Transportation Services as Specific Logistics Projects for Oversized Cargo in Poland

Iwona Pisz and Iwona Łapuńka

Abstract Market observation demonstrates that the transportation-freight forwarding-logistics sector carries out diverse projects based on clients' orders. The majority of those orders are unique and project related. Recently, the project approach to logistics has gained significance. Logistics project management is a relatively new area of knowledge about logistics and supply chains. The paper presents the essence and characteristics of transportation services as a specific logistics project. The authors characterize the transportation-freight forwarding-logistics sector, with particular focus on the sector of oversized cargo transportation. The demand for such services depends on the industry, energy, infrastructure development, investment projects in particular countries, as well as on economic policies. The paper identifies key factors that need to be taken under consideration when planning oversized cargo transportation services, i.e., specific characteristics, conditions, technology, tools, techniques, and methods, for example, a method of transportation service cost estimations. The proposed method uses fuzzy set theory. It can be implemented into the practice of transportation-freight forwarding-logistics enterprises, facilitating the modeling of uncertainties typical in such undertakings. A practical example of a transportation service is presented.

Keywords Transportation-freight forwarding-logistics sector • Transportation service • Logistics project • Oversized cargo • Oversized load • Logistics service provider

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Introduction

The basic service on the logistics market, arising out of the need for moving various goods from their collection point to their destination, is transportation. This includes transportation of special loads (abnormal loads, oversized cargo), which can be considered highly problematic and therefore requires special attention. The process of its management is similar to project management, especially logistics project management [1, 2]. A project involving logistics project is a multistage process and multifunctional effort, the activities of which depend on several people (enterprises), resources, and dependencies [3].

The services are the application of competences including knowledge and skills by one entity for the benefit of another [4, 5]. Logistics services are a unique subset of industrial services. This kind of services spans the boundaries between suppliers and customers and has become increasingly important to successful supply of chain operations. Logisticians understand that these sets of activities constitute the very essence of their business [6]. The logistics services can vary in complexity and can be carried out in short or long supply chains. Market observations indicate that logistics services have become increasingly sophisticated, by far exceeding their traditional perception [7]. They begin to resemble projects characterized by singularity, uniqueness, temporariness, limited budget, and, occasionally, innovativeness. The majority of commissions received by logistics service providers constitute separate and singular transportation-freight forwarding-logistics processes, which necessitate detailed analysis, planning, as well as appropriate management methods. Therefore, they are often treated as a specific type of projects, called logistics projects [8].

The aim of the paper is to present the essence and characteristics of transportation services as a specific logistics project. Authors characterize the transportation-freight forwarding-logistics sector, with particular focus on the sector of oversized cargo transportation. The demand for such services depends on the industry, energy, infrastructure development, investment projects in particular countries, as well as on economic policies. Transportation of nonstandard cargos creates nonstandard problems. The management of such services requires specific knowledge, resources, and managers. The paper identifies the key factors that need to be taken under consideration when planning oversized cargo transportation services, i.e., specific characteristics, conditions, technology, tools, and techniques.

Changes in the Transportation-Freight Forwarding-Logistics Business

Transportation-freight forwarding-logistics business enterprises should be analyzed in the context of processes carried out in the areas of supply, production, returns, and waste management. The functioning of enterprises in this line of business is

determined by independent demand on the market of goods and services. Market research shows that the transportation-freight forwarding-logistics business is characterized by an increased intensity of competition, which makes traditional methods of managing such enterprises and of competing on the market suboptimal. Further observations indicate that the ability of adopting new solutions does not necessarily guarantee a long-lasting competitive edge of a given transportation-freight forwarding-logistics enterprise on the market. Under such conditions, swift and flexible adaptation to the needs of the client gains importance. This can be achieved by creating and implementing new and innovative ventures in order to improve the functioning of logistics, mostly by means of cooperation with other units, e.g., by carrying out logistics projects. Such undertakings allow optimization and cost reduction in a logistics chain, and thus entrepreneurs should perceive them as a main factor that facilitates achieving a competitive position [9].

With regard to supply, the observation of the market of logistics services provided by diverse transportation-freight forwarding-logistics business enterprises reveals the following ongoing transformations: an increase in the number of enterprises providing specialized logistics services; migrations between enterprises; a shift in the roles of transportation-freight forwarding-logistics business enterprises related to the introduction of new customer service strategies, new technologies, products, and services; change in the market share; as well as increasing competition. In economic practice, this means that changes in the functioning and development of transportation-freight forwarding-logistics business enterprises are perceptible on the market of goods and services. Large transportation-freight forwarding-logistics enterprises offer a broad scope of services on a large scale, offering their clients values bundled to maximize benefits. Moreover, they effect improvement by implementing measures that allow their clients to enhance their operational effectiveness, competitiveness, and innovativeness, as well as change the functioning of their supply chains.

The implementation of diversification strategies by large transportation-freight forwarding-logistics business enterprises facilitates the identification of market opportunities, the flexible reaction to clients' needs, and the reduction of risks associated with potentially worse financial condition of a given group of clients. Large transportation-freight forwarding-logistics business enterprises outsource transportation functions to small business units, focusing on the management of a large number of geographically dispersed subcontractors. In order to effectively carry out such processes, IT solutions are constantly developed and subsequently implemented in enterprises. The implementation of an IT system for the purposes of synchronizing the flow of goods constitutes an example of a logistics project execution. Practically speaking, in this case, the future success in logistics depends on possessing IT tools for the effective management of extensive logistics projects. Specialization is yet another trend discernible on the market of logistics services—here many enterprises sense their opportunity, focusing on carrying out highly specialized logistics services, where the competition from large businesses is comparatively small. This is, for instance, the case with specialized transportation, including oversized cargo, as well as with value-added services.

