

Road Freight Transport Enterprises

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Road freight transport involves many adversities, along with the growing effect of carbon dioxide transmitted by vehicles on the natural environment, greenhouse gas emissions, or extensive energy use. Within the smart mobility concept, the acknowledged management of enterprises' relationships with customers within their service is profoundly determined by the deployment of compelling Intelligent Transportation Systems (ITSs) applications in forming united cooperation with the customers.

smart mobility

smart city

logistics customer service

transport enterprise

management

1. Introduction

Road freight transport involves many adversities, along with the growing effect of carbon dioxide transmitted by vehicles on the natural environment, greenhouse gas emissions, extensive energy use, or contribution to climate change.

Limiting the negative effects of transport is an important goal of smart mobility in many cities' regions. The main aspects of the activities are shifting transport to the least polluting and most efficient modes of transport, the use of more sustainable transport technologies, and infrastructure, and ensuring that transport prices fully reflect the negative environmental and health impacts. The transformation toward low-carbon mobility is supported by digitalization and modern technological solutions such as Intelligent Transportation Systems (ITSs). The main benefits of using Intelligent Transportation Systems undoubtedly include ^[1]:

- reduction in driving times and energy consumption by 40–70%;
- reduction in exhaust emissions by 30–50%;
- reduction in costs of road fleet management;
- improving road safety, thus reducing the number of collisions and accidents by 40 to even 80%.

Regarding transport, the need for a systems approach is underlined, inter alia, through the dissemination of ITS deployments to support the transition to low-emission transport and zero-emission vehicles, respecting the central role of electrification and renewable energy sources and enabling operational efficiency improvements. In particular, it calls for the better planning of road infrastructure due to the intense expansion of freight transport vehicles on the roads.

Increased competition in the market means that customer service is often what differentiates a company, product, or service in the consumer's mind the most—it allows it to be successful on the market or is the cause of failure. In current fast-moving and technology-enabled business conditions, the urgency to stipulate that exceptional customer service is a more and more pivotal diversifier in the marketplace [2][3][4]. The results of the survey research conducted by [5] among 13 thousand customers in different branches signified that over 66% of the customers leave the transport service provider because of deficient quality of service. Moreover, near 90% of representatives of the companies admit, as presented in the inquiry findings by [6], that a current crucial competition area for enterprises is the level of customer service.

Under the pressure of changes in the market, road freight transport service providers also offer their customers reliable deliveries, improving the energy efficiency of transport and reducing the negative impact of transport on the natural environment, reducing transport time but increasing connectivity, comfort, cohesiveness, and control in management processes in road freight transport enterprises. As remarked by [7], “shipping and delivery are usually the primary post-purchase services that are of concern to most customers during the purchasing process”. The basis of this competitive offer is a high level of logistics customer service, supported by the appropriately developed logistics resources of the company. Building a more customer-oriented approach in the logistics management of enterprises means increasing requirements referred to the level of the service offered. According to [8], in logistics, customer service “physical as well as information technology is changing the landscape of material handling and transportation protocols”.

The modern environment in which road freight transport enterprises currently operate presents them with new challenges in Poland—one of the European leaders in the field of truck fleets and road freight transport. The contemporary market of road freight transport services is constantly changing, especially due to the environmental and information habitat [9]. Currently, the sector of these services is characterized by high expansion, which is identified with relatively high consumer demand. Such a situation generates the basis for the profits achieved by individual entities, which determine the further development of the transport services sector. However, their current customers' demands comprise the necessity of more responsive transport systems consecutive to the prompt customers' service [10], steadily modifying transport relations in order to more diversified models of goods delivery [11][12], including the implementation of the principles of sustainable transport development [13], the use of modern technologies allowing for environmental protection, and the management of the energy potential of transport means [14], as well as more advancements in logistics service, sustained by applications of information and communication technology.

