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Analysis of selected disruptions occurring in ferry shipping

Analiza wybranych zakłóceń występujących w żegludze promowej

Keywords: ferry shipping, disruption, ferry terminal, maritime transport.

Słowa kluczowe: żegluga promowa, zakłócenie, terminal promowy, transport morski.

1. Introduction

Ferry shipping is considered as a specific type of regular shipping.¹ It complements the rail and road transport networks allowing to create a coherent transport system. Trucks and passenger vehicles, railway wagons and general cargo, as well as passengers may be carried using specialized ships.² These ships include passenger ferries, roll-on/roll-off ferries, car ferries and other. In addition, ferry services constitute an important element of land and sea

¹ Kujawa, Jerzy. Organizacja i technika transportu morskiego. Gdańsk: Wydawnictwo Uniwersytetu Gdańskiego, 2015.

² Urbanyi-Popiołek, Ilona and Klopott, Magdalena. „Nowe Wyzwania dla Żeglugi Bilskiego zasięgu na Morzu Bałtyckim.” *Logistyka* 2 (2012): 747-756.; Høyem, Harald and Odeck, James. “Assessing the socially optimal capacity at a selection of Norwegian car ferry crossings.” *Case Studies on Transport Policy*, Vol. 10, issue 1, (2022): 41-59. DOI: 10.1016/j.cstp.2021.10.008.; Škurić, Maja, Maraš, Vladislav, Davidović, Tatjana and Radonjić, Aleksandar. “Optimal allocating and sizing of passenger ferry fleet in maritime transport.” *Research in Transportation Economics*, vol. 90,100868 (2021). DOI: 10.1016/j.retrec.2020.100868.

transport chains, supporting intermodal transport operations and travellers' movement between countries.³

Ferry shipping plays an important role in the sustainable development of transport.⁴ It is characterized by, among others:

- regularity of performed services,
- the use of specialized vessels–ferries,
- the need to use specialized infrastructure and equipment in ports and terminals to ensure efficient services for passengers and cargo handling,
- performing transport services based on agreements and specific transport tariffs, etc.⁵

In Poland, ferry connections are carried out from/to seaports that are of fundamental importance for the national economy. It should be emphasized that 90% of trade between the Scandinavian countries and Poland takes place using maritime transport.⁶ Thus, in the Baltic Sea region, ferry shipping is of great significance, which is also reflected by the activities performed by ferry carriers.

Market conditions, including high competition, impact the occurrence of various obstacles in ferry shipping operation, which in turn affects the transport companies' behaviour. The conducted literature analysis revealed that different disruptions in ferry services may occur. For example, the limitations in ferry traffic in 2020, caused by COVID-19 pandemic, were observed.⁷ Moreover, disturbances in ferry traffic due to weather conditions took place. Therefore, complex analysis of disruptions in ferry shipping is needed.

The aim of the presented study is to identify disruptions occurring in ferry traffic and analyse the causes of disruptions reported by selected carrier operating in ferry terminal in Świnoujście seaport (Poland). The ferry transport market in Poland was analysed, and the

³ Rydzkowski, Włodzimierz and Wojewódzka-Król, Krystyna, ed., *Transport* (Warszawa: PWN, 2009).; Kotowska, Izabela., Kotowska, Izabela., Mańkowska, Marta and Pluciński, Michał. *Morsko-ładowe łańcuchy transportowe*. Warszawa: Difin, 2016.; Høyem, Harald and Odeck, James. "Assessing the socially optimal capacity at a selection of Norwegian car ferry crossings." *Case Studies on Transport Policy*, Vol. 10, issue 1, (2022): 41-59. DOI: 10.1016/j.cstp.2021.10.008.

⁴ Kotowska, Izabela. (2015) "The Role of Ferry and Ro-Ro Shipping in Sustainable Development of Transport." *Review of Economic Perspectives*, vol.15, no.1, (2015): 35-48. DOI: 10.1515/revecp-2015-0010.

⁵ Kujawa, Jerzy. *Organizacja i technika transportu morskiego* (Gdańsk: Wydawnictwo Uniwersytetu Gdańskiego, 2015).

⁶ Rydzkowski, Włodzimierz and Wojewódzka-Król, Krystyna, ed., *Transport*, Warszawa: PWN, 2009.

⁷ Jones, Lora, Palumbo, Daniele and Brown, David. "Coronavirus: How the pandemic has changed the world economy". *BBC News*, (2021), accessed on 15 September 2023, <https://www.bbc.com/news/business-51706225>.; Jabeen, Sebastian, Farhan, Muhammad, Zaka, Muhammad Ahmad, Fiaz, Muhammad and Farasat, Mobina. "COVID and World Stock Markets: A Comprehensive Discussion." *Front Psychol*, vol. 12, (2021). DOI: 10.3389/fpsyg.2021.763346.; Urbanyi-Popiołek, Ilona. "Maritime tourism in the time of covid-19 pandemic in the Baltic Eea region – challenges for ferry and cruise operators." *Economic and Social Development: Book of Proceedings*, (2020): 397-405.

causes of disruptions in ferry traffic were examined based on data provided by the Unity Line Limited (Unity Line) shipowner, operated in the ferry terminal in Świnoujście.