On the other hand, small- and medium-sized transportation-freight forwarding-logistics business enterprises strive to increase their transportation potential by purchasing specialized means of transportation and loading and unloading equipment. Such enterprises introduce new products and services into their offer and aim to perform new functions, e.g., freight forwarding, warehousing, and relocating equipment and machinery, in order to gain new clients and increase the satisfaction of their regular clients. They employ the strategy of focusing on a market niche and decide to cooperate with other enterprises through outsourcing more often than large enterprises. Increased diversification increases their chances of survival and development on the market and creates a basis for developing and increasing competitiveness and innovativeness. This is particularly noticeable in the way third-party logistics (3 PL) operators perform their functions, aspiring to the role of fourth-party logistics (4 PL) operators [7, 10]. Proper execution of tasks by such logistics operators requires particular competences, access to appropriate technologies, IT support, and know-how. At present, the management of workflow in transportation-freight forwarding-logistics business enterprises is a complex, unique, and innovative process. Therefore, it requires extensive knowledge, skills, and appropriate competences as well as proper management methods and procedures, including simulation and modeling of material flow management, and multivariate analysis of the effectiveness of logistics processes. Bearing this in mind, it is necessary to implement the project approach into management practice into transportation-freight forwarding-logistics business enterprises.

Contemporary transportation-freight forwarding-logistics business enterprises discern the necessity of building interorganizational relations with specialized logistics enterprises, including those small and medium sized, based on active or passive cooperation, and hence the need to create specialized clusters grouping together given enterprises in a particular line of business. Building relations between enterprises allows to integrate and connect processes and resources for the purposes of carrying out services, as well as to introduce added value for clients. The nature of interorganizational relations results from the strategy adopted by the enterprises. In order to carry out complex undertakings, including logistics projects, enterprises build partnerships with other participants in the transportation-freight forwarding-logistics market. Such integration constitutes a set of undertakings and initiatives, which are used by a given enterprise in order to integrate the processes with its suppliers and recipients. Such activities allow enterprises to carry out diverse investments and thus to expand the scope of services they currently provide; in so doing enterprises better adapt to the increasing expectations of their clients.

The increasing number of partnerships based on logistics outsourcing arises from the necessity for cooperation as part of carrying out a particular order, which exceeds the capabilities of a single transportation-freight forwarding-logistics business enterprise or results from undertaken investment projects. Cooperation as part of challenges undertaken by enterprises contributes to the development of more flexible organizations, which are based on knowledge, core competences, and mutually profitable long-standing business relations. This also promotes learning in organizations. In this context, a learning organization would be a transportation-freight forwarding-logistics

business enterprise continually expanding its capabilities in order to shape its future. A learning organization is a place where people can continually learn, develop, and improve their qualifications. Such an organization is capable of reacting to market needs in a swift and effective manner, adapting to market requirements, and responding to market changes. Over the course of time, it can become an intelligent enterprise, which, by means of learning, reaches its optimal state, looks for development opportunities, and achieves successes, simultaneously avoiding setbacks.

An increasing number of enterprises implement the project approach into their business practice. Market observation demonstrates that transportation-freight forwarding-logistics business enterprises carry out diverse projects based on clients' orders. The majority of those orders are unique and project related. Recently, the project approach to logistics has gained significance. Logistics project management is a relatively new area of knowledge about logistics and supply chains. The increased interest in planning and carrying out logistics projects and the associated problems is mirrored by an increasing number of trainings on the market of advisory and training services, as well as by an increase in scholarly publications. The significance of project management is supported by the examples of projects that ended in success or failure, carried out in different lines of business and in a variety of enterprises, including transportation-freight forwarding-logistics business enterprises.

The market of logistics services is continually on the rise. The number of enterprises competing for the largest project-based orders increases as well. The analysis of financial data of logistics enterprises demonstrates an increase in the number of enterprises whose turnover exceeds 100 million zlotys. The number of such enterprises has doubled since Poland's accession to the European Union. At the same time, the group of enterprises capable of developing their sales at the pace of the leaders in the area, and achieving similar incomes, expands in a consistent manner. This segment stands out as a market entirety among a mass of smaller enterprises (acting as subcontractors), whose development is significantly slower and income lower by far. Passive and active cooperation established between transportation-freight forwarding-logistics business enterprises brings about not only notable benefits but also dangers. Without doubt, one of key benefits is the diversification of activity as part of currently developed networks of designated logistics operators and integrators.

Defining Oversized Cargo Transportation

Present studies do not provide a precise or uniquely applicable definition of the oversized cargo. The determinates of oversized cargo are [11]:

- Cargo dimensions
- Cargo weight
- Available cargo space on the vehicle
- Permissible pressure and stress on the loading surface
- Permissible stress on surface of road/rails

Table 1 Definition of oversized cargo in different modes of transport

Transport mode	Definition of oversized cargo
Road transportation	Oversized cargo exceeds maximal permitted parameters of standard road vehicle or exceeds permissible axle load of the vehicle. In consequence, there are oversized vehicles instead of oversized cargos
Rail transportation	Oversized cargo exceeds standard loading gauge or exceeds permissible axle load of the railway. Such a situation is called extraordinary delivery, which means that such transport can cause difficulties in rail transport and it is necessary to take special technical and/or operating actions
Inland shipping	Oversized cargo is a cargo that overcomes the vessel's length and/or width or which overcomes the standard air draft of the vessel (vertical clearness of bridges, gates, etc.). It is taken under consideration on the restricted visibility of the helmsman as well
Sea transportation	Oversized cargo is defined as: break bulk or general cargo unit which overcomes the parameters of standard cargo units. This means it weighs hundreds or even thousands of tons and its dimensions are counted in tens or even hundreds of meters
Air transportation	Oversized cargo is such cargo which cannot be located in air container or on special consolidation unit. The only way to transport it is to use a special transport airplane
Intermodal transportation	Oversized cargo is the cargo that exceeds the average permissible parameters of means of transport in terms of size, shape, and/or permissible pressure and stress on the loading surface of at least one means of transport

Source: adapted from [11]

Oversized cargo can be classified with regard to its outer dimensions, weight, and shape. The particulars of a given cargo determine the methods and means of its transportation, the equipment, the mode of mapping out the route and acquiring permits, and, in turn, the feasibility of carrying out a particular order. Oversized cargo can be classified into a number of groups: standard over-dimensional, special over-dimensional (bulky but not heavy), heavy but not bulky, simultaneously heavy and bulky, and long [11]. Table 1 presents the definition of oversized cargo in different transport modes.

