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THE ROLE OF ICT IN TRANSPORT AND LOGISTICS PROCESSES MANAGEMENT*

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Abstract. The complexity of managing transport and logistics processes is a massive challenge in finding optimal management solutions that meet the requirements of green development. There are questions about management support for transport and logistics processes. In addition, the subtleties of developing solutions for maintaining existing transport and logistics activities highlight the complex nature of transport and logistics management processes. The article focuses on applying advanced solutions for the practical management of transport and logistics processes. In the transport and logistics sector, an increase in new suppliers of telemetry systems is observed every day, which has been going on for 4-5 years, and this is statistically visible in the IAA Transportation 2022 records of one of the largest biennial transport and logistics exhibitions. There is an evident growth in the number of participants of manufacturers and service providers of telemetry systems, which since the exhibition held in 2016 has more than doubled, while around the world, the number of new companies supplying telemetry systems has increased to more than 300 per year. The growth of competitiveness also impacts the development of functions that provide new opportunities for customers to make their business more efficient or to receive services that ensure a comfortable life. Digital information generated by vehicles, which, when systematized, is presented to the end driver, is gradually becoming the future of this area of business and leads to responsible resource utilization, monitoring, control, and utilization of user-friendly technologies, leading toward a more sustainable future. An analysis of scientific papers has proven that the theoretical link exists between telemetry systems and their application in the transport sector; however, the judge research gap is in applying different quantitative methods for solving transport problems with the help of telemetry solutions.

Keywords: transport; telemetry; telematics; information platform; information; ICT; management

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1. Introduction

Globally, Europe stands out as an innovative pioneer in transportation and logistics. This region prioritizes technological advancements focusing on intelligent transportation systems (ITS) and Europe emphasizing the sector's digital transformation. As exemplified by the European Commission's May 17, 2018 document, EU strategic initiatives aim to establish the European Union as a leader in automated and interconnected mobility systems. These approaches underscore the importance of integrated IT systems for efficient transport and logistics management. Such a strategy leads to optimized resource usage, reduced emissions, and enhanced living and working conditions, benefiting stakeholders such as customers, service providers, and carriers.

The EU, United Nations, and G20 countries increasingly implement policies and actions to promote sustainability. Promoting sustainability at the municipal level is quite common in sustainable mobility and transport (Gallo et al. 2020). Policies promoting sustainable mobility can be divided into environmental, social, economic and technological. Sustainable transport policy includes climate, air quality, safety, and traffic safety. Gaia-X is a European initiative that aims to create an open and secure digital ecosystem, allowing companies and individuals to share data while maintaining control through secure identity and trust mechanisms, with a decentralized architecture linking various providers of computing elements. Catena-X is a project aligned with Gaia-X principles, focusing specifically on the automotive industry, providing a global data space that connects suppliers through a trusted and interoperable data-driven value chain, emphasizing data sovereignty and ownership, and illustrating a practical use case for a general data system constructed in the cloud (Zhang & Qi, 2021; Pörtner, Möske & Riel, 2023).

This scientific article aims to study not only the possible impact on future companies in the transport and logistics sector but also to build on the available practical knowledge acquired through a literature review. There is also a desire to analyze the current situation in the transport and logistics sector, to present the expected future trends, the principles of operation of telemetry systems and how the latter could help to manage transport fleets more efficiently. With the emergence of more and more suppliers of telemetry systems, there is a problem – the lack of interface between all these systems, which would allow transport and logistics companies to use the information provided by several such systems. By leveraging the integration of information and communication technologies (ICT) alongside emerging wireless communication and cloud computing tools, an exceptional opportunity arises to establish a comprehensive system. This system has the potential to adeptly oversee intricate processes sustainably, thereby mitigating risks and avoiding unsustainability.

Dynamic systems could empower logistics decision-makers and stakeholders to observe real-time processes and proactively anticipate potential delays and complications while adhering to eco-conscious and user-friendly approaches. Such enhancements translate to heightened efficiency, customer information precision, and an enriched participant experience.

A definite answer cannot yet be given to the entire transport and logistics sector because the process has just begun. It is fascinating to observe it from the outside, both by the prominent representatives of this sector and in the actions of medium or small ones, by digitizing the processes of enterprise management and trying to make the most efficient use of the available human and technical resources.

Vehicles generate many data, from driver driving readings to technical information. If all vehicles on the roads would systematize the information generated and transmit it to a shared vehicle information network system (i.e. platform) that would be available, such information could make it possible to control the flow of vehicles on the roads, provide technical equipment manufacturers with information on the wear and tear of specific components, such as brake pads, during the operation of the vehicle under different conditions, etc.