2. Literature review

2.1. Characteristics of the ferry transport market in Poland

The transport policy of the European Union (EU) places great emphasis on the promotion of intermodal transport, environmental protection and the creation of a single European transport area, in which there is a wide network of connections between EU member states.⁸ Moreover, developing of modern infrastructure, intelligent IT systems and ticketing services, etc. support transport services evolution and create favourable conditions for the widespread use of ferry shipping in passenger and freight transport.⁹

In 2023 ferry connections in Poland were carried out by four shipowners/carriers, such as: Stena Line, TT-Line, Polish Baltic Shipping Co. (Polferries), Unity Line. These carriers offered their customers the transport services between selected ports of the Baltic Sea region on routes running, among others, through seaports in Świnoujście, Gdańsk and Gdynia (Fig. 1) to seaports located in Ystad, Trelleborg, Nynäshamn or Karlskrona (Sweden) and Copenhagen (Denmark).¹⁰

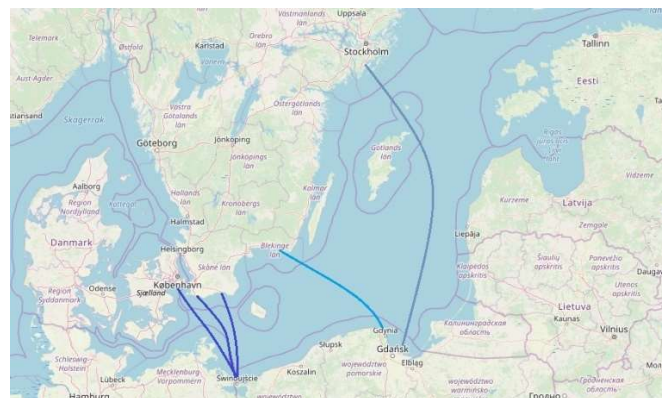


Figure 1. Ferry connections carried out in Polish seaports in 2023

Source: own study based on: Google Maps, <https://maps.google.com/>, accessed on 12 December 2023.

⁸ Troitton, David Romiro. "Transport policy in the European Union." MEST Journal, 3(2), (2015): 135-141. DOI: 10.12709/mest.03.03.02.15.

⁹ Biała Księga Transportu, Dyrekcja Generalna ds. Mobilności i Transportu, Luksemburg 2011: Komisja Europejska.

¹⁰ Polferries, <https://polferries.pl/>, accessed on 07 February 2023.; Unity Line, <https://www.unityline.pl/>, accessed on 07 February 2023 and 07 April 2023.; TT-Line, <https://www.ttline.com/pl/>, accessed on 07 February 2023; Stena Line, <https://www.stenaline.pl/>, accessed on 07 February 2023.

Over the last decade, a significant interest in ferry services in Poland has been observed. Figure 2 presents the international passenger traffic in Polish seaports in 2014-2022. It should be mentioned that the largest number of passengers serviced in the analysed years was noticed in the port of Świnoujście. From 2014 to 2022 this port handled 9 219 513 passengers in total. In turn, during 9-year period the port of Gdynia serviced 5 130 628 passengers, port of Gdańsk - 1 192 880.¹¹ A collapse in passenger transport in 2020 dealt with COVID-19 pandemic occurrence. The situation changed in 2021, when it was possible to travel taking into account the existing restrictions (including mandatory vaccinations, protective masks, limited number of passengers, increased disinfection efforts, etc.). It should be noted that ferry services are used not only by truck drivers, but also by tourists or people working outside their place of residence.

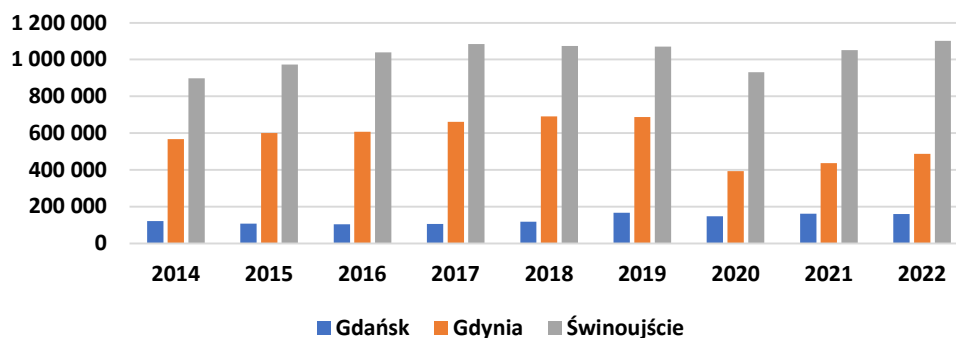


Figure 2. International passenger traffic in selected seaports in 2014-2022 (number of passengers)

Source: own study based on: Rocznik Statystyczny Gospodarki Morskiej 2018, Warszawa-Szczecin: Główny Urząd Statystyczny, 2018; Rocznik Statystyczny Gospodarki Morskiej 2022, Warszawa-Szczecin: Główny Urząd Statystyczny, 2022; Rocznik Statystyczny Gospodarki Morskiej 2023, Warszawa-Szczecin: Główny Urząd Statystyczny, 2023.

The port of Świnoujście is also the leader in the trucks handling, when compared to other Polish seaports (Fig. 3). While analysing the statistical data, an overall increase in the number of serviced trucks in this seaport over the analysed period 2014-2022 can be noticed. As in the case of international passenger traffic, a decrease in trucks handling in 2020 and 2022 was recorded. The reason for this downturn was the COVID-19 pandemic. Between

¹¹ Rocznik Statystyczny Gospodarki Morskiej 2018, Warszawa-Szczecin: Główny Urząd Statystyczny, 2018.; Rocznik Statystyczny Gospodarki Morskiej 2022, Warszawa-Szczecin: Główny Urząd Statystyczny, 2022.; Rocznik Statystyczny Gospodarki Morskiej 2023, Warszawa-Szczecin: Główny Urząd Statystyczny, 2023.