Carrying out diverse investments or unique projects in a number of countries requires delivering appropriate elements, i.e., the objects of delivery. The elements necessary for carrying out projects often constitute nonstandard cargo, whose weight and/or dimensions exceed the carrying capacity and/or load space parameters of standard means of transportation and/or road infrastructure. On the market of goods and services, there exists a demand for the transportation of diverse cargos from different parts of the world, over a variety of distances (Fig. 1). The cargos differ, for instance, in shape, dimensions, or tonnage. A demand for the transportation of nonstandard cargo, which cannot be transported by standard means, is observed. Economic growth and associated investments in the public and private sectors contribute to an increase in nonstandard cargo transportation. The oversized freight market is fueled by significant energy project [12]. Oversized cargo transportation

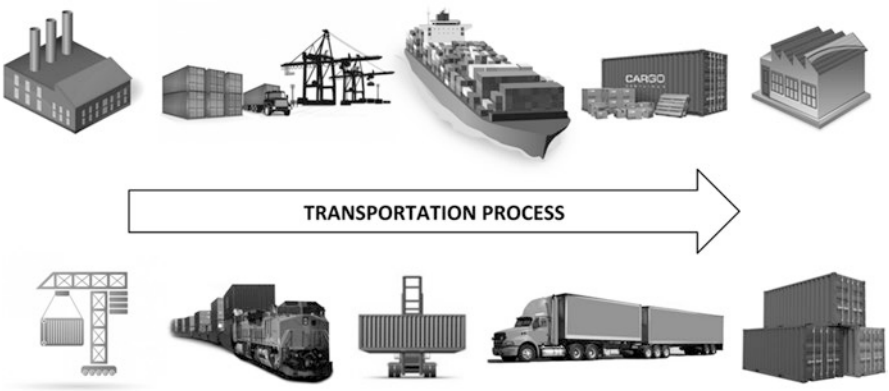

Fig. 1 An example of intermodal transportation of oversized load (source: own elaboration)

influences the economic development of a given country as well as the development of the industry, the infrastructure, and the energy sector.

A significant interest in nonstandard cargo transportation is observed on the market of goods and services. A smooth movement of the oversized cargo carrying vehicle needs special permits [11]. They are different in each country. In Poland, we can observe that there is a big demand for nonstandard transportation. Respectively, Table 2 and Fig. 2 present data on the number of permits issued by appropriate departments of the General Directorate for National Roads and Highways in Poland between 19 October 2012 and 31 December 2014. The data were obtained from individual departments of the General Directorate for National Roads and Highways at the request of the authors. According to the data, an increase in the demand for oversized cargo transportation is noticeable; this is particularly true with regard to very specific cargos requiring the issue of a one-time permit of category VII for the passage on national roads. It is estimated that oversized cargo transportation constitutes about 10 % of all transit [13].

The data presented in the table demonstrate that the number of permits issued for particular categories differs significantly between the departments of the General Directorate for National Roads and Highways. For instance, the departments in Wroclaw, Szczecin, and Poznan issue the highest number of category VII permits for the passage of nonstandard vehicles. In 2014, these departments issued over 45 % of all category VII permits. This may be due to the fact that the majority of oversized cargo transportation is carried out in those provinces (main communication routes) or that a large number of oversized cargo transportation enterprises are located in those provinces or in their vicinity. Moreover, the number of permits issued by a given department of the General Directorate for National Roads and Highways is influenced by the quality of service offered by these departments. It must be emphasized that entrepreneurs may apply for a permit of a given category in one of 16 departments. Surveys of oversized cargo transportation enterprises have shown that they usually apply for the category

Table 2 The number of permits issued for a given category for the passage on national roads in Poland issued appropriate departments of the General Directorate for National Roads and Highways in Poland for the period from 19 October 2012 to 31 December 2014

Headquarter of the department	Year 2012	Year 2012	Year 2012	Year 2012	Year 2013	Year 2013	Year 2013	Year 2013	Year 2014	Year 2014	Year 2014	Year 2014
	Permit category	Permit category	Permit category	Permit category	Permit category	Permit category	Permit category	Permit category	Permit category	Permit category	Permit category	Permit category
	IV	V	VI	VII	IV	V	VI	VII	IV	V	VI	VII
Białystok	0	3	1	2	0	15	2	31	1	15	2	31
Bydgoszcz	3	48	6	15	3	138	42	232	14	105	39	232
Gdańsk	2	41	11	10	2	108	28	276	1	121	71	305
Katowice	17	52	30	25	15	99	86	235	25	100	107	181
Kielce	0	9	11	36	9	18	29	223	8	36	19	207
Kraków	0	22	10	45	20	101	60	112	11	94	49	217
Lublin	10	28	18	12	16	47	9	65	12	57	17	51
Łódź	4	30	14	7	16	48	21	35	14	58	36	48
Olsztyn	0	0	20	101	1	56	21	309	0	48	23	214
Opole	2	60	32	24	9	80	28	146	8	14	56	246
Poznań	7	103	37	184	28	288	99	770	29	309	167	494
Szczecin	2	45	13	40	3	127	22	279	3	127	31	502
Rzeszów	2	8	18	13	13	36	20	147	8	56	38	144
Warszawa	5	56	21	29	15	134	46	81	12	158	72	109
Wrocław	0	61	2	197	7	115	21	692	1	97	27	740
Zielona Góra	5	6	3	4	19	8	3	100	21	13	1	117
Total	59	572	247	744	176	1418	537	3733	168	1408	755	3838

