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BUSINESS ENVIRONMENT OF RAIL TRANSPORT IN THE CONTEXT OF THE VALUE CHAIN

Summary. The value chain can be defined as a set of all processes and procedures necessary to deliver a product or service to the end-user through various stages of development. A concept of the value chain is essential in the context of transport, as the transport process is usually one of the last elements of the value chain and determines the final value of a product or service offered. In recent years, the domestic and international rail transport market has undergone significant changes, including ongoing globalisation processes, growing importance of international trade, increase in intermodal transport significance, numerous investment outlays in transport infrastructure, means of transport, and the area of rail transport interoperability. All the above-described aspects have an impact on the value chain in transport. This paper presents an analysis of the value chain in

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transport processes in an aspect of rail transport. Elements of the railway transport organisation process, which affect the entire value chain, were briefly characterised in this article. Moreover, based on statistical data and a literature review, factors that fundamentally impact the efficient organisation of rail transport processes were identified.

Keywords: value chain, transport process, intermodal transport, rail transport, organisation of transport

1. INTRODUCTION

Rail transport is a significant branch of transport given passenger transport turnover, the number of passengers transported, cargo transport turnover, and the weight of transported cargo. However, there has been a stagnation in the development of rail transport services in the European market in recent years. This happens despite actions taken in recent years in the field of transport, for example, improving the interoperability of the European rail system. In the last 15 years, rail transport has not significantly increased its share in the transport market. During this period, the share of rail transport on the European market was nearly 7% in passenger and approximately 12% in freight transport [1]. Passenger transport turnover was related mainly to domestic routes, which accounted for nearly 90% of all rail transport. In the case of freight transport turnover, the share of international transport was almost 50%.

It is worth underlining that rail transport is one of the most sustainable transport branches [2]. It is significant in the context of the goals of European climate policies, such as reducing the negative impact of transport on the natural environment. The above-mentioned trends are reflected in the activities of logistics companies. Thus, in the European Union, significant emphasis is placed on the development of intermodal transport. At the same time, liberalisation of access to the rail network enables the implementation of entirely new market models and innovative technological solutions. The structures of operating costs of intermodal terminals are also analysed. Examples of activities improving the organisation of railway transport are the use of multi-system locomotives, which will significantly contribute to the internationalisation of rail transport and the elimination of bottlenecks in cross-border transport.

Furthermore, the above activities positively affect the organisation of rail supply chains, including processes related to planning, implementation, and control of activities associated with cargo flow from sender to recipient. Efficient and timely implementation of processes directly affects the value chain, which is a general mental construction that considers any process essential for business activity from a strategic perspective. Through the analysis of the value chain, numerous research can be performed. Examples of such research are cost assessments considering transport and other services related to the transport process.

This paper is divided into five sections. In the second section, changes in the Polish rail market during the last five years were characterised. The statistical data showing international exchange in rail transport, also during the pandemic caused by the COVID-19 virus, were analysed. The following part of this article presents an overview of the literature on the quality of services in a rail value chain. Further, the fourth section covers general considerations on the value chain in rail transport processes, while the fifth section focuses on detailing the different stages of value chain creation in rail transport processes. Finally, the last part of this article presents the summary and conclusions.

2. CHANGES IN THE RAIL FREIGHT TRANSPORT MARKET

Recently, much attention has been given to the ecological aspects of life in the context of sustainable development as an ability to meet current needs without prejudice to future generations [3]. Particular attention is related to the development of ecological means of transport, characterised by low emission of harmful compounds. Hence, the popularity of low-emission means of transport is growing, and much research is being carried out to improve the energy efficiency of rail transport. The modern and effective infrastructure used to implement rail transport processes, both on a macro and micro scale, favours the development of regions and urban centres. Moreover, it has a positive impact on the business environment of rail transport. Sustainable rail transport generates the need to conduct research focused on improving the infrastructure potential of suppliers providing services to customers. Development of rail transport concerns line infrastructure, means of transport, and additional infrastructure, enabling comprehensive customer service and ensuring optimal organisation of rail traffic [4, 5]. Research on supply chain models [6-8] and change management analysis in the setting of the safety of railway transport systems are carried out.

The current economic situation indicates considerable interest in freight and passenger transport integrated logistics solutions. At the same time, globally, in many areas of the economy, it is becoming increasingly popular for companies to offer comprehensive services that meet all customer needs. This situation also applies to the transport industry. The freight market is characterised by a high demand for integrated logistics solutions that require the combination of different freight services within one transport network [9]. However, the services offered have to be competitive in terms of prices related to the tariffs in rail transport. In the coming years, there will be a significant development of technological solutions influencing the shortening of transport processes and acceleration of the delivery of goods to customers [10, 11]. In the Polish and global markets, the main determinants of a rail freight development are:

- growing trade internationalisation,
- interoperability,
- increasing importance of intermodal transport,
- development and modernisation of line and point infrastructure as well as means of transport.

In addition, in the case of Poland, the strategic location of the country within the Trans-European Transport Network (TEN-T) corridors has great importance [122, 133]. The share of rail transport in a modal split is also significant. In 2020, the overall share of rail transport in a cargo modal share in the Polish market amounted to over 16%, while road transport accounted for nearly 72%, pipeline transport 10%, and inland and sea shipping for about 2%.

