Marketing analysis of multimodal transportation dynamics in logistics infrastructure

Nikolay Penev[1], *Liudmyla* Shyriaieva [2], *Darya* Legeza[3], *Mykola* Merkulov[4], and *Iryna* Honcharova[4*]

[1] Trakia University, Students town, 6000 Stara Zagora, Bulgaria
[2] Odesa National Maritime University, 65029 Odesa, Ukraine
[3] Dmytro Motornyi Tavria State Agrotechnological University, 69063 Zaporizhzhya, Ukraine
[4] Izmail State University of Humanities, 68601 Izmail, Ukraine

Abstract. The basis of economic growth is the presence of a transport system that fully satisfies the needs of all participants in the economic process. The motivation for the study was that, against the backdrop of European integration processes, the transport systems of the EU countries and Ukraine began to quickly converge, which created the need to study potential innovations in the transport industry and identify the most problematic regions and modes of transport. There is also a constant increase in demand for multimodal transport, especially cross-border transport, and their implementation requires information on the current state of transport systems in countries involved in multimodal transport. Implementation of innovations is necessary to ensure multimodality. The study used statistics from 2012 to 2021, publicly available from Eurostat. Based on the study results, it is possible to determine in which countries the demand for innovation marketing is expected. That is, the study will be useful to specialists in developing and promoting innovations as an overview of the market of potential consumers of this service.

1 Introduction

Marketing is a multifactorial process since it affects various industries and areas of activity in carrying out some innovation processes. Therefore, for the successful implementation of innovation, clear marketing is necessary, allowing one to consider innovation processes from various points of view. Innovations previously applied in other regions or for other enterprises are often introduced in other places, but with preliminary analysis and adaptation. Innovations in logistics infrastructure are significant since the work of almost all sectors of the economy depends on the quality of logistics services.

Due to the constantly increase in demand for multimodal transportation, this industry in the field of logistics services is constantly in the stage of improvement, which leads to increased attention to innovative processes. To ensure optimal marketing of innovations in multimodal transportation, it is necessary to conduct a qualitative analysis of the current situation in the industry.

* Corresponding author: cehovich2610@gmail.com

Despite the growing demand for multimodal transport, the degree of potential influence of the dynamic of multimodal transport as the basis for ensuring sustainable infrastructure development has yet to be sufficiently studied [1-3]. The proposed study outlines a statistical approach to forming a set of marketing activities that make it possible to determine the directions for the development of infrastructure elements to ensure the sustainable development of the region's infrastructure by improving infrastructure facilities in individual territories of the selected region.

When forming market infrastructure objects, it is important to con- sider the components that influence the formation of infrastructure efficiency. When forming the marketing of innovations to ensure sustainable development of the region's infrastructure, factors such as economic efficiency and the ability to obtain the most significant degree of satisfaction of the needs of all users by involving the infrastructure facilities of the region in their business are taken into account, and it is also necessary to take into account compliance with environmental standards and requirements, which are currently needed for transport infrastructure.

2 Literature review

The problems of modern logistics are considered from different angles for different levels of development of logistics infrastructure and different exter- nal conditions. Moreover, internal ones influence the formation of logistics [4-7]. A constant search and implementation of innovations is necessary to create a logistics infrastructure that meets all the requirements of a modern economy [8-10]. For the high-quality implementation of innovative activities, analysis tools are needed to obtain high-quality information about the areas of innovative activity and areas in which the introduction of innovations in the logistics infrastructure is a priority [11-14].

In modern conditions, multimodal transportation is the most in-demand, but they are still considered through components that are traditional by type of transportation [15-18]. The development of logistics infrastructure is also greatly influenced by globalization [2,19], processes, and the desire to reduce the harm caused by vehicles to the environment [20].

To obtain marketing of innovations in multimodal transport, components such as the type dynamics of transport currently used in the selected region are considered. To determine priority directions in infrastructure development, a system is initially built and ranked by priority for the use of various modes of transport. If we consider the GDP of the countries in which transport flows are studied, then by the share of GDP, we can track the degree to which elements of transport are involved in supporting the economy as a whole [21, 22].