Source: own elaboration

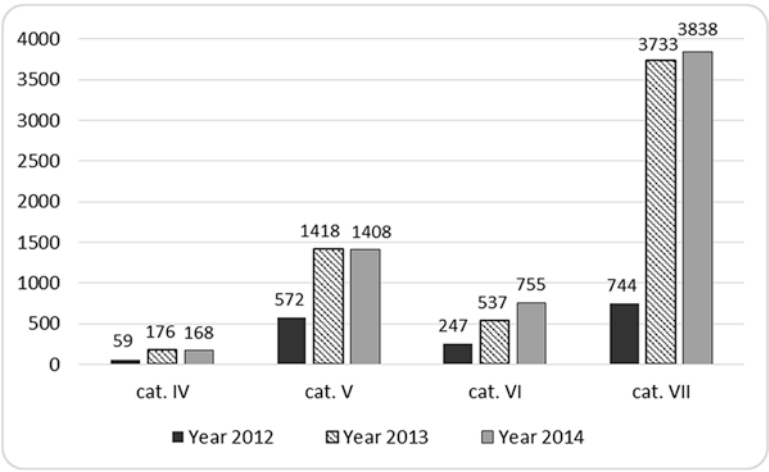

Fig. 2 Statistic of permits issued for IV–VII category for the passage on national roads in Poland for the period from 19 October 2012 to 31 December 2014 (source: own elaboration)

VII permits in the departments where service is most effective, the time needed to issue a permit is relatively the shortest, and the number of successful applications is high (the departments in Wroclaw, Szczecin, Poznan, and Warsaw). The situation is different for permits of other categories. In the case of category IV–VI permits, entrepreneurs usually apply in the departments of the General Directorate for National Roads and Highways in the province where a given enterprise is registered.

These are the actual data on the number of appropriate permits for nonstandard road transportation in Poland. Furthermore, a fraction of such transports are carried out without requisite permits. Sometimes, cargo parameters diverge from the ones specified in the permit, which means that entrepreneurs misdeclare the size of the transported cargo. The passage of nonstandard vehicles on public roads without permits or violating the conditions stipulated in the permit is subject to a fine under an administrative decision. Upon inspection, such a decision is issued by appropriate local unit of the police, road transportation inspection, border guards, customs, or the road administrator.

The data in Fig. 2 demonstrate that the number of issued category VII permits is on the increase. In this case, these are one-time permits for nonstandard vehicle passage on the route stipulated in the permit. They are valid for 14 days in the case of a single passage or for 30 days for multiple passages. Category IV–VI permits are issued for multiple passages and are valid for 1, 6, 12, and 24 months, respectively. The entrepreneur declares the required validity period when applying to the appropriate department of the General Directorate for National Roads and Highways for the permit for the passage of a nonstandard vehicle. Therefore, the analysis of the number of category IV–VI permits requires additional information on the validity period of the permits, which we were unable to obtain from the GDDKiA departments.

Oversized Cargo Transportation Planning

The planning process for moving oversized cargo continues to grow in detail and complexity (Fig. 3). Project cargo logistics is one of important aspects of the supply chain. As we have already stated, the service providers are becoming more sophisticated in how they plan and partner for success when transporting oversized and heavyweight cargo. Moving the oversized cargos is complex, especially with the permitting and planning necessary to transport this type of load [14]. A lot of planning is required to avoid problems of nonstandard load transportation. The enterprise which realizes this special type of logistics project has to control every detail of the project. This process includes many steps and should include what-if scenarios.

The basic tasks comprising oversized cargo transportation include: planning, budgeting, organizing (including obtaining appropriate permits), and supporting activities, i.e., pilotage, police escort, road infrastructure disassembly, raising railway/tramway systems, inspection of bridges and ferry loading ramps, tours of inspection, labeling vehicles according to local regulations, loading separate cargos onto ferries, and transshipment of oversized cargo. Of particular significance is the preparatory stage of a logistics project. Special requirements and conditions of oversized cargo transportation include various permits, route surveys from state departments of transportation, police escorts, etc.

The organization of oversized cargo transportation is a complex process, primarily consisting of: preparation of cargo for transportation, selection of appropriate means of transportation, route planning, and obtaining permits for oversized cargo transportation [15]. By analogy with logistics project planning, it is necessary to assess time, cost, and risk and to perform overall ex ante and ex post project evaluation.

Legal Basis for Oversized Cargo Transportation

Enterprises transporting elements with nonstandard features, shapes, or dimensions are required to carry out specialized services using nonstandard means of transportation and according to different procedures and regulations. Oversized cargo

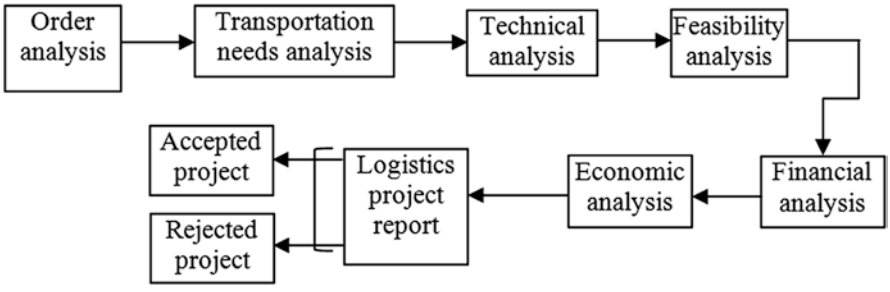

Fig. 3 An integrated model for decision analysis of logistics project execution (source: own elaboration)

transportation requires special permits, depending on the type of transportation and detailed arrangements with appropriate infrastructure administrators.

Oversized cargo transportation requires specific formal conditions to be fulfilled. Every country in which such transportation is carried out has its separate regulations with regard to permissible parameters. In practice, this involves permitted driving time, traffic regulations, conditions of pilotage, and police escort. Every country is different with regard to the conditions of securing special permits; and the waiting periods vary as well, ranging from several days up to several weeks. The appropriate authority or institution may refuse to issue a transit permit on a number of grounds, e.g., environment protection or lack of proper infrastructure. Permit prices vary depending on the country in which transportation is carried out and are related to the length and weight of the set, route length, number of axes, and length, width, and height of cargo and transport. Every special permit specifies the conditions of carrying out the transportation, which mostly concern speed limits and mandatory stopovers at certain locations. The transportation period (day or night) is also specified, along with an hourly time frame and the necessity for escort (if applicable). At times, bridge strength and capacity may need to be assessed or the route may require a tour of inspection.

