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Impact of Transport Trends on Sustainability in the Western Balkans: A Future-Oriented Business Sector Perspective

Tomislav Letnik , Katja Hanžič, Matej Mencinger * and Drago Sever

Faculty of Civil Engineering, Transportation Engineering and Architecture, University of Maribor, Smetanova 17, 2000 Maribor, Slovenia; tomislav.letnik@um.si (T.L.); katja.hanzic@um.si (K.H.); drago.sever@um.si (D.S.)
* Correspondence: matej.mencinger@um.si

Abstract: This study examines the impact of emerging transport trends on the Western Balkans and their potential to improve the sustainability and efficiency of the transport sector in the region. In the context of global efforts to reduce environmental impacts and improve transport safety, the study aims to better understand the perspective of the business sector in order to align strategic planning for the introduction of new transport technologies and practices with the expectations of the business sector. Using a questionnaire-based survey on the Mentimeter platform, the study gathers insights from 49 transport and logistics experts. The analysis uses violin plots and heat maps to visualise the expected impact of the identified trends. The results show a consensus among the experts that the emerging trends are likely to lead to a reduction in accidents, congestion, and emissions, while at the same time increasing operating costs and investment in infrastructure. In particular, trends such as alternative fuels, electrification, and smart city initiatives are highlighted as important drivers for reducing emissions. The study concludes that while these trends are likely to lead to the achievement of environmental and safety goals, they also lead to economic challenges as operating costs increase and significant infrastructure investment is required. The study emphasises the need for strategic investment, policy adjustments, and capacity building to lead the Western Balkans towards a sustainable transport future.

Keywords: transport trends; congestion; accidents; infrastructure investment; operational costs; policy adaptation

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1. Introduction

Transport is an essential part of modern society. It enables the smooth movement of people, goods, and services and plays a central role in global networking and economic growth [1,2]. However, its significant impact on the environment, characterised by pollution, accidents, and congestion, is a growing concern [3]. These negative impacts are exacerbated by the sector's vulnerability to unpredictable global events such as pandemics, economic recessions, geopolitical tensions, and fluctuating energy prices [4,5]. These dynamics emphasise the urgent need for resilient transport systems supported by diverse infrastructures that can adapt to changing circumstances.

In response to these challenges, the European Union (EU) has taken proactive steps to promote a resilient and sustainable transport system [6]. Recognising the integral role of transport in society and its impact on the environment, the EU has embarked on a path towards sustainability and anchored these goals in ambitious initiatives such as the Green Deal and the Fit for 55 programme [7,8]. These comprehensive strategies aim to radically reshape the continent's environmental landscape. They aim to achieve a significant reduction in greenhouse gas emissions and a gradual transition to a carbon-free society. EU policy focuses in particular on developing a transport system that takes into account not only the environmental but also economic, social, and safety aspects [6]. The EU's approach is to improve the resilience and adaptability of transport infrastructure to withstand various types of disruptions, from natural disasters to socio-economic shocks [9]. This includes investing in sustainable and versatile modes of transport, such as electric and hydrogen-powered vehicles, and improving public transport systems to reduce dependence on private cars.

Furthermore, the EU's vision is in line with the concept of Society 5.0, which envisages a harmonious fusion of digitalization and environmental awareness. This forward-looking approach is transforming the transport sector and emphasising the importance of integrating sustainable practices into its core activities [10]. The introduction of intelligent transport systems that utilise advanced technologies such as AI, IoT, and big data is central to this transformation [11,12]. These systems improve the efficiency, safety, and sustainability of transport while providing adaptable solutions for rapidly changing scenarios. In addition, accessibility and inclusivity are important aspects of ensuring that all members of society have equal access to efficient and sustainable transport options, regardless of their socio-economic background. This is crucial for social cohesion, economic equality, and the overall quality of life.

Despite the momentum of global initiatives to improve transport systems, their regional impact needs to be carefully analysed. As Europe sets out to put these transformative strategies into action, it becomes clear that the impact and feasibility of these initiatives can vary greatly from region to region, as each region has its own unique challenges and contexts [13]. This brings us to the specific focus of our study: the Western Balkans. Distinct in its geographical and socio-economic characteristics, the Western Balkans is an important area for analysing the implementation and effectiveness of EU transport policy. Our analysis aims to shed light on how the Western Balkans, with their strategic importance and specific needs, can adapt to and benefit from the EU's vision for a sustainable transport future.

