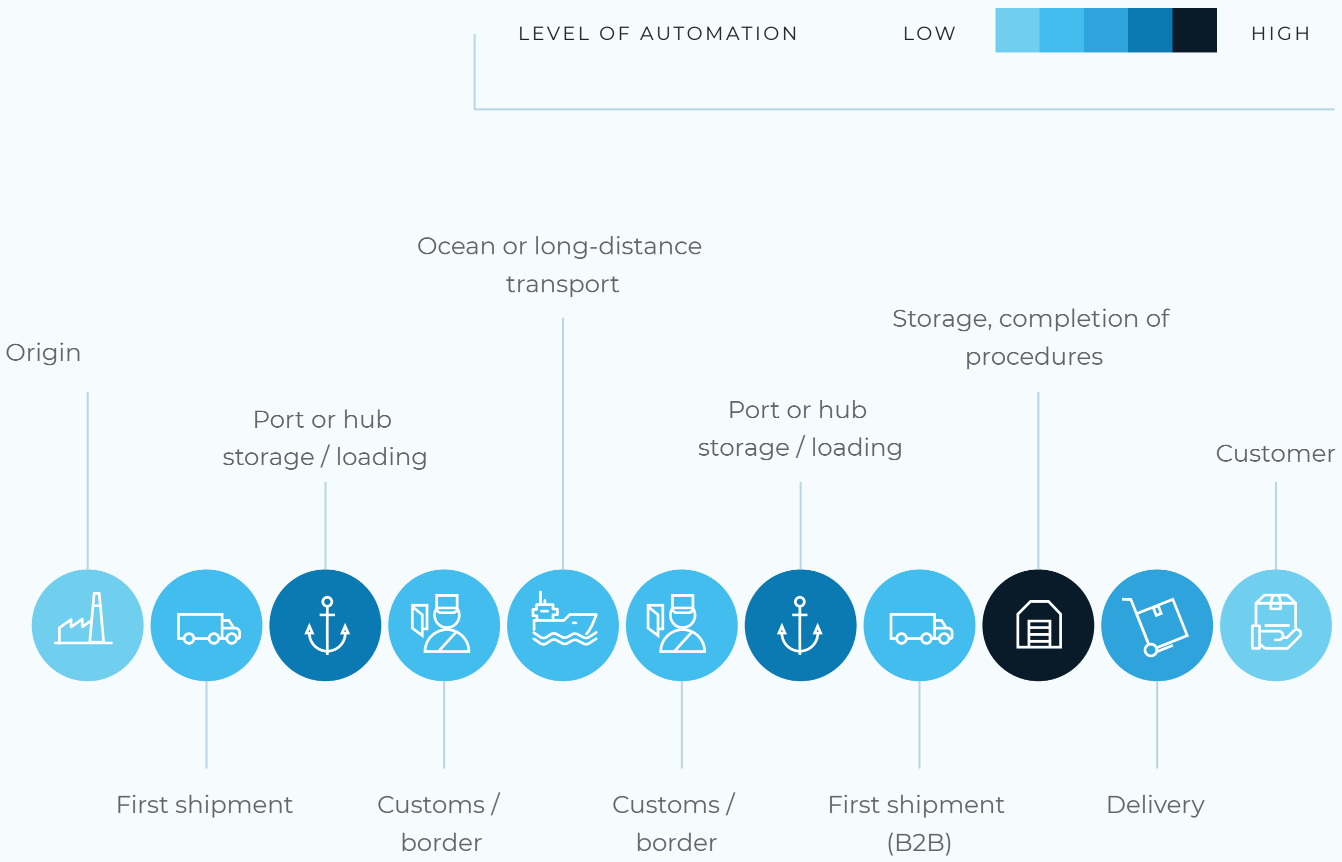
Automation: Port automation applications have been implemented for a long time, especially in container terminals. While some terminals carry out the handling process with manual operations, some terminals are fully automated. Examples include the "autonomous feeder ship and autonomous container yard" application, which was developed in 2018 with the cooperation of Kalmar Industries, a Finnish supplier of port equipment, digital solutions and tracking systems, and Yara International, the Norwegian multinational chemical company. Accordingly, the pier of Porsgrunn in Norway has adopted a fully digitized container handling solution, including a fully automated, rail-mounted gantry crane for loading, unloading and container storage management. With the help of autonomous equipment, software and services, operations can be carried out autonomously, at low cost and with zero emissions.[43]