The oversized cargo is transported mostly by road, because it is treated as the cheapest way and the most flexible means of transportation [11]. Transit of oversized cargo on public road requires special permits. In the case of international transit, such permits must be issued by each country en route. Moreover, every country has designated public administration units, which issue permits for oversized cargo transportation. In Poland, new regulations with regard to oversized cargo transportation have been in force since 19 October 2012. According to these regulations, nonstandard vehicle traffic is allowed as long as the following four conditions are fulfilled: a permit for the transit of a nonstandard vehicle of appropriate category has been obtained (such a permit must be issued based on an administrative decision of the appropriate authority); conditions of transit specified in the permit must be observed; the nonstandard vehicle must be piloted if one of the following is exceeded (length, 23 m; width, 3.2 m; height, 4.5 m; and gross vehicle mass, 60 ton); and the operator of a nonstandard vehicle must act with due caution. In addition, section 64a–64i of the act divides nonstandard vehicle transit permits into seven categories, depending on the technical features of the vehicle and the type of road on which transit takes place [16, 17]. Table 3 presents the basic characteristics of such permits.

The abnormal transportation business is a specific one. The companies which do the business deserve special attention. Usually they are gathered in some association. For example, ESTA is a European association of professional organizations representing companies active in the mobile crane rental and nonstandard road transportation business. ESTA represents national trade associations whose members are engaged in mobile crane and access platform rental as well as nonstandard road transportation companies. Individual companies can become special members, if there is no appropriate national association in their country. The primary objective of ESTA is the harmonization of rules and regulations for crane companies and haulers across Europe [18].

Table 3 The basic characteristics of permits of road transportation in Poland

Permit	Oversized vehicles	Type of road	Term of permit
Cat. IV	(a) GVW not higher than permissible values (b) Width not exceeding 3.4 m (c) Length not exceeding: • 15 m for a single vehicle • 23 m for a combination of vehicles • 30 m for a combination of vehicles with steering axles (d) Height not exceeding 4.3 m (e) Load axles not exceeding values designated for roads with permissible load of a single drive axle of up to 11.5 t	National	1, 6, 12, 24 months
Cat. V	(a) Axle loads not higher than values permissible for the specific road (b) Width not exceeding 3.4 m (c) Length not exceeding: • 15 m for a single vehicle • 23 m for a combination of vehicles • 30 m for a combination of vehicles with steering axles (d) Height not exceeding 4.3 m (e) GVW not exceeding 60 t	Public	1, 6, 12, 24 months
Cat. VI	(a) Width not exceeding: • 3.4 m for an undivided road • 4 m for a dual carriageway, LOS: A (motorway), S (expressway), and GP (fast traffic trunk road) (b) Length not exceeding: • 15 m for a single vehicle • 23 m for a combination of vehicles • 30 m for a combination of vehicles with steering axles (c) Height not exceeding 4.3 m (d) GVW not exceeding 60 t (e) Axle loads not higher than values designated for roads where the permissible single axle load does not exceed 11.5 t	National—in accordance with the list of roads enumerated in Art. 64c section 8	1, 6, 12, 24 months
Cat. VII	(a) Dimensions and GVW exceeding the values enumerated in categories I–VI (b) Axle loads higher than values designated for roads where the permissible single axle load does not exceed 11.5 t	The specific route indicated in the permit	14 days for single passage, 30 days for multiple passages

Source: adapted from [16]

One of the members of ESTA is the Polish Heavy Transport Association (OSPTN). The primary objective of OSPTN is to facilitate changes in legislation regarding nonstandard vehicle cargo transportation and nonstandard vehicle pilotage. OSPTN strives to introduce changes in the nonstandard vehicle registration and in the rules that govern the issuing of transit permits. One of its other aims is to facilitate changes in the so-called EU nonstandard vehicle certification of approval. Moreover, the association carries out scientific and technical activity with regard to nonstandard vehicle transit and supports social initiatives for constructing roads and expressways. In order to effectively carry out its goals, OSPTN cooperates with local governments and administrations, academic and cultural institutions, and nongovernmental organizations. It also cooperates with business entities, public figures, and mass media. OSPTN carries out informational and promotional activity via a self-published magazine, a website, and an information bureau. It works for the general public by organizing conventions, workshops, meetings, and promotional actions; coordinating trainings and conferences devoted to transportation; as well as exchanging experiences with similar institutions abroad [19].

Organizing Logistics Project Resources and Activities

Carrying out a logistics service in the context of oversized cargo transportation displays features of a logistics project. It constitutes a group of diverse activities, the aim of which is to meet requirements in terms of time, cost, and scope. Oversized cargo transportation is the final element in a long chain of specialist logistics operations. It requires an appropriate approach, the use of suitable methods and equipment. From the perspective of an employer, i.e., an entrepreneur responsible for delivering oversized cargo, an order to deliver such cargo is a unique undertaking, which requires an individual approach. This necessitates an assessment of the market of oversized cargo transportation, selecting a logistics operator based on the chosen assessment criteria, and commissioning the organization and execution of oversized cargo transportation. In order to carry out such a logistics service, a contractor, i.e., a logistics operator, must prepare thoroughly, possess or rent appropriate equipment, as well as demonstrate knowledge and experience in this type of transportation. It is essential to determine the feasibility of transportation, analyze all possible means of transportation, choose the optimal one, and to assess and select loading and unloading equipment. Moreover, it is necessary to analyze available means of transportation and all permissible routes of oversized cargo transportation and to select the optimal route. A logistics operator should make plans for loading, unloading, and securing individual elements of the cargo and determine the possible approaches for protecting the cargo against external conditions.