The Western Balkans, located at the crossroads of important cultural and trade routes, have always been a nexus of various influences [14]. However, this strategic location has not been fully reflected in a robust transport infrastructure. The region faces significant infrastructure bottlenecks that hinder efficient mobility and economic growth [15,16]. Major challenges include an underdeveloped road and rail network, limited transport corridors, and inadequate maintenance of existing infrastructure. These inadequacies not only affect regional connectivity but also the prospects for international trade and tourism. One of the most pressing problems is the lack of comprehensive transport corridors. The existing network is often characterised by missing links and sections that do not meet modern standards, which affects the efficiency and safety of transport. This is particularly evident in cross-border areas, where different standards and systems in different countries further complicate the situation. The fragmentation of transport infrastructure hinders the seamless movement of goods and people, which is a crucial factor for regional integration and economic development [17].

In addition, the Western Balkans face low levels of transport and logistics services, which is reflected in the region's performance in various logistics indices, such as the Logistics Performance Index (LPI). This is attributed to several factors, including inadequate infrastructure, bureaucratic hurdles, inefficient customs procedures, and a lack of modern logistics and supply chain management procedures [18–20]. As a result, the region is struggling to attract significant foreign investment and effectively integrate into global supply chains. The development of the transport sector in the Western Balkans must be an urgent priority if integration into the EU is to be successful. This includes not only the modernisation and expansion of physical infrastructure but also the implementation of policy reforms to facilitate cross-border transport, the introduction of advanced logistics and transport management systems, and the promotion of regional cooperation to ensure a harmonised approach to transport challenges [21]. By addressing these issues, the Western Balkans can capitalise on their geographical position, strengthen their role in international trade, and pave the way for sustainable economic growth and regional integration.

As can be seen, the Western Balkans face many challenges and are therefore worth considering as a study case in the field of the transport sector. Many researchers have dealt with transport issues in this region, but none of them are from the perspective of emerging trends, especially from the perspective of the business sector. It has been shown that business stakeholders have an advanced understanding of emerging technologies and their likely impacts, as well as strategic practices, which could be of great benefit for policymaking [22]. Their opinion is often not taken into account in this very demanding process. For this study, a comprehensive but straightforward methodology was developed to gather stakeholders' opinions and assess the most promising trends that could drive the development of a sustainable transport system in the Western Balkans. In this way, we provide, for the first time, a comprehensive overview of the expected impact of emerging trends on emissions, congestion, accidents, operational costs, and infrastructure investments, which can inform decision-makers and make an important contribution to the discourse on sustainable transport from a regional perspective.

In the following sections, we provide an examination of the current transport landscape and a detailed analysis of key trends, including a literature review, and their potential impact on sustainability in the Western Balkans. Through this comprehensive approach, the study aims to provide valuable insights and practical recommendations for promoting a sustainable and resilient transport ecosystem in the region that meets both regional aspirations and global environmental goals.

2. Transportation System Trends—Literature Review

In order to understand the trends in the transport system, a comprehensive examination is required. For this study, we have analysed the academic literature to identify the most frequently cited trends in this area. By examining existing research and studies, we have gained valuable insights into the direction in which transport systems are evolving [23].

In this context, we analysed the identified trends in terms of their impact on two important fronts. On the one hand, we assess their impact on congestion, accidents, and emissions, as these are key indicators of the efficiency of a transport system and its environmental impact. On the other hand, we assess the trends in terms of costs related to infrastructure investments and operational expenses. This dual analysis is important to understand not only the benefits of these trends in improving the transport system but also their economic feasibility and their impact on future planning and development.

The identified global trends are presented in Table 1, which includes concise definitions of opportunities for the advancement of the transport system, thereby contextualising their significance. Furthermore, a curated list of the literature, reviewed for analysis, is also presented.

Table 1 shows the diverse range of trends shaping the future of transportation. Each trend represents a significant change in how transportation systems are designed, operated, and experienced. From the electrification of vehicles and the digitization of traffic systems to the development of intelligent transport systems and the adoption of new business models, these trends collectively aim to enhance the efficiency, safety, and sustainability of transport. While they offer substantial benefits, each also brings a set of challenges that require thoughtful planning and investment to fully realise their potential in shaping future transport systems.

