European Research Studies Journal
Volume XXIV, Issue 2B, 2021

pp. 850-859

Intelligent Transport Solutions of Logistics 4.0 in the Context of Changes in Driving Style: A Systematic Literature Review

Submitted 17/03/21, 1st revision 24/04/21, 2nd revision 27/05/21, accepted 30/06/21

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Abstract:

Purpose: *The aim of this paper is to analyze the relationship between the use of Logistics 4.0 tools and a change in the behavior of drivers to more ecological and safer. We analyze the social acceptance of the intelligent tools implemented in vehicles, and identify a possible research gap in this area.*
Design/Methodology/Approach: *In this article, a systematic review is used for the quantitative and qualitative assessment of publications available in two digital databases – WoS and Scopus. The review allows verifying whether there is a significant research gap within the analyzed problem.*
Findings: *In the article, is indicated that the digital databases of publications contain only 26 full-text papers relating to the analyzed research problem, which confirms the hypothesis of the existence of a research gap.*
Practical Implications: *The practical implications of this publication include the need to refine research on the social aspect and the readiness of drivers to implement and use intelligent transport systems with benefits for reduction of the environmental impact and increased safety.*
Originality/Value: *The importance of the Smart City tools and their use as part of increasing the safety and environmental friendliness of driving is a key factor in changing driver behavior. The pro-ecological policy of the European Union imposes a change in the style of driving. Only 26 related publications have been identified, thus this paper contributes to the literature by proving in-depth analysis of the problem under consideration.*

Keywords: *Driving style, intelligent transport, logistics 4.0, drivers behavior, eco-driving, social acceptance.*

JEL codes: *R41.*

Paper Type: *Research Paper.*

Acknowledgement: *This article was funded by Poznan University of Technology, Faculty of Engineering Management [project number: 504101/0812/SBAD/4177].*

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1. Introduction

Currently, the ecological awareness and pro-ecological policy are strongly promoted by the European Union, thus striving to meet the postulates of sustainable development is extremely important (Pająk and Cyplik, 2020). The dimensions of sustainable development refer to the following aspects: social, economic and environmental. The road transport generates the greatest amount of exhaust fumes and pollutants emitted to the atmosphere (European Commission, 2016). The human factor plays an extremely important role, as drivers' skills and their conscious and responsible behavior have a very large impact on the harmfulness of driving (Thisaiveerasingam and Jayaweer Bandara, 2019). The harmfulness of road transport may be reduced, by following by drivers the principles of ecological and economic driving. In addition, adhering to the principles of eco-driving also allows increasing road safety (Wang and Boggio-Marzet, 2018). In the case of decarbonization of road transport, important factors are intelligent systems, which are often supported by solutions based on artificial intelligence (European Commission, 2016).

Logistics 4.0 concept assumes continuous real-time data exchange, thus enabling even more accurate decision-making process. Continuous communication both between system users, and its entities contributes to the increase in process efficiency. Intelligent tools and solutions used in the most modern vehicles (such as, as lane assist, traffic-sign recognition, identification of pedestrians or obstacles appearing on the road, speed control or distance between vehicles) contribute to increase road safety. In addition, these vehicles are very often equipped with economical combustion engines, hybrid or electric engines, thus, which allow reducing their emissions. Integration of smart technologies within Smart City, i.e. infrastructure using telematics smart solutions, contributes to the development and full use of the infrastructure of large urban agglomerations (Cichosz and Pluta-Zaremba, 2019; Sheeba *et al.,* 2019; Tong *et al.,* 2019).

One of the key aspects related to the sustainable transport, is the behavior of drivers, as it influences the safety and harmfulness of road transport (Thisaiveerasingam and Jayaweera Bandara, 2019). The driving safety results from drivers' predispositions, their age, experience or sex, but also from conscious respecting or breaking the rules of the road, which significantly affect driving safety (Pino *et al.,* 2014). It is driver mistakes that are the cause of over 80% of road accidents (Issa, 2016).