43 https://www.ibm.com/blogs/internet-of-things/iot-shipping-lines/

2.5. Port Automation (Smart Ports)

The ultimate goal of port automation is to eliminate human error in operations, optimize all port operation processes, and minimize the ports' environmental effects. However, the expectations for the supply chain, the costs of the transition to automation processes and the difficulties of adaptation in both human resources and equipment affect the speed of the transition process.

FIGURE 13. Level of Automation in Global Supply Chains[44]



44 McKinsey&Company, Automation in logistics:Big opportunity, bigger uncertainty, 2019

The definition and scope of automation may differ across industries. In terms of port administration, port automation has five elements[45]:

- **Automated Equipment:** Typically, port automation includes cranes, stacking and internal transport equipment, and gate automation. These technologies have evolved over time, and are now successfully implemented across ports. With this equipment, port operations are carried out more consistently and operational disruptions are minimized.
- **Equipment Control Systems:** The systems that control the machinery and equipment used at the port provide error-free execution of operations, and accelerate decision-making with real-time data collection.
- **Terminal Control Tower:** Control towers (or offices) allow the entire port to be optimally managed and coordinated. In doing so, they create workflows, optimize vehicle routes, monitor and control flows, give work instructions to equipment, while providing real-time feedback at the same time.
- **Human-Machine Interaction:** The widespread use of robots and other automated equipment increases their interaction with each other and with the people at the ports. Accelerating the operations at port areas, which are rather dangerous, and having the operations carried out by robots through machine learning are both imperative for occupational safety.
- **Interaction with the Port Community:** The real-time and uninterrupted sharing of data from the port area offers more efficient communication with the parties on land and sea. Port that are able to digitize their processes and make this interaction transparent stand out from the other parties in the supply chain (such as shipowners, logistics service providers, freight buyers, customs officers, etc.).

Container terminals are highly automated, as they are more structured and predictable than other freight terminals. It is estimated that there are a total of 47 semi- or fully automated container terminals in the world today. This number represents approximately 3 percent of all container terminals in the world[46].

Semi- or fully automated ports across the world are located at the start, end or major transfer centers of the global supply chains with heavy cargo handling. That is why automation investments are progressing more slowly in intermediate locations such as Türkiye.