2014 and 2022 the port of Świnoujście handled 4 160 935 trucks, the port of Gdynia – 1 648 722 and Gdańsk – 190 163 vehicles.¹²

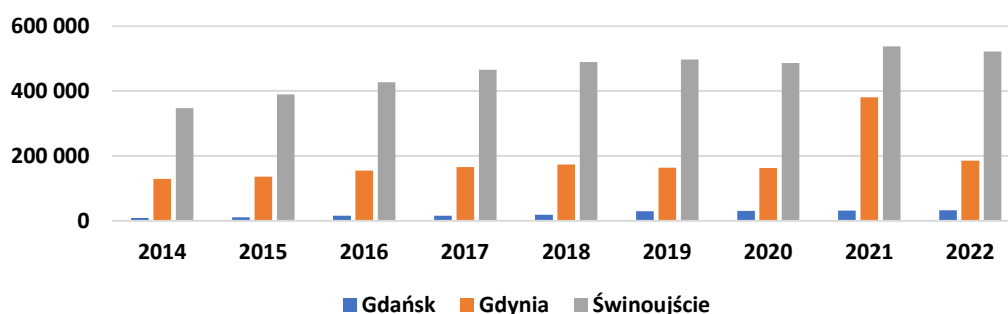


Figure 3. International truck traffic in selected seaports in 2014-2022 (number of trucks)

Source: own study based on: Rocznik Statystyczny Gospodarki Morskiej 2018, Warszawa-Szczecin: Główny Urząd Statystyczny, 2018; Rocznik Statystyczny Gospodarki Morskiej 2022, Warszawa-Szczecin: Główny Urząd Statystyczny, 2022; Rocznik Statystyczny Gospodarki Morskiej 2023, Warszawa-Szczecin: Główny Urząd Statystyczny, 2023.

In 2020, COVID-19 pandemic also contributed to a decrease in the number of passenger vehicles and motorcycles handled in Polish seaports (Fig. 4). During 9-year period the total number of passenger vehicles and motorcycles handled in port of Świnoujście was 2 257 862, in port of Gdynia- 925 280, in port of Gdansk – 572 647.

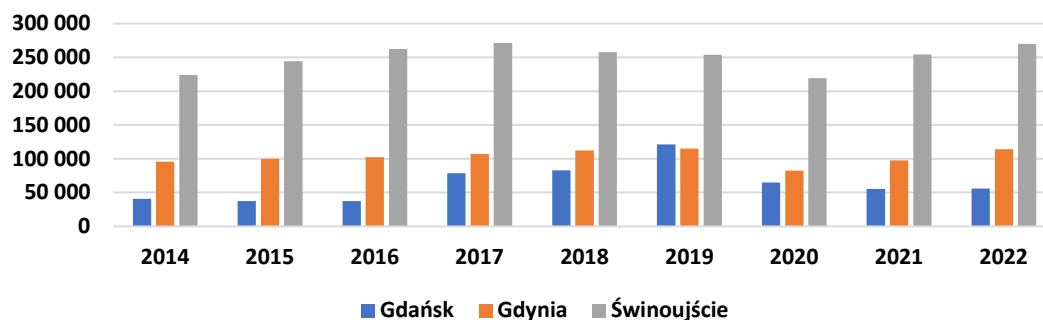


Figure 4. International traffic of passenger vehicles and motorcycles in selected seaports in 2014-2022 (number of passenger vehicles and motorcycles)

Source: own study based on: Rocznik Statystyczny Gospodarki Morskiej 2018, Warszawa-Szczecin: Główny Urząd Statystyczny, 2018; Rocznik Statystyczny Gospodarki Morskiej 2022, Warszawa-Szczecin: Główny Urząd Statystyczny, 2022; Rocznik Statystyczny Gospodarki Morskiej 2023, Warszawa-Szczecin: Główny Urząd Statystyczny, 2023.

¹² Rocznik Statystyczny Gospodarki Morskiej 2018, Warszawa-Szczecin: Główny Urząd Statystyczny, 2018.; Rocznik Statystyczny Gospodarki Morskiej 2022, Warszawa-Szczecin: Główny Urząd Statystyczny, 2022.; Rocznik Statystyczny Gospodarki Morskiej 2023, Warszawa-Szczecin: Główny Urząd Statystyczny, 2023.

To sum up, it can be stated that over the analysed 9 years a trend of an increase in the number of trucks handled was observed, which may be related to the development of international trade and favourable conditions for the expansion of intermodal transport services in Poland. The pandemic significantly impacted the international traffic of passengers, passenger vehicles and motorcycles, causing downturns in seaport transshipments. The leader in ferry traffic handling in Poland was the port in Świnoujście, where the Świnoujście Ferry Terminal Ltd. is located. In 2023 this terminal cooperated with three shipowners, such as Unity Line, TT-Line, Polferries¹³ and provided a wide range of services throughout the year.¹⁴

2.2. Division of disruptions occurring in ferry traffic

Various situations affecting ferries traffic may occur at ferry terminals. These situations may be referred to the disruptions, which are understood as unplanned or undesirable situations, which may result in the reorganization of ferry handling processes in the terminal. Disruption is also defined as "a violation of the established order or course of affairs, processes, etc."¹⁵ or "an unexpected phenomenon leading to interruption or at least delay in the tasks performance".¹⁶ Wieteska G. defined disruption as "an expected or unplanned event, causing unplanned negative deviations in the processes of delivering products and services carried out in accordance with the objectives of the organization".¹⁷

It can be assumed that disruption in ferry traffic is a situation that causes disorganization of the entities' service processes and leads to a delay or change in the manner of performing a given task, including loading/unloading the ferry and handling the transport means or servicing passengers inside the terminal. Disruptions occur in various modes of

¹³ Polferries, <https://polferries.pl/>, accessed on 07 February 2023.; Unity Line, <https://www.unityline.pl/>, accessed: on 07 February 2023 and 07 April 2023.; TT-Line, <https://www.ttline.com/pl/>, accessed: on 07 February 2023.