The in-depth literature review focuses mainly on the expected impact on the transport sector. Table 2 outlines the expected impact of each identified trend on various aspects, such as congestion, accidents, emissions, operational costs, and infrastructure investment. When assessing the impact, not only the aspect of increase or decrease is considered, but also a scale ranging from 'potential' to 'likely', and 'expected' to 'significant'. In cases where divergent views are found in the literature, the term 'varies' is used to reflect these discrepancies. In addition, temporal aspects were also identified in certain cases, taking into account initial (meaning short-term) and long-term aspects.

Table 1. List of identified trends and corresponding literature.

Trend	Opportunities	Literature
Electrification	Shift towards electric vehicles (EVs) to reduce emissions and air pollution, including EV infrastructure development.	[24–31]
Digitization	Integration of digital technologies like IoT and AI into transportation for improved traffic management and logistics optimisation.	[11,12,26,27,32–34]
Automation	Incorporation of autonomous vehicles into the transport system to increase efficiency and reduce human error-related accidents.	[33,35–38]
Intelligent Transport Systems (ITS)	Use of advanced technologies in transportation infrastructure and vehicles for improved traffic management, safety, and efficiency.	[39–42]
Informatics Process	Application of IT and data analytics in transport systems for optimised operations and planning.	[43–50]
Change in Travel Habits	Shifts in preferences towards sustainable transport modes and teleworking.	[51–55]
Smart Cities and Communities	Development of urban areas integrating digital technologies, including transportation.	[10,43,44,56,57]
Increased Regionalisation	Creating shorter, localised supply chains to reduce transport route pressure and distances.	[58–63]
Alternative Fuels	Adoption of non-traditional fuels like electricity, hydrogen, and biofuels in transportation to reduce environmental impact.	[64–68]
Development of Transport Infrastructure	Expansion and modernisation of infrastructure to improve transportation efficiency and safety.	[69–73]
New Business and Logistics Models	The emergence of new models like e-commerce and shared mobility is changing transportation demand and usage.	[22,74–80]
Transport Techniques and Technology	Advances in vehicle design, traffic management systems, and routing algorithms.	[75,81–85]

Table 2. Assessment of trends and their influence on various transport aspects.

Trend	Congestion	Accidents	Emissions	Oper. Costs	Infr. Invest.
Electrification	Potential increase	Potential decrease	Significant decrease	Long-term decrease	High initial increase
Digitization	Significant decrease	Likely decrease	Decrease	Long-term decrease	Considerable initial increase
Automation	Likely decrease	Decrease	Likely decrease	Long-term decrease	High initial increase
Intelligent Transport S.	Decrease	Decrease	Decrease	Long-term decrease	Substantial initial increase
Informatics Process	Decrease	Likely decrease	Decrease	Long-term decrease	Significant initial increase
Change in Travel Habits	Likely decrease	Varies	Decrease	Varies	Initial increase (adoption)
Smart Cities and Comm.	Decrease	Decrease	Decrease	Long-term decrease	High initial increase

Table 2. *Cont.*

Trend	Congestion	Accidents	Emissions	Oper. Costs	Infr. Invest.
Increased Regionalisation	Decrease in major routes	Likely decrease	Decrease	Varies	Increase (adaptation)
Alternative Fuels	Varies	Varies	Significant decrease	Long-term decrease	High initial increase
Development of Transport Infrastructure	Varies	Likely decrease	Varies	Varies	Considerable increase
New Business and Logistics Models	Varies	Varies	Varies	Long-term decrease	Adaptation needed
Transport Techniques and Technology	Varies	Likely decrease	Decrease	Varies	Varies

As shown in Table 2, the trends identified through a comprehensive review of the relevant literature show multiple implications for the transport sector. These trends not only highlight the dynamic interplay between technological innovation, infrastructural change, and societal shifts but also emphasise the evolving nature of transportation challenges and opportunities.

The trend of electrification brings a significant reduction in emissions, a major benefit of switching to electric vehicles (EVs), as highlighted in references [24–26]. However, due to the increasing popularity of EVs, this trend could lead to more traffic congestion, particularly in urban areas, due to the growing popularity of EVs, as noted in [27]. The integration of advanced driver-assistance systems in EVs indicates a potential reduction in accidents [28], although the need for significant investment in charging infrastructure is a notable consideration [29]. Over time, a decrease in operational costs is expected due to the higher energy efficiency of EVs [30,31].