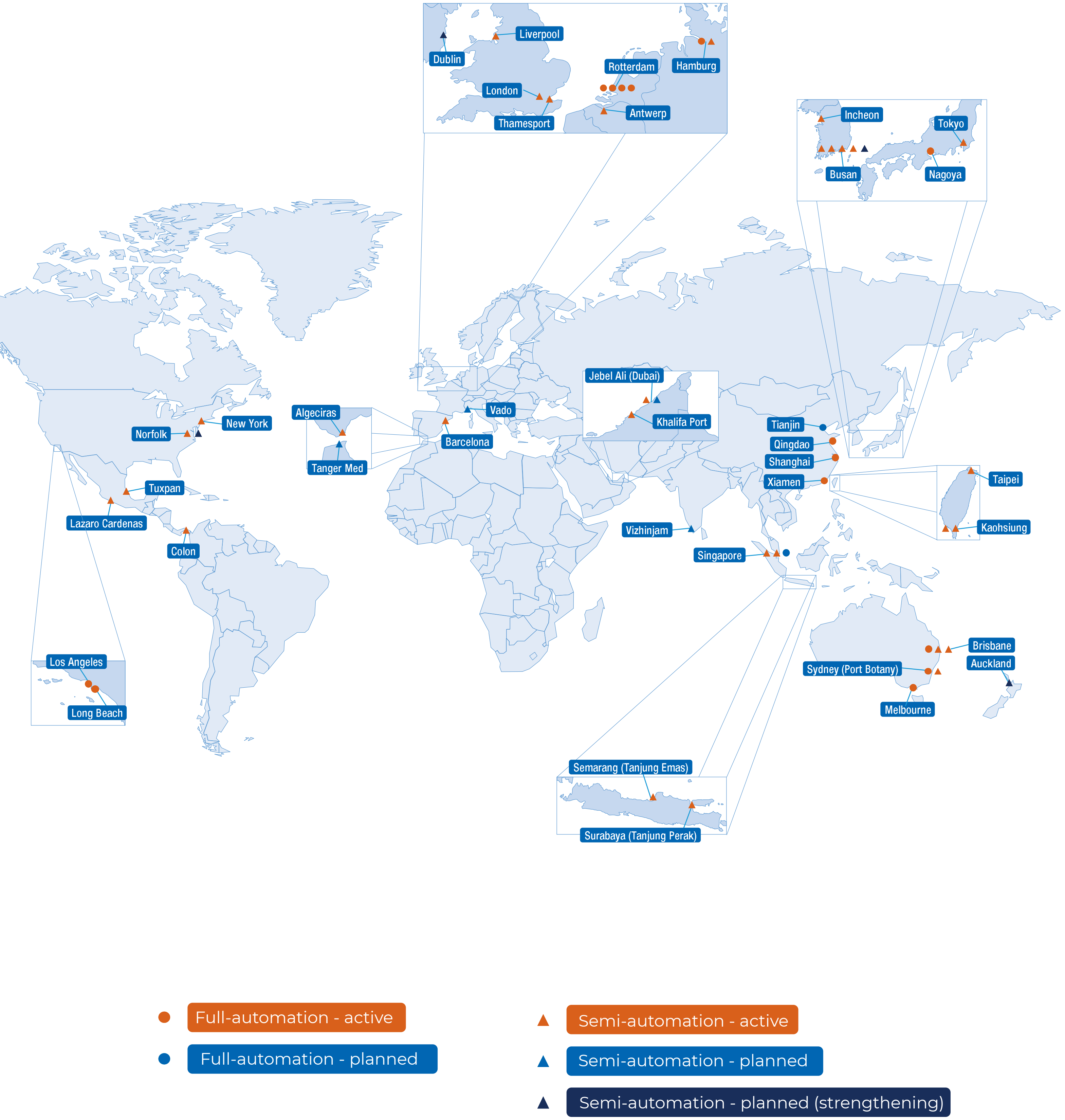
The reasons for automating the port services industry are rather clear; reduced labor costs and carbon emissions. Automated ports are free from human errors and able to provide uninterrupted service. In other words, the lights-out factories of the maritime transport industry are automated ports.

While it can be said that automation applications in the port services industry have progressed relatively slowly compared to other industries, things have accelerated in recent years. Although the transition to automation brings high investment costs for ports, this transition reduces the operating costs at ports by 25 percent to 55 percent, and increases efficiency by 10 percent to 35 percent.

45 McKinsey&Company, The Future of Automated Ports, 2018

46 https://www.icontainers.com/us/2018/10/09/the-future-of-automation-at-terminals-and-ports/

FIGURE 14. Ports Operated and Planned in Semi- and Full-Automation



2.6. Port 4.0

The impact of Industry 4.0 on all production and service industries is categorized under “Port 4.0” for port services. Service production processes at ports into phases can be categorized under the following phases:

- **Port 1.0:** Yard and dock cranes operate independently of each other, and the coordination of site workers and site operation processes is poor.
- **Port 2.0:** Operations are carried out in a process-oriented manner. Operators stationed in the control tower organize and manage all port operation processes.
- **Port 3.0:** Operational processes are optimized with automated equipment and algorithms, and human-centered operations are restricted and replaced by machine and equipment-oriented process designs.
- **Port 4.0:** All actors in the supply chain are able to physically monitor cargo flow, while information and operation flows are digitally managed with a focus on efficiency and speed. Terminal operators, road and rail logistics companies, logistics service providers (freight forwarders) and freight owners (exporters-importers) are interconnected for the optimization of all processes within the ecosystem.