¹⁴ Terminal Promowy w Świnoujściu, <http://www.sft.pl/>, accessed on 14 February 2022.

¹⁵ Słownik Języka Polskiego PWN, <https://sjp.pwn.pl/>, accessed on 10 November 2023.

¹⁶ Konecka, Sylwia. "Determinanty ryzyka zakłóceń w łańcuchu dostaw." *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, 382, (2015): 66-79.

¹⁷ Wieteska, Grażyna. *Zarządzanie ryzykiem w łańcuchu dostaw na rynku B2B*, Warszawa: Difin, 2011.

transport, including air¹⁸, road¹⁹ and rail transport.²⁰ In addition, in the subject literature the disruptions occurring in intermodal transport were examined.²¹ It should be noted that available publications do not contain a comprehensive analysis of disruptions, the selected cases are mainly characterized.

Konecka S. reviewed the literature on features of disruptions in the supply chains and made an attempt to classify disruptions based on the attributes that characterize them (Table 1).²² In turn, Hoffa-Dąbrowska P. proposed the criteria for division disruptions of logistics processes.²³ The main causes of disruptions occurrence may be related to the natural environment (e.g., unfavourable weather conditions), technical and technological breakdowns, human activities.

Table 1. Examples of disruptions division

Example	Criterion
Example 1	- caused by the natural environment, e.g. blizzards, - caused by technical and technological breakdowns, e.g. failures of technical equipment, - caused by human activities, e.g. strikes, product recall.
Example 2	- impact strength, e.g. small, medium, large,

¹⁸ Ng, Kam K.H., Keung, K.L., Lee, Carman K.M. and Chow, Y.T. "A Large Neighbourhood Search Approach to Airline Schedule Disruption Recovery Problem." in: 2020 IEEE International Conference on Industrial Engineering and Engineering Management, (Singapore: IEEM, 2020), 600-604. DOI: 10.1109/IEEM45057.2020.9309768.; Kwasiborska, Anna and Kądzioła, Krzysztof. "Application of causal analysis of disruptions and the functional resonance analysis method (fram) in analyzing the risk of the baggage process." *Scientific Journal of Silesian University of Technology. Series Transport*, vol. 119, (2023): 63-81. DOI: 10.20858/sjsutst.2023.119.4.

¹⁹ Lu, Xiaohui, Chan, Faith Ka Shu and Chan, Hing Kai. "Investigation of Transport Logistics Disruptions from Urban Floods: A Case Study of the Chinese Coastal Megacity—Guangzhou, China." in: *Intelligent and Transformative Production in Pandemic Times. Lecture Notes in Production Engineering*, ed. Huang, Chin-Yin, Dekkers, Rob, Chiu, Shun Fung, Popescu, Daniela, and Quezada, Luis, (Cham: Springer, 2023), 637-647. DOI: 10.1007/978-3-031-18641-7_59.; Gurtu, Amulya. "Truck transport industry in the USA: challenges and likely disruptions." *International Journal of Logistics Systems and Management*, vol 44, issue 1, (2023): 46-58. DOI: 10.1504/IJLSM.2021.10036285.; Read, Gread J.M., McLean Scott, Thompson, J., Stanton, Neville A., Baber, Chris, Carden, Anthony and Salmon, Paul Matthew. "Managing the risks associated with technological disruption in the road transport system: a control structure modelling approach." *Ergonomics* 5 (2023): 1-17. DOI: 10.1080/00140139.2023.2226850.

²⁰ Pineda-Jaramillo, Juan and Viti, Francesco "Identifying the rail operating features associated to intermodal freight rail operation delays." *Transportation Research Part C: Emerging Technologies*, vol. 147, 103993 (2023). DOI: 10.1016/j.trc.2022.103993.; Monsuur, Fredrik, Enoch, Marcis, Quddus, Mohammed and Meek, Stuart. "Modelling the impact of rail delays on passenger satisfaction." *Transportation Research Part A: Policy and Practice*, vol. 152, (2021): 19-35. DOI: 10.1016/j.tra.2021.08.002.

²¹ Ke, Ginger Y. and Verman, Manish. "A framework to managing disruption risk in rail-truck intermodal transportation networks." *Transportation Research Part E: Logistics and Transportation Review*, vol. 153 (C), (2021), 102340. DOI: 10.1016/j.tre.2021.102340.; Akyüz, M. Hakan, Dekker, Rommert, and Sharif Azadeh, Shadi. "Partial and complete replanning of an intermodal logistic system under disruption." *Transportation Research Part E: Logistics and Transportation Review*, vol. 169, issue C, (2023): 102968. DOI: 10.1016/j.tre.2022.102968.

²² Konecka, Sylwia. "Determinanty ryzyka zakłóceń w łańcuchu dostaw." *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, 382, (2015): 66-79.

²³ Hoffa-Dąbrowska, Patrycja. „Metodyka modelowania zakłóceń procesów logistycznych.” PhD diss, Poznań: Politechnika Poznańska Wydział Inżynierii Zarządzania, 2016.

