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Classification of Disruptions Occurring At The Ferry Terminal in Poland*

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Abstract

The market for transport services faces the development of ferry shipping for both cargo and passengers. While performing the transport services, various disruptions may occur at the ferry terminals. Challenges related to the proper management of cargo or passenger handling processes at the ferry terminal result from the need for cooperation of shipowners, terminal managers or persons supervising ferry lines. These entities are responsible for making decisions and reacting immediately during any disruptions. The literature review carried out showed that issues related to the occurrence of disruptions at ferry terminals in Poland have been analysed to a limited extent.
The objective of this article is to make an attempt to identify and classify the disruptions occurring at the ferry terminal in Poland. The article analyses ferry traffic in Poland and discusses an example of possible development of disruptive situations. Based on the literature review results and observations, the disruptions that may occur in the area of the ferry terminal were identified and classified. It was stated that in order to reduce the negative impact of disruptions, ferry terminals managers and shipowners should develop and implement specific procedures for different scenarios of undesirable events development. The results of the research may be of interest to ferry terminal managers, shipowners and ferry lines managers.

Keywords: ferry terminal, disruption, classification, ferry shipping.

Introduction

Ferry shipping plays crucial role in the functioning of coastal states. It constitutes the part of maritime transport and takes the form of regular shipping Kujawa (2015). This shipping is a compliment to the transport network primarily for road and rail transport, in addition, it is also commonly used for the transport of trucks and passenger cars, trailers, railway wagons or passengers Urbanyi-Popiołekand Klopott (2012), Høyem and Odeck (2022). Furthermore, it is characterized by the regularity of connections, the use of specialized vessels (ferries), infrastructure and the performance of transshipment operations in the system of horizontal loading or unloading (roll-on/roll off) Kujawa (2015). In addition, ferry shipping is an element of intermodal transport, as the main section of the cargo transport route takes place using maritime (by ferry) or rail transport, and, in most cases, the cargo collecting and delivery part of transport chains takes place using road transport. In 2022 there were some 900 active ferries in Europe, which accounted for approximately 70% of global ferry traffic Cuculic et all (2022).

In addition to its basic transport function, i.e. the movement of people or cargo, ferry shipping also performs such functions as Urbanyi-Popiołek (2012): commercial, tourist, revenue-forming or city-forming. In Poland, ferry connections to Scandinavia (Sweden, Denmark) are made from seaports that are of international importance.

Various difficulties can occur when handling ships and cargo at ferry terminals. These difficulties may be external (global) or internal (local or site specific). An example of this can be the difficulties in the functioning of seaports caused, for example, by the COVID-19 pandemic, which had a negative impact on the economy of the entire

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world Jones, Palumbo and Brown (2021), Urbanyi-Piołek (2020). The armed conflict in Ukraine is another example, hindering the proper operation of seaports, and thus indicating that seaports are elements of critical infrastructure Tubielewicz and Forkiewicz (2011). Due to the fact that seaports were unable to operate to full capacity in 2022, there was increased vehicle traffic on the Polish-Ukrainian border, exceeding over a million vehicles Przybylski (2023).

Conducted literature review revealed the research gap related to the insufficient examination of disruptions occurring at ferry terminals in Poland. Research problem was formulated as follows: what kind of disruptions may occur at a ferry terminal in Poland?
The objective of the article is to make an attempt to identify and classify the disruptions occurring at a ferry terminal in Poland. The article analyses ferry traffic in Poland, provides a cause-and-effect analysis of the development of disruptive events.

Characteristics of ferry shipping in Poland

Ferry terminals are the elements of significant infrastructure needed for the proper functioning of ferry navigation, which is strongly developed in the Baltic Sea region Kamińska (2019). In Poland, ferry terminals are located in three ports, namely:

1. Gdansk (Westerplatte Ferry Terminal),
2. Gdynia (Ferry Terminal in Gdynia),
3. Swinoujscie (Swinoujscie Ferry Terminal).

It is worth emphasizing that the ferry terminal in Swinoujscie is the largest terminal in Poland and the largest in the western part of Poland. Table 1 presents ferry connections that were carried out in Poland in 2024 by five shipowners.