Therefore, modes of transport and separate components of the region are considered separately from the point of view of the economic and geographical division at the current moment. This allows to obtain information about the dynamics of selected indicators both for the region as a whole and for the specified mode of transport [23-26]. This division allows for a joint analysis of both economic and infrastructural indicators. To ensure an innovative marketing plan, the most vulnerable modes of transport and regions are selected [27-29]. The basis for the successful promotion of multimodal transportation in the transport services market is the quality of their provision. For the concept of quality of service provision, the most important indicators are the characteristics of the degree of satisfaction of customer requests, the compliance of the provided service with the expectations that customers had when ordering this type of service, and, as a decisive factor, the economic efficiency of the performed service both for the one who produced this service and for the one who provided this service [30-33].

In the case of providing transport services, the time factor is also added, since for a potential client of a transport service one of the decisive factors when choosing a service provider is delivery time. Since to carry out further actions with goods that are received as a result of the consumption of transport services, the entrepreneurs order them to plan to carry out some further actions to make a profit, and the efficiency of the economy depends on the speed of cash turnover, the time factor is decisive from the point of view of analyzing the quality of the provided transport services. To characterize the quality of multimodal transportation, it is necessary, in addition to the traditional quality characteristics of transport services, to consider features that directly affect the quality of transportation carried out by several modes of transport. Figure 1 shows the main quality requirements for multimodal transport. From the point of view of price optimality, a comparison is made with the prices of individual links in the delivery of goods from producer to consumer, taking into account two components: prices for transporting goods by various modes of transport and prices for transshipment of goods. An additional component of the price may be the cost of temporary storage in intermediate warehouses without a time connection between different modes of transport.

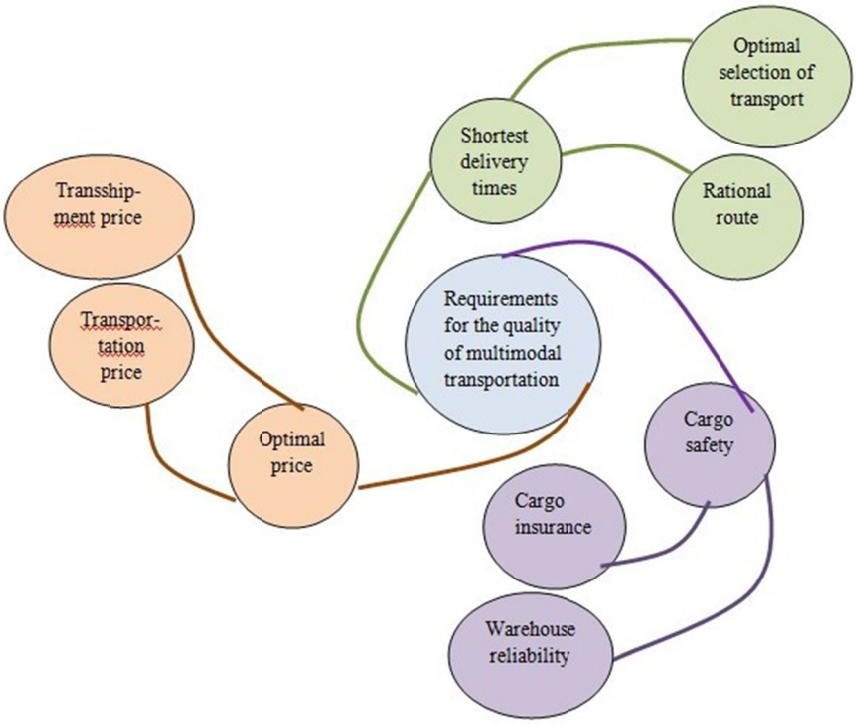

Fig. 1. Quality requirements for multimodal transportation.

Particular attention should also be paid to the safety of cargo during transportation. To ensure additional safety, various cargo insurance options are being considered both at individual stages of transportation and during forced storage.

From the point of view of cargo safety, additional study of the storage conditions of goods is also required if it is necessary to wait for transshipment along the route, which means the degree of preservation of the consumer qualities of the transported goods along the route. A particularly important factor in the quality of multimodal transportation is delivery time.

To ensure the quality of multimodal transportation, it is necessary to make the optimal choice of vehicles to ensure multimodal transportation and the most rational route. All of the listed factors affecting the quality of multimodal transportation directly depend on the degree of development of the infrastructure as a whole and its elements. At the same time, the degree of involvement of infrastructure elements in the implementation of multimodal transportation depends directly on how aware managers of multimodal transportation are about the structure and quality of infrastructure elements, and how the interaction of services that ensure the functioning of infrastructure elements is established with business representatives.