	<ul style="list-style-type: none"> - impact on supply chain links, e.g. related to one link or the whole supply chain, - the number of supply chain links that were affected at the same time by the disruption, - the duration of the disruptive event, e.g. short, medium, long. - the link responsible for the disruption, e.g. resulting from the fault of the carrier, supplier/subcontractor, recipient, etc.
Example 3	<ul style="list-style-type: none"> - location, close to suppliers, inside the company, close to customers, joint responsibility, - range of duration, - significance/volume of the losses caused by the disruption, e.g. small, medium, large, - cyclicalities of disruptions, - disruption profile – the dynamics of losses caused by the disruption during its occurrence, - level of consequences following the disruption – the level of stability achieved after the disruption has subsided.
Example 4	<ul style="list-style-type: none"> - category, e.g. planned, unplanned, - frequency of disruption e.g. every minute, hour, every day, every week, every month, every year, - type of occurrence, e.g. normal (related to daily activities carried out by the enterprise), abnormal (not related to daily activities performed by the enterprise), - severity of the disruption, e.g. insignificant, minor, routine, serious, critical, catastrophic, - probability of occurrence, e.g. unlikely, rare, occasional, probable, frequent, - cost, e.g. low, medium, high, - resources involved, e.g. small, medium, large, - source of disruption, e.g. known, unknown, - the impact of the disruption on supply chain planning, e.g. short-term plans, general plans, aggregated plans, strategic plans in the field of logistics, strategic plans at the business unit level, strategic plans at the corporate level, - type of flow within the supply chain, e.g. flow of information, goods, funds, - recommended actions against disruption, e.g. acceptance, avoidance, transfer, insurance, etc.

Source: own study based on: Konecka, Sylwia. "Determinanty ryzyka zakłóceń w łańcuchu dostaw." *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, 382, (2015): 66-79; Hoffa-Dąbrowska, Patrycja. „Metodyka modelowania zakłóceń procesów logistycznych.” PhD diss, Poznań: Politechnika Poznańska Wydział Inżynierii Zarządzania, 2016.

The factors affecting the occurrence of disruptions in seaports or ferry terminals are presented in Table 2. These are factors that can be known in advance and occur during the operation of ships, as well as those that may be unexpected. Infrastructural factors have a significant impact on the quality of ferry traffic, because seaport's quays must be adapted to service the calling ships, transport means and cargo. The occurrence of these factors may be related to bottlenecks existing at ferry terminals, for example, limited number of parking

places for trucks in the terminal or limited handling capacity, which may result in an extension of the service time required for vehicles service at the ferry terminal. Disruptions may impact the delays or cancelations of ferries.

Table 2. Examples of factors affecting the disruptions' occurrence

Factor	Description
Environmental	Unfavourable weather conditions, storm, fog, atmospheric precipitation, etc.
Technical and technological	Technical problems of transport vehicles and handling equipment, e.g. failure of ships' components, material failure and degradation, etc.
Human	Human mistakes caused by inattention, routine, non-compliance with procedures, etc.
Infrastructural	Infrastructure limitations, insufficient number of quays or parking lots, limited storage area, etc.
Organizational	Interruption within transport chains, delays in deliveries, non-compliance with the "Just in Time" rule, etc.
Economical	Lack of funds for the expansion or modernization of terminal's infrastructure, etc.
Informative	Inadequate communication, errors in information flow, commands, documents, etc.
Social	Strikes, war, terrorism, travel restrictions, pandemic, etc.
Cybercrime	Attacks/interceptions on electronic systems for the management of ports, terminals, ships, etc.

Source: own elaboration based on: Filina-Dawidowicz, Ludmiła, Selivanova, Alla, Moźdrzeń, Daria and Stankiewicz, Sara (2023) "Directions for Improving the Efficiency of Intermodal Transport." in: Smart Technologies in Urban Engineering. STUE 2022. Lecture Notes in Networks and Systems, ed. Arsenyeva, Olga, Romanova, Tatiana, Sukhonos, Maria, Tsegelynyk, Yevgen, (Cham: Springer, 2023), vol 536, 808-819. DOI:10.1007/978-3-031-20141-7_72; Unity Line, <https://www.unityline.pl/> [accessed: 07.04.2020; 07.02.2023]; Paulauskas, Vytaitas, Paulauskas, Donatas and Filina-Dawidowicz, Ludmiła. "Evaluation of Seaports and Terminals Possibilities to Adapt to Changes in Market and Economic Conditions." in: Transport Means 2022. Part II. Proceedings of the 26th International Conference, (Kaunas: Kauno Technologijos Universitetas, 2022), 617-622. DOI: 10.5755/e01.2351-7034.2022.P2.; Semenov, Iouri, Filina-Dawidowicz, Ludmiła and Trojanowski, Piotr. "Integrated approach to information analysis for planning the transport of sensitive cargo." Archives of Transport, vol. 51, issue 3, (2019): 65-76. DOI: 10.5604/01.3001.0013.6163.; Semenov, Iouri, Filina-Dawidowicz, Ludmiła, Wiktorowska-Jasik, Anna and Moźdrzeń, Daria. "The quality assessment of ro-pax ferries services: Research techniques and procedures." World Review of Intermodal Transportation Research, vol 10, issue 3, (2021): 202-224. DOI: 10.1504/WRITR.2021.117665.; Filina-Dawidowicz, Ludmiła., Cerenova-Bickova, Anna., Semenov, Iouri, Moźdrzeń Daria, Wiktorowska-Jasik Anna and Bickovs, Deniss. "Information support of cargo ferry transport: Case study of Latvia." Procedia Computer Science, vol 176, 163593 (2020): 2192-2201. DOI: 10.1016/j.procs.2020.09.256; Urbanyi-Popiolek, Ilona. "New Insights into the Ferry Business in the Turbulent Environment." European Research Studies Journal, vol. XXV, issue 4, (2022): 63-73. DOI: 10.35808/ersj/3067.; Bronk, Robert., and deWitte, Paula. "Maritime Cybersecurity: Meeting Threats to Globalization's Great Conveyor." Computational Methods in Applied Sciences, vol 56, (2022): 241-254. DOI: 10.24251/HICSS.2020.240.; Lehto, Maritti. "Cyber Security in Aviation, Maritime and Automotive." Computational Methods in Applied Sciences, vol. 54, (2020): 19-32. DOI: 10.1007/978-3-030-37752-6_2.