The structure of the paper consists of four sections. The first section presents the role of information and telematics systems in the transport and logistics business. The second section describes the principle of operation and functionality of information and telematics systems. The third section focuses on the application of platforms to support the transport and logistics processes management. The last fourth section shows the literature review results on telemetry usage in transport.

1. The role of information and telematics systems in the transport and logistics business

Information and telematics systems are relatively new and must be more visible and constantly changing (Atkins et al., 2022). This has increased the interest of researchers in understanding how different public figures can adapt information and telematics systems to improve and facilitate different forms of change. This new area of research focuses in particular on the study of how information and telematics systems can be used by businesses, households, governments and other stakeholders to encourage the development of services in the transport and logistics sector.

In the era of global connectivity, managing transport and logistics processes has become crucial for companies, including large-scale deliveries, resource sharing and data sharing, to improve service delivery and enable more sustainable and efficient operations (Choi et al., 2019; Dano et al., 2021). It is, therefore, vital to propose information and telematics systems adapted to the transport and logistics sector.

According to Musaigwa et al. (2022), the application of information and telematics systems depends to a large extent on the integration of data from vehicles and cargo (Du et al., 2019; Liu et al., 2022) and cooperation between companies, including those operating in the transport and logistics sector. In particular, the automotive, IT, and high-tech sectors are increasingly dependent on information and communication technologies to manage the physical processes of transport and logistics (Roussat et al., 2023), and transactions often involve interaction with each other.

By applying advanced solutions, companies gain a competitive advantage. This has led to increased interest in providing services in the sector and has recently been systematically reviewed in research and development. The scope and diversity of datasets have expanded in response to the increasing volume and variety of data used for transaction exchanges (Zhang et al., 2022). With the introduction of these revolutionary technologies, the focus was on maximizing total value creation. This change has led to the introducing of innovative transport and logistics process management models that reflect a dynamic response to the changing industrial environment (Dolgui, 2018).

Previously, until 1990, companies relied on electronic data exchange and freight transport systems for data exchange and interconnection (Demir, 2020). These systems facilitated access to data for analysis and helped companies anticipate demand (Hu et al., 2021), promote better collaboration, speed up transportation and logistics processes, reduce costs, and improve customer service (Attaran et al., 2023).

Over the past decade, companies have integrated Business Intelligence technologies and predictive analytics solutions, as noted by Lorenc & Burinskiene, 2021). These technologies have allowed a comprehensive understanding of transport and logistics processes, simplified decision-making processes, and provided insights into local optimization (Barbosa-Povoa et al., 2018). Companies face the challenge of seamlessly integrating into their transportation and logistics networks today. Although many international companies have common resources, they seek new methods and effective implementation models (Light et al., 2015). Systematic data analytics allows companies to receive alerts and make optimal decisions quickly.

Hodapp et al. (2022) emphasize the importance of organizations using integrated IT solutions to drive business growth and leverage the practical insights generated by the growing variety of potential opportunities.

Before attempting to understand the possible vision of the future interface of technical devices, telemetry systems and the platform's business model, it is necessary to analyze the current situation in the transport and logistics sector. Like other business sectors, the latter is inevitably forced to change and accept innovations created by information technology, which makes it possible to optimize the daily processes of this type of work, which can be done by identifying the current situation and applying the correct ways to solve the problem to it.

The primary purpose of this subdivision is to find out, identify and study the trends in the transport logistics supply chain in today's market and the emerging problems faced by representatives of this sector. Supply chain activity is changing dramatically, and experts predict these changes will only increase soon (Wallace et al., 2021). The scientific transport article identifies ten main trends that will significantly impact the spheres of transport logistics and supply chains (Stank et al., 2015). The main characteristics are presented below:

- Systemic focus – optimization of the entire supply chain network, creation of customer value;
- Information synthesis – information is entirely shared, and general interpretation and analysis of processes help to improve work efficiency;
- Cooperative relations – shared commitments and creation of benefits, total systemic benefits;
- Demand formation – proactively formed demand, creation of total systemic benefits;
- Data transformation – constantly changing conditions, information and its processing;
- Flexible network integration – dynamic selection of partner customers in information systems according to the necessary criteria in the current situation;
- Process optimization – leading to reduction of CO_2 emissions and sustainability benefits.