As the description implies, Port 4.0 is a system that includes not only in-port developments, but also the integration of actors from all aspects of the process.

2.7. Developments in Sustainability and Environmental Protection

Maritime transport has a share of 2.5 to 3 percent in total greenhouse gas emissions[47]. Concrete measures have been taken for both ships and ports to reduce this rate in the future.

The IMO 2020 regulation introduced by the World Maritime Organization, which came into effect as of January 1 , 2020 and reduced the permitted sulfur emission limit from 3.5 percent to 0.5 percent outside of emission control areas, has been one of the most significant steps for sustainability regulations in the industry[48]. In order to comply with this regulation, shipowners have switched to using liquefied natural gas (LNG) instead of liquid fuels. For instance, French shipowner CMA CGM, one of the world's largest container line operators, received its ships running on LNG fuel with 22,000 TEU capacity at the beginning of 2020, and started using the ships in its operations[49].

Environmental pressure is mounting; not only for transport companies, but for ports as well. Ports are trying to reduce their carbon emissions by using equipment with electricity or alternative fuels instead of diesel-powered ones. In addition, some ports in countries such as the UK, Netherlands and Finland have started implementing tariff discounts to encourage ships with lower emissions. Ports need to take environmentally friendly and sustainable steps to gain competitive advantage in the future. In fact, it is observed that sustainability investments are effective in ensuring customer satisfaction and loyalty in maritime industries[50].

Cruise ships in particular continue to operate ship machinery and all related systems so that the guests staying on the ship at the visited ports can receive the same quality services during the cruise. This causes the level of carbon emissions to stay the same, while it should normally decrease when the ship is docked. In some cruise tourism ports, ships are provided with electricity (cold ironing) during their stay at the port (to prevent fuel use)[51]. In doing so, the exhaust gas emissions of ships are reduced during their stay at ports.

FIGURE 15. Bir Kıyı Güç Ünitesi

47 UNCTAD Maritime Review, 2019

48 IMO 2020 Sulphur Regulation

49 https://www.cmacgm-group.com/en/news-medias/cma-cgm-containerships-nord-delivery

50 Yuen, K. F., Wang, X., Wong, Y. D., & Zhou, Q. (2018). The effect of sustainable shipping practices on shippers' loyalty: The mediating role of perceived value, trust and transaction cost. *Transportation Research Part E: Logistics and Transportation Review*, *116*, 123-135.

51 https://www.maritime-executive.com/features/is-cold-ironing-redundant-now

Other developments in the field of sustainability include the recently built logistics centers and dry ports, which are expected to become more widespread in the future. Dry ports are established in the hinterland of the ports for procedures such as customs clearance, container loading and unloading and other logistics activities. Dry ports usually have direct inland connection (often by rail) with ports. With direct port connection, these logistics centers offer significant advantages for ports and their hinterlands. A study conducted in Finland shows that dry ports directly connected to the port by rail significantly reduce carbon dioxide emissions and transport costs[52]. Another academic study conducted in the port of Gothenburg in Sweden emphasizes that the use of dry ports reduces carbon dioxide emissions by 25 percent, while reducing port congestion and truck waiting times[53].

52 Lättilä, L., Henttu, V., & Hilmola, O. P. (2013). Hinterland operations of sea ports do matter: Dry port usage effects on transportation costs and CO2 emissions. Transportation Research Part E: Logistics and Transportation Review, 55, 23-42.