According to the above concisely signalized practical implications, to present the results of the analysis of the effect of ITS applications on logistics customer service in road freight transport enterprises as determined by alignment with logistics resources: logistics information, logistics location, and logistics knowledge. The research proposes selected ITS applications as an advancement of logistics customer service in road freight transport enterprises are divided into a group of six applications critical within the area of vehicle support: four applications dedicated to improving the energy efficiency of transport and reducing the negative impact of transport on the natural environment, two applications dedicated to reducing transport time but increasing connectivity and comfort, as well

as a group of ten different applications chosen as crucial for general management support: six applications dedicated to controlling in transport management processes, three applications dedicated to increasing accessibility and comfort of transport, and one application dedicated to improving cohesiveness and control in transport management processes. A critical review of the extensive literature on the subject confirmed no recognition of research findings on the proposed interdependence between the explicit objectives, which signifies an identified research gap in these areas of logistics management science. As perceived by [15], logistics customer service may be classified as a multi-dimensional construct of divergent components which comprises diversified approaches and is influenced by a considerable range of variables. By sharing such an approach to the broad scope of logistics customer service, the entry's goal is to present it as a construct remaining in specific relations with ITS applications, also conditioned by the above-mentioned logistics resources.

2. Road Freight Transport Enterprises

Within the extent of road freight transport, a considerable array of technological solutions has been submitted to intensify the flow of products and information more efficiently and support enterprises' management. As particularly auspicious outcomes, the ITS applications are considered, the use of which by enterprises has been evolving. The consideration of ITS applications' increase has led to scrutiny and compound information assemblage, which assist in advantageous implications, e.g., by referring to road freight and shipment conditions, traffic events, efficient and secure route management, arrangements of infrastructure, accidents oversight, truckload supervision, mobility control, fleet management, energy efficiency management of transport means, control of negative environmental effects of transport and many others. In regards to this apparent distinction, independent systems settle their functionalities above communicating with the exterior areas and interdependent systems handle connection within ITS terminals set up within singular vehicles, domains of transport infrastructure, central ITS subsystems, etc., [16]. To organize, integrate, and regulate the transport system sufficiently, highly developed technological solutions of ITS applications transform data for conversion and progression for the purpose of transport proficiency. Undoubtedly, ITS applications' aptitude for advancement is an essential goal in the management processes and for extending the transportation systems of whole types.

Based on currently available solutions and implementations in road freight transport, it can be assumed that ITS will play a major role mainly in two areas, i.e., [17]:

- in agglomeration transport and mobility management;
- in inter-agglomeration and international transport—in information systems on public roads and motorways, in road toll systems, as well as in the field of interoperability.

As ITS applications encompass diversified technological innovations assigned for the field of transport, they are addressed to upholding different spheres of transport activity, and, due to this, they are categorized in distinct approaches. The only and irrevocable proposal on this subject has not been approved in literature recommendations yet; therefore, researchers of the concern assume designations that are favorable for given

research purposes. Inter-domain explications are emphasized by certain functional advantages, along with the most meaningful in the context of this entry and that suggested by [18], namely vehicle management [19][20][21][22] and general management in the enterprises [23][24][25][26][27]. The list of ITS applications belonging to the categories of vehicle management and general management in the enterprises were selected based on the proposals by [28] and [29], which have been chosen with consideration of practices relevant for road freight transport enterprises. As presented in **Figure 1**, six ITS applications were selected as critical within the area of vehicle support, and ten different applications were chosen as crucial for general management support in road freight transport enterprises.