3 Theoretical framework

The attractiveness of multimodal transportation for customers can only beachieved with a constant improvement in the quality of services provided. To improve the quality of multimodal transportation, it is necessary to introduce innovations into the activities of all participants in multimodal transportation. The implementation of innovative activities in multimodal transportation directly depends on the degree of involvement of various modes of transport in the implementation of multimodal transportation.

Therefore, to obtain a comprehensive positive effect, innovations in each of the linksof multimodal transport should be considered as components of the overall success of multimodal transport. Thus, marketing innovations in multimodal transport come down to the implementation of systematic innovation activities in the totality of all components of multimodal transport, that is, in the transport sector as a whole.

To obtain quantitative characteristics that make it possible to plan innovations to increase the attractiveness of multimodal transport, it is necessary to consider individual components of the transport infrastructure, determine the main and minor numerical characteristics of infrastructure objects, and identify the correspondence between the characteristics of one component to the characteristics of another object.

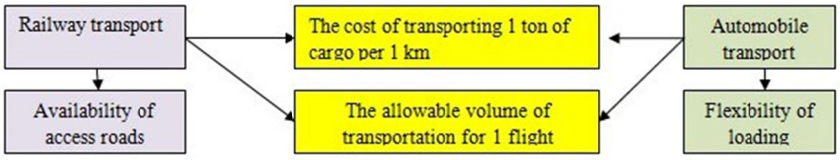

Fig. 2. An example of comparing the characteristics of two types of transport.

Figure 2 shows characteristics that make it possible to compare rail and road transport services, as well as characteristics showing the differences between these two types of transport as carriers of goods. To compare services for the delivery of goods by rail and road transport, we can consider such quantitative characteristics as the cost of transporting 1 ton of cargo per 1 km and the volume of possible transportation by a unit of transport for 1 trip. Qualitative characteristics are also given that show the differences between these types of transport, such as the presence of access roads near the customer for the services of transporting goods by rail and the flexibility of the schedule for the possible loading of goods by road.

When analyzing quantitative indicators for transport, various factors influencing these indicators are considered. First of all, much attention is paid to external factors, such as the cost of fuel introduced by the governments of the countries through which transportation is carried out, payment for the use of elements of transport infrastructure, restrictions on

carbon dioxide emissions, the working hours of vehicle drivers and other factors that externally influence on quality indicators of cargo transportation. Also considered are such internal factors of multimodal transportation as waiting time for loading and unloading mechanisms, replacement transport, and waiting for inspection cargo, if this is determined by the type of cargo.

The resulting basis for analyzing multimodality factors is the basis for the development of innovations. When considering similar quantitative indicators for different modes of transport, similar innovations may arise aimed at improving a specific indicator across several modes of transport. These innovations can be combined into a single complex and occur as a single end-to-end innovation. When planning it, a subsection is allocated for each type of transport, which allows you to plan the implementation of the selected innovation, taking into account the characteristics of a particular type of transport. For example, for aviation and road transport, an innovation could be the vacuuming of cargo to reduce the volume of transported cargo. For this innovation, categories of cargo that can be vacuumed are determined, and special packaging and equipment are developed for vacuuming cargo at loading points. Such an innovation can easily be defined as end-to-end, in addition, it can be extended to other types of transportation of goods, such as water and rail, however, it cannot be extended to pipeline transport.

Moreover, uniqueness can characterize the spread of innovation not to the entire type of transportation, but only to one project or to a group of projects. Such highly specific innovations are useful as an object for studying the characteristics of innovative adaptation since such innovations in whole or in part can be used on a more global scale.

4 Methodology

To obtain information about the necessary innovations in the field of trans- port infrastructure, four main types of transport are considered - rail, road transport, sea transport, and the delivery of goods to the islands by water ways. These modes of transport need to be prioritized. Let us introduce a designation for each of these modes of transport following the Eurostat names, and we will obtain a certain set T, which will describe the use of various transportation models in tons-kilometers when transporting goods (1).

$$T = \{Railways, Roads, Maritime, Inland\ waterways\} \quad (1)$$

We will consider the resulting sets for the period from 2012 to 2021, which will allow us to track the dynamics of changes in the European Union in the field of each of the specified groups of transportation [11, 34-36].