The behavior of drivers in the context of sustainable transport is also important in relation to fuel consumption and the harmfulness of car transport. Adherence to the principles of eco-driving (e.g., engine braking, using the highest possible gear, smooth cornering, no sudden acceleration or braking), contributes to a decrease in fuel consumption between 2.5 to 10% (Barla *et al.,* 2017). It seems to be crucial to adopt both the skillful use of systems for road safety in urban infrastructure, as well

to accept the intelligent solutions available in the latest, often electric, vehicles. In addition, due to the increasing importance of ecology in transport processes, the use of these technologies in the near future will become not only a choice, but also a duty for drivers.

Due to the very wide scope of the nomenclature related to intelligent solutions in the field of Logistics 4.0, the authors of this paper analyze the correlation between intelligent transport (related to Logistics 4.0 tools) and the driving style. The analysis also includes an important social aspect related to the acceptability of using such tools in road traffic. The purpose of this article is to conduct a systematic literature review, which links the quantitative and qualitative assessment of the papers published on Logistics 4.0 solutions in the context of drivers' behavior. According to the authors, there is a significant correlation between intelligent tools and drivers' behavior, also in the context of social acceptance of modern solutions in Smart City areas however. The article presents a hypothesis:

H1: There is a research gap in the context of social acceptance of intelligent transport solutions used in both vehicles and urban infrastructure, which improve the behavior of drivers in terms of driving safety and environmental friendliness.

2. Research Methodology

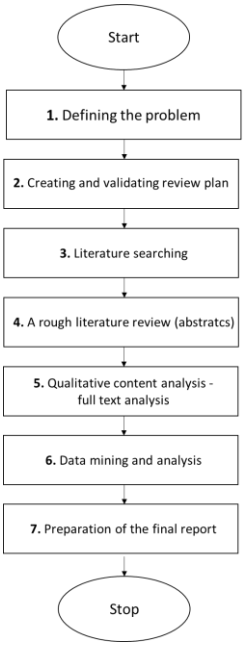
In this article the systematic literature review is used in order to verify the impact of the use of intelligent solutions on the behavior of drivers in relation to the social aspect, i.e. the acceptance by road users of Logistics 4.0 tools supporting the enforcement of eco and safe-driving principles. The impact of these tools is considered not only in the context of modern vehicles, but also for the infrastructure of urban agglomerations.

A systematic literature review is a method of searching for publications on the subject matter, most often available in digital literature databases. This review aims for assessing the state-of-art in the field of the phenomenon under study. That includes a quantitative and qualitative analysis of articles available in the databases, and most often, on this basis a research gap is identified that may be developed in further research (Okoli and Schabram, 2010). One of the algorithms most often used in systematic literature reviews is the diagram shown in Figure 1.

The first step in a systematic literature review is to define the purpose of the conducted research. The goal must be properly identified and shall include an analysis of the state-of-art a specific field or the identification of research gaps. The purpose of this paper is to identify the correlation between the use of intelligent technologies and the change in drivers' behavior to be greener and safer. The next step in this process is to create an appropriate literature review plan, thanks to which it is possible to later perform a quantitative and qualitative analysis. The plan of the literature review assumes defining the purpose of the research, keywords, research

area or the method of data extraction and analysis. The first two steps are therefore the stage of preparation for the analysis of the created literature database.

***Figure 1**. Steps of systematic literature review*



***Source:** Own work based on Hiao and Watson, 2019.*

As part of this publication, the authors decided to narrow down the search of databases based on keywords: driving style, intelligent transport. The third step involves searching for the appropriate literature items that meet the criteria indicated in the second point of this algorithm (Hiao and Watson, 2019). Literature search may also be based on specific research methodologies, e.g., PIRSMA methodology (Pati and Lorusso, 2017). Articles considered for analysis are usually searched in digital full-text publication databases based on the appropriate configuration of keywords.