The above trends and the resulting problems are aimed at optimizing the supply chain and opportunities to improve the processes used in the future based on information found in scientific articles. These points are closely related to integrating information technology and telematics systems into the activities of transport logistics companies and existing business management systems, which require reliable, adequately processed and systematized timely data. Tracking and telematics systems can become essential factors that will enable or prevent the implementation of these trends, the development of the transport business and the optimization of processes. However, the transport logistics business is not limited to the supply chain, although it is one of the essential factors, and the transportation activity itself is of particular importance.

Although cars remain the dominant force in the various types of transport sector for most people, many different transportation options are observed daily (Wallace et al., 2021). Various startups in this sector can achieve impressive results quickly and offer a new way of transportation. World-class companies such as Uber, Grabtaxi, more widely known in Lithuania Taxify, CityBee offer their customers alternative transportation services for short and long distances. Young drivers are more likely to use the services of these companies, thus not obliging themselves to buy a car, insurance premiums or the costs necessary to maintain the car's technical condition. Uber can be used as an excellent example for adapting the platform's business success in the transportation sector, which started its activities as a limousine rental company and did so by phone. By generating the idea of creating a platform that combines a network of people looking for transportation and people providing transport services, Uber has been an unprecedented success. At the same time, drivers working at Uber enjoy a more significant number of passengers and more frequent bookings. Consumers pay a lower price than for taxi services. One can call an Uber car or cancel it with a few-click telephone assistance. It is a success story that has already happened and has become a trend today. At the same time, in Forbes magazine, the authors single out six main potential transportation trends that will change humanity's current understanding of transportation in the future (Stank et al., 2015):

- Autonomous vehicles – vehicles that are not controlled by hands and feet are already a reality today; fully autonomous vehicles will become a reality shortly;
- Electric vehicles – the basis of such vehicles are transit buses, minibuses, and vehicles that can travel relatively short distances are becoming increasingly economically attractive and can travel longer distances without stopping to charge the battery;
- Networked vehicles – traffic conditions and intensity become achievable in vehicles, as vehicles have an internet connection and can share information;
- Shared use – as the need for information dissemination increases, the need for mobility tools increases so that shared options enable mobility without the most frequently unused private cars;
- Efficient multimodal network – by receiving a large amount of data from different vehicles, it becomes possible to adapt and change the arrival/departure schedules according to the needs of the driver; it is additionally possible to choose one of several proposed route options for achieving the final destination;
- Newly designed vehicles – lighter vehicles are already becoming a trend, and this is also an important factor in extending the distance of electric vehicles.

There is a high probability that it will not take a long period to see entire fleets of vehicles that will be autonomous, consumers will be able to share cars and reach their travel points, and all vehicles will be connected to a shared network, which will make it possible to control the flow of transport movements and optimize vehicle congestion in cities or high-importance roads.

However, for all the innovations of the future, which are predicted in the management of vehicle fleets, a system will be needed that will be able to connect technical solutions with information technology platforms. Without this interface, it isn't easy to imagine a smoothly functioning system that provides users with convenient vehicle control and the necessary tools with the help of which this process can be controlled. These days, prototypes of suitable design technical devices are still being sought to ensure the sustainable and spontaneous capture and transmission of vehicle-generated data to the end user. Such information systems are not interconnected, but the creation of a platform that combines these systems into a platform whole would make it possible to search for points of contact between common systems and problem areas of the joint transport fleet and try to solve them by creating additional technical equipment or an information technology system.

2. The principle of operation and functionality of information and telematics systems

Systems such as information technology, tracking or telematics are usually made up of the following elements – an information processing device, an information recording and storage device, a telematics component that collects the generated information, in other words, a sensor, and a device that sends collected, systematized information from the vehicle to other devices, which can use GPRS (mobile communication), Internet connection or wireless Internet connection Wi-Fi (Porter et al., 2015). All of the above elements of information technology, tracking or telematics systems can be configured and inserted into the selected vehicle, be it a tow truck, semi-trailer, passenger car or ship, as needed. An information processing device controls the information recorder, sensors and the information transfer device, thus combining these elements into a single functional system that can not only receive data but also exchange it with each other or transmit it to the necessary third tool - a telephone application or an online portal - by generating messages about specific parameters, such as driving speed, traffic conditions, changes in the technical characteristics of the vehicle, etc., on the vehicle and to warn its user, owner or other person involved of the need to take appropriate action to remedy the problem. Such a message can be generated as an SMS message to the assigned phone number, an e-mail to the responsible person, or an event tile presented as a certified document (Porter et al., 2015).