Table 1. Ferry connections in Poland in 2024

Owner	Port in Poland	Port in Scandinavia	
		Sweden	Denmark
Stena Line	Gdynia	Karlskrona	-
TT-Line	Swinoujscie	Trelleborg	-
Polferries	Swinoujscie	Ystad	Kopenhaga
	Gdansk	Nynäshamn	-
Unity Line	Swinoujscie	Ystad	-
	Swinoujscie	Trelleborg	-
Finnlines	Swinoujscie	Malmo	-

Source: Author's own elaboration based on: Finnlines (2024); Stena Line (2024); Polferries (2024); Unity Line (2024); TT-Line (2024)

Five active shipowners on the ferry transport market operated in 2024. The Finnlines company has recently entered the Polish market. This shipowner has its quay near the ferry terminal in Swinoujscie SFT (2024). It can be noted that the connections that are offered from Poland to Scandinavia are mainly to Sweden or Denmark (with only one shipowner offering the connection to Denmark). None of the carriers offers direct connections from Poland to Norway.

Table 2 presents statistical data on passenger service in three Polish seaports in 2018-2022. In 2018-2019 the number of passengers handled in Gdansk port grew, while in the subsequent years, fluctuations in these numbers were noticed. When comparing data for 2018 and 2022, a downward trend in passenger service in the port of Gdynia can be observed. However, in the analysed years, the largest number of passengers handled the port in Swinoujscie compared to other ports was observed. From the observations carried out, it can be noted that in all three ports in 2020 there was a decrease in the number of passengers served. This is due to the fact that the COVID-19 pandemic was prevailing in the world at that time. In turn, in 2021, an increase in passenger transport is observed taking into account the introduced restrictions (mandatory vaccinations, protective masks, limited

number of passengers in the cabins, etc.). It should be noted that passengers using ferry shipping are not only truck drivers, but also tourists or people working in Scandinavia.

Table 2. Number of passengers handled in 2018-2022

Year	Port		
	Gdansk	Gdynia	Swinoujscie
2018	118 031	690 511	1 073 521
2019	166 245	687 763	1 069 406
2020	147 926	393 434	930 125
2021	162 380	437 035	1 051 684
2022	160 361	487 634	1 102 279

Source: Author's own elaboration based on: Yearbook (2018); Yearbook (2023)

While analysing the number of trucks serviced in Polish seaports, an increasing trend in servicing these vehicles was noticed in the port of Gdansk. This growth between 2018 and 2022 amounted to 14069 vehicles. In the analysed period, the number of trucks handled in port of Gdynia fluctuated. The highest number of vehicles was handled in 2021, during the pandemic, while the lowest in 2020. However, in 2020 and 2022 in the port of Swinoujscie, an increase in the number of handled trucks was observed.

Table 3. Number of trucks handled in 2018-2022

Year	Port		
	Gdansk	Gdynia	Swinoujscie
2018	17 955	173 374	489 497
2019	29 113	163 343	496 562
2020	30 401	162 320	486 519
2021	31 232	380 715	537 930
2022	32 024	184 656	521 657

Source: Author's own elaboration based on: Yearbook (2018); Yearbook (2023)

Summing up the analysis of selected statistical data, it is possible to notice the development of ferry shipping in Poland in analysed years, i.e. 2018-2022; presented statistical data demonstrate that the interest in ferry transport services is large.

In addition, the ferry terminal in Swinoujscie stands out from the terminals in Gdansk and Gdynia. First of all, this distinction can be observed in terms of the number of passengers or trucks served. This terminal has a well-developed infrastructure and a high frequency of ferries connections. Every day there are several departures of ferries from this terminal to Scandinavia. It can therefore be concluded that this terminal is highly developed compared to other Polish terminals.

Characteristics of the processes carried out at the ferry terminal on the selected example

Brief characteristics of the Swinoujscie ferry terminal

The Swinoujscie Ferry Terminal is the largest terminal in Poland. It provides 24-hour port services all year round for ferries (sea, ro-ro, ro-pax, cruise ships) as well as other transport means (trucks and passenger cars, road trailers, railway wagons) and passengers. Besides to standard equipment, such as passenger sleeves (galleries), ramps, transshipment equipment, etc., the terminal possesses parking area for trucks (modern parking with 278 parking spaces), an intermodal terminal and storage yards. In addition, it is equipped with six quays with a total length of about 960 m. It is worth emphasizing that the terminal is located along transport corridors, connecting railway, road and water infrastructure SFT (2024), which results in significant interest among customers.