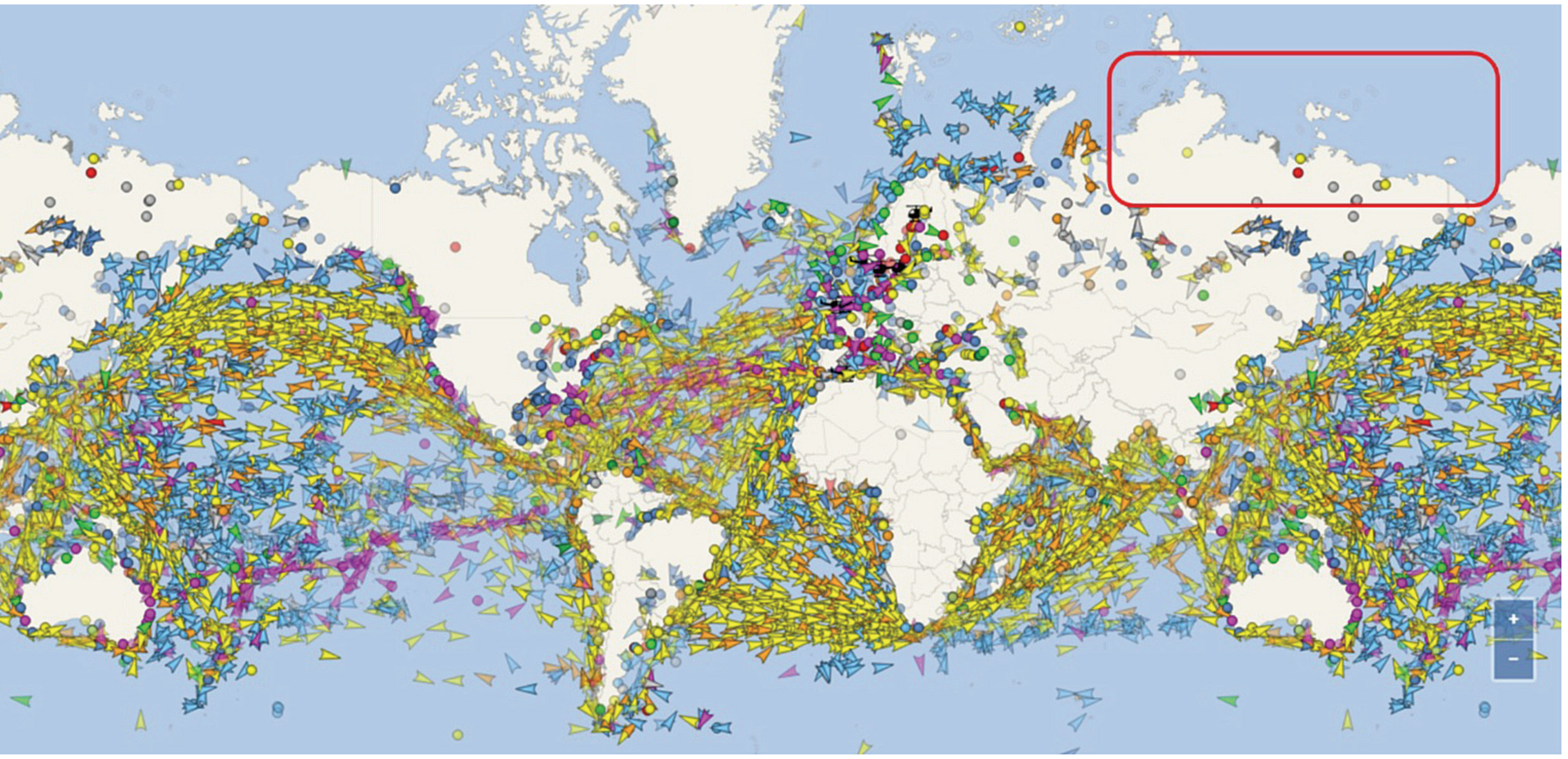
53 Roso, V. (2007). Evaluation of the dry port concept from an environmental perspective: A note. *Transportation Research Part D: Transport and Environment*, *12*(7), 523-527.