Carrying out oversized cargo transportation requires estimating the time and cost of execution of this logistics service, performing risk assessment of the entire undertaking, an effectiveness assessment for a given project, and, finally, assessing and choosing the cooperators required for the efficient execution of a given order. To

this end, it is necessary to prepare a work breakdown structure. Such structure enumerates the basic tasks, based on which the cost, time, and risk of a particular logistics project are assessed; moreover, it facilitates identifying the need for outsourcing services and selecting potential subcontractors for a project-based order. It is necessary to plan the time frames and effectiveness of individual activities and time correlations and to synchronize with other activities within the given enterprise and with its cooperators. A logistics operator should elaborate at least two scenarios and execution variants, as well as cause-and-effect analyses of successive project activities. All the above is well justified, since the analysis of time and flow of tasks requires thorough knowledge of the object of such activities, of the methods for executing them, and of the resources that determine their prompt completion; the determination of working conditions; the preparation of a project budget and simulations of expenditure; and the required cash flow for a given project. The analysis of different variants allows to elaborate flexible budgets and variant-based resource reservation, all of which serve to minimize risk. Planning future activities and how to use resources (own and third party), planning the conditions of execution of oversized cargo transportation, predicting conflicts and emergency situations, and preparing a coordination plan of logistics operations are all necessary for the effective execution of a given logistics project.

Resource planning results from expenditure planning. The type and nature of resources used for the purposes of carrying out a given logistics project depend on the nature, scope, and object of delivery. Due to its level of complexity, the execution of a particular logistics project requires access to diverse resources, both renewable and nonrenewable. The resources are often owned by third-party business entities; and for the purposes of carrying out a logistics project, they may be made available (temporarily) on certain terms as part of cooperation. The selection of business partners, i.e., the owners of resources, requires assessment and making a decision based on specified criteria. The criteria for assessing suppliers may be quantitative or qualitative. Due to the complexity of the process, it is proposed to apply appropriate methods that would support decision-makers. During resource planning, the selection of means of transportation suitable for a given cargo constitutes a significant issue. The basic parameters influencing selection are its size, structure, and weight. The number of axes, the loading capacity, the efficiency of the hydraulic system, and the power of the tractor unit are important parameters when selecting motor vehicles. Vehicles for transportation of oversized cargo are among the most technically advanced means of transportation.

The estimation of costs of oversized cargo transportation is a time-consuming process, and its level of uncertainty and risk is high. It is particularly difficult to assess the total cost in the planning phase due to the large number of variables and their nature. Each transportation service requires individual cost estimating. Each order is a specific one and therefore needs a special approach. The basic components of the cost of oversized cargo transportation include: loading and unloading, energy carriers (including fuel), drivers' remuneration, pilotage, route inspection, permits, expert evaluations, infrastructure adaptation, toll charges (including transportation on toll road sections), ferry crossings, cargo insurance, vehicle insurance,

licenses, cargo security, tires, depreciation, order management, etc. Previous experience and appropriate methods for evaluating planned expenditure of performing the service are highly useful for assessing the total cost of oversized cargo transportation. Owing to previous experience, it is possible to accurately estimate the particular components of expenditure at each stage of a given logistics project. Dividing a particular logistics project (in this case, oversized cargo transportation) into separate components and assessing the expenditure on each component, followed by the aggregation of these estimates, can be helpful.

Based on observation of practice, logisticians typically leverage their knowledge, experience, and estimators to estimate logistics project costs, i.e., they usually rely on their intuition. Researchers have worked to develop cost estimators that maximize the practical value of limited information available in order to improve cost estimate accuracy and reliability, which should improve the suitability of resultant designs and subsequent project execution work. In practice there are many methods of estimation of costs of project accomplishment. Methods used to set project costs may be divided into three groups [20]:

- Approximation methods
  - Assessing by experts
  - Conscious guessing
  - Rough estimation
  - Empirical
  - By analogy
  - Parametrical methods
  - Cost estimation equations
  - Statistical
  - Probabilistic
  - Mathematical models
  - Detailed methods
  - On the basis of job batches
  - On the basis of work preparation methods
  - Other detailed methods

Using the abovementioned methods may help in achieving general estimates of project cost, but may fail with uncertainty. How does one perform estimation of uncertain project cost then? The total cost of a project is dependent on many variables, assumptions, and conditions. These variables influence significantly the size of the probable cost. The most difficult aspect of project cost estimating is gathering date of sufficient variety, quantity, and quality. The existing methods of cost estimation lead to determining quantity of total project cost as one single quantity, i.e., certain quantity as opposed to ambiguous quantity—uncertain. Single project cost may be treated as one of the possible options—a possible cost variant [21].

It is possible to employ methods based on fuzzy set theory into the practice of transportation-freight forwarding-logistics enterprises; such methods facilitate modeling the uncertainties characteristic of such undertakings. Triangular fuzzy

sets are very often used in the practice because the parameters defining them can be easily specified in linguistic terms [22, 23]. Therefore, triangular fuzzy sets are applied to describe uncertain cost of activities [24]. Input parameter cost estimations are positive triangular fuzzy numbers (fuzzy cost of activities of the logistics project network). Output parameter, i.e., total logistics project cost, is also a triangular fuzzy number—interval (Fig. 4). The interval indicates that the project cost is estimated at this interval with α-confidence (α-cut). The α-confidence of fuzzy number of project cost $\tilde{K}$ is defined as follows [22]:

$$\tilde{K}_{\alpha} = \left\{ x \in X : \mu_{\tilde{K}}(x) \geq \alpha \right\}, \quad \forall_{\alpha \in [0,1]} \tag{1}$$

Note that $\tilde{K}_{\alpha}$ is a crisp set rather than a fuzzy set. Using α-confidence, $\tilde{K}_{\alpha}$ can be represented by different levels of confidence intervals. Figure 4 shows the shape of fuzzy number with α-confidence level.