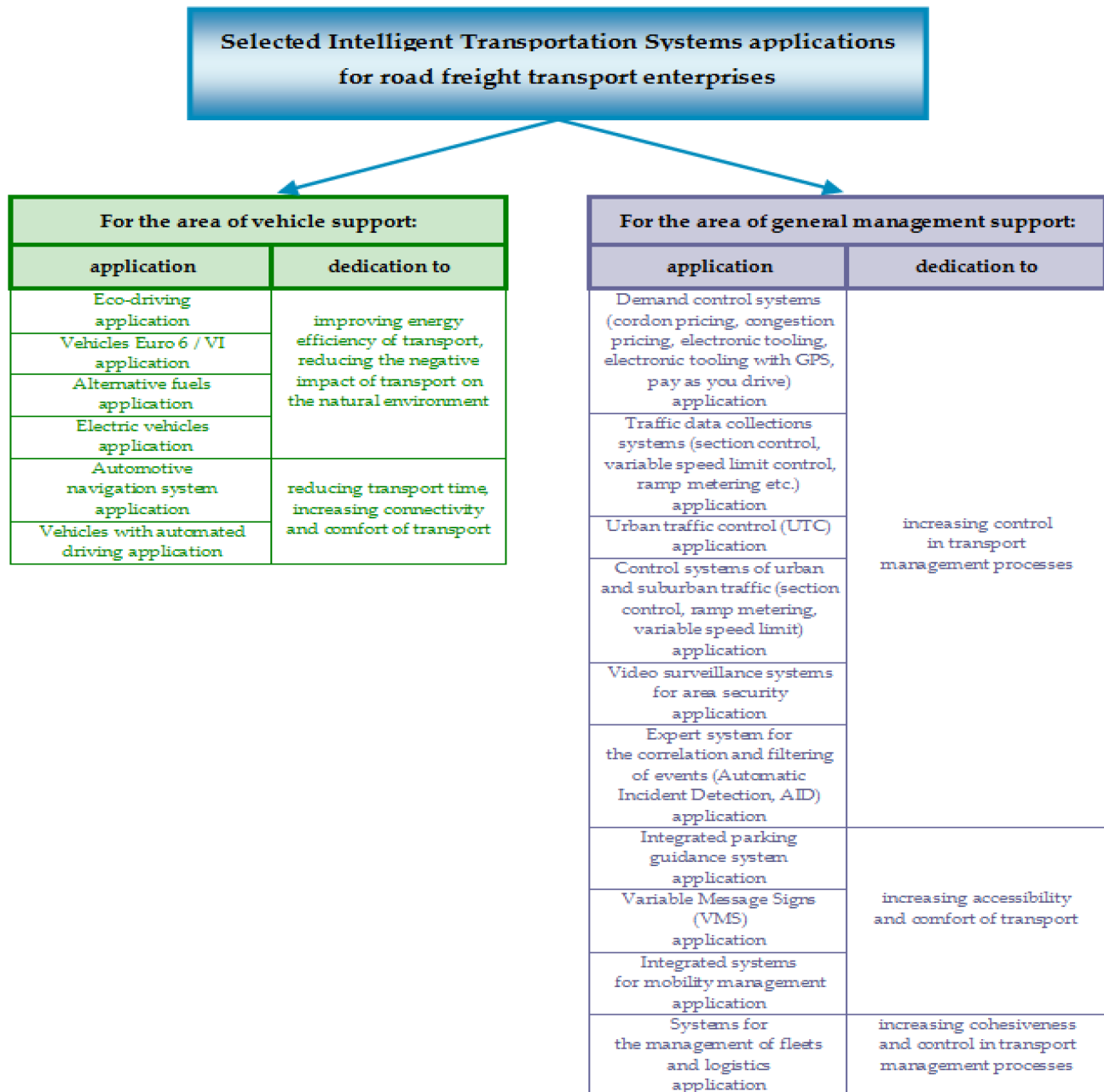


Figure 1. Selected ITS applications dedicated to vehicle support and general management in road freight transport enterprises.

