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Determination of Ship Length and Draft on the Planning Stage of Cruise Ports in Türkiye

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Abstract

The evolution of cruise tourism, despite facing unprecedented challenges from the Covid-19 pandemic, has shown resilience, with a rapid recovery observed in 2022. This manuscript emphasizes the significance of analyzing cruise ship length and draft data for Turkish ports to facilitate effective development planning. Despite data availability challenges, percentiles of ship lengths and drafts have been established, offering insights into port capacity and future infrastructure requirements. The examination of ship length and draft requirements highlights the diverse needs of ports from Alanya to Trabzon. Continuous monitoring and adjustment of development plans are essential to adapt to evolving industry trends, such as the increasing size of cruise ships. Projections indicate a consistent upward trend in ship sizes, emphasizing the need for forward-looking investment strategies. This study provides a foundation for informed decision-making in port development, offering insights to optimize port efficiency and competitiveness. By assessing regional effects and proposing pragmatic investment approaches, the manuscript serves as a valuable resource for guiding future infrastructure investments in Türkiye's maritime industry, ensuring its sustainable growth and competitiveness.

Keywords: Cruise Port, Ship Length, Ship Draft, Development Plan, Infrastructure Investment.

1. Introduction

Cruise tourism in the world started towards the end of the 1960s. The establishment of the world's cruise companies, such as NCL (Norwegian Cruise Line-1966), RCI (Royal Caribbean International-1968) and CCL (Carnival Cruise Lines-1972) coincided with these dates [1]. Cruise tourism is a type of tourism that allows passengers to accommodate, eat, drink, have fun, do activities and visit more than one settlement at the same sea travel.

Approximately 30 million people traveled by cruise, in 2019. The yearly change in total cruise tourism passengers in the world has been compiled between the years 2003 and 2022 [2 - 9]. There is a significant decrease in number of passengers in the cruise industry in 2020 and 2021 due to the Covid-19 pandemic (Fig. 1), while the total number of passengers increased by approximately 1,000,000 (~7%) passengers each year before the pandemic.

The coefficient of determination is 0.98 in the linear regression line for the total number of cruise passengers between the years 2003 and 2019, when the Covid-19 pandemic is not taken into account. This shows that the total number of cruise passengers between 2003 and 2019 is consistent with the linear regression line (shown in the dashed red line in the Fig. 1). The number of passengers, which decreased due to the Covid-19 pandemic, shows a rapid recovery in 2022. It is expected that the increase in passenger numbers will continue and the number of

passengers will exceed 30 million in 2023. It is also expected that the number of passengers will converge estimated linear regression line over time.