Fig. 1. Infrastructure of the ferry terminal in Swinoujscie, SFT (2024)

In the terminal area, different complex processes related to the handling of ships, cargo and passengers are performed. These processes also require a substantial involvement of the ships' crews and terminal employees. In addition, they are also affected by the reliability of auxiliary devices for handling cargo or servicing passengers. Due to the correct course of the processes of handling individual entities (cargo or passengers), terminal operates according to a strictly set schedule, while maintaining a high level of security. This contributes to the high efficiency of the terminal operation and customer satisfaction.

Simplified process of ship's service

The service process of ferry entering/leaving the Swinoujscie ferry terminal is presented in Figure 2.

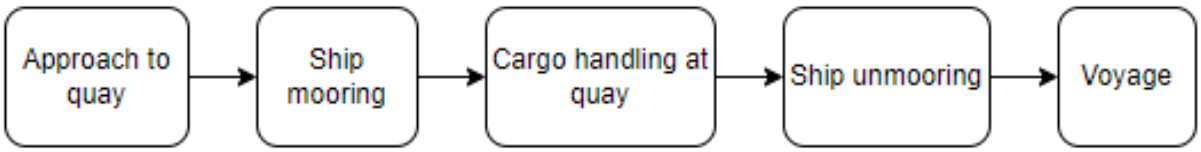


Fig. 2. Simplified ferry service process at the ferry terminal in Swinoujscie

Author's own elaboration based on: SFT (2024)

The process of servicing a ship entering the Swinoujscie port begins at an early stage, when the shipowner notifies the import of cargo using a special list, which should include such information as: name of the ferry, date and time of entry/exit, draught, number of passengers, number of cars and trucks, number of semi-trailers and vehicles with hazardous goods, etc. Then ship has to be moored safely at the designated quay. An hour before the planned approach to the quay, the ferry reports to the terminal such information as: the time of mooring, the draught of the vessel and the method of mooring – it depends on the location of the ramp. The subsequent activity is the mooring process, in which the crew, in cooperation with the terminal staff, secures the ferry at the quay. At this stage, the shipowner is also obliged to provide appropriate documents, including the "IMO General Declaration" confirming the mooring. The next process deals with cargo handling operations. Subsequently, the ship is unmoored, after reporting its readiness to leave the quay at the ferry terminal, the mooring ropes are dropped by the terminal employees (in accordance with the rules of the port master's office), and the shipowner is obliged to report the "IMO General Declaration" document confirming the readiness to unmoor the vessel from the quay.

Simplified process of cargo service

The processes carried out for the cargo at the ferry terminal in Swinoujscie ferry terminal can be divided into two types - namely export and import services. In the case of export, the process begins with the entry of loads into the terminal area from hinterland. Depending on the type of load, there are different ways of entry terminal, such as through the truck check-in building, through gate number two for dangerous goods or through the main gate for oversize loads. The next step is to report to the shipowner's cargo office, where vehicle drivers collect tickets, information sheets, receive a necessary information, etc. Then the cargo vehicles are directed to the yard inside the terminal, where vehicles are waiting to be loaded. In the case of trucks, they are moved to the internal yard of the terminal, where they are waiting for loading. In the event that the semi-trailers are waiting for loading, documents such as a report on the technical condition, and confirmation that the shipowner's office has made a reservation for a specific ferry, as well as documents (cargo or registration documents of semi-trailers) are

additionally provided. Moreover, the semi-trailers can be moved to the storage yard and wait for a specific ferry or wait directly for loading on ship.

In the case of handling dangerous goods, the handling process is controlled in detail from the moment the cargo is delivered to the terminal area to ensure safety. The shift manager at the terminal receives information about the type and size of the load. The cargo may be left at the terminal in the designated hazardous cargo storage zone and information about it must be reported to the cargo office of the shipowner. The next step deals with cargo loading onto the ferry. The loading process takes place using port superstructure (equipment). Dangerous goods can also be transported directly by trucks, in this case the handling process is performed the same way as for a semi-trailers. During export service, the process of handling loads is completed by securing it on the ship.