From 2016-2020, nearly 44% of a transport turnover was performed as part of international transport. The above indicator runs to the detriment of the European trend regarding a share of transport turnover in international transport (approximately 50%). Undoubtedly, the COVID-19 pandemic significantly affected a share of the cargo transport in international transport. Before the pandemic, a share of international transport in the total number of transports performed by rail in Poland was approximately 47%. The data below indicates a great interest in the business environment in rail transport usage for cargo transport from 2016-2018 [144-16]. As shown in Figure 1, restrictions in the exchange of goods caused by the COVID-19 pandemic contributed to the decrease in rail transport from 2019-2020, although in the export of goods in 2020, there was an increase in transport turnover compared to 2019 by nearly 2%.

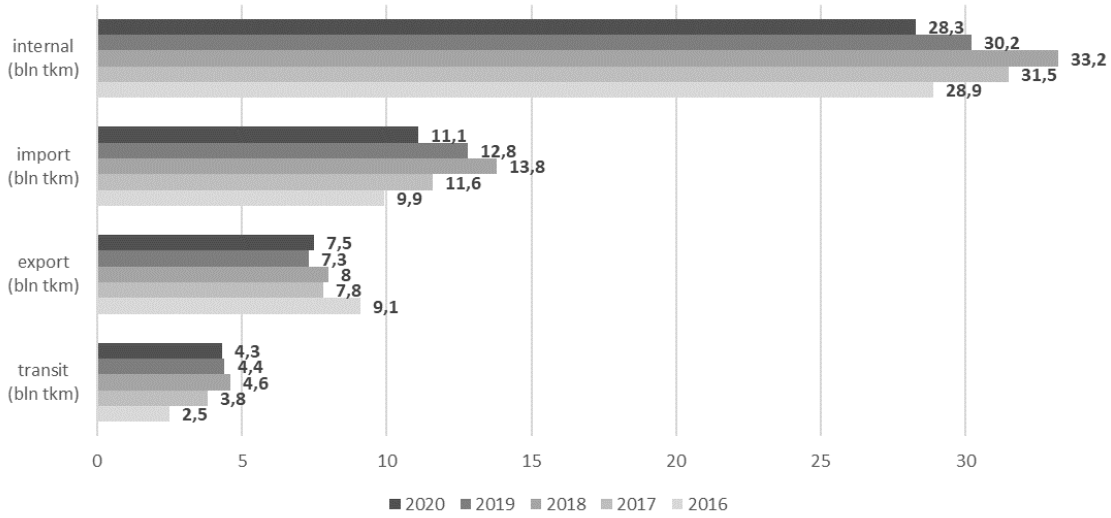

Fig. 1. Polish freight rail transport turnover from 2016 to 2020 [14-16]

The essence of intermodal transport is the movement of cargo in one load unit using at least two different, successive modes of transport [177]. Intermodal transport is an alternative to road transport and is essential in shaping sustainable transport policies. The development of intermodal transport is seen as a key element in solving many transport system problems, both in Poland and in the European Union. In intermodal transport, the same loading unit is used throughout the whole transport route, referred to in the literature as the intermodal loading unit. Intermodal loading units are usually containers or unified transport units of another type, such as swap bodies or combined transport semi-trailers. A detailed description of the transport process, considering all permissible transport operations in intermodal transport, can be very complex [18, 19]. However, the use of loading units of the type mentioned above enables the simplification of loading works, thus reducing the labour intensity of reloading, reducing the risk of damage during transshipment, and decreasing storage costs [20]. Analysis of the operating costs of intermodal terminals, related to the size of terminals and technologies used for cargo handling, and risk analysis for the operation of rail freight transport, are also important [211, 22].

In Poland, the importance of intermodal transport is constantly growing. In 2020, a total of 5 million containers were handled at intermodal hubs, of which nearly 63% were in land-sea transshipment terminals. In that year, almost 36.7 million tonnes of cargo were transported using large containers by rail and road transport [15]. Nearly 58% of large containers were transported by rail. Thus, an increase in the weight of the cargo transported by rail using large containers was recorded at 14% compared to 2019. The average distance of transporting 1 ton of cargo by a large container using rail transport was 360 km. As part of intermodal transport, over 10% more containers were transported using rail than in 2019. Therefore, it can be assumed that the business environment of rail transport responds positively to the stabilising pandemic situation in Poland.

Combined transport is essential from the standpoint of developing transport systems in Poland and Europe. Combined transport is a type of transport in which the loading unit on the main route is transported between terminals by rail, inland waterways, or sea. Its delivery from the sender to the hub and from the hub to the recipient is carried out by road over the shortest possible distance. In the case of combined transport, road transport performs a service function

to the mode of transport used on the main transport route. The radius for delivering cargo from/to the hub should not exceed 25 km, in exceptional cases 50 km. Transports carried out as delivery by road transport consider the specificity of planning transport routes in distribution areas. In the case of transport by inland waterways or sea, the delivery radius from/to the hub should be up to 150 km.

Similar to intermodal transport, during the transport process by combined transport, transshipments are carried out without changing the loading unit. The main idea of combined transport is the fact that it combines the advantages of different types of transport, for example, the ability to transport large volumes of cargo over very long distances characteristic of rail transport and sea shipping with high-level accessibility and flexibility, which is typical for road transport.

In Poland and throughout the European Union, numerous measures are taken to increase the competitiveness of rail transport, including intermodal transport. Among others, they are:

- investments in the modernisation of the railway infrastructure enabling achievement of a higher commercial speed of freight trains;
- providing 700-750 m long main tracks on crucial railway lines, which is a key issue for the organisation of intermodal transport;
- modernisation of railway traffic control devices, including an introduction of solutions enabling control of axial load;
- implementation of technological and innovative innovations in intermodal hubs [233].