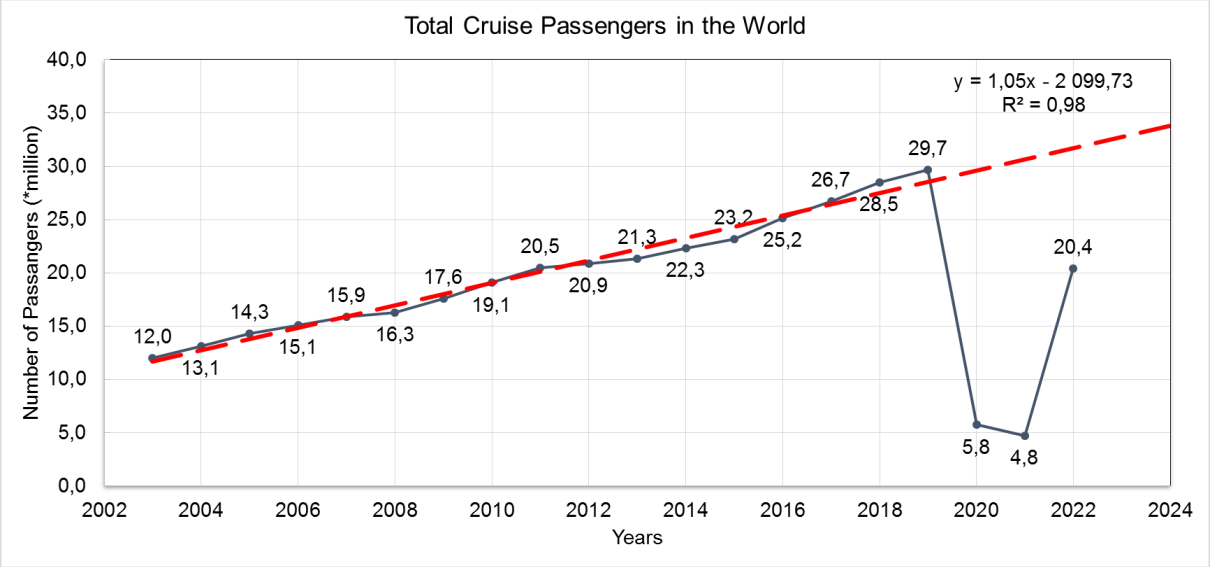

Fig. 1. Total cruise tourism passengers in the world

Cruise tourism in the world is organized in many regions. The most preferred regions are the Caribbean-Bahamas-Bermuda, Central and Western Mediterranean, Northern Europe, North America West Coast, Eastern Mediterranean, Asia and China, …etc. in 2022. Approximately 1,13 million passengers (~5.6%) traveled to the Eastern Mediterranean and ~2,6 million passengers (~12.9%) traveled to Central and Western Mediterranean [10] out of a total of ~20,4 million passengers in the world.

Türkiye's cruise ports are mostly located in the eastern Mediterranean region. It is seen that the highest number of ships was 1,615 in 2011 and the highest number of passengers was 2,256,053 in 2013 (Table 1), when the number of ships and passengers arriving at Turkish ports between 2003 and 2023 [11, 12] is analyzed.

There is a decrease in the total number of ships from 2016 to 2022, due to the construction of the Galataport project between 2016 and 2021 and the Covid-19 pandemic. It is seen that Istanbul, which is an important center of attraction, has also negatively affected other cruise ports in Türkiye in this duration. However, it is estimated that the number of cruise ships and passengers visiting Turkish ports will continue to increase in the coming years, in parallel with the increase in the number of cruise passengers in the world.

The length and draft information of the cruise ships that will be served in the ports of Türkiye in the coming years is important in order to make development planning. Therefore, the length and draft of cruise ships arriving at Turkish ports have been compiled and analyzed. Thus, it is aimed to estimate the length and draft of cruise ships to be served in existing and planning ports.

Table 1. Total number of cruise ships and passengers arriving at Turkish ports

Years	Number of Ships	Number of Passengers
2003	887	581,840
2004	927	645,264
2005	1,048	757,563
2006	1,317	1,016,314
2007	1,421	1,368,400
2008	1,612	1,605,372
2009	1,328	1,484,194
2010	1,368	1,719,098
2011	1,615	2,190,098
2012	1,541	2,098,381
2013	1,530	2,259,053
2014	1,401	1,792,298
2015	1,440	1,888,522
2016	578	626,840
2017	307	306,485
2018	247	213,771
2019	344	300,896
2020	5	1,824
2021	78	45,362
2022	993	1,010,767
2023	1,192	1,542,522

The ship length and draft are significant parameters that will affect the amount of investment in the planning of a cruise port. The appropriate selection of the ship length and draft influences the payback period of the investment over the economic life of the cruise port. Selecting values larger than necessary will increase the amount of investment, while selecting values smaller than necessary will result in the inability to service the ships. In this study, it was intended to provide ideas and guidance for the existing and planned cruise ports in Turkey.

The data used in the research were verified by checking the IMO numbers of the ships. The data are compiled according to the schedules of cruise ships arriving at the ports of Türkiye. The results of the study can be validated by comparing them with the values that will be realized in the following years. Evaluations can be made based on the differences between the estimates and the actual values.