Digitization, which includes the implementation of IoT and AI in traffic management, is poised to reduce traffic congestion significantly [26]. Enhanced data analytics can lead to more efficient transport and logistics processes and reduce the time vehicles spend on the road, thereby also reducing emissions [11,32]. This trend is also likely to decrease accidents by integrating advanced safety features into vehicles, as discussed in [12]. While the initial investments in digital infrastructure are considerable [27], the long-term perspective points towards reduced operational costs due to improved efficiency in transport logistics [33,34].

Automation, particularly the integration of autonomous vehicles, is expected to ease congestion [35], decrease emissions and fuel consumption [36], and reduce accidents, as these vehicles are designed to minimise human error [37]. Significant investments in infrastructure are required to support this transition [38], but the promise of long-term savings in operational costs due to reduced maintenance and fuel expenses is a key factor [33].

Intelligent Transport Systems (ITS) are anticipated to decrease congestion and accidents through enhanced traffic efficiency and safety features [39]. The implementation of ITS contributes to a reduction in emissions by optimising traffic flow and vehicle operations [40]. In addition, Cooperative Intelligent Transport Systems (C-ITS) enhance these capabilities by enabling direct communication between vehicles and road infrastructure [41]. While the initial investment for ITS is substantial, the potential for long-term operational savings is significant [39,42].

The informatics process involves using IT and data analytics to optimise transport operations, expected to decrease congestion [43–45]. It also has the potential to improve safety and reduce accidents through data-driven decision-making [46–48]. The reduction in emissions is another anticipated benefit [46], though the initial investment in IT infrastructure and data systems is noteworthy [49,50].

Changes in travel habits reflect a societal shift towards more sustainable transport modes, likely to decrease congestion [51,52] and emissions [53]. The impact on accidents and operational costs can vary depending on how transport infrastructure adapts to these changing patterns [54]. This trend also indicates a need for investment in public transport systems, cycle paths, and pedestrian walkways [55].

The development of smart cities and communities is expected to decrease urban congestion through the application of digital technologies for traffic optimisation [44]. These technologies also contribute to reducing emissions and improving safety [10,43]. The initial investment for developing smart city infrastructure is substantial [56,57] but is offset by the potential for long-term operational savings [10].

Increased regionalisation suggests a decrease in congestion on major transport routes as businesses shift to shorter, localised supply chains [58,59]. This change is also expected to decrease emissions and may reduce the risk of accidents [60]. However, the impact on operational costs [61] and the need for investment in regional transport infrastructure [62,63] can vary.

The adoption of alternative fuels is likely to significantly reduce emissions [64], particularly when EVs are powered by renewable energy sources [65]. The impact of this trend on congestion and accidents varies depending on the adoption rate and the characteristics of alternative fuel vehicles [66]. The shift to alternative fuels requires considerable investment in infrastructure, such as charging and fuel stations [67]. However, these initial significant investments are offset by long-term operational savings due to the higher energy efficiency, lower maintenance requirements of alternative fuel vehicles, internalisation of external costs, and economies of scale [66,68].

The development of transport infrastructure can have varying impacts on congestion and accidents, depending on the nature of the infrastructure and the extent of its development [69]. This expansion is crucial for reducing congestion and improving road safety, but it may also lead to increased traffic volumes and emissions [70,71]. The associated operational costs [72] and the need for investment in infrastructure development are significant considerations [71,73].

New business and logistics models have the potential to change traffic patterns, impacting congestion and accidents [74,75]. The increase in delivery vehicles due to e-commerce, for example, may contribute to urban congestion [22,76]. However, innovations in logistics efficiency could mitigate this impact [77,78]. The need for adjustments in transport infrastructure to support these evolving models, along with their influence on operational costs, is noteworthy [79,80].

Lastly, transport techniques and technology encompass advances in vehicle design and traffic management systems [81–83]. While these advancements have the potential to decrease emissions and improve safety, their impact on congestion and operational costs varies [84,85]. The investment required in technology development and implementation is an important factor in realising the benefits of these techniques [75].

3. Impact Assessment on the Western Balkans—Survey Methodology and Results

The methodology focuses on analysing the potential impact of various emerging trends on different aspects of transport. The main objective is to understand how the trends identified and explained in the previous section will affect congestion, accidents, emissions, operational costs, and infrastructure investments from a business expert point of view.

3.1. Methods and Material

The study employs a questionnaire-based survey method, utilising the Mentimeter platform for data collection (see Appendix A for the graphical results of the Mentimeter survey). Each of the identified trends was orally presented before experts were asked to evaluate the potential impact of each trend on congestion, accidents, emissions, operational costs, and infrastructure investment for the period until 2030 on a scale of −3 to 3. A score of −3 indicated that a particular trend is expected to have a high influence on reducing considered aspects, while a score of 3 indicated a high increase.