There is not a single principle of operation of telematics systems (Porter et al., 2015). The components that make up this type of system are usually the same, but the programming of these components can change and have

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several different variations. An essential part of such systems is a programmable, configurable information processing device that performs various functions in different systems. The processor can be programmed to react, identify certain pre-programmed situations and inform the end user about them. In this way, the risk of the human factor is reduced since the user is not obliged to create the necessary messages or warnings about the vehicle or the entire transport fleet himself since this is done for him by the processor and thus conditionally limits, which effect the functionality of information, tracking or telematics systems.

It is also possible to program the information programming device so that it automatically updates the software of all the components that make up the common telematics system, analyzing the flow and quality of the data sent (Porter et al., 2015). This function generates enormous benefits for a typical, everyday user who does not have to worry about updating equipment, visiting a service partner and other issues that use time and resources, since this function generates huge benefits for a typical, everyday user who does not need to worry about updating equipment, visiting a service partner and other issues that use time and resources, since this function generates enormous benefits for a typical, everyday user who does not need to worry about updating equipment, visiting a service partner and other issues that use time and resources, since this function generates huge benefits for a typical, everyday user who does not need to worry about updating equipment, visiting a service partner and other issues that use time and resources, since this function generates huge benefits for a typical, everyday user who does not need to worry about updating equipment, visiting a service partner and other issues that use time and resources, since this function generates huge benefits for a typical, everyday user who does not need to worry about updating equipment, visiting a service partner and other issues that use time and resources, since this function generates enormous benefits for a typical, everyday user who does not need to worry the information is processed and the proposal for the best solution to the problem is proposed by the system itself.

Another example of the functionality of telematics systems is the unconditional communication of several vehicles and exchanging information with each other (Porter et al., 2015). Thanks to the tracking telematics system, cars can be connected to a shared network, where information received from all vehicles on this network is collected, processed and systematized, and feedback is created with the selected information for each vehicle according to the criteria necessary for it at that time. This creates the possibility of implementing a prototype of an autonomous vehicle and integrating it into the transport, transport and logistics or supply chain sectors by simplifying transportation processes.

New telematics systems, methods, functions, and values to be created will or will become a strong basis in the transportation of the people of the future, in the transport and logistics or supply chain sectors, based on the processing of generated data and its integration into existing systems (Guenkova et al., 2015). The data being developed makes it possible to understand the places of efficiency of the transport and logistics sector, which, if optimized, could lead to more efficient work, resource utilization and, of course, the profitability of companies in this sector.

Based on the divisions of tracking telematics systems proposed by the scientific article, it is possible to form four of the most common, comprehensive parts that define the possible functions of systems of this type (Englebrecht et al., 2014):

- Traffic condition information – position at the given moment and movement of other vehicles or pedestrians;
- Vehicle information – vehicle technical standing data, pending maintenance or repair;
- Environmental information – the condition of the road and current or future weather conditions;
- Driver behaviour information – monitoring of driving efficiency, economy and safety of equipment, as well as protected functions – notifications warnings that help the driver to properly assess the situation and make appropriate decisions.

Traffic condition information – M2M (a machine transmits information to another machine) platforms are an essential condition allowing several different vehicles to communicate autonomously and share the available information (Booysen et al., 2012). Vehicles can automatically, without user intervention, reschedule an existing route to a new one, having received information from other vehicles about road accidents, congestion or unforeseen situations that do not allow the intended section to be overcome as quickly as planned. This function is crucial in the cargo transportation, transport and logistics sector, especially in the auto industry, where cargo must be delivered at a particularly accurate time, otherwise, the entire production process is stopped, and the company of the manufacturing industry loses huge money with each late minute, and the transport logistics company is obliged to pay a penalty of the amount of the value of the cargo for outstanding obligations. With this system, such situations can be avoided.

Vehicle information – has proposed to use smart devices as an alternative to the OBU (additional equipment for accessing vehicle data) to obtain ECU (Electronic Vehicle Control Control) information remotely. The ECU is usually achieved using the OBD-II connector standard in the transport manufacturing industry by connecting a wireless additional component to it, which transmits all the generated data. In this way, the data generated by the vehicle can be reached at a considerable distance from the vehicle. Also, based on the same principle, it is possible to install an automatic auto-event detection system, for which a GPS position should be added to the existing components, and a smart device and an accelerometer can generate it.