2. Material and Method

Data on cruise ship arrivals at Turkish cruise ports have not been archived regularly in the past. The arrival and departure dates and the ship name of the cruise ships coming to Alanya, Antalya, Bodrum, Çanakkale, Çeşme, Dikili, İstanbul, İzmir, Kuşadası, Marmaris and Trabzon ports can be compiled between 2020 and 2024 [13]. The name of the cruise ships arriving at the studied ports were checked with the International Maritime Organization (IMO) number and after that the ship length and draft were obtained. Tables containing information on ship name, IMO number, passenger capacity, ship length and ship draft were prepared for each port. It was found that a total of 145 different ships arrived at the ports studied in Türkiye.

Prepared ship length and draft data were examined to check the fitness of the normal distribution for each port. As a result of the examination, it was seen that the ship length and ship draft values did not fit the normal distribution. Therefore, a suitable distribution was searched but no suitable distribution can be found. The objective is to determine the ship length and draft for planning the development of a port. Therefore, percentiles of ship lengths (Table

2) and ship drafts (Table 3) were prepared for the studied ports and Türkiye (the total ships of the studied ports). The ship length and draft values were calculated at the 10^{th}, 20^{th}, 30^{th}, 40^{th}, 50^{th}, 60^{th}, 70^{th}, 80^{th}, 90^{th}, 95^{th}, and 99^{th} percentiles for the studied ports and Türkiye. For example, the 10^{th} percentile of the ship length and draft is determined by estimating that only 10% of the ships arriving at the port are serviced. Thus, the length and draft of the ships have been obtained for these percentage values.

Upon closer examination of the ship lengths obtained from our study, it becomes evident that different ports have varying requirements to accommodate incoming ships at different percentile levels. For instance, at Alanya port, ship lengths of 264 meters, 294 meters, and approximately 295 meters correspond to accommodating 90%, 95%, and 99% of incoming ships, respectively (Table 2). Similarly, in Antalya port, ship lengths of 295 meters, approximately 296 meters, and 316 meters cater to the same percentile levels of accommodated ships. This pattern extends across other ports such as Bodrum, Çanakkale, Çeşme, Dikili, Istanbul, Kuşadası, Marmaris, Trabzon, and throughout Türkiye. Each port has its specific requirements, reflecting its unique characteristics and capacities. These findings underscore the importance of tailoring development plans to meet the diverse needs of each port, ensuring efficient and effective accommodation of cruise ships now and in the future.

Table 2. Percentiles of ship lengths (m) served in the studied ports and for all vessels in Turkish ports

Percentiles (%)	Alanya	Antalya	Bodrum	Çanakkale	Çeşme	Dikili
10	181.00	105.00	110.50	134.00	181.00	111.00
20	204.00	181.00	160.00	159.00	200.00	112.00
30	207.00	206.50	199.00	160.00	206.60	112.00
40	207.00	210.17	210.17	181.00	210.17	112.00
50	207.00	211.00	224.00	181.00	210.17	159.00
60	214.65	237.20	244.00	228.00	210.17	181.00
70	226.64	242.00	268.00	228.00	210.17	206.50
80	241.60	253.33	277.00	228.00	210.17	211.00
90	264.00	295.00	294.00	229.00	210.17	217.20
95	294.00	295.26	295.00	229.00	211.00	224.00
99	294.28	316.00	315.24	237.58	230.61	230.58
Percentiles (%)	**İstanbul**	**İzmir**	**Kuşadası**	**Marmaris**	**Trabzon**	**Türkiye**
10	159.00	181.00	134.00	181.00	162.01	134.00
20	181.00	207.00	159.00	207.00	186.78	160.00
30	206.70	216.00	186.00	207.00	204.70	200.00
40	219.00	238.00	215.00	210.17	209.60	210.17
50	238.00	247.50	215.00	236.31	211.00	215.00
60	249.00	293.00	228.60	264.00	211.00	230.61
70	293.00	324.00	285.08	264.00	211.00	264.00
80	294.00	333.00	294.00	264.00	222.77	294.00
90	330.00	333.00	295.00	264.00	232.23	295.26
95	333.00	333.00	318.20	295.00	234.11	330.00
99	339.24	333.00	347.00	296.05	235.62	340.00