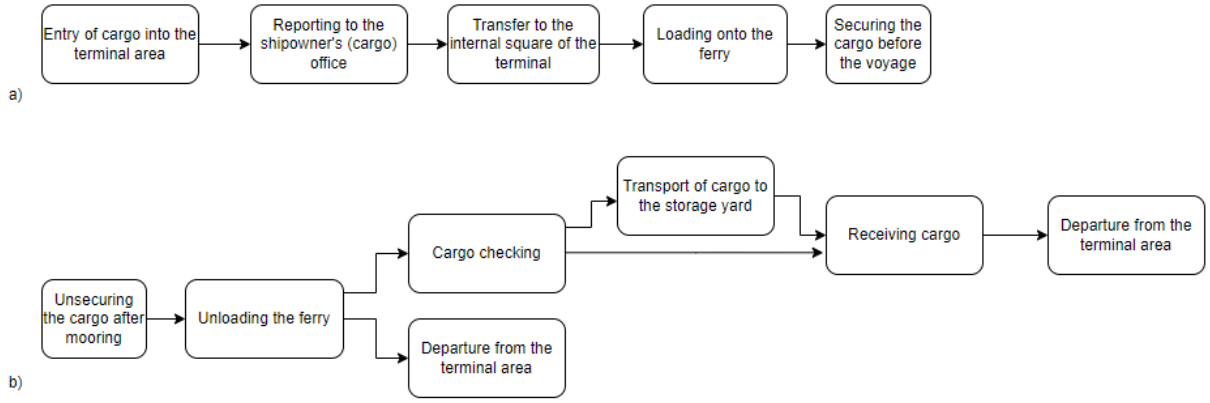


Fig. 3. Simplified cargo handling process at the Swinoujscie Ferry Terminal: a) export, b) import

Author's own elaboration based on: SFT (2024)

The process carried out for the handling of imported cargo begins with unsecuring it by the crew of the vessel after the ferry is moored. Then the process of unloading from the ferry trucks or semi-trailers using the port superstructure begins. There are two options, in which one concerns the truck exit from the terminal area directly from ship, while the other concerns cargo transported in semi-trailers. In case of semi-trailers service, they are checked for damage and availability of needed documents. Then they may leave the terminal area or be transported using the port equipment to the storage yard, where after some time semi-trailers are picked up and leave the terminal. In the case of dangerous goods transported by trucks or semi-trailers, the process is carefully supervised from its beginning to the end, in order to ensure the greatest possible safety level. It should be noted that the process of cargo handling in both import and export relations is similar, and there are several options for cargo service.

Simplified process of passengers service

The process of servicing passengers boarding the ferry starts about 2 hours before the planned departure of the ferry. During this time, passengers arrive at the ferry terminal, where they are checked in at the main building. After check-in, passengers are waiting for boarding the vessel. Then terminal employees supervise the passage of passengers from the terminal through, among others, the sleeves (passenger gallery) on board the ship, where passengers go to their cabins or spend the cruise on board the ferry in the public area. After completing the check-in of passengers, the shipowner's representative has to notify the dispatcher of the ferry terminal on the completion of the passenger boarding process.

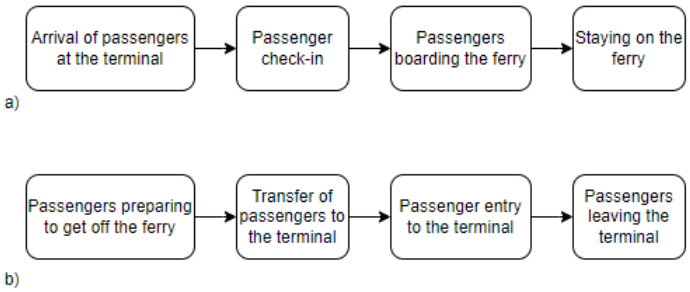


Fig. 4. Simplified passenger service process at the Swinoujscie Ferry Terminal a) passengers boarding the ferry b) passengers disembarking

Author's own elaboration based on: SFT (2024)

In the case of passengers leaving the ferry, the process begins with preparing passengers to do it. During this time they prepare their luggage and wait for the vessel to be moored at the quay. Once the ship is safely moored, preparation for the safe disembarkation of passengers takes place, and the shipowner's representative reports to the terminal dispatcher the process of starting the disembarkation, when passengers, assisted by employees, leave the deck through the staircase, and then the sleeve (passenger gallery) moving to the terminal area, where they proceed to the terminal hall and leave it.