The membership function has the shape of a triangle (Fig. 4). The shape depends on parameters *l*, *m*, and *u*. Parameter *l* indicates an optimistic cost of an activity of a given logistics project, *m* most probable cost, and *u* pessimistic cost. In the point $x = m$, class *t* membership function assumes the value of 1, whereas in points $x = l$ and $x = u$, membership function assumes the value of 0. An uncertain logistics project cost can be described by a fuzzy number defined by its membership function. The cost of an activity has an uncertain character. The cost is "about 4.5." It means the cost of the activity can be in the range of 1–10.5 conventional cost units (c.c.u.). The optimistic cost of the activity is equal to 1 c.c.u., the most probable cost is equal to 4.5 c.c.u., and the pessimistic one is estimated as 10.5 c.c.u.

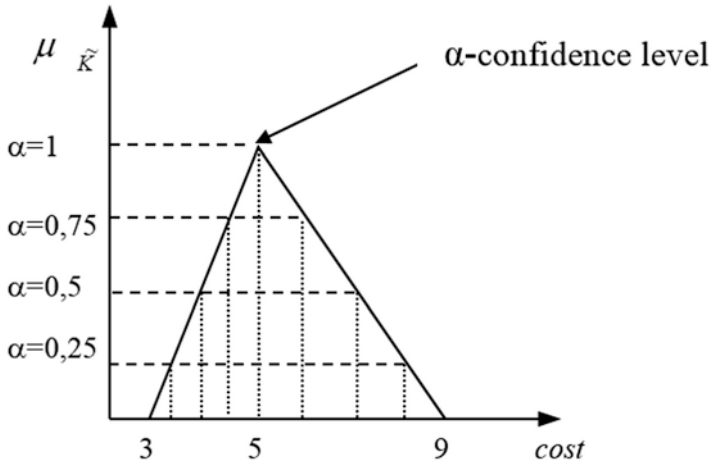

Fig. 4 The membership function of a given fuzzy cost $\tilde{T}_{\alpha} = (1; 4.5; 10)$ and its α-cut (source: own elaboration)

Table 4 Specification of a logistics project cost

Activity	Fuzzy cost [c.c.u.]	Fuzzy cost [c.c.u.]	Real cost [c.c.u.]
Cost of transport permit	"about 2000.00"	(1200.00; 2000.00; 2400.00)	1866.67
Cost of pilotage service	"about 1200.00"	(1000.00; 1200.00; 1600.00)	1266.67
Fuel cost	"about 1100.00"	(1000.00; 1100.00; 1400.00)	1166.67
Road taxes	"about 350.00"	(300.00; 350.00; 370.00)	340.00
Cost of vehicle driver	"about 550.00"	(500.00; 550.00; 700.00)	583.33
Cost of loading	"about 150.00"	(140.00; 150.00; 300.00)	196.67
Cost of unloading	"about 150.00"	(140.00; 150.00; 300.00)	196.67
Cost of load insurance	"about 900.00"	(800.00; 900.00; 1300.00)	1000.00
Total	"about 6400.00"	(5080.00; 6400.00; 8370.00)	6616.67

Source: own elaboration

In Table 4, cost assessments of an example of oversized cargo transportation are presented. The item of costs (activity cost of logistics project) is expressed in conventional cost units. The last column in the table concerns the real cost of a given project variant determined with the use of chosen method of defuzzification:

$$y = \frac{l + m + u}{3} \tag{2}$$

The fuzzy cost of the logistics project is in the range of 5080.00–8370.00 c.c.u. The optimistic cost is equal to 5080.00 c.c.u. The most probable cost is equal to 6400.00 c.c.u. and the pessimistic one is estimated as 8370.00 c.c.u. The single value of the cost of the logistics project realization is equal to 6616.67 c.c.u.

Oversized cargo transit constitutes a special type of transportation. It requires dedicated and thus costly equipment. It must be emphasized that in the case of mass transportation, a range of ready-made semitrailers can be readily purchased, whereas in the case of nonstandard transportation, these must be ordered beforehand (e.g., multi-axis modules are typically ordered approximately 2 years in advance). Entrepreneurs specializing in oversized cargo transportation are required to anticipate future market situation as well as the directions of economic development. For instance, a particular enterprise must assess whether or not it requires multi-axis semitrailers and to what kind of cargo will they be dedicated—low or high, long or extendable, perhaps heavy, etc. Entrepreneurs are expected to be able to suitably configure the vehicle and the semitrailer designed for the transportation of such cargos, since there is no single applicable standard. Such a configuration is particular to a given transportation order. Nonstandard cargo transportation is carried out with suitably fitted vehicles, the carrying capacity, structure, and labeling of which are usually different from those of standard means of transportation. In order to organize the transit of such vehicles, appropriate permits are required, as well as advance arrangements with appropriate infrastructure administrators. This involves obtaining specific permits and decisions of authorized entities.

Fig. 5 Example of special vehicle used in oversized cargo transportation (source: [26])

The transportation of oversized cargo requires special means of transportation as well as dedicated handling equipment (Fig. 5). Such cargo is characterized by large linear dimensions, the outline of which exceeds the dimensions of a vehicle or transportation unit. The nonstandard size, weight of the load, and pressure on the axis of the vehicle demand special care in the loading process. Securing oversized cargo on transport vehicles arises from the necessity to make it unmovable against the vehicle in such a way that it will arrive at the destination unchanged (geometrically, in shape and dimensions) and undamaged and at the same time not endangering people and the environment. This process frequently demands unconventional approach, also "oversized" due to the special parameters of the cargo. Securing such cargoes always demands individual calculations, assistance of the surveyor, and application of "unconventional" methods: welding, applying special fastening structures, cradles, etc. [11]. The process of securing oversized cargo can be aided by specific software system. One of the software systems is easyLOAD

system developed by Goldhofer company. The program supports decision-making in the loading process. It is the first and only software on the market to be TÜV approved for transport engineering. The advantages of the easyLOAD system are the following [25]:

- Optimal planning with regard to the loading and configuration of the vehicle
- Documentation for their customers for professional transportation
- Clear loading instructions for the driver
- Facilitates transport authorization with the authorities
- Verification for transportation checks regarding the proper loading of the vehicle

An example of loading process planning is respectively shown in Figs. 6 and 7.