After studying the dynamics of the percentage of cargo transportation for all types of transport, countries are selected in which there is a decrease in the annual index of transport transportation to the countries' GDP. A certain set of countries (2) was obtained the number of elements of which is no more than 25% of the total number of countries studied.

$$C = \{Country1, Country2, \dots, CountryN\} \quad (2)$$

For group C of countries, a group study of indicators of the use of various modes of transport is carried out, that is, for each of the elements of the set (3) over the same periods for which the data for (1) and (2) were selected.

$$U = \left\{tran_{im_{urail\$defaultview}}, tran_{im_{umar\$defaultview}}, tran_{im_{uroad\$defaultview}}\right\} \quad (3)$$

5 Results

Since this study examines the indicators of the European Union countries in the field of transport provision and the ability to transport goods by various transport routes, according to the proposed methodology, statistical indicators are freely available and can be used for any analysis. Figure 3 shows the results of a study of annual indicators of transported goods in the countries of the European Union for the period from 2012 to 2021 [37]. Transportation by road is the least popular, which is explained by the high cost of transportation, the low carrying capacity of vehicles, and the environmental aspects of using this type of transport. For railway transport, there is an increase in the share of transportation performed by this type of transport, which is explained by the order of magnitude greater carrying capacity of this type of transport. Transportation by import modes of transport, both sea and river, is characterized by fluctuations within the period, but in general, there are no significant fluctuations for the period under study.

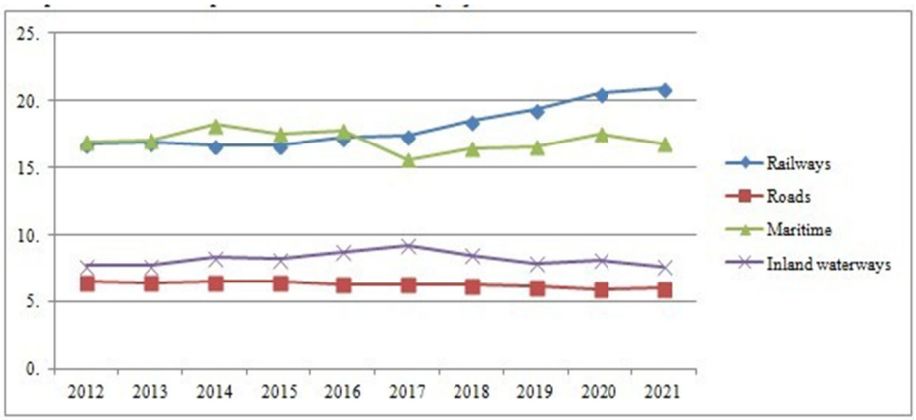

Fig. 3. Annual figures (as a percentage of total cargo traffic) by EU countries.

Next, to obtain information on the volume of freight traffic relative to GDP, we will analyze the same period from 2012 to 2021, was analyzed, taking the 2015 indicators as 100 Based on the results of this stage of the study, we find that it is necessary to consider possible marketing of innovations in the field of transport infrastructure for Estonia, Latvia, Portugal, Switzerland, Luxembourg, and Ireland. However, due to the small size of Luxembourg's transport infrastructure and the physical lack of potential for its development, we will select only five countries (Figure 4).

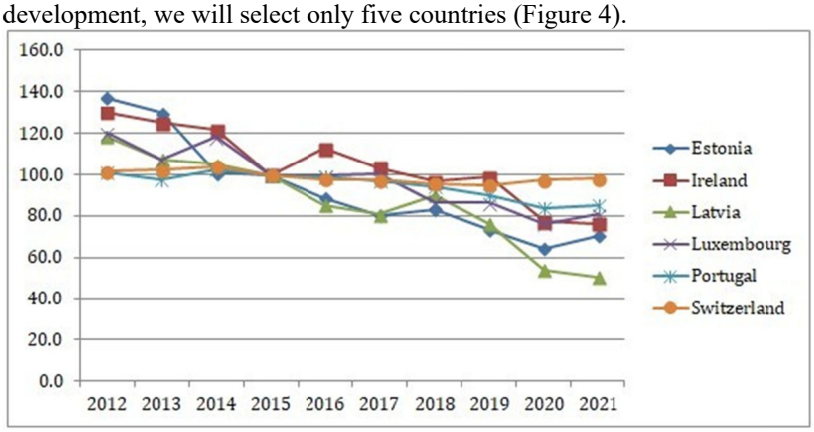

Fig. 4. Volume of freight transport relative to GDP(2015=100%).