Many intermodal terminals are not only transshipment points but also multifunctional logistics centres. This type of hub is significant for the development of intermodal transport. In addition to transshipment, the most critical function of this type of point is short-term storage. However, apart from that, intermodal terminals provide, for example, forwarding, service, insurance, and customs services. Consequently, intermodal terminals constitute an essential element of infrastructure for both rail and road transport [24].

There is no doubt that significant infrastructure investments are necessary to develop intermodal transport, contributing to improving the provided transport services quality. Nevertheless, investments of this type require substantial financial and spatial outlays (intermodal terminals are large-area facilities). Moreover, intensive infrastructure on railway lines works poses a great challenge, as they limit the capacity of railway lines, reducing the average commercial speed of trains and increasing the possibility of frequent delays.

In addition, it is worth paying attention to other aspects related to the organisation of railway traffic, such as, for example, determining the order of trains on railway lines, determining the time intervals, estimating travel times on railway lines, or determining the types of railway means of transport for individual transport tasks. All the issues mentioned above impact the fact that the organisation of intermodal transport with rail transport is a complicated decision-making problem. For example, arranging intermodal transport with rail transport at one stage of the journey is a more complex issue than the use of semi-trailer trucks on the whole route.

Moreover, the limitation of the competitiveness of intermodal transport is caused by restrictions in access to intermodal loading units (primarily containers), as well as the reluctance of operators and intermodal carriers to cooperate, share rolling stock, and create alliances [23].

Interoperability has a significant impact on the development of rail transport. Interoperability can be defined as the technical compatibility of railway systems in various European Union member states. In the past, rail transport developed independently from one country to another, using different tools, interfaces, and applications. The implementation of interoperability makes it possible to travel by rail between countries without the need to perform various activities,

such as, for example, changing a locomotive or changing the bogies in the rolling stock. Through activities related to interoperability, significant savings can be made for costs, travel time, and resources used. Interoperability brings benefits to transport organisers, carriers, shippers, and customers. At the same time, meeting the interoperability requirements not only increases the competitiveness and efficiency of rail transport but also has a positive impact on the natural environment.

Summarily, the development of any transport system (including intermodal transport) requires making decisions involving the rational use of specific economic, human, organisational, and spatial resources. In the case of this type of decision, the entire decision-making process should be carried out using multi-criteria and multi-aspect analysis methods that enable the comparison of various scenarios and support a selection of the best variant [0].

3. SERVICE QUALITY IN RAIL FREIGHT TRANSPORT IN THE CONTEXT OF THE VALUE CHAIN

The value chain concept is understood as the scope of activities necessary to develop a product or service through all the required stages, starting from design and production to its delivery to the customer [26]. The value chain is a complex issue. It can be defined as a system of interconnected links that are just as important to each other. Links in value chains are activities such as design, production, packaging, confectioning, internal logistics, transport, marketing, recycling, and information flow. Connections between individual links in the value chain are usually two-way, and they can interact with each other.

Various concepts that define the value chain can be found in the literature [277, 288]. Nevertheless, their common feature is an attempt to model a specific scope of activities necessary to deliver a good or service to the end customer. Value chain analysis has become more common due to the dispersion of production and the components required to produce goods or services. The described issue has a direct effect on production efficiency; therefore, it has a global character. Value chain analyses make it possible to optimise and evaluate the quality of the processes within the scope of individual links.

The most common techniques for managing value chains are:

- Just-in-time (JIT) – a method which assumes that materials and products are delivered in the right quantities, time and place, in line with the expectations of the end customer, which significantly simplifies production and transport processes;
- Total quality management (TQM) – a method focusing on comprehensive quality management while checking the achieved results that occur at the end of a given link;
- Continuous improvement (CI) – a method consisting of a continuous, systematic search for improvements in individual links of the value chain to introduce changes in the entire process gradually.

Concerning transport processes, a comprehensive analysis of the value chain, mapping its individual links, and assessing the quality of information and cargo flows allows for identifying all necessary activities to meet the emerging transport needs of the end customers. The value chain indirectly influences the value of the service provided or the price of the offered product for sale. Thus, the value chain can be the subject of analyses and practical implementations both in road transport [299] and rail transport [30].

The quality of a transport service (a measure of value chain assessment) can be defined as the degree to which a service or product meets the requirements of transport users. It is an essential measure of technical, operational, and economic characteristics related to a transport route, means of transport, time, and the product being transported. It can also be defined as a set of features related to the transport route, workforce, work tools, and organisation of the transport process (Figure 2).

Considering rail transport as one of the elements of the supply chain, it is necessary to mention the quality measures of rail transport, such as:

- cargo safety, which is an essential element of added value in rail transport (cargo damage results in measurable losses for all parties of the transport process: customer, carrier and process organiser);
- transport safety, which is a factor related to a wide range of regulatory issues in rail transport;
- flexibility of services provided, that is, the possibility of fulfilling orders for both large and small volumes of cargo;
- ability to dynamically respond to changing customer needs;
- ability to respond to disruptions in transport (since in rail transport any disorder can have far-reaching effects, it is a crucial measure);
- availability of transport means;
- availability of logistic infrastructure;
- certainty of the fulfilment of transport orders;
- advisory resources in an area of shipping and shipping-related documentation;
- flexibility in terms of the frequency of transport orders fulfilment;
- reliability understood as a guarantee of the fulfilment of a planned transport order;
- punctuality.

In the case of rail transport, all described quality measures impact an assessment given by the clients to all entities involved in the transport process.