Classification of disruptions in ferry terminals

Managing disruptions and diagnosing them are not simple tasks Wang and Ding (2015). The occurrence of disruptions may be triggered by various types of situations that affect the processes of handling cargo or servicing ships (ferries) or passengers and may occur depending on their specificity. Therefore, it can be stated that disruptions at a ferry terminal are unplanned or undesirable situations that lead to modification or disorganization, in real time, of the processes occurring at this terminal. In turn, another definition of disruptions indicates that it is "*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*" Wieteska (2011) or "*an unexpected phenomenon leading to interruption or at least delay in the performance of tasks*" Konecka (2015).

Authors of the subject literature e.g. Craighead et all (2007) present the definition of supply chain disruption as "*unplanned and unforeseen events that disrupt the normal flow of goods and materials in the supply chain"*, and it should be noted that ferry shipping constitutes part of intermodal supply chains, while Macdonald and Corsi (2013) dealt with the management of disruptions in supply chains, including major events, reconstruction and their performance.

Disruptions may be planned or unplanned. In public transport systems, they can be unplanned, e.g. the occurrence of an accident, technical failure, etc., or planned, such as construction/modernization works. In most cases, however, the transport networks are affected by planned disruptions, which cause, for example, disabling the element of the transport system or the means of transport from use for a longer or shorter period of time. The occurrence of such a disruption may cause a number of difficulties related to the movement of passengers or cargo Morten et all (2021).

Chang and Dowlatabadi (2019) believe that "*disruptions in the transport system are widely recognized as the main source of spatial and economic consequences of natural disasters."* These disruptions may occur when, for example, there is a shortage of fuel, which is treated as a primary raw material or components for means of transport, which will cause the disruption to occur on a broader scale, when an armed conflict occurs (e.g. war), or the COVID-19 pandemic Mańkowska et all (2021). The pandemic resulted in limited operation of supply chains. Milewska et all (2024) developed a classification of disruptions in production, logistics, transport and supply chains, which demonstrates how global or regional this problem may be.

Disruptions in ferry traffic may be of a different nature, e.g. disturbances caused by natural and climatic factors, e.g. natural disasters or large glaciations in some regions Islam et all (2021), Taylor (2017). In addition, the natural and climatic factor can also include strong winds, fogs, waves, etc. Coll et all (2013), which may also contribute to cancellations or delays of ferries.

Another group of disruptors are, for example, infrastructure issues Filina-Dawidowicz et all (2023), issues with information flows Semenov et all (2019), economic disruptions Paulauskas et all (2022). Cybercrime also belongs to the significant elements that may cause disruptions in shipping Bronk and deWitte (2022). It is a current issue, and various sources provide information on, among others, server intrusions, server management or data theft.

Other factors causing disruptions may include problems related to the capacity of ferries Hanssen et all (2020) which also results in extending the waiting time of customers for the next ferry and delays in deliveries.

While systematizing the knowledge on disruptions, it should be emphasized that disruptions occur in various modes of transport. In road transport, they are specified in a number of research works Lu et all (2023), Persa (2022), Karam and Reinau (2022), Gurtu (2023), Milewska et all (2024). In air transport, disruptions are specified, for example, in selected publications Crew (2016), Compa (2018), Okulicz et all (2020), Kwasiborska and Kądzioła (2023), and in the case of rail transport, information about disruptions is specified, among others, in the following works Pineda-Jaramillo (2023), Monsuur et all (2021), Slivkova et all (2022). Nevertheless, it should be noted that these studies do not develop a comprehensive disruption analysis.

Disruptions in ferry traffic can be classified in various ways. The conducted analysis of subject literature indicated that there are numerous sources of disruptions occurring in maritime transport or directly in ferry shipping, but they are not comprehensively presented.

In Table 4 the criteria for the division of disruptions were proposed, and selected examples were shown. The most common effects of disruptions are delays or cancellations of ferries.