The main aim of the research is to uncover whether there is any specific trend that will have a particularly high impact on a certain aspect. Conversely, the aim is also to find out whether there is an aspect that will be particularly high across all trends. In essence, this study provides a forward-looking examination of the complex interaction between emerging trends and their potential impacts on different aspects of transport and logistics. The findings are expected to provide valuable insights for researchers, policymakers, and practitioners to enable informed decision-making for a sustainable and efficient future of transportation.

The expert group was composed of 49 professionals, mainly from the business sector, representing 76% of the total. In terms of experience, the majority of respondents had more than 15 years of experience (42%), followed by those with 8–15 years (30%), 2–8 years (26%), and a minority with less than 2 years (2%). In terms of educational qualifications, most have a Master's degree (57%), followed by a Bachelor's degree (26%), and 8% each have a PhD or other educational qualifications. Professionally, the experts were split between Transportation and Traffic Engineering (47%), Economics and Law (28%), and a combination of Civil, Mechanical, and Electrical Engineering (6%), with the remainder (18%) coming from various other fields. Geographically, the vast majority were from Serbia (82%), with the remainder from Bosnia and Herzegovina (6%), Montenegro (4%), Macedonia (4%), and North Macedonia (2%).

The sample size for this study, comprising 49 experts mainly from the business sector in the Western Balkans, provides a statistically sound basis for the analysis conducted. While larger samples can often increase the generalizability of results, the sample size of nearly fifty professionals is adequate for complex multivariate techniques, especially when the respondents are subject matter experts. Given that these individuals bring a high level of domain-specific knowledge, their insights are likely to be particularly informative and nuanced, thereby increasing the relevance of the results. Furthermore, the homogeneity of the respondents in terms of their professional background and regional focus increases the contextual relevance of the study and makes it a valuable contribution to understanding the impact of transport and logistics trends in this specific economic and geographical milieu.

3.2. Survey Results

In this section, we first discuss the statistical relevance of the survey, followed by an analysis of the distribution of responses, as depicted in Figure 1, which shows a violin plot across five aspects. Figures 2 and 3 show the median and mean distributions of the responses, respectively. Finally, we present some partial results of the relationship maps.

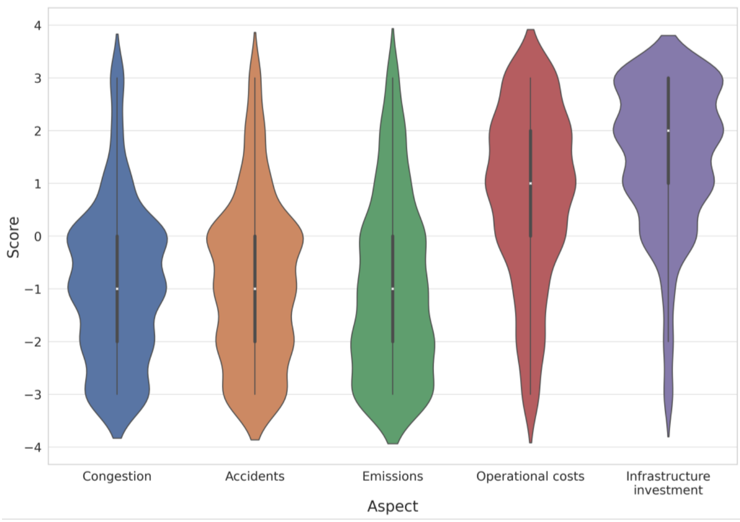

Figure 1. Violin plot distribution of scores for each aspect across all trends.