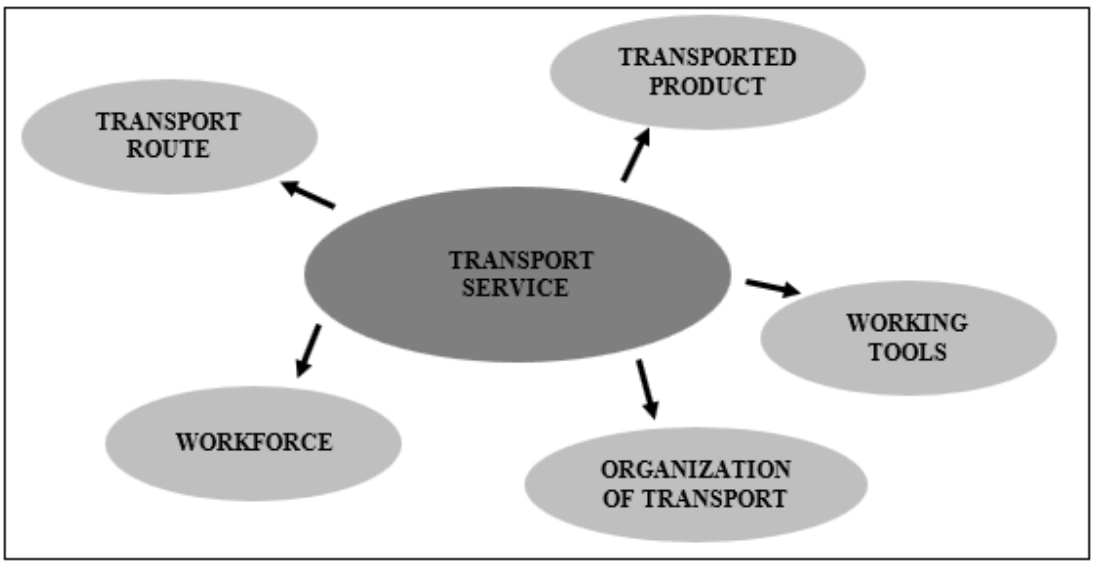

Fig. 2. Features of transport service related to quality

4. THE ESSENCE OF THE VALUE CHAIN IN RAIL TRANSPORT PROCESSES

During consideration of the value chain concept, it is necessary to indicate factors that affect the creation of added value for the customer ordering a transport of goods by rail transport. When analysing the value chain, it should be noted that it is related to the comprehensiveness of services provided, logistics, and the sustainable development of transport systems [0]. Each production company has to plan production, sale, storage, or refill of production means. The needs mentioned above mean that the goods are transported, stored, and reloaded. Therefore, there is a need to design and build production, storage, and transport infrastructure that should be adapted to each other.

Properly adjusted infrastructure along with modern IT solutions in production and transport processes ensure continuity of production and an efficient flow of goods from the producer to the consumer. The efficiency of the flow of goods means that it should be:

- harmonious − technical, technological and organisational solutions should be adjusted between participants;
- economical − eliminating unnecessary cells from the system.

A harmonious and economical flow of goods is favoured by creating transport and storage chains. Characteristic features of the value chain in intermodal transport are presented in Figure 3. Conclusively, it can be said that the value chain in rail transport affects the final value of goods, which would not be delivered to end customers due to the lack of an efficiently organised transport process.

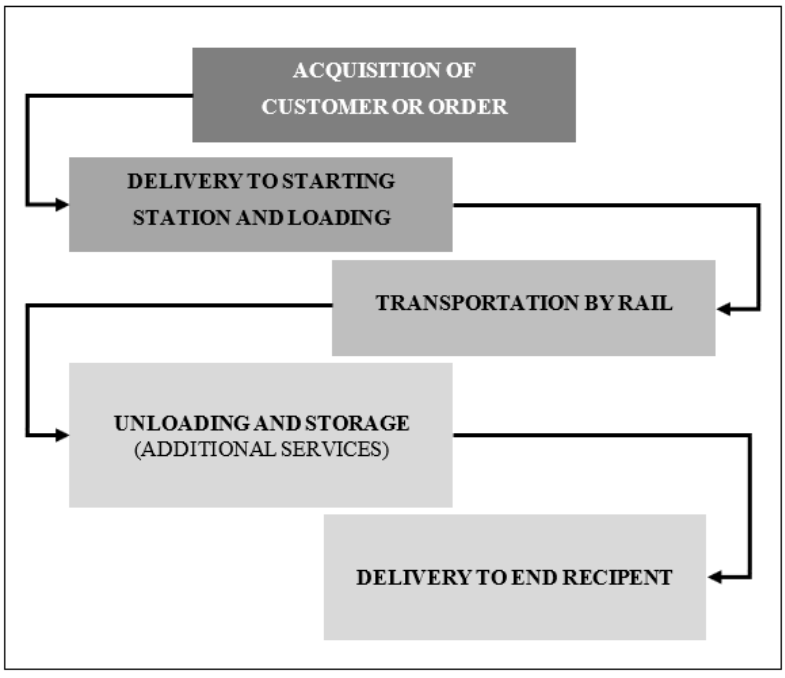

Fig. 3. The value chain in intermodal transport

5. STAGES OF CREATING THE VALUE CHAIN IN RAIL TRANSPORT

5.1. Acquisition of order or customer

Carriers respond to market needs, acquire customers or transport orders for services that are not directly related to the rail transport process. In this case, rail operators use subcontractors offering additional services. Usually, subcontractors providing this type of auxiliary service are forwarding agent companies. They offer services such as an organisation of transport and carry out activities preceding or following transport, which are usually beyond the scope of the services provided by the carrier (Figure 4).