For ferry terminals, where the ferry turnover is quite high, a slight delay or cancellation may contribute to the disorganization of the terminal work. It should be noted that every terminal sets a specific schedule for the movement of ships (arrivals and departures), as well as the stopping time and the service station – the quay, which allows the service of a given vessel due to the appropriate technical parameters.

Table 4. Division of disruptions at the ferry terminal

Criterion	Division	Examples of disruptions
Place of occurrence	Terminal	Disorganization of passenger/cargo handling at the terminal
	Vessel	Disorganization of passenger/cargo handling on board
	Other port areas	Unexpected occurrence of various situations on the fairway, e.g. collision
Entity involved in the disruption	Shipowner	Issuance of inappropriate orders, lack of adequate financing for transport means (ferries), poor notification of the ferry
	Passenger; Driver	Lack of language competences, lack of communication, health issues, lack of information from the company about the cargo
	Terminal employee in the loading zone; office worker; other port employee	Inappropriate traffic management at the terminal, ignorance of the regulations/rules prevailing at the terminal, lack of information from superiors
Type of cargo handled	Trailer Semi-trailer Railroad car Truck Passenger Car	Damaged means of transport or intermodal loading units, inadequate total weight, lack of appropriate transport documents, inadequate adaptation of the cargo for transport
Group of factors causing disruptions	Natural and climatic	Storms, winds, waves, fogs
	Technical and technologic	Failure of the transport means – damage to components
	Human	Property damage, health issues, ignorance of regulations, communication issues
	Systemic	Inadequate management, no updating of procedures, insufficient training of employees

Range of disruptions	Information (communication)	Inadequately communicated/displayed messages for passengers, lack of a uniform information and communication system for participants, employees and other entities
	Cybercrime	Hacking into booking servers, posting incorrect information on websites, blocking booking systems, data theft
	Social	Restrictions to the movement of people and cargo/goods due to threats, e.g. war, sanitary restrictions, strikes
	Infrastructure	Damage to the transshipment ramp at the terminal, inefficiency or low capacity of buildings for passenger service, insufficient number of places (parking, quays, passenger and driver service buildings, ramps), terminal access infrastructure not matching the capacity of the terminal, technical parameters of the water pool that are not sufficient for every size of ro-ro vessel
	Economical	Lack of funds for the modernization of linear and punctate infrastructure inside the port/terminal
Consequences of hazards	Short-term	Ferry delay
	Long-term	Ferry cancellation
The degree of severity of the effects	Significant	Cancellation of the ferry due to failure or bad weather
	Insignificant	Unable to book via the online system, delayed loading
Type of disruption	Planned	Modernization/construction works in the port/terminal
	Unplanned	Fire in the terminal area, leakage of dangerous substances, damage to the access ramp

Source: Author's own elaboration

Response to potential disruptions at ferry terminals (Fig. 4) requires an identification of the processes occurring in the terminal, then their analysis and classification Hrušovský et all (2021). Following these activities, an appropriate planning strategy for the processes at a given stage – in this case at the ferry terminal – should be proposed in order to minimize the impact of disruptions on the terminal operation and ferry service.

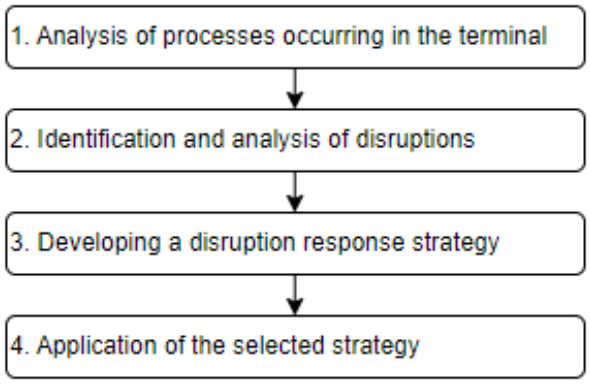


Fig. 5. Strategy for responding to potential disruptions at the ferry terminal

Author's own elaboration

Figure 6 presents an example of diagram of the development of situations causing the cancellation or delay of the ferry at the ferry terminal. The sources of the disruptions and their effects were presented. This diagram shows the course of the disruptions development process, the understanding of which is important for making decisions to eliminate the occurrence of undesirable effects.