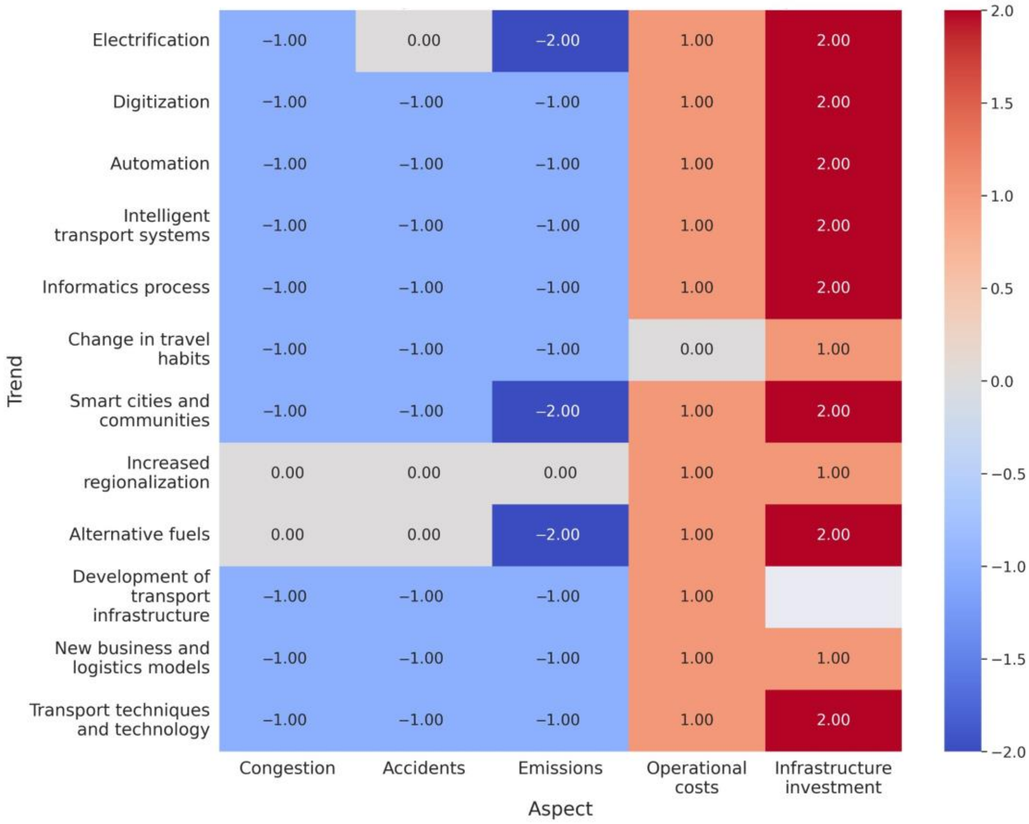

Figure 2. Median impact score heatmap of each trend on analysed aspects.

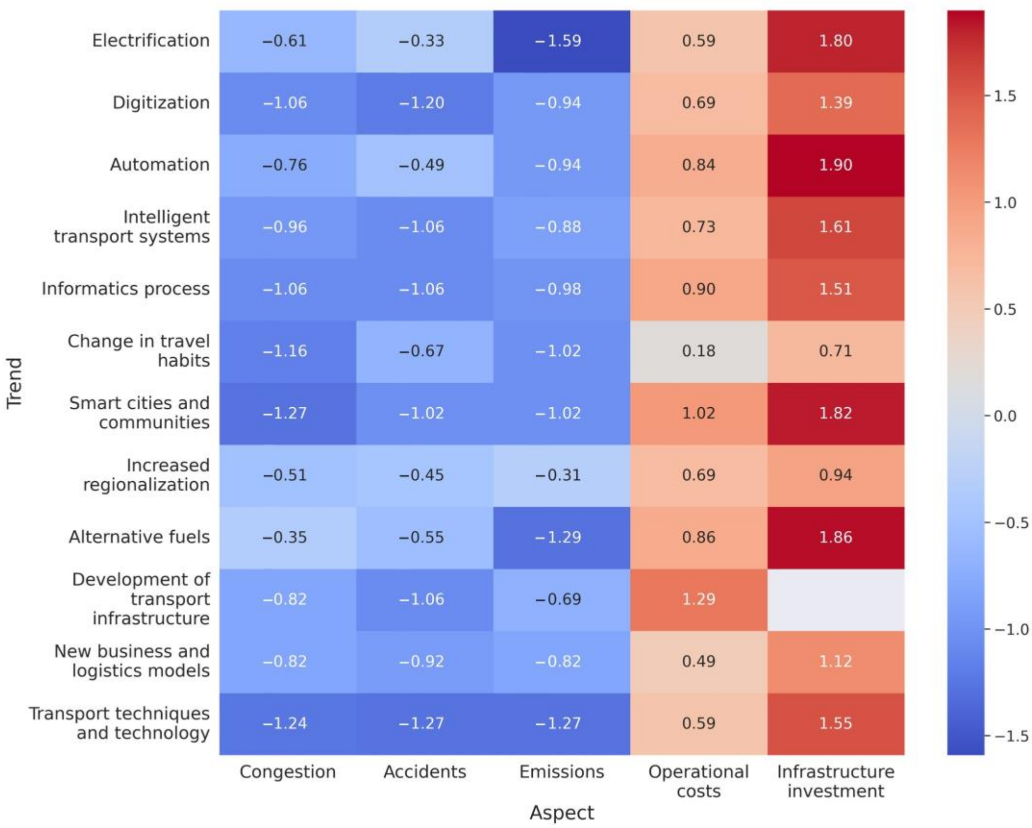

Figure 3. Mean impact score heatmap of each trend on analysed aspects.