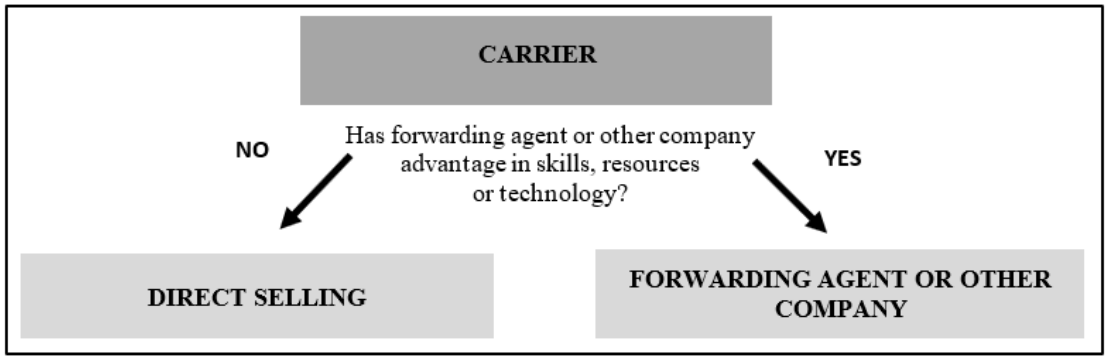

Fig. 4. Conditions for sale of transport services

5.2. Delivery to the shipping station and loading

As previously described, in intermodal transport, cargo is transported from starting points (for example, warehouses) to the shipping station by road. The transport in this relation is carried out by the sender, forwarding agent, and rail carrier who will carry out the transport on the main route or another external company. A cargo is reloaded from a road transport means to an intermodal train at a railway station. Before that, a sender has to order an appropriate type of rolling stock, ensuring that empty wagons of the correct type will be sent to the shipping station at the proper time. The diagram showing transport between warehouses and shipping stations is presented in Figure 5. An important element in building the added value in the supply chain in intermodal transport is the proper coordination of transport streams, that is, road and rail transport [311].

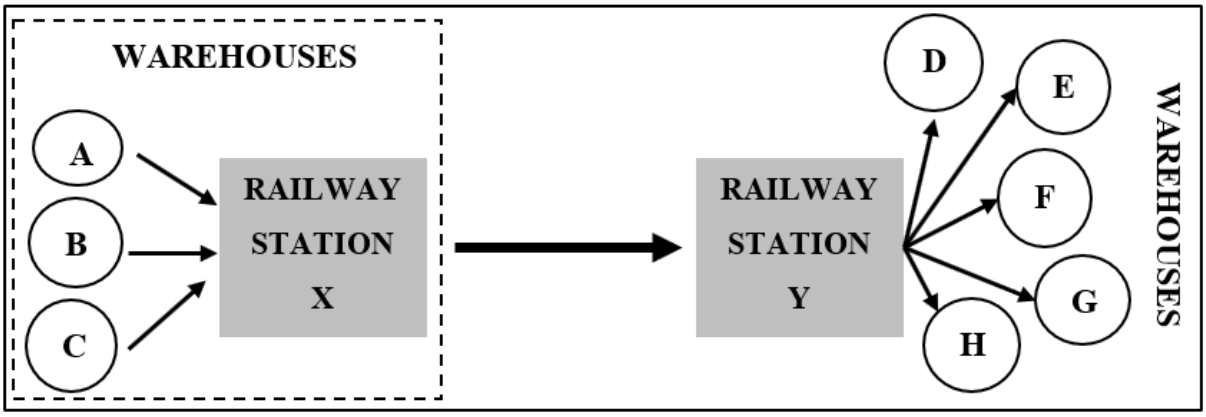

Fig. 5. Transportation scheme for relation: warehouses – shipping station [311]

5.3. Transport between shipping station and destination station

Rail transport is a crucial element in creating value in the supply chain. Due to the complex nature of the processes related to the organisation of rail transport, customer satisfaction depends on the proper cooperation of all entities responsible for the organisation of transport. The diagram of rail transport use in intermodal transport is shown in Figure 6.

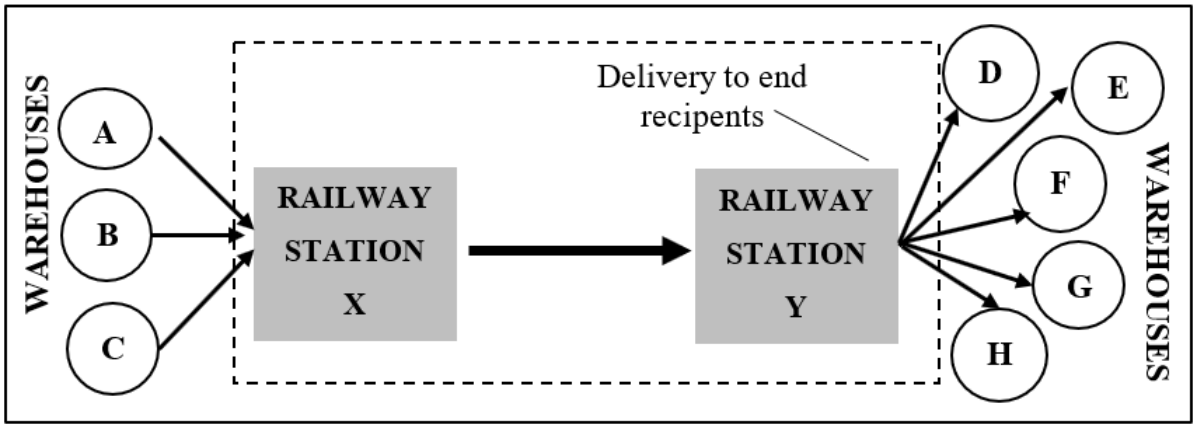

Fig. 6. Transportation scheme for relation: shipping station – destination station [31]

In the current market realities, planning, organisation, and implementation of transport are essential elements of railway carriers' activity. It should be emphasised that planning transport processes are one of the most important tasks in a transport company, especially in the case of transport processes using rail transport. Proper planning allows a carrier to develop its business. Profits of transport companies are generated by meeting customer requirements, and adequate planning for the transport process strengthens the satisfaction of contractors. Therefore, a transport process should be planned in such a way as to meet the demand for transport (deliver the cargo to the destination) while ensuring the optimal cost of the order.