Upon scrutinizing the ship drafts obtained through our meticulous study, it becomes conspicuously clear that a spectrum of draft depths is imperative to adequately harbor incoming vessels at various percentile levels. In the bustling port of Alanya, for instance, ship drafts measuring 8.00 meters, 8.61 meters, and 8.90 meters are requisite to accommodate 90%, 95%, and 99% of incoming ships, respectively (Table 3). Similarly, in the bustling Antalya port, the requisite ship drafts are 8.20 meters, 8.25 meters, and 8.26 meters to cater to the same percentile levels of accommodated ships. This trend extends seamlessly across other critical ports such as Bodrum, Çanakkale, Çeşme, Dikili, Istanbul, Kuşadası, Marmaris, Trabzon, and encompasses the entirety of Türkiye's maritime infrastructure. Each port exhibits distinct draft depth exigencies, mirroring its idiosyncratic characteristics and capacities. These discernments underscore the paramount importance of tailoring development strategies to meet the multifaceted needs of each port, thereby ensuring the seamless and efficient accommodation of cruise ships both in the present and as we chart our course into the future.

Table 3. Percentiles of ship drafts (m) served in the studied ports and for all vessels in Turkish ports

Percentiles (%)	Alanya	Antalya	Bodrum	Çanakkale	Çeşme	Dikili
10	6.00	4.30	4.90	4.30	5.95	5.80
20	6.20	6.00	6.00	5.50	6.20	6.00
30	6.20	6.32	6.00	5.95	6.60	6.00
40	6.20	6.80	6.80	5.95	6.80	6.00
50	7.20	7.13	7.00	6.00	6.80	6.00
60	7.50	7.30	7.20	6.70	6.80	6.56
70	7.70	7.60	7.75	6.70	6.80	6.71
80	7.80	7.70	8.00	6.70	6.80	7.05
90	8.00	8.20	8.20	6.80	6.80	7.41
95	8.61	8.25	8.38	6.80	7.21	7.54
99	8.90	8.26	8.60	7.96	7.80	7.75
Percentiles (%)	**İstanbul**	**İzmir**	**Kuşadası**	**Marmaris**	**Trabzon**	**Türkiye**
10	5.95	6.20	5.50	6.00	5.46	5.80
20	6.00	6.80	6.00	6.20	6.11	6.00
30	6.70	7.20	6.20	6.37	6.60	6.20
40	7.05	7.50	6.80	6.80	6.60	6.80
50	7.60	7.70	6.80	7.30	6.60	6.80
60	7.80	8.14	7.50	8.00	6.73	7.50
70	8.10	8.60	7.85	8.00	7.19	7.80
80	8.30	8.65	8.00	8.00	7.46	8.00
90	8.60	8.65	8.60	8.00	7.66	8.60
95	8.70	8.65	8.70	8.20	7.73	8.65
99	9.00	8.65	9.10	8.22	7.79	8.90

The size of a ship arriving at a port is influenced not only by the facilities provided by the port but also by the characteristics of the destination. Some ports receive large cruise ships while others receive smaller cruise ships. Thus, the study was able to assess the regional effect on ship length and ship draft. In addition, the size of ships has also been increasing over the years. The change in ship length and ship draft values over time has been compiled depending on the year of construction of the ships arriving at Turkish ports. It is estimated that the ship length will reach 400 meters in approximately 2050 according to the linear regression curve fitted

between ship length and year of construction (Fig. 2). An annual increase of 2 meters in ship length is expected considering the ship length increase by 50 meters in about 25 years.