Environmental information – the main technical elements necessary for this function are the GPS position and the accelerometer. One of the first road condition monitoring systems has been developed to detect map anomalies on the road, such as unexpectedly appeared potholes, fallen trees, etc., using the already mentioned technical means (Eriksson et al., 2008). Later, this system was supplemented with sensors that generated messages and could send them and warn the driver and other persons about the information received.

Driver Behaviour Information tool was developed as the first finite driver monitoring system (Johnson et al., 2011). The system they designed can detect, identify and classify aggressive or non-aggressive driving manoeuvres according to the results obtained using data generated by the accelerometer, gyroscope, magnetometer and GPS. Later, additional functions were added that made it possible to classify drivers according to the driving stylistics and allocate effective driving scores based on this, and this system became extremely popular in the transport and logistics sector when evaluating drivers and paying additional bonuses for work according to the available effective driving score or looking for answers to the question - why the set efficiency of the company is not achieved.

The principle of operation of telemetry systems remains similar to the technical equipment that captures and systematizes the data generated by the vehicle. Of course, the quality and functionality are different; it all depends on the final production and the monthly service cost, but the platform creation should be fine with this. However, the problematic location could be the amount, size and processing of the generated data since the amount of information the language talks about is enormous.

3. The application of platforms to support the transport and logistics processes management

Four meanings of the platform are defined, which are described based on the leverage method and the architectural openness of the platform's structure (Nowicka, 2021). Types of platforms:

- Organizational platforms;
- Product family platforms;
- Market brokerage platforms;
- Ecosystem platforms.

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This subsection is designed to understand the basic logic of the ecosystem platform, which combines the characteristics of two other platforms: product families and market intermediaries. The ecosystem platform operates on an architecturally open principle, thanks to which external resources such as suppliers, manufacturers and customers are managed. This platform uses three different methods of the type of leverage, which allows you to generate a higher yield with the available resources. This is done by recombining available resources, projects and standards (leverage of production), facilitating the creation of new goods or services (leverage of innovation) and manipulating market pricing mechanisms, possibly reducing friction. Reduction in transaction search costs (transaction leverage) (Thomas, 2014).

It is argued that platforms can mobilize added value that may not be visible to the public and thus help them to make broader and more efficient use of available resources and time or provide expert, creative opinions that would contribute to the implementation of ideas for participants in an open infrastructure system (Chase, 2015). Control in this type of system or community is the division of participants into developers and consumers of products or services. Evaluation of the work of the platform takes place through a positive created network effect, which is an inevitable cycle, during which the creators of the platform, taking appropriate strategic actions, grow the value of the platform, attracting new users who again influence the new cycle with additional progress of the platform (Parker et al., 2016). Business logic is based on various interactions and open problematic issues, which requires coordination so that both the consumer and the creator or supplier of the service can make the most of the added value created and use it as simply as possible. Control is a prerequisite for the platform, it is necessary in order to differentiate the best users from the worst and remove the latter from the platform by ensuring its high-quality functioning (Lane et al., 2017). The management system is also a necessary tool to control the conditions of consumer participation on the platform, distribute value-sharing issues between consumers, or resolve disputes between consumers and suppliers.
To achieve a positive change in the network and global development, it is important:

- Achieving a critical mass of value creation (Evans and Schmalensee, 2016);
- To take care of real-time adaptation, mentoring and management of the consumer community (Choudary, 2015);
- To ensure that the chosen policy of presenting values on the platform is important for its creators and users (Parker, Van Alstyne, Choudary, 2016).

It is claimed that the two components of the platform are essential, although sometimes they are forgotten, which distinguishes the platform's business model from the traditional linear business model (Choudary, 2015). These components are:

- Rapid adaptation to changing consumer consumption habits and patterns;
- The ongoing process of assessing the state of the platform.

These are the essential mechanisms of operation of the platform that follow from the sources of information retrieval and the management structure of the platform. Traditionally, currency exchange in economic transactions is considered to be the equivalent of money, but in the case of platforms, information or social currency, as an example, one can give reputation, is the same value, sometimes perhaps even higher, generating instruments than monetary transactions, which is created through value-added activities that can be created by platforms (Choudary, 2015).

At the core of this research lies a pioneering approach by constructing a management structure tailored to the dynamics of transport and logistics processes. Here, "management structure" refers to a systematic handling of transport and logistics processes. The basis of this approach is the integration of data transport and logistics processes and operational management rules. Responding to diverse transport needs and challenges by integrating new management rules and increasing support for multispectral transportation and logistics activities.