3.2.1. Statistical Relevance of the Survey

To assess the statistical relevance of the survey and its results, several statistical tests were performed with SPSS (version 29.0, IBM, Chicago, IL, USA). For 12 trends and five aspects, we used 7-point Lickert Scale questions (including a neutral option) to collect the information on all 60 pairs that appeared in the survey. To test the reliability of all five variables along the 12 trends, we used Cronbach's alpha coefficient. A value of 0.912 was obtained in this study. Please note that the results are considered reliable if the Cronbach's alpha is above 0.6 [86,87].

The factor analysis indicates that the selected factors are relevant for explaining the variability of the assessed impacts. The commonalities across all 12 trends and the five aspects (congestion, accidents, emissions, operational costs, and infrastructure investments) are presented in Table 3.

Table 3. Communalities of aspects over the trends.

Trend	Congestion	Accidents	Emissions	Oper. Costs	Infr. Invest.
Electrification	0.067	0.371	0.734	0.799	0.766
Digitization	0.726	0.676	0.375	0.779	0.785
Automation	0.630	0.799	0.370	0.729	0.736
Intelligent transport systems	0.670	0.636	0.473	0.718	0.717
Informatics process	0.842	0.898	0.611	0.684	0.719
Change in travel habits	0.628	0.766	0.548	0.304	0.955
Smart cities and comm.	0.765	0.758	0.707	0.791	0.757
Increased regionalisation	0.828	0.804	0.752	0.802	0.815
Alternative fuels	0.658	0.725	0.467	0.814	0.832
Dev. of transport infr.	0.800	0.732	0.731	0.026	
New bus. and log. models	0.768	0.747	0.667	0.764	0.710
Transp. techn. and technol.	0.869	0.837	0.773	0.688	0.628

High commonalities, such as those observed for "Development of transport infrastructure" in congestion (0.800) and emissions (0.731), indicate a significant shared variance. On average, the factors account for approximately 71.7% of the variance across all measures, which is a robust indication of their relevance. Nevertheless, some trends, such as "Electrification" and its influence on congestion, show low communalities (0.067), indicating more complex relationships or external variables not captured by the analysis. Despite these outliers, the statistical evidence broadly supports the pertinence of the selected factors in transportation and logistics impact studies.

The Kruskal–Wallis test, a non-parametric statistical test, was used to compare the medians across different categories of transportation trends. The summary of the results is presented in Table 4.

Table 4. Kruskal–Wallis test.

	Hypothesis Test Summary			
	Null Hypothesis: The Medians of ASPECTS Are the Same across Categories of Trend	**Test**	**Significance (p)**	**Decision (Null Hypothesis)**
1	ASPECT: Congestion	Independent-Samples Median Test	<0.001	Reject
2	ASPECT: Accidents	Independent-Samples Median Test	0.002	Reject
3	ASPECT: Emissions	Independent-Samples Median Test	0.074	Retain
4	ASPECT: Operational costs	Independent-Samples Median Test	0.316	Retain
5	ASPECT: Infrastructure investment	Independent-Samples Median Test	0.005	Reject

For the Kruskal–Wallis test, the expected significance level is $p < 0.050$. The test results show significant differences in the medians for congestion ($p < 0.001$), accidents ($p = 0.002$), and infrastructure investment (p = 0.005), which leads us to reject the null hypothesis for these variables. These results suggest that these particular aspects of transportation are influenced by the trends in question. In contrast, the median for emissions (p = 0.074) approached the threshold of significance (p = 0.05), suggesting a potential impact of trends on emissions, whereas the median for operational costs (p = 0.316) showed no significant difference, meaning that we cannot reject the null hypothesis. The latter emphasises that operational costs are less relevant for selected trends.