It was noticed that seaport infrastructure should be adapted to meet global technical standards.²⁴ This applies primarily to the infrastructure required to operate ships, ensure the efficiency and convenience of cargo handling and passengers' service, as well as to IT ports' infrastructure.²⁵ It was stated that smaller and medium-sized ports may need more financial outlays to be able to introduce modern IT technologies in order to avoid system disruptions in the future.²⁶ Moreover, the vessels' technical state should be regularly maintained to ensure their interrupted operation.

The COVID-19 pandemic has caused a lot of disruptions to ferry traffic around the world. The introduced restrictions affected the volume of international trade and production of goods. This has contributed to disruptions in maritime transport chains,²⁷ changing the directions and frequency of ferry connections. It should be noted that the scale and nature of the impact of COVID-19 on land and sea transport chains depended on the type of terminal and the function it performed. In addition, the COVID-19 pandemic contributed to stricter security requirements for travellers both at terminals and onboard.²⁸

In the available literature an in-depth analysis of transport services, needs and requirements of consumers using ferry services in the Baltic Sea region was performed.²⁹ It was mentioned that regular surveys should be carried out among customers in order to get their opinions and determine ways to increase the efficiency of ferry services. The main issue

²⁴ Krile, Srećko, Maiorov, Nikolai and Fetisov, Vladimir. "Forecasting the operational activities of the sea passenger terminal using intelligent technologies." *Transport Problems*, vol. 13, issue 1, (2018) 27-36. DOI: 10.21307/tp.2018.13.1.3.

²⁵ Yau, Kok-Lim Alvin, Peng, Shuhong, Qadir, Junaid, Low, Yeh-Ching and Ling, Mee Hong. "Towards Smart Port Infrastructures: Enhancing Port Activities Using Information and Communications Technology.", *IEEE Access*, vol 8, 9079821, (2020): 833387-83404. DOI: 10.1109/ACCESS.2020.2990961.; Fruth, Markus, and Teuteberg, Frank. (2017) "Digitization in maritime logistics—What is there and what is missing?" *Cogent Business and Management*, vol. 4, issue 1, (2017), 1411066. DOI: 10.1080/23311975.2017.1411066.; Jović, Marija, Tijan, Edvard, Aksentijević, Sasa and Sotošek, Bozidar. (2019) "The role of electronic transportation management systems in seaport digitalization." in: *32nd Bled eConference Humanizing Technology for a Sustainable Society, BLED 2019 - Conference Proceedings*, ed. (Bled: University of Maribor Press, 2020) 159663, 1-15. DOI: 10.18690/978-961-286-280-0.1.; Di Vaio, Assunta, and Varriale, Luisa. "Digitalization in the sea-land supply chain: experiences from Italy in rethinking the port operations within inter-organizational relationships." *Production Planning and Control*, vol. 31, issue 2-3, (2020): 220-232. DOI: 10.1080/09537287.2019.1631464.

²⁶ Paulauskas, Vytautas, Filina-Dawidowicz, Ludmiła and Paulauskas, Donatas. "Ports digitalization level evaluation." *Sensors*, vol. 21, issue 18: 6134 (2021). DOI: 10.3390/s21186134.

²⁷ Mańkowska, Marta, Pluciński, Michał, Kotowska, Izabela. and Filina-Dawidowicz, Ludmiła. "Seaports during the covid-19 pandemic: The terminal operators' tactical responses to disruptions in maritime supply chains." *Energies* vol. 14, issue 14, (2021), 4339. DOI: 10.3390/en14144339.; *Gospodarka morską*, <https://www.gospodarkamorska.pl/porty-transport-koronawirus-a-promy-zawijajace-do-polskich-portow-47882>, accessed on 17 February 2023.

²⁸ Srećko Krile, Maiorov, Nikolai and Fetisov, Vladimir. "Modernization of the infrastructure of marine passenger port based on synthesis of the structure and forecasting development." *Sustainability*, vol. 13, issue 7: 3869, (2021). DOI: 10.3390/su13073869.

²⁹ Semenov, Iouri, Filina-Dawidowicz, Ludmiła, Wiktorowska-Jasik, Anna and Moźdrzeń, Daria. "The quality assessment of ro-pax ferries services: Research techniques and procedures." *World Review of Intermodal Transportation Research*, vol 10, issue 3, (2021): 202-224. DOI: 10.1504/WRITR.2021.117665.

considered by people choosing ferry services is the availability of these services, including ships' capacity and number of ferry departures offered by the terminal.³⁰ The quality of service, price, convenience³¹ and travel time³² also impact the choice of the carrier by passengers. Moreover, travellers' attention is paid to the need to shorten the waiting time at the ferry terminal.³³ Therefore, limitation of ferries delays number is expected.

Based on conducted literature review it can be concluded that the disruptions occurring in ferry traffic so far have been analysed selectively. This justifies the need to undertake research in this area and to examine the causes of disruptions in ferry traffic.

3. Research Methodology

Based on the analysis of the subject literature and the observations made, information on selected disruptions occurring in ferry traffic was collected.

In order to identify and analyse the causes of disruptions, a case study of ferry traffic performed by Unity Line carrier at the ferry terminal in Świnoujście seaport was considered. Unity Line carries out ferry services on the Świnoujście–Trelleborg and Świnoujście–Ystad routes. The data available at the information portal www.promy24.com,³⁴ where messages for travellers using Unity Line services were published and archived, was used in the study. The data available from 06.08.2020 to 19.06.2023 were analysed in detail. Then collected data were examined and appropriate conclusions were drawn.