We have searched the Web of Science and Scopus scientific databases. The publications that meet the review criteria are taken into account for further analysis. Exclusions are most often made on the basis of abstract analysis (step four in Figure 1). The fifth step involves qualitative assessment of the full text of articles published in digital databases and the selection of those items that meet the specified purpose of the review and the identified selection criteria. The sixth step includes the extraction and analysis of the data contained in the full texts. Very often, this analysis is a combination of a quantitative study (research on the frequency of e.g., keywords, citations) and a qualitative analysis relating to the degree of coverage by individual scientific publications of the subject of the research (Wojtkowiak and Cyplik, 2020).

In this study, a quantitative analysis is performed in terms of the number of results for the driving style and intelligent transport query, which have appeared in subsequent years. Additionally, a quantitative analysis of keywords identified in individual articles, broken down by publication years, is also performed. The last step of a systematic literature review includes the presentation of the final results in the form of a report that can be used to develop further research in the analyzed area (Liao *et al.*, 2017).

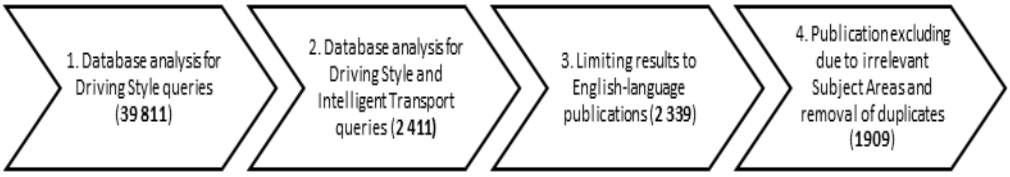
3. Research Results

The analysis of the publications began with a review of articles in the Scopus database for the query "driving style". 31,515 entries were identified for this query. Then, the database was searched for publications linking both the driving style and intelligent transport solutions, which allowed limiting the studied scope to 2,394 publications. In the next step, the analyzed database of articles and book chapters was limited only to English publications, which allowed to create a database containing publications up to 2,322 documents. Publications that didn't belong to the specific subject areas were also excluded from the study. The excluded subjects were: Medicine, Physics and Astronomy, Biochemistry, Genetics and Molecular Biology, Chemistry, Health Professions, Agricultural and Biological Sciences, Chemical Engineering, Earth and Planetary Sciences, Neuroscience, Arts and Humanities, Nursing, Immunology and Microbiology, Pharmacology, Toxicology and Pharmaceutics, Veterinary and Dentistry which allowed the base to be limited to 1,894 results.

In the case of the Web of Science database, 8,296 results were identified for the "driving style" query. Then, the database was searched for publications relating to both driving style and intelligent transport solutions, which allowed limiting the studied scope to 17 publications. All identified articles were published in English and were limited to subject areas also considered in the Scopus database.

The next step in this analysis was the removal of duplicates, which allowed for the creation of a common publication database containing 1,909 titles. The steps taken in the analysis along with the quantitative specification are presented in the Figure 2.

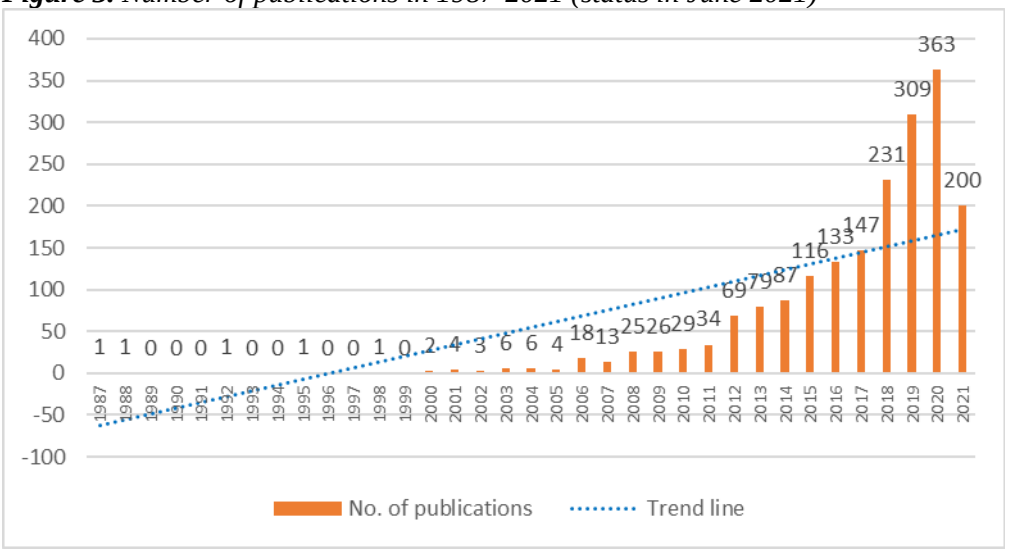
Figure 2*. Systematic literature review – preparation and quantitative results*