For these countries, we will consider the dynamics for the same period for all four modes of transport to select a direction for innovation in the field of transport services for selected countries and selected modes of transport.

Figure 5 presents the results of a study of selected countries by percentage of the total number of transport operations carried out by rail transport [37]. According to the results obtained, we see that Portugal has positive experience in introducing innovations in this type of transport infrastructure, since during the period under study there was an increase in the number of goods transported by rail by 2.75 times. For Ireland (a decrease of 11.4%) and Switzerland (a decrease of 14.8%), marketing of innovations in this mode of transport is necessary. For Estonia (2.6 times increase) and Latvia (1.9 times increase), it is necessary to continue improving the logistics infrastructure to achieve the planned results from innovation.

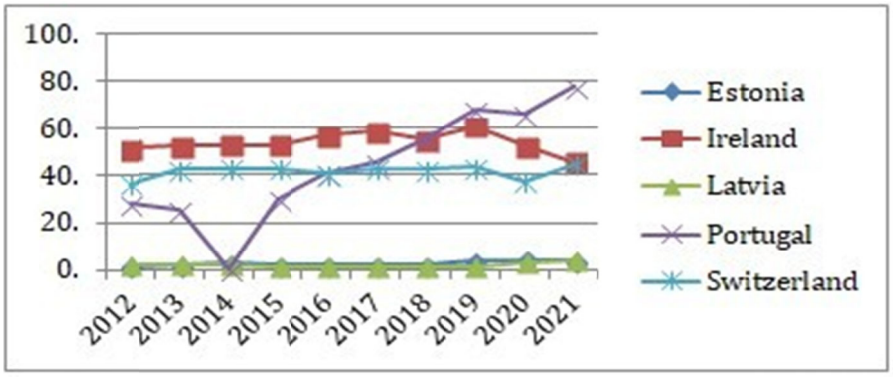

Fig. 5. Research on railway transport (*tran*$_{im}$*urailde faultview*).

The analysis of which is presented in Figure 6, then there is no data for Switzerland, since freight transport is not carried out [33]. Portugal is characterized by an increase in the shareof transportation by sea by 51%, which indicates the presence of effective marketing technologies for the development of logistics infrastructure in this mode of transport.

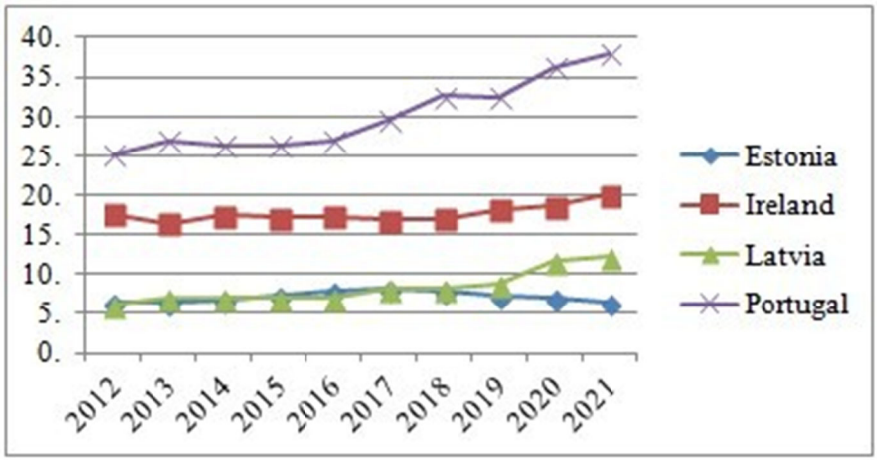

Fig. 6. Maritime transport study (*tran*$_{im}$*umardefaultview*).

For Ireland, further research into innovation in logistics infrastructure is needed as there has only been a 14.2% increase in freight throughput. The least attention is paid to the development of this industry in Estonia, despite the presence of free access to the sea, it has lost its position in the volume of maritime transport, in contrast to Latvia, which has increased cargo turnover by 2.1 times (Figure 7).