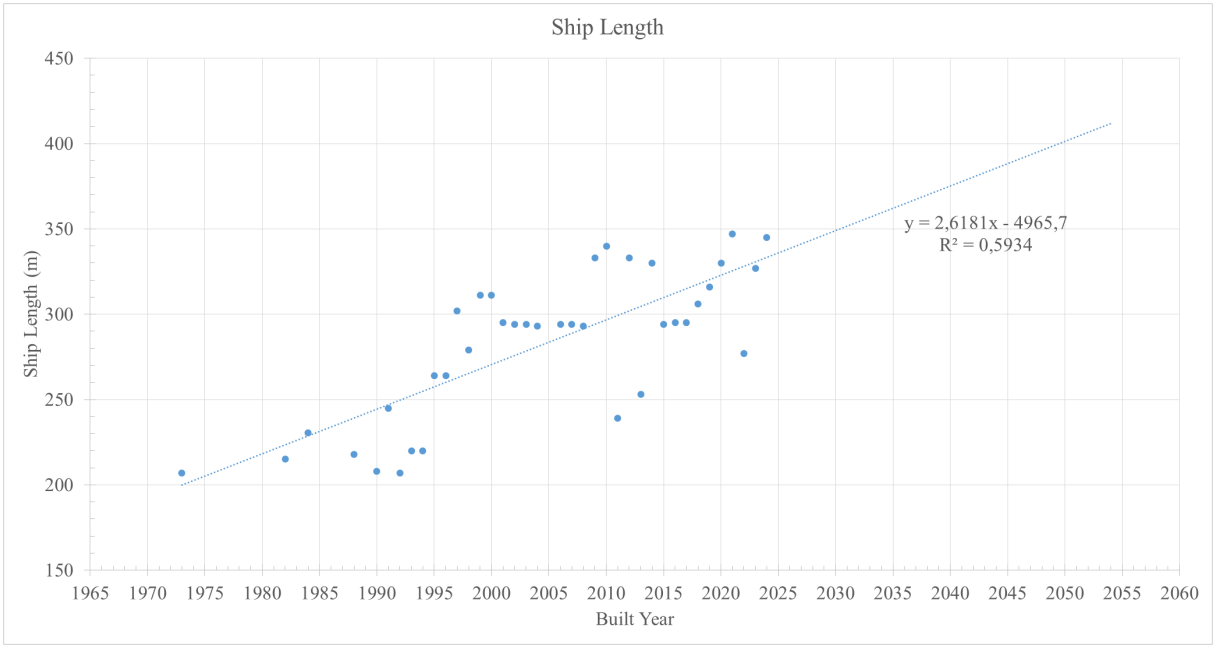

Fig. 2. Estimation of ship length

It is estimated that the ship draft will reach ~9.20 meters in approximately 2050 according to the linear regression curve fitted between ship draft and year of construction (Fig. 3). An annual increase of ~0.01 meters in ship draft is expected considering the ship draft increase by 0.20 meters in about 25 years.