Organising transport processes requires proper selection of the rolling stock and other resources necessary to meet a given demand. Therefore, system solutions should be sought to consciously and effectively plan the movement of loaded and empty wagons on the transport network. Figure 7 shows a diagram of the carrier's planning structure from an annual perspective. As previously mentioned, properly selected methods and procedures of implementing the process significantly affect the carrier's profitability and its assessment by the customer. Planning of wagons, locomotives, train crews, timetables, and work of railway stations are carried out based on the annual sales plan and the key effectiveness indicators used in the planning process. These indicators depict the relationship between commercial data and parameters describing the efficiency of a company's operation.

It should be noted that planning in a shorter term than a month (usually weekly - called scheduling) requires more detail in parameters of orders reported in longer perspectives, that is, in the annual plan, quarterly forecast, and monthly schedule. This is an area of operational management where clients confirm their previous needs. Before a planned transport, the sender orders wagons appropriate for the type of cargo. Thus, the carrier must adequately manage its own resources, such as wagons, locomotives, train crews, manoeuvring staff, etc.

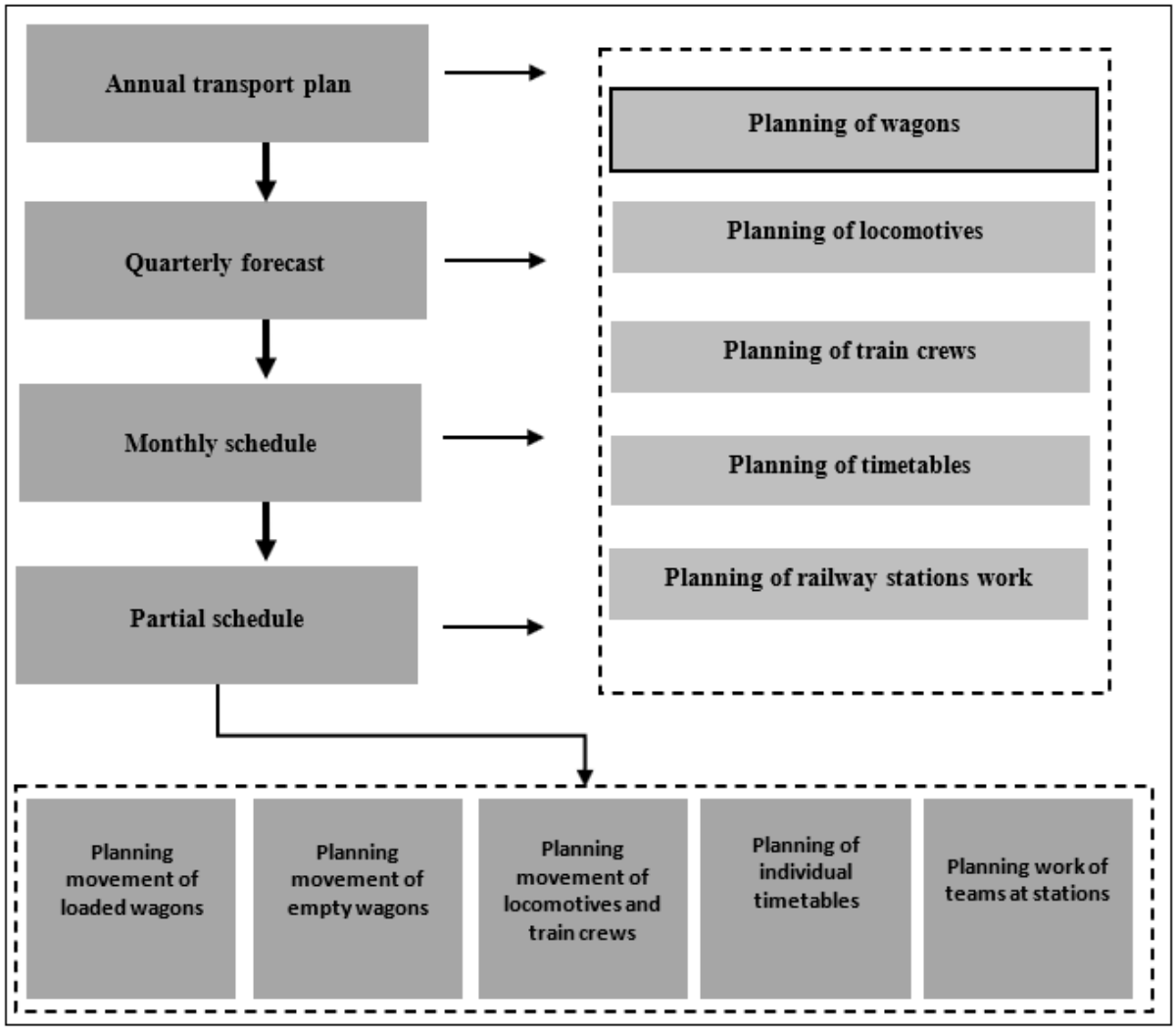

Fig. 7. The process of work planning by railway carriers from an annual perspective