Source: *Own creation.*

Figure 3 presents the quantitative analysis of papers depending on the year of publication. The first article was written in 1987 and related to the description of Petri nets. It should also be noted that since 2006 there has been a significant increase in the number of publications, which continues until 2020, which is confirmed by the trend line on the chart. In addition, in mid-2021 the number of publications amounted to 200, which may also indicate the expected number of articles exceeding 400 papers at the end of 2021.

Figure 3. *Number of publications in 1987-2021 (status in June 2021)*



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Additionally, an analysis of the keywords indicated in these publications was also carried out. Out of 4,413 keywords in selected publications from both databases, only those that appeared at least three times were taken into account for the network analysis. As a result, 395 keywords were identified, as well as the mutual relations between them, as shown in Figure 4 and Figure 5. The maps were created with the use of the VOSviewer tool. The analysis of the correlation between the keywords revealed 20 clusters - areas for which individual keywords are more or less related to each other. As can be seen in Figure 4, the biggest clusters in terms of drivers were, driving style, eco-driving, driving/driver behavior. In the case of harmfulness of road transport, following keywords were included, fuel consumption, energy consumption, traffic safety, and electric and hybrid vehicle or fuel economy. The intelligent solutions in the area of Logistics 4.0, included, machine learning, deep learning, artificial intelligence, IoT, automated driving and vehicles.