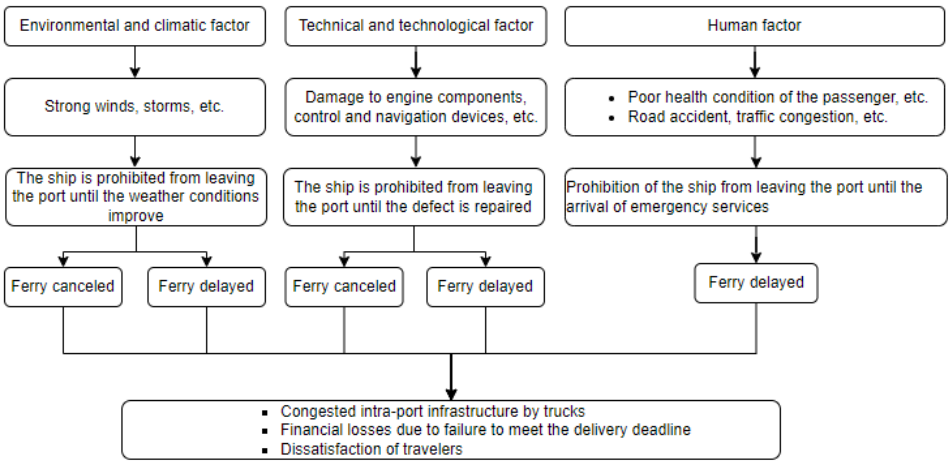


Fig. 6. Examples of the development of situations causing the cancellation or delay of the ferry at the ferry terminal

Author's own elaboration

Analysing one of the examples of situations development that may take place under the influence of a technical and technological factor, it can be noticed that there are two possible variants of developing events leading to the cancellation or delay of a ferry. In the event of damage to the components of the vessel, their repair can be quick, the ship can then leave the port with a slight delay, and this delay can usually be made up during the cruise. It may also happen that the ship cannot sail with damaged components, then the cruise is cancelled. This can cause a number of negative consequences, including, for example, the fact that drivers cannot deliver cargo on time, as a result of which financial losses may occur for the organizer of the cargo transport, as well as for other users of the ferry services. However, shipowners, in order to meet expectations of their customers, often change their ticket reservations for the next possible connection, so that the waiting queue is not too long and terminal congestion is minimized. It is worth emphasizing that disruption may develop as a consequence of the simultaneous occurrence of various factors Filina-Dawidowicz et all (2019), Filina-Dawidowicz et all (2021).

Conclusion

Ferry shipping plays crucial role in the sea-land transport chains. There are three ferry terminals in Poland, however, the ferry terminal in Swinoujscie leads, when compared to other terminals in Poland in terms of the number of serviced passengers and trucks handled.

Based on the results of the analyses carried out, it can be concluded that the disruptions may be both unplanned or planned. Criteria and possible divisions of disruptions are defined differently in the literature, which also indicates a their different perception. It is worth noting that disruptions may occur at the various stages of the processes of handling cargo or servicing passengers. The proposed division of disruptions at the ferry terminal was based on author's own observations and analysis of the subject literature. It is worth emphasizing that a disruption may also vary depending on the size and infrastructure of the ferry terminals. An important element of the disruption analysis is to determine the scope of the effects and the frequency of their occurrence.

Occurrence of disruptions in the operation of passengers, transport means and cargo at a ferry terminal may cause the disruptions in the entire transport chains. In order to reduce the negative impact of disruptions, ferry terminals managers and shipowners should develop and implement specific procedures for different scenarios of undesirable events development. By planning procedures and scenarios for the development of these events, the level of safety at the ferry terminal can be increased or existing procedures/rules to conduct operations may be improved.

To sum up, it can be concluded that many disruptions may take place at ferry terminals. The disruptions presented in the article do not include all the possible ones, however, on the basis of them, it is possible to analyse the processes of passenger service or cargo handling at ferry terminals and implement solutions to eliminate their occurrence.

Further research will be focused on an in-depth analysis of the sources of disruptions occurring in ferry terminals and critical nodes of transport chains in which disruptions most often occur.

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