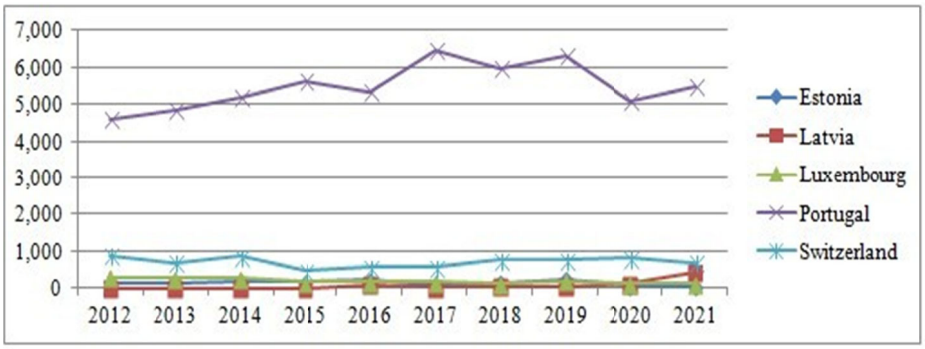

Fig. 7. Road transport ($tran_{im}uroaddefaultview$).

When studying the share of goods that were transported by road, countries such as Estonia, Latvia, Luxembourg, Portugal, and Switzerland were chosen as the main objects of study (Figure 7) [37]. There are no data available for Ireland in the European Union statistics system. Portugal is characterized by a 20% increase in cargo turnover, which indicates the success of ongoing activities in the field of marketing innovations in the logistics infrastructure. For Latvia, there was a 38-fold increase in cargo transportation, however, this indicator cannot be accepted as a base for the study, since this growth is most likely due to improved methods of collecting statistics, and not innovations in logistics. The remaining objects of the study are characterized by a decrease in cargo turnover: Estonia by 64%, Luxembourg by 52.2%, and Switzerland by 22.5%. This decrease may be because in these countries the modality of transportation is changing, that is, traditional routes and means of delivery are changing to more economical and less harmful to the environment. That is, there are shifts in multimodality for transported goods.

6 Conclusions

To market innovations in the field of logistics infrastructure, it is necessary to analyze the use of available funds and identify ways to improve the efficiency of their use. In the proposed study, the countries of the European Union were selected, which showed the worst results in terms of the share of transported goods in the countries' GDP. The study results revealed that in some countries, the marketing of innovations in the logistics infrastructure has been developed, and these countries are now introducing innovations. The most successful innovative processes in the field of logistics infrastructure are taking place in Portugal, where over the past 3-5 years, there have been many programs aimed at innovation in logistics, such as C-Roads, ePlcenter, and others, which has led to an increase in freight transportation by rail by 2 .75times, increasing the volume of sea transportation by 51% and increasing road transportation by 20%.

It is evident that growth in various transportation sectors, while the share of transportation in GDP is decreasing, indicates an increase in the number of multimodal transportation and an increase in the quality of logistics infrastructure. Also interesting are the results for Latvia, in which the increase in rail transportation was 1.9 times, and

the increase in road transportation was 40 times. Such imbalances indicate the need to continue to explore the possibilities of innovation in the field of multimodal transport and the field of logistics infrastructure. Similar conclusions can be drawn for Estonia, where rail transport increased by 2.6 times, road transport increased by 64%, and sea transport remained virtually unchanged despite its favorable geographical location. Ireland, Luxembourg, and Switzerland showed very stable results. These countries were chosen as study countries due to the decline in the number of goods to the countries' GDP. Upon closer examination of the GDP structure of these countries, which have their economic and geographical characteristics, one can notice that these countries have a low need for volumes of transported cargo. However, despite this, Ire- land increased transportation by sea by 14.2%; in Luxembourg and Switzerland, transportation by road increased by 52.2% and 22.5%, respectively.

These changes, with a decrease in the share of transport transportation in countries' GDP, also indicate an increase in the attractiveness of multimodal transportation in these countries. Obtaining a more efficient logistics infrastructure requires two types of actions: improving the organization of cargo transportation and investing in logistics infrastructure facilities. Before deciding to change the physical composition of the components of the logistics infrastructure, a preliminary analysis of existing logistics capabilities must be realized. For this type of analytical activity, multimodal transportation is the most representative since its implementation involves many logistics infrastructure facilities, making it possible to study the state of the logistics infrastructure as a whole and find elements that require innovation for successful operation. Within the European Union, there are exciting practices for marketing innovations in transport, as illustrated by the results. Several countries require unique innovation developments.

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