Figure 4. *Network visualization for keywords*

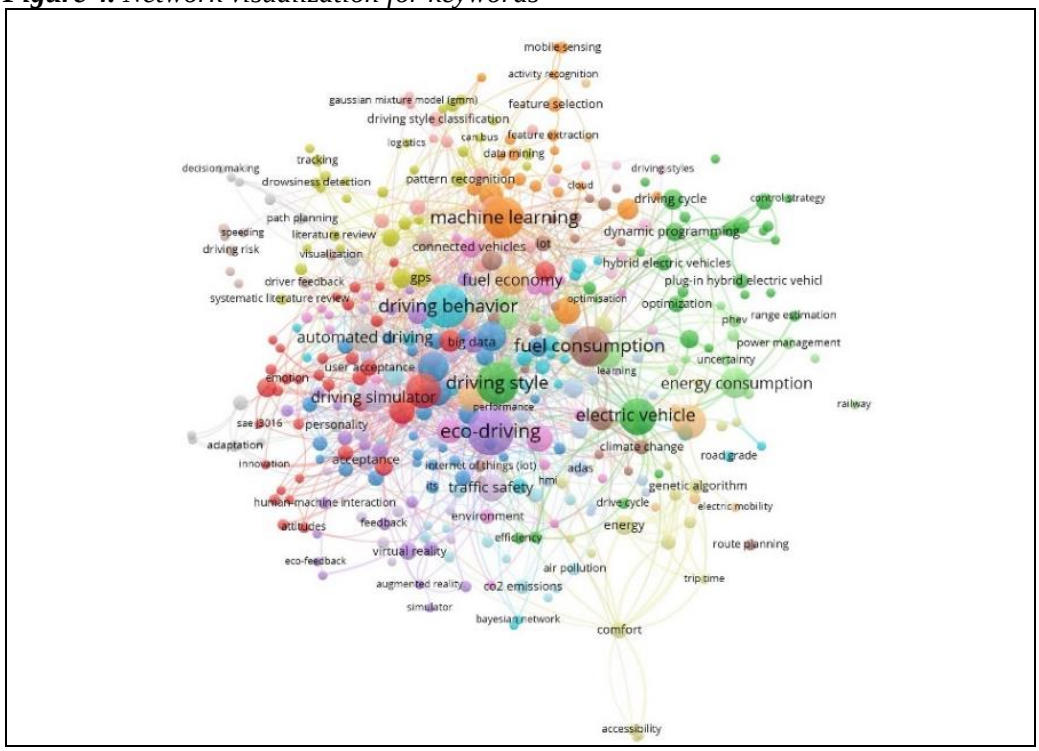

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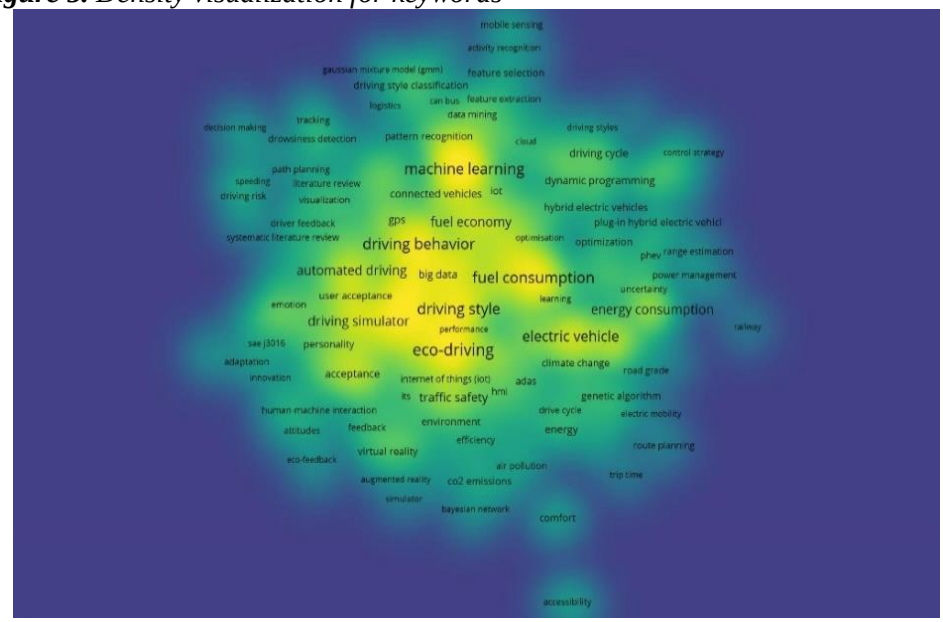
Figure 5. *Density visualization for keywords*