4. Research Results

During analysed period 89 cases of disruptions were identified. Based on the obtained data, it can be noticed that the number of cancellations of ferries accounted for 93% of all recorded disruptions, while 7% were delays (Fig. 5).

³⁰ Høyem, Harald and Odeck, James. "Assessing the socially optimal capacity at a selection of Norwegian car ferry crossings." *Case Studies on Transport Policy*, Vol. 10, issue 1, (2022): 41-59. DOI: 10.1016/j.cstp.2021.10.008.

³¹ Pantouvakis, Angelos M. "Who pays the ferryman? An analysis of the ferry passenger's selection dilemma." *Maritime Policy & Management* 34(6) (2007): 591-612. DOI:10.1080/03088830701695321.

³² Škurić, Maja, Maraš, Vladislav, Davidović, Tatjana and Radonjić, Aleksandar. "Optimal allocating and sizing of passenger ferry fleet in maritime transport." *Research in Transportation Economics*, vol. 90, 100868 (2021). DOI: 10.1016/j.retrec.2020.100868.

³³ Sandberg Hanssen, Thor-Erik and Larsen, Berner. "The influence of waiting time on the value of headway time on a ferry service in Norway." *Research in Transportation Economics*, vol 82, 100879 (2020). DOI: 10.1016/j.retrec.2020.100879.

³⁴ Promy24, www.promy24.com, accessed on 06 August 2023 to 19 June 2023.

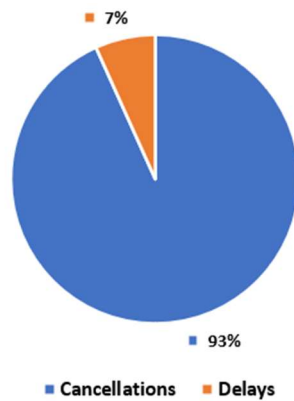


Figure 5. Cancellations and delays of ferries in analysed period (percentage share)

Source: own study based on: Promy24, www.promy24.com, accessed on 06 August 2023 to 19 June 2023.

Among the causes of ferries' cancellations, the weather conditions that occurred in the period from autumn to spring formed 71% of all cancellations (Fig. 6). 23% of ferries' cancellations occurred due to technical problems (e.g. failure of ship components, etc.). Remaining 6% of cancellations were faced in the result of periodic inspections/repairs of ferries in shipyard. Unlike cancellations due to weather and technical reasons which were unplanned, the cancellations due to periodic inspections/repairs in shipyard were planned in advance.

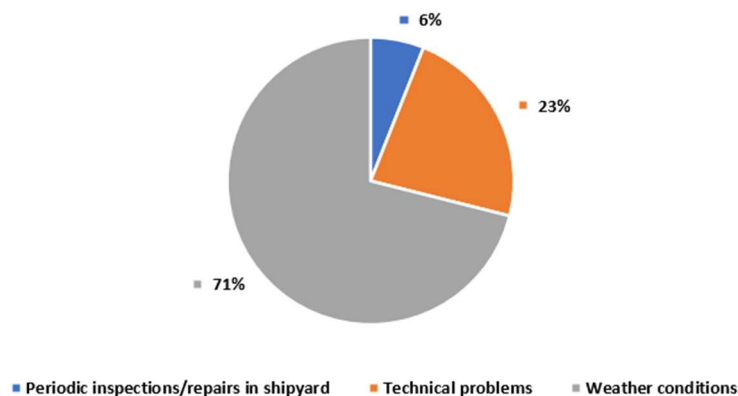


Figure 6. Causes of cancelling ferries (percentage share)

Source: own study based on: Promy24, www.promy24.com, accessed on 06 August 2023 to 19 June 2023.

It can be noticed that the largest number of cancellations due to weather conditions affected m/f Galileusz, m/f Copernicus and m/f Jan Śniadecki ferries. Furthermore, these three vessels were listed at the top of cancellations for technical reasons. This result may be influenced by the technical condition of ships and intensity of ferries operation. In the

analysed database there were also messages without a defined vessel name ("no name" item in Figure 7), which may mean that these messages concerned all ships of analysed shipowner.

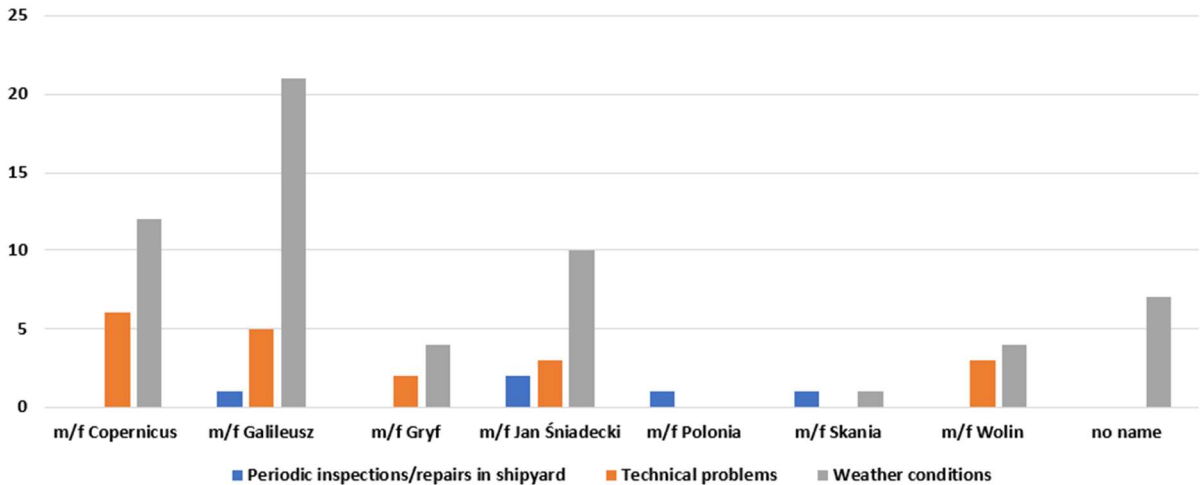


Figure 7. Causes of cancelling ferries by vessel’s name (number of cancellations in the analysed time)

Source: own study based on: Promy24, www.promy24.com, accessed on 06 August 2023 to 19 June 2023.