2.8. Northern Sea Routes

Due to global warming and the melting of the glaciers, the use of sea routes that could not be used widely for trade operations has become more prominent. Accordingly, the IMO announced the Arctic Shipping Routes consisting of four routes in 2014. The first of these routes is the "Northern Sea Route," which connects Asia and Europe from the north of Siberia. Other routes are the "Northwest Passage," which starts from Asia, crosses the Bering Strait and reaches the Americas via the Arctic coasts of the United States and Canada, the "Arctic Bridge," which connects North America to Europe from the south of Greenland, and the "Transpolar Sea Route," which goes right through the middle of the North Pole and connects the Bering Strait to Europe[54]. The Arctic Bridge and Transpolar Sea Route are currently in the pipeline. However, services are carried out with icebreakers on the Northwest Passage and the Northern Sea Route throughout the year. Examination of the current global ship traffic in Figure 13 reveals that there is no ship traffic in the northern region of Russia.

It is foreseen that all of the aforementioned routes will be used intensively by 2050[55]. In fact, countries such as the United States, Canada, Japan and South Korea, and especially China and Russia, are increasing their logistics investments in the region.

FIGURE 16. Ship Traffic on Northern Routes on a screenshot from vesselfinder.com



54 https://transportgeography.org/?page_id=412

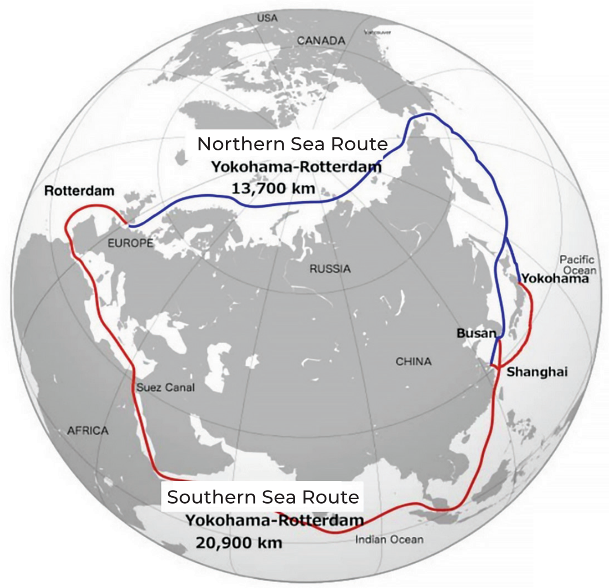
55 Melia, N. & Haines, K. & Hawkins, E. (2017). Future of the Sea: Implications from Opening Arctic Sea Routes. Foresight, Government Office for Science, UK

e most active route is the Northern Sea Route due to trial voyages. While the total distance traveled by a ship from the Port of Rotterdam Port in the Netherlands to the Port of Yokohama in Japan by passing through the Suez Canal is 20,900 km under normal circumstances, the distance is shortened by approximately 35 percent to 13,700 km when the same shiptakes the Northern Sea Route.[56]

Arctic routes, which particularly stand out as alternatives to the Far East-Europe main maritime trade route frequented by our country, attract the attention of shipowners for many reasons. The active use of these routes poses a threat to the market, and especially for many ports located on the Mediterranean. After the 2050s, it can be expected that the Northern Sea Route, which will replace the Far East-Europe route that includes the Mediterranean, will be vital for the future of the ports on the Far East-Europe route. However, it should be noted that developments in the Belt and Road Initiative will determine just how frequently the Northern Sea Route will be used[57].

FIGURE 17. Arctic Sea Routes[58]

FIGURE 18. Comparison of Northern Sea Route and the Current Route[59]



56 Moorman, Y. & Stoel, E. & Heemskerk, K. & Mermands, S. (2016). Arctic routing: From Rotterdam to Yokohama via the Arctic or San Francisco via Arctic, Rotterdam Mainport University (Project)

57 https://www.reuters.com/article/us-arctic-shipping-maersk-idUSKCN1L91BR

58 https://transportgeography.org/?page_id=412

59 Bossche, M., Hussen, K., Korte, T., Janse, R. and Jong, O. (2019). Prospects and Impacts of commercial navigation along the Northern Sea Route.

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