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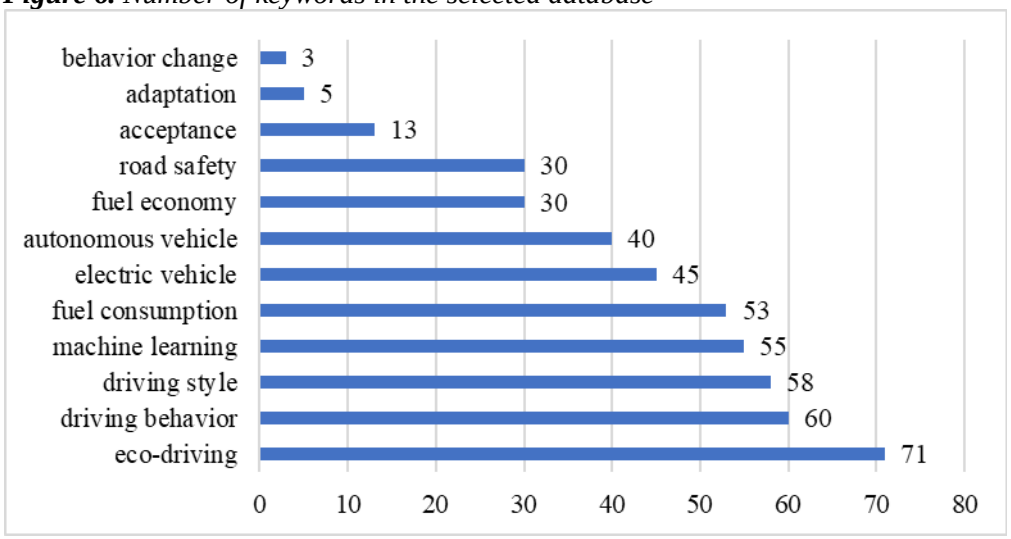
The social acceptance of the possibility of using intelligent solutions in car transport and urban infrastructure was also verified. The concept of "acceptance" was mostly correlated with the concepts of autonomous vehicle and driving, machine learning, automation and driving/driver behavior. In the case of the concept of "adaptation", the greatest relationship was found with the terms: driving style, driving behavior and human-computer interaction. It should be mentioned, that both of these terms were characterized by weaker connections with other keywords, which clearly indicated a much lower degree of correlation than in the case of the most common keywords. In the analyzed list, the most frequently appearing keywords from among 1,909 publications were: eco-driving, driving behavior and driving style, for which the number of appearances was: 71, 60 and 58, respectively, while the strength of connection with other keywords was 148, 116 and 116, respectively. The concept of acceptance occurred only 13 times in the statement, and the connection strength was 26. The keyword adaptation appeared only 5 times in the entire list, but its connection strength was 14.

The network analysis made it possible to select the appropriate keywords, which were then used to narrow down the area of the researched publications. The selected keywords include: eco-driving, driving behavior/style, machine learning, fuel consumption, electric vehicle, autonomous vehicle, road safety, artificial intelligence, and due to the importance of the social aspect – acceptance and adaptation, as shown in Figure 6.

Figure 6. *Number of keywords in the selected database*



Source: *Own creation.*

By identifying preferred keywords, the studied range was limited to 845 items. The database of these publications was analyzed. The abstracts were read to verify

whether there were a significant percentage of articles examining the relationship between the use of intelligent solutions in the Logistics 4.0.

Among the analyzed abstracts, 247 full texts were selected referring to at least one of the three analyzed areas: intelligent transport, driving style or social acceptance of Logistics 4.0 tools. The analysis of the full texts showed that only 26 publications available in the Scopus and WoS databases referred to the identification of the relationship between the social acceptance of intelligent transport solutions and changes in drivers' behavior. The subsequent 38 items described only to the relationship between the use of Logistics 4.0 tools and the change of driving style to a more economic and ecological one. The remaining 183 items related to individual Smart City tools, without taking into account their impact on the behavior of drivers, or they only covered the analysis of a driving style.

4. Conclusions

This paper analyzes the relationship between the use of intelligent solutions in the field of Logistics 4.0, linking both in the context of vehicles and in terms of urban infrastructure. We took into account the aspect of social acceptance of the use of intelligent solutions for improving of a driving style. The motivation for this analysis is the observed increase in the emissions from vehicles and the need to improve safety, in particular in large urban agglomerations.

A systematic review of the literature is focused on a quantitative and qualitative analysis of the papers in Scopus and WoS databases. Despite the initially large number of publications for queries, intelligent transport and driving style (1,909), a detailed analysis of keywords with the use of web visualization showed significant relationships between subsequent areas of keywords. Thanks to the appropriate configuration of keywords, it has been possible to limit the number of publications to almost 900. Thanks to abstracts analysis the number of papers have been narrowed down t to 183 items. In the last phase of the review only 26 relevant paper have been identified (only 1.3% of all analyzed publications), thus confirming the hypothesis about the existence of a research gap with regard to the social acceptance of intelligent solutions supporting the change of driving style to a more ecological and safer. This result clearly indicates the need to expand research in the analyzed area in order to identify drivers' readiness to accept intelligent solutions supporting driving and efficient use of urban infrastructure. This issue will be much more widely explored in our future research.

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