The following sub-processes can be distinguished in the process of planning works on an annual basis in rail transport [32, 33]:

- wagons planning sub-process – includes activities related to purchase, modernisation, maintenance, and use of wagons. The availability of wagons determines the transport capacity of the carrier and has a significant impact on operational efficiency. Having the appropriate series of wagons is crucial because loads ordered for transport need wagons with different parameters. The service life of wagons is long (counted in tens of years); therefore, decisions related to the purchase of wagons must be well thought out and consider long-term plans regarding customer needs in the future. While the wagons are in use, transport tasks are performed, and repairs are made (currently and periodically);
- locomotives planning sub-process – it covers, similarly to the wagon's planning sub-process, all activities related to the purchase, modernisation, maintenance, and use of locomotives. Changing market conditions impact transport turnover and force carriers to offer various services. As indicated earlier, also in the case of locomotives, the purchase should be preceded by a long-term demand analysis due to the length of locomotives operation;

- train crews planning sub-process – process strongly related to locomotives planning sub-process. The basis for developing train crew's plans are schedules for locomotives and wagons. Planning, in this case, is complex as it is limited by the rules described in the Labour Law and the current situation related to human resources. Any difficulties related to the train crew's schedules may disrupt the organisation of rail traffic within the company;
- annual timetable planning sub-process – includes the creation of a yearly timetable. This sub-process is closely related to the annual sales plan and implemented in close cooperation with the infrastructure governor. Carriers must submit applications for route sharing for the annual timetable. In the case of well-identified customer needs, the carrier has guaranteed routes to carry out its own transport well in advance and at a lower price. In the long run, bad transport planning causes the need to submit corrections to the annual timetable and increases the number of applications for individual timetables;
- railway stations' work planning sub-process – consists of developing technological assumptions for the station's operation and covers activities between the arrival of the train at the station and its departure. Part of the process is to define the station's operating standards. The main activities of this sub-process are the handling of the train at the station and the operations performed during passing trains through the stations. The technology of a station's operation determines the place and duration of individual activities in the process of moving wagons. For the implementation of tasks, stations employ manoeuvre locomotives, manoeuvring teams, and others necessary to perform the assigned tasks. The maximum bandwidth parameters are established in the technical documentation of each railway station. Proper planning of the station's operation in the long term has a significant impact on the quality of transport services;
- short-term schedule planning sub-process – in scheduling shorter than a monthly period (usually these are weekly periods), additional data (not required for annual and quarterly plans) is needed. This sub-process is about obtaining data from customers regarding the time of shipment, type of load, type of wagons, etc. The role of the carrier is to distribute resources in such a way as to meet customers' needs globally while maintaining an appropriate quality of services. Moreover, cost optimisation should be considered.

All above-described sub-processes significantly contribute to adding value to the supply chain. It should be emphasised that the rail transport process also includes a sub-process of order fulfilment monitoring, which has a significant impact on the customer's perception of the carrier in the value chain. This sub-process includes service status tracking, complaints service, and handling of transport abnormalities. It is worth mentioning that a vital element of the after-sales service in rail transport is also complaints service. Two types of damage can be distinguished, that is, irregularities (delays, damage, and loss) of shipments and damage of wagons used in a transport process. The last element of the order fulfilment monitoring sub-process is handling irregularities in the transport process. They are the basis for submitting complaints by the customer. The activities under this sub-process are performed at shipping stations, intermediate stations, and destination stations.

Given the carrier's cooperation with the client, commercial activities performed in cargo rail transport are extremely important (Figure 8).