To understand whether and how the platform business model correlates with management structure fulfillment requirements must be used as essential concepts to support the business model of platforms. These principles are: (1) Value; (2) Flow of values; (3) General flow; (4) Affinity; (5) Perfection.

The first principle. The value concept also combines improving the quality of a product or service and delivery action, while constantly gradually reducing costs for suppliers and the cost of a good or service for consumers (Womack and Jones, 1996). Platforms collect information from each transaction, storing this information in both directions, taking into account the level of satisfaction of both the supplier and the user after the provision or receipt of the service (Moazed and Johnson, 2016). The information collected is then adapted to the algorithms used on the platform in order to create a system in which the most suitable suppliers are paired with the needs of individual consumers and the latter remain satisfied. In addition, platforms reduce the overall cost of processes by eliminating intermediate links such as brokerage companies. The basic meaning of the ecosystem platform directly correlates with the definition of value creation.

The second is the flow of values. The flow of values consists of three critical points:

- Solving the problem;
- Information management;
- The physical task of transformation.

The flow of values is the approach to a linear business model, where the platform, although trying to solve the problems the potential user faces in the desired way, does not work in the same way as the flow of values, more like a network of values. The platform can only work properly if it pairs the required manufacturer service provider with the right user and generates a maximum value on both sides (Parker, Van Alstyne & Choudary, 2016). In this aspect, the platform and flow of values coincide.

The third principle is the general flow. Organizations turn their attention to a stable general flow that connects one process with another without any extraneous interference that could complicate the work. The ecosystem platform replaces entire companies and the services they offer, an example of which can be used by intermediary companies of the whole value chain when a new platform business model is introduced, which eliminates the constant competition in intermediate chains, which is the usual daily practice of liner businesses (Parker, Van Alstyne & Choudary, 2016). The ecosystem platform expands the concept of general flow from the interface of individual companies and individual projects to a common ecosystem platform, where it is possible to find the best solution for a particular project from existing proposals or agree on the preparation of such a proposal.

The fourth – thrust – is embedded in the platform's business model logic. A successful platform creates a network effect, which creates additional value for each platform participant every time a new supplier or user of a product or service joins the platform. All this can be described as a growing double attraction - when a new supplier arrives, new customers are attracted, or with an increase in the number of consumers, additional suppliers appear willing to meet the resulting consumer demand on the platform. Meanwhile, the owner of the platform balances demand and supply by changing the pricing of the services or products provided (Evans & Schmalensee, 2016).

The fifth principle is perfection. The platform business model is a powerful tool for achieving perfection. Such a business model competes with conventional linear business models and other platforms, which means double competition. In the future, there are expected to be more ways for consumers, service providers, and product providers to become part of different but simultaneously similar functionality platforms (Parker, Van Alstyne, Choudary, 2016). Participants in these several platforms can become the key to pursuing perfection soon. The cycle of real-time feedback on the received service with the management of a vast flow of information already makes it possible to solve particular problems, such as waste related to the production process, and an appropriate

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management system prevents such activities (Choudary, 2015). The constant pursuit of perfection is integrated into the platform's curation processes and platform management systems.

All five principles are naturally integrated into the success factors that determine the functioning of the ecosystem platform. It is possible to single out the general flow as an essential factor that strongly contributes to the implementation of successful projects, and conventional intermediation companies with linear operations often need to be able to ensure the high-quality performance of this process. In conclusion, the platforms' business model highlights the importance created by understanding and evaluating the value relevant to the consumer, which should have been more often underestimated or overlooked earlier (Pekuri, Pekuri & Haapasalo, 2013).

4. The review of literature on telemetry usage in general and in transport

During the literature review, the author tries to identify a research gap in the application of telemetry systems in transport. The literature review consists of two stages. First, the author applied bibliometric analysis, and later on - the comparison analysis, which shows the popularity of quantitative methods when telemetry is used to solve transport problems.

The author performed a bibliometric analysis of the application of telemetry systems. In Table 1, we see that the application of telemetry has a long history, starting from 2008, when the most cited publication appeared. The next stage of the telemetry development was in 2017, which included 2 most cited papers, which appeared and left behind papers from 2014-2016 had lower popularity. Later on, 2 new papers were published in 2018 and 2020 accordingly, but their citation is still low and are close to 100 citations per paper.