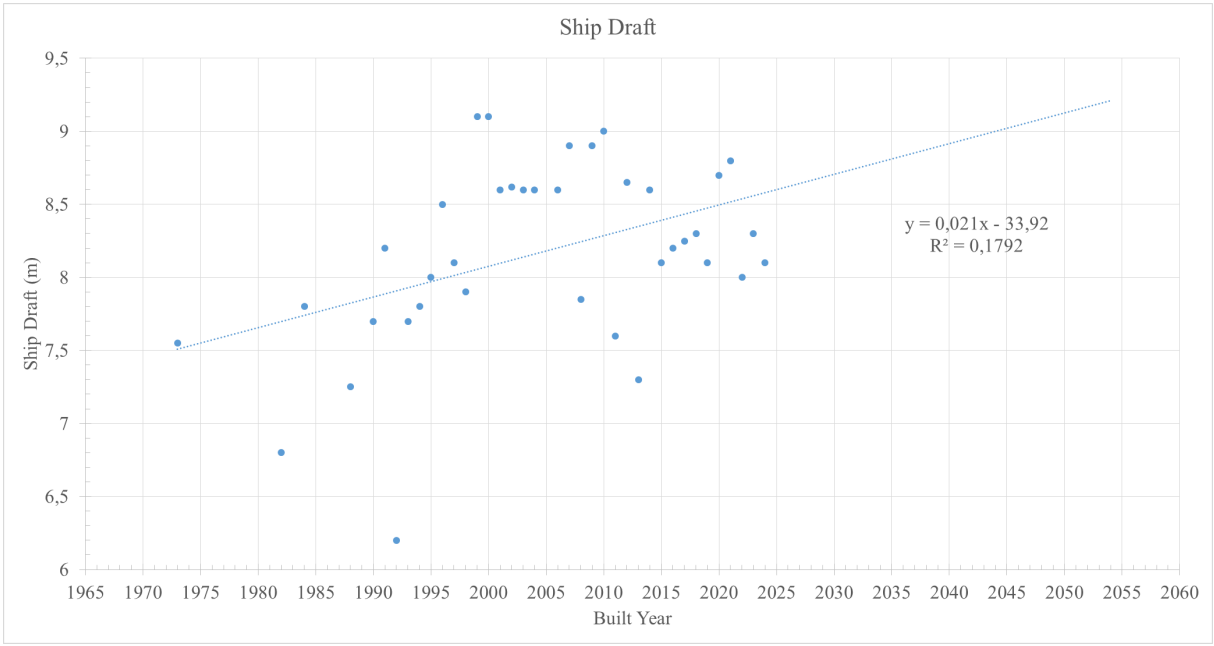

Fig. 3. Estimation of ship draft

The investment process (planning and construction) in a port in Türkiye takes approximately 10 years. It would be appropriate to study the investment plans of a port in 10-year periods considering this situation. Therefore, the demands of the ports in 10, 20 and 30 years from the current ship length and draft values (of the ports studied) were estimated by considering the increase in ship length and draft. Thus, the current infrastructure status of the ports was analyzed and investment needs were evaluated. In addition, investment needs are also presented in ports where the port infrastructure capacity has already been reached.

3. Results and Discussions

Some ports serve similar vessel lengths and drafts. There are 5 groups for ship length consist of Alanya-Marmaris, Antalya-Bodrum, Çanakkale-Trabzon, Çeşme-Dikili, İstanbul-İzmir-Kuşadası among the ports studied. The ship length is ~296 m in Alanya and Marmaris ports, ~316 m in Bodrum and Antalya ports, ~238 m in Çanakkale and Trabzon ports, ~231 m in Çeşme and Dikili ports, ~347 m in Istanbul, İzmir and Kuşadası ports in order to provide service to all ships. 4 groups are obtained as Alanya-Istanbul-Kusadasi, Antalya-Marmaris, Bodrum-Izmir, Çanakkale-Çeşme-Dikili-Trabzon considering the vessel drafts. The ship draft is ~9.10 m in Alanya-Istanbul-Kuşadası ports, ~8.26 m in Antalya-Marmaris ports, ~8.65 m in Bodrum-Izmir ports, and ~7.96 m in Çanakkale-Çeşme-Dikili-Trabzon ports in order to provide service to all ships.

Taking into account the escalation in ship length and the ship lengths discerned from the investigation (Table 2):

- The anticipated requirements of Alanya port over the next 10, 20, and 30 years, starting from the current ship length of approximately 295 m, are estimated to be 305 m, 315 m, and 325 m, respectively.

- For Antalya and Bodrum ports, prognostications for the next 10, 20, and 30 years, based on the current ship length of around 316 m, indicate potential demands of 326 m, 336 m, and 346 m, respectively.

- Çanakkale port's projected needs over the same timeframe, beginning from the existing ship length of roughly 238 m, may reach 248 m, 258 m, and 268 m, respectively.

- For Çeşme and Dikili ports, the anticipated requirements over the next 10, 20, and 30 years, with the current ship length at about 231 m, could be 241 m, 251 m, and 261 m, respectively.

- Istanbul port's demands are expected to rise over the next 10, 20, and 30 years, starting from the current ship length of about 340 m, with estimations standing at 350 m, 360 m, and 370 m, respectively.

- Similarly, Izmir port's needs, based on the current ship length of 333 m, are forecasted to increase to 343 m, 353 m, and 363 m over the same periods.

- Kuşadası port's anticipated demands over the next 10, 20, and 30 years, beginning from the current ship length of 347 m, are estimated to be 357 m, 367 m, and 377 m, respectively.