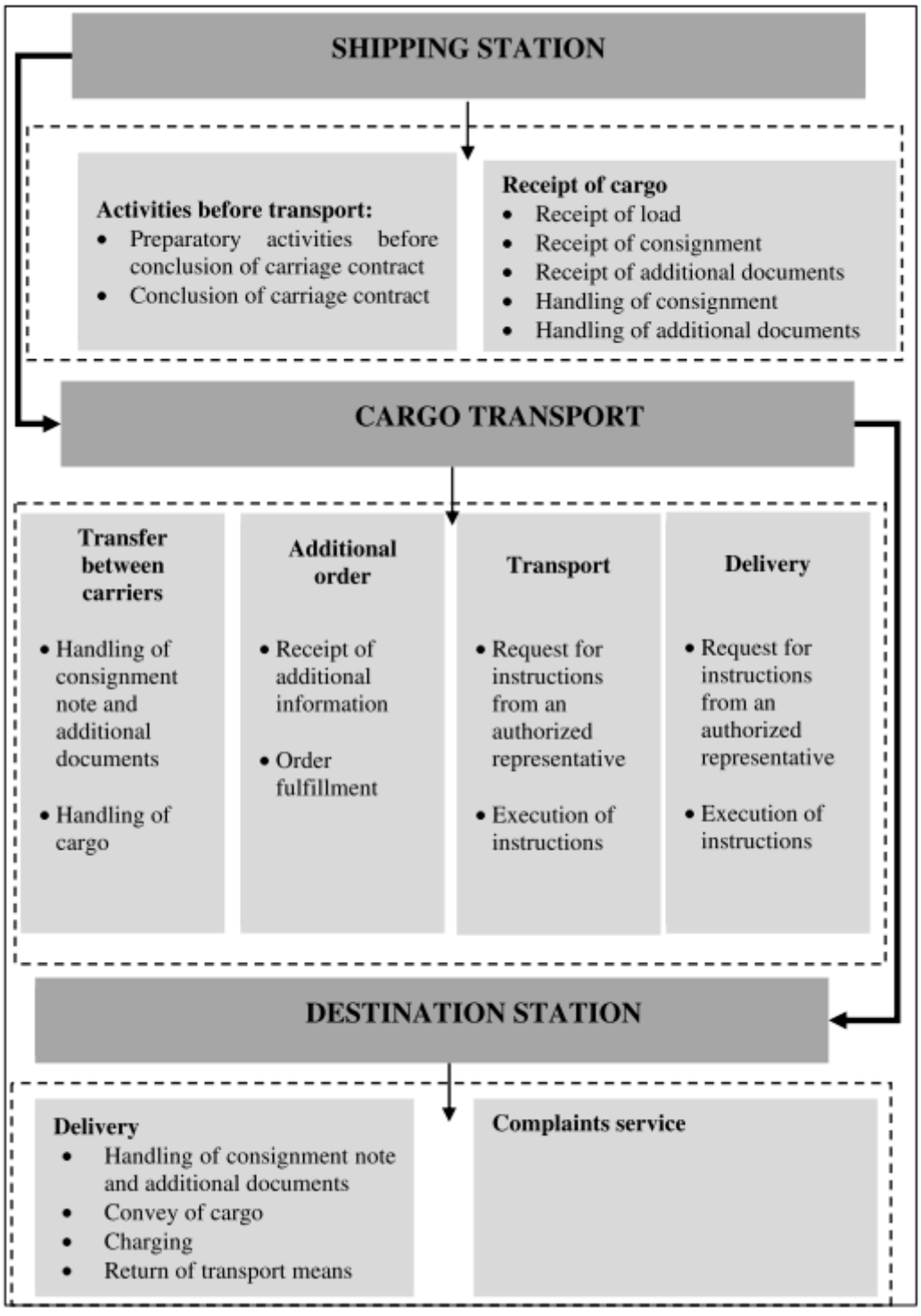

Fig. 8. The most important activities in the organisation of the rail transport process

5.4. Unloading, storage, and additional services

At this stage, the transport operator often orders additional services from specialised logistics companies and forwarding agents. These additional auxiliary services are:

– consulting on transport solutions,

- preparing shipping documents and other documents related to shipment dispatch (insurance, sanitary, customs, etc.),
- carrying out loading activities,
- cargo insurance,
- customs clearance,
- security services,
- picking up cargo and checking it,
- preparation of damage protocols,
- settling payments for transport services,
- temporary storage, etc.

The determinant of a professional logistics company is possessing resources that can offer the services mentioned above or the ability to obtain them quickly. The value for the client is the ability to order such services from one entity. In this case, one company is responsible for all operations and documentation related to the requirements set by legal regulations (such as customs clearance, phytosanitary clearance, etc.). Therefore, consolidation of logistics and forwarding agents is observed in the global market [30]. The diagram showing transport in the relation between destination station and warehouses is presented in Figure 9.

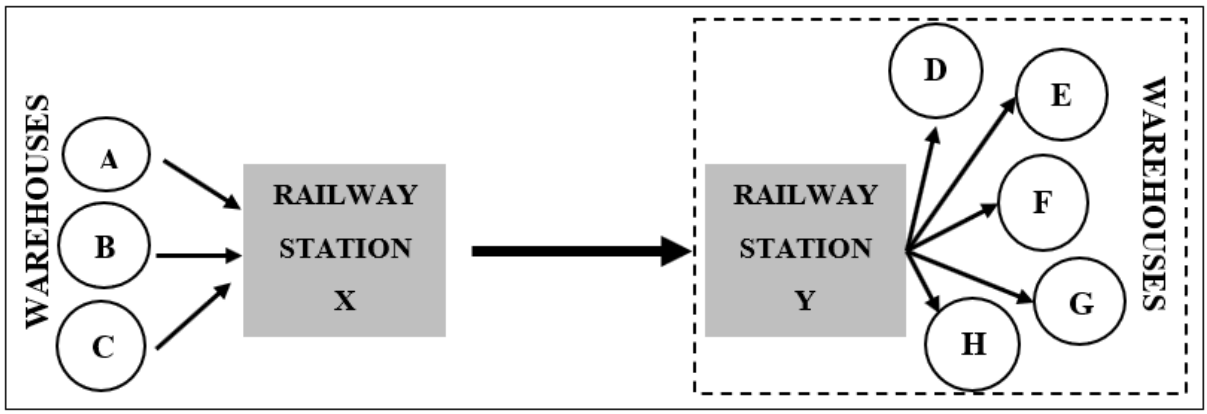

Fig. 9. Transportation scheme for relation: destination station – warehouses [30]

6. CONCLUSIONS

The direction in which the logistics and organisation of rail transport are heading is managing the entire supply chain by one operator. Organising the flow of goods requires a comprehensive approach to supply chain management and the concentration of many logistics functions in one operator or group of companies. The development of broadly understood combined transport channels is currently taking shape and will be further strengthened in the future.

As part of the supply chain, intermodal transport will be a standard of service. Both intermodal transport and the continuous expansion of a range of warehousing services and related individual solutions for customers are the directions of the logistics market.

Observing the above considerations, it can be concluded that the determinants of the development of intermodal transport are the modernisation of the line and point infrastructure, including an expansion of intermodal infrastructure (intermodal terminals), meeting the interoperability requirements, and increasing the competitiveness and quality of rail transport on the freight market. In addition, it is necessary to equalise the chances of competing road and rail carriers through non-investment support, that is, preferential access rates for intermodal rail and fragmented transport. To improve the quality of services provided, it is necessary to introduce organisational changes so that it is possible to offer services that consider the entire transport chain, such as "door-to-door" and "just-in-time" services.

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