Table 1. Most cited papers focusing on telemetry

Publications	Number of citations higher than 100 citations per paper
Hunkeler et al. (2008)	412
Naik et al. (2017)	291
Light (2017)	257
Thangavel et al. (2014)	230
Singh et al. (2015)	223
Froiz-Míguez et al. (2018)	122
Mishra & & Kertesz (2020)	117
Yokotani et al. (2016)	106

The bibliometric analysis shows three clusters: IT-related cluster, Internet of Things setup cluster and the application of telemetry solution cluster. IT-related cluster focuses on platform setup questions: sensors, monitoring, control, servers and working conditions. Internet of Things setup cluster includes security, network, protocols, blockchain and algorithm questions. The last application cluster specifies the performance, evaluation, scenario, industry, smart city and other topics.

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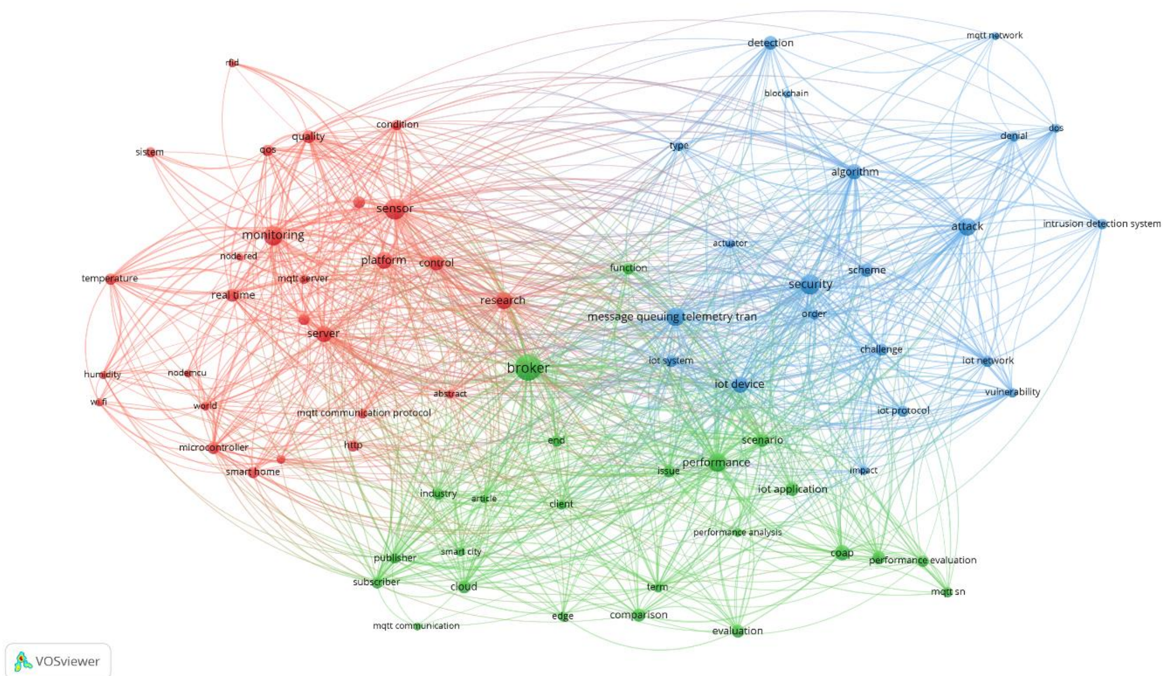

Figure 1. Bibliometric analysis of publications focusing on telemetric systems

Figure 1 shows the three clusters named earlier, which are equal sized and have an almost identical number of topics: the first cluster (marked in red) includes 27 items, the second cluster (marked in blue) – 21 items and the last cluster (marked in green) – 24 items.

The author revised the usage of quantitative methods in telemetry and its application in transport. The research results are presented below in Table 2 and divided into mathematical parts, simulation methods, heuristic, hybrid and analytical methods.