The main causes of ferries delays were weather conditions (83% of all delays) and technical problems (17%). The reason of ferries’ periodic inspections/repairs in shipyard was not listed among the causes impacting the delays (Fig. 8).

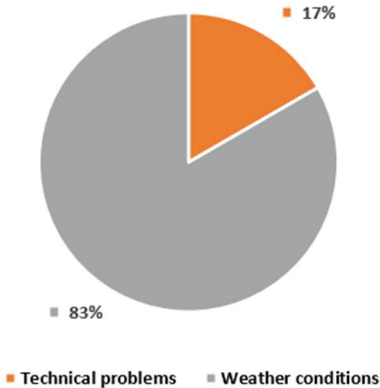


Figure 8. Causes of ferries delays (percentage share)

Source: own study based on: Promy24, www.promy24.com, accessed on 06 August 2023 to 19 June 2023.

Summing up the above results, it can be concluded that the disruptions occurring in ferry traffic, which were identified during the available data analysis, may be caused by

unfavourable weather conditions, ferries' technical problems and periodic inspections/repairs in shipyard. It is difficult to predict when, for example, a technical defect of a ship will occur, the same applies to unfavourable weather conditions. These disruptions may not be predicted in every case. In turn, vessel's periodic inspections/repairs in shipyard are planned in advance and vessels are withdrawn from service for a certain time. That information should be provided to travellers early enough to take a decision. A prolonged overhaul could be an unforeseen situation that will extend the waiting time for the ship to return to its sailing schedule.

Conclusions

Ferry shipping is an important part of maritime transport and intermodal transport chains. It should be noted that in Poland over analysed nine years ferry shipping was developing, and its popularity is growing.

Disruptions occurring in ferry traffic were identified and analysed. These disruptions may be caused by different factors, such as environmental, technical and technological, human, infrastructural, organisational, and other. In order to ensure the proper functioning of ferry traffic, it is necessary to analyse possible impact of these factors to avoid unfavourable consequences, such as ferries delays or cancellations. The examples of possible disruptions' division were also presented.

The analysis of the data provided by selected shipowner revealed that unfavourable weather conditions were the main cause of both cancellations and delays occurrence in ferry traffic in examined terminal. Based on analysed messages three causes of disruptions were identified. It is worth noting that information on disruptions provided to the passengers by the ferry line did not include messages about human factor impact on cancellations or delays of ferries, which does not exclude its occurrence. This factor may not be presented by the carrier, but it may affect the disturbances' occurrence in ferry terminals. The impact of this factor can be related, among others, to the behaviour of vehicles' drivers (e.g. non-compliance with the rules of moving around the terminal, etc.).

Research results are influenced by the number of analysed cases, the data shared by one shipowner was analysed. Therefore, Authors would like to continue the examination of problems occurring at ferry terminals and will investigate the disruptions noticed by other ferries' carriers in future research studies.

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Summary

Over the last decade, a dynamic development of ferry traffic in Poland has been observed, which influences the need to improve the services offered by ferries carriers. When managing ferry traffic, disruptions may occur due to the influence of various factors. The occurrence of these disruptions poses challenges for ferry operators and ferry terminals' managers, cooperating and taking decisions on the organisation of ferry services in ports. The aim of the article is to identify disruptions occurring in ferry traffic and to analyse the causes of disruptions reported by a selected carrier operating in the ferry terminal in the seaport of Świnoujście (Poland). The ferry transport market in Poland was analysed in the article, and disruptions that may occur in ferry traffic were identified. The analysis of disruptions' causes reported by the selected ferry carrier showed that unfavourable weather conditions were the most frequent cause of ferries' cancellations and delays. The results of the study may be of interest to ship owners', managers of ferry terminals and seaports.

Streszczenie

W ciągu ostatniej dekady obserwowany jest dynamiczny rozwój przewozów promowych w Polsce, co wpływa na potrzebę doskonalenia usług oferowanych przez przewoźników promowych. Podczas zarządzania ruchem promowym mogą występować zakłócenia spowodowane wpływem różnych czynników. Wystąpienie tych zakłóceń wiąże się z wyzwaniem dla armatorów i menedżerów terminali promowych, współpracujących i podejmujących decyzje odnośnie organizacji obsługi promów w portach. Celem artykułu jest identyfikacja zakłóceń występujących w ruchu promowym oraz analiza przyczyn zakłóceń zgłaszanych przez wybranego przewoźnika funkcjonującego w terminalu promowym w porcie morskim Świnoujście (Polska). W artykule przeanalizowano rynek przewozów promowych w Polsce, a także zidentyfikowano zakłócenia mogące wystąpić w ruchu promowym. Analiza przyczyn zakłóceń raportowanych przez wybranego przewoźnika promowego wykazała, że najczęstszą przyczyną odwołań i opóźnień promów były niekorzystne warunki atmosferyczne. Wyniki badań mogą być interesujące dla armatorów statków, menedżerów terminali promowych i portów morskich.