- For Marmaris port, projections indicate potential demands of 307 m, 317 m, and 327 m in 10, 20, and 30 years, respectively, considering the existing ship length of around 297 m.

- Lastly, Trabzon port's anticipated requirements over the same periods, starting from the current ship length of approximately 236 m, are estimated at 246 m, 256 m, and 266 m, respectively.

Taking into account the rise in ship draft and the ship drafts derived from the study (Table 3), the anticipated demands for various ports were determined as follows:

- Alanya port's requirements in 10, 20, and 30 years from the current ship draft of 8.9 m could be estimated at 9.0 m, 9.1 m, and 9.2 m, respectively.

- For Antalya and Marmaris ports, based on the current ship draft of approximately 8.3 m, demands may escalate to 8.4 m, 8.5 m, and 8.6 m over corresponding periods.

- Projections for Bodrum port, with a present ship draft of 8.6 m, suggest demands of 8.7 m, 8.8 m, and 8.9 m in 10, 20, and 30 years, respectively.

- In Çanakkale port, with the current ship draft at around 8.0 m, estimations indicate demands of 8.1 m, 8.2 m, and 8.3 m over the same time frame.

- Likewise, for Çeşme, Dikili, and Trabzon ports, with a current ship draft of 7.8 m, demands could be estimated at 7.9 m, 8.0 m, and 8.1 m in 10, 20, and 30 years, respectively.

- Istanbul port's demands, based on the current ship draft of 9.0 m, are estimated to increase to 9.1 m, 9.2 m, and 9.3 m over corresponding periods.

- For Izmir port, with the current ship draft standing at 8.7 m, demands may rise to 8.8 m, 8.9 m, and 9.0 m in 10, 20, and 30 years, respectively.

- Lastly, for Kuşadası port, with a current ship draft of 9.1 m, demands are projected to be 9.2 m, 9.3 m, and 9.4 m over corresponding periods.

It is recommended to make development plans for Izmir, Alanya, Çanakkale, Marmaris and Dikili ports in the short term and Bodrum, Kuşadası ports in the long term according to the data compiled from the official pages of the ports and the estimations considering the current situation of the ports.

4. Conclusions

The evolution of cruise tourism since its inception in the late 1960s has been marked by steady growth, despite unprecedented challenges posed by the Covid-19 pandemic. The industry's resilience was evident in the rapid recovery witnessed in 2022, with expectations of surpassing pre-pandemic passenger numbers in the near future.

Analyzing cruise ship length and draft data for Turkish ports is crucial for effective development planning. Despite challenges in data availability and distribution fitting,

percentiles of ship lengths and drafts have been determined to guide planning efforts, providing insights into port accommodation capacity and anticipating future infrastructure needs.

Examining ship length and draft requirements for various ports reveals a diverse range of vessel sizes and draft depths necessary to accommodate incoming ships. Each port, from Alanya to Trabzon, presents unique planning considerations based on specific requirements and limitations.

Continuous monitoring and adjustment of development plans are crucial to align with evolving industry trends, such as the increasing size of cruise ships over time. Proactive measures, guided by thorough data analysis, are essential to ensure Turkish ports remain competitive and capable of meeting the demands of the growing cruise tourism industry.

Ship sizes are growing all over the world. The change in ship sizes in Turkey has been examined in the context of cruise ships, and there is an increase similar to the global trend in ship sizes.

Projections indicate a consistent trend of increasing ship sizes over time, with estimations suggesting ship length will reach 400 meters and ship draft approximately 9.20 meters by 2050. This underscores the need for forward-looking investment strategies, considering the lengthy planning and construction process for port infrastructure in Türkiye.

In conclusion, this study lays a foundation for informed decision-making in port development, offering valuable insights to optimize the efficiency and effectiveness of Turkish ports in serving cruise ships both now and in the future. By assessing regional effects on ship length and draft, the study provides valuable insights into the changing landscape of maritime transportation and proposes a pragmatic approach to investment planning.

Ultimately, the recommendations presented in this study serve as a valuable resource for guiding future infrastructure investments, ensuring the sustainable growth and competitiveness of Türkiye's maritime industry.

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