Table 2. The quantitative methods and models for investigating telemetry systems in transport

Types	Modeling technique	Solution methods	Authors investigating telemetry systems	Authors investigating telemetry systems in transport
Mathematical programming methods	Single-objective	Linear programming (LP)	Castro et al. (2021)	
	Multi-objective	Mixed integer linear programming (MILP) Fuzzy-goal programming Dynamic programming Queuing model Non-linear programming	Dallanora et al. (2022) Anjum et al. (2022) Pereira et al. (2023) Ali et al. (2023) Ji et al. (2023)	Peng et al. (2023) Lin et al. (2019)
Simulation methods	System dynamics (SD)		Darbali-Zamora et al. (2021)	De Rango et al. (2022)
	Discrete event (DES)		Evans et al. (2022)	

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Heuristic methods	Simple heuristic	Simulated annealing heuristics (SAH)	Bhamare et al. (2019); Tan et al. (2021)	
	Artificial intelligence (Al) techniques	Markov chains	Jadon et al. (2021)	Pearson et al. (2022)
		Petri nets	Hassanien et al. (2020); Kherba-che et al. (2023)	
		Bayesian network modeling	Yakimov et al. (2022)	
		Fuzzy logic		Teran et al. (2020)
		Artificial Neural network		Fam et al (2021)
		Grey system and rough sets	Hassanien et al. (2020)	
	Meta-heuristic approach	Genetic Algorithm (GA)	Wei et al. (2021)	
		Evolutionary Algorithm (EA)	Hassanien et al. (2020)	
		Differential evolution algorithm	Abdelghafar et al. (2022)	
		Particle swarm optimization (PSO)	Qu et al. (2021)	
		Ant Colony Optimization	Zhao et al. (2023)	
		Greedy Randomised Adaptive search procedure	Kristiansen et al. (2019)	
Hybrid model	Hybrid simulation			
Analytical model	Multi-criteria decision making (MCDM)	Analytical hierarchy process (AHP)	Yin et al. (2022)	Othman et al. (2022)
In total			22 publications	6 publications

The results show that many meta-heuristic methods are used to apply telemetry solutions. However, these methods are not applied in transport area. The application of telemetry solutions involves, in most cases mathematical and simulation methods. In situations when telemetry solutions are used in transport AHP method and some artificial intelligence techniques, system dynamic simulation and several multi-objective mathematical programming methods are involved. This literature review shows that telemetry application for transport is much more rarely presented than a general application of telemetry solutions. In most cases, general telemetry solutions are oriented to IT problem-solving situations. The number of publication presented by the end of Table 2 shows that the application of telemetry solutions for solving general problems are almost 4 times higher than the use of telemetry solutions for solving transport issues.

Conclusions

The transport and logistics sector is undergoing a time of change when changes are gradually coming to conventional linear business models, which are inevitably related to digitalization. New technical devices are being developed that are expected to help solve emerging problems at the time of the giver and will help to properly prepare for future trends, which will inevitably force specific changes in the business.

Technical equipment installed at the vehicle can provide vehicle information. Telemetry systems offer the opportunity to transfer the generated and systematized data over long distances, accumulate it and analyze it for specialists in their field, thus trying to find ways to make work processes more efficient, make better use of human or technical resources and improve the indicators of enterprises.

However, such interfaces between information technology systems and technical devices in vehicles are so far isolated and are not combined into a shared network that would connect all service providers and users with a common platform. The creation of such a platform would make it possible to provide higher-quality services at a more affordable price, taking into account the individual needs of users. Ensuring a quality service in the market would expand the consumer base, which would create additional demand that would have to be met by existing service providers or open the door to new market players, ensuring even greater competitiveness in the market. For now, it would be too bold to claim that the platform's business model linking hardware, telemetry systems, developers and users of these systems is a clear future for this business segment. Looking at the success stories of the big players of other segments in adapting the business model of the platforms, it is realistic enough to apply it in the transport and logistics segment to create added value.

Thanks to the platform occurrence, it will also be possible to systematize the information generated by a considerable flow of vehicles and make targeted use – to reduce traffic congestion on roads heavily overloaded with the flow of cars, to collect information about the technical characteristics of vehicles by operating them in different climatic conditions, ensuring a higher quality product adapted to specific markets in the future.

The literature review results show a research gap in applying telemetry solutions for solving transport problems. The application of telemetry solutions in transport is almost 4 times lower than their application for IT and other areas. Contemporary publication from 2019-2023 shows the application of telemetry solutions in the transport sector is still promising.

Such innovations are needed in the face of increasing global demand for efficient transportation and logistics, coupled with a growing emphasis on sustainability and eco-friendly practices. The potential impact of this research is far-reaching, enhancing efficiency, reducing costs, and contributing to the broader goals of environmental stewardship and economic growth. These intelligent components are pivotal in automating green practices, effectively reducing sector volatility and vulnerability to unforeseen disruptions, climatic shifts, and other adverse factors. This alignment concurs with global governmental initiatives emphasizing intelligent transport systems to foster sustainability and meet stringent environmental standards.

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