Of the selected ITS applications for the area of vehicle support in road freight transport enterprises, listed in **Figure 1**, the first four applications are solutions dedicated to improving the energy efficiency of transport and reducing the negative impact of transport on the natural environment due to the requirements of the European sustainable transport policy. Beginning with the eco-driving application, the effects of its use should determine the essential environmental benefits by reducing the carbon dioxide produced and by reducing the consumption of fuel and the mechanical parts of the vehicle such as brakes and tires. Similarly, vehicles euro 6 application, which aims to support the reduction in toxic exhaust emissions provided by vehicles powered by petrol or diesel engines, along with hybrid cars, as they too exploit petrol or diesel engines parallel to their electrical elements. Currently, transport still depends on oil for 94% of its energy commitment, while research and technological progress has led to auspicious confirmations of effective alternative fuel solutions for all transport modes. Regarding the development of the European alternative fuels strategy, for the long-term replacement of oil as an energy source in all modes of transport, the next two applications refer to alternative fuels used in road freight transport and electric vehicles. Alternative fuels within the meaning of the European Union are fuels or energy sources that serve, at least in part, as a substitute for crude oil-based energy sources in transport and which have the potential to contribute to decarbonizing transport and improving the environmental performance of the sector. The world is facing serious energy challenges because the global energy demand will increase by over 30% by as early as 2040 [\[30\]](#). Transport accounts for a third of this demand, while the number of cars on the road is expected to double over the next thirty years to two billion [\[31\]](#). A serious challenge is therefore the reduction in carbon dioxide emissions to the atmosphere and the improvement of air quality, for which it is necessary, among others, to increase the role of alternative fuels concerning gasoline and diesel oil and the use of electric vehicles, which also support the mentioned applications.

The remaining two applications for the area of vehicle support in road freight transport enterprises help to reduce transport time but increase connectivity and comfort. The first one is the most popular automotive navigation system application, which allows for setting routes, monitoring vehicles in motion, managing a car fleet, reacting to emergency situations, managing traffic, and supervising the transport of goods. The second application, among the listed ones, is used in vehicles with an automated driving application, and is a much less popular solution but with a predicted growing trend in use, such as by assigning the qualification to drive (i.e., convenient monitoring and action functions) to the vehicle automation system.

Ten applications that were chosen as crucial for general management support in road freight transport enterprises are primarily oriented towards increasing the driving comfort of road freight transport, increasing accessibility, cohesiveness, and control in management processes. They take into account various areas of road transport facilities, largely related to control in the transport management processes within six applications, i.e., demand control systems, traffic data collections systems application, an urban traffic control application, control systems of an urban and suburban traffic application, video surveillance systems for the area security, and expert system for correlation and filtering of events application. The solutions covered by the applications related to the increasing accessibility and comfort of transport are assisted by three apps, such as integrated parking guidance system, variable message signs' application, and integrated systems for mobility management. A separate application also

supports the management of fleets and logistics in the transport enterprises as an improvement in cohesiveness and control in transport management processes.

ITS applications belong to logistics infrastructure resources in the enterprise, as well as other information technology solutions in cooperation with various value-added services [32]. They maintain in the enterprise valued, and rare automatic systems are formed by precedent occurrences, decisions, and preferences which shape the organization in the enterprises, including its management processes. Effective implementation of these technological solutions commonly intensifies the distinction of their functions with the effect of a more compelling association with other functions in the enterprise. According to [33], information technology solutions and related value-added services are indispensable for enterprises to enhance and upgrade logistics customer service potential, which is considered in terms of both its level and capability. They may offer rare and intermutual experiences within immensely inventive services which help to build relationships with customers. As remarked by [34], information technology solutions, as part of logistics infrastructure, ensure the energy efficiency of transport and reduce the negative impact of transport on the natural environment, reducing transport time but increasing connectivity and comfort, increasing accessibility, cohesiveness, and control in management processes, which support enterprises in attaining customer satisfaction. Enterprises evolve their infrastructure assets, including ITS applications, to manage and control the environments and energy efficiency of transport modes [35], improve performance compelled by comprehending infrastructure services, among other road or rail transport, multimodal transport, and their arrangement, management, and interfaces. The results of the research presented by [36] indicate that information technology solutions may help to develop strategic conveniences for enterprises and alter competitive edges.

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