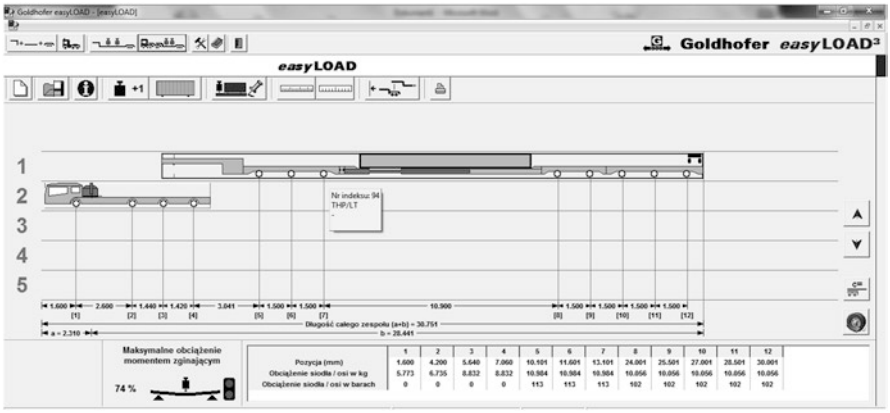

Fig. 6 An example of loading planning in easyLOAD system (source: own elaboration)

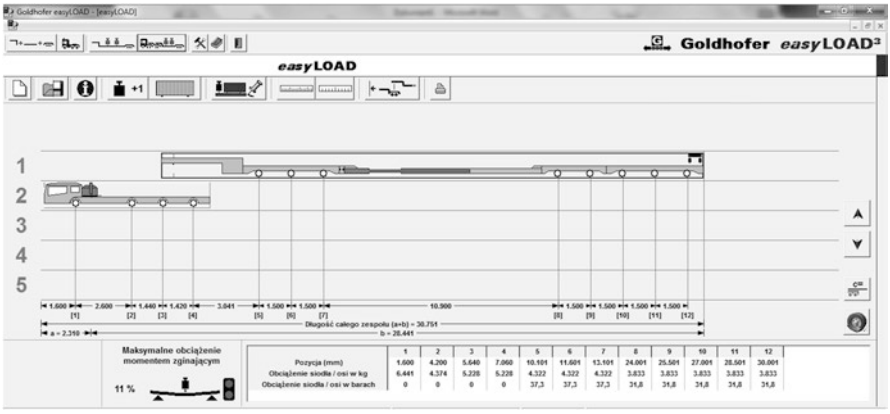

Fig. 7 An example of loading planning in easyLOAD system (source: own elaboration)

An Example of Transportation Service

We consider an example of oversized transportation realized by one of logistics providers. Bedmet Logistic Damian Bednarz Sp. K. is a Polish enterprise which specializes in heavy transport. The range of the enterprise operating includes: road transportation, inland waterway transportation, railway transportation, sea transportation, transshipment and storing, as well as relocations. A few months ago, the enterprise received an order to transport converter elements for Huta Katowice. The logistics project of transportation this kind of load needed special permits for road transportation. The enterprise was forced to do specialist expertise of several bridges, a roundabout reconstruction, the road marking dismantle, and dismantle and reassemble of about 100 light sirens. The oversized cargo sailed to the commercial port of Świnoujście in two parts. The total weight of the load equaled 800 ton. The route began in Świnoujście. The load was transported by barges to the river port in Malczyce. The biggest items of the converter elements in the first stage of the barge transport had dimensions of 11×5, 85×4, 51 m and weight of 97 ton. In Malczyce the load was unloaded. The Bedmet Logistics used the lifting capacity of 500 ton. Then the load was loaded on vehicles and transported by special road vehicles to Dąbrowa Górnicza. The transportation was realized in 3 days, but the process of this logistics project planning was longer. It took a few weeks. This kind of order is an example of oversized cargo transportation service. Delivery of such cargo is a unique undertaking, which required an individual approach. The process of transportation of oversized cargo is presented in Fig. 8. The basic components of the cost of oversized cargo transportation included: energy carriers, loading and unloading, drivers' remuneration, pilotage, route inspection, permits, expert evaluations, infrastructure adaptation, toll charges, barge crossings, cargo insurance, vehicle insurance, licenses, cargo security, tires, depreciation, order management, etc. This logistics project was realized in cooperation with other enterprises. The cooperation guaranteed the fulfillment of all of the order requirements. This new experience and the results of the project were documented and can be treated as source of knowledge for other logistics projects during the process planning of new projects.

Fig. 8 The process of transportation of a given nonstandard load (source: own elaboration)

Conclusions

The complexity of a logistics project in the context of oversized cargo transportation is mostly related to the object of the project, the sites where cargo is loaded and delivered to, the time frame of transportation, technical parameters of the cargo, its dimensions and weight, the number of distinct means of transportation used for delivering the cargo, their type, number and type of resources necessary for carrying out the project (including the means of loading and unloading), available infrastructure, the use of intermodal transportation, time of project execution, route of transportation, relationships with other orders, the number of subcontractors, the scope of outsourced work, legal regulations, elements of the project, and the relationships arising between different projects carried out by a given enterprise or a delivery/supply chain. These factors constitute the basic sources of risk in the execution of a given logistics project.

The effective execution of oversized cargo transportation necessitates the use of suitable methods, tools, and techniques that make up together an appropriate approach to the management of such services. Our discussion is based on the statement that the execution of oversized cargo transportation exemplifies the fulfillment of short-term market needs. We draw an analogy between the management of orders for oversized cargo transportation services and project management. A given order can be treated as a project, and in this case, due to its specific features, as a logistics project. The planning of such a service corresponds to the planning of an undertaking characterized by uniqueness, thus involving nonroutine decision-making. We propose applying the project approach to the management of a given process—oversized cargo transportation, as part of carrying out a service.

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