3.2.2. Distribution of the Results

A violin plot presentation (Figure 1) is used to show the distribution of scores for each transport aspect across different trends. Each "violin" represents one aspect. The width of a violin at a given level represents the proportion of responses at that level, so a wider section of a violin indicates a higher density of responses. The violin plot and the heatmap (in continuation of the article) were created with Python (version 3.8), using the data visualisation functions of the Seaborn library.

As can be seen from the violin plots, most experts believe that the trends will lead to an overall reduction in accidents, congestion, and emissions while increasing operational costs and infrastructure investment.

In the case of "Congestion", "Accidents", and "Emissions", the median score is $\widetilde{x} = -1$, indicating a consensus among the experts that these trends will have a moderately positive impact (i.e., a reduction) on these aspects. Specifically, the mean scores for "Congestion", "Accidents", and "Emissions" are $\overline{x} = -0.88$, -0.84, and -0.98, respectively. Furthermore, the 25th and 75th percentiles for each of these subcategories are -2 and 0, indicating that half of the scores lie within this range, demonstrating a moderate to strong belief in the positive impact.

Some important differences can be observed in the violin charts of "Operational costs" and "Infrastructure investment". The median and mean score for "Operational costs" are $\widetilde{x} = 1$ and $\overline{x} = 0.74$, respectively, which indicates an expected increase in these costs. For "Infrastructure investment", the median score is $\widetilde{x} = 2$ and the mean score is $\overline{x} = 1.47$, which implies a stronger belief in a significant increase in infrastructure investment. In addition, the 25th and 75th percentiles for "Operational costs" are in the range from 0 to 2, while for "Infrastructure investment", they are between 1 and 3. This indicates that for "Operational costs", experts' opinions vary from no change to a substantial increase, whereas for "Infrastructure investment", there is a stronger consensus towards a moderate to a large increase.

As can be seen, the median and mean scores vary between different aspects when all trends are considered together. For a more detailed overview, first the median and then the mean scores for each trend and each aspect are analysed as follows.

3.2.3. Median Impact Scores of Each Trend on Each Analysed Aspect

For the analysis of median impact, a heatmap is shown in Figure 2. The colour of each cell in the heatmap corresponds to the median impact score, with blue colours representing negative impact scores and red colours representing positive impact scores. The number in each cell is the actual median impact score.

The analysis shows that the experts largely agree on the positive effects of most trends on reducing traffic congestion, accidents, and emissions ($\widetilde{x} = -1$). Exceptions are observed for: "Alternative fuels" with a neutral impact on congestion and accidents ($\widetilde{x} = 0$) and a significant impact on reducing emissions ($\widetilde{x} = -2$); "Electrification" with a neutral impact on accidents ($\widetilde{x} = 0$) and a significant impact on emissions ($\widetilde{x} = -2$), and "Increased regionalisation" with a neutral impact on congestion, accidents, and emissions ($\widetilde{x} = 0$).

On the contrary, increased operational costs are expected for most trends ($\widetilde{x} = 1$), except for "Change in travel habits", which is considered neutral ($\widetilde{x} = 0$). Similarly, significant infrastructure investments ($\widetilde{x} = 2$) are expected for most trends ($\widetilde{x} = 2$). In this case, "Change in travel habit", "Increased regionalisation" and "New business and logistics models" are expected to have a neutral impact ($\widetilde{x} = 0$).

In summary, the heatmap analysis shows a consensus among the experts that the trends analysed are expected to have the greatest impact on reducing emissions and will have a major impact on infrastructure investment. The highest scores in relation to this observation are recorded for "Electrification", "Smart cities and communities" and "Alternative fuels".

3.2.4. Mean Impact Scores of Each Trend on Analysed Aspects

In addition to the median scores presented in the previous section, the mean impact scores were also analysed. This approach makes it possible not only to recognise the most likely impacts but also to understand potential extremes. This provides policymakers and stakeholders with a more complex and robust understanding of future dynamics in the sector to be considered for comprehensive strategic planning and risk assessment.

Also in this case, the heatmap (Figure 3) provides a graphical representation of the impact score of each trend for each aspect. The colour of each cell in the heatmap this time corresponds to the mean impact score, with blue colours representing negative impact scores and red colours representing positive impact scores. The number in each cell is the actual mean impact score.

As can be seen from Figure 3, the heatmap of the mean impact score represents a much more differentiated situation. The following conclusions can be drawn for a particular aspect:

- Congestion: "Smart cities and communities" ($\overline{x} = -1.27$), "Transport techniques and technology" ($\overline{x} = -1.24$), and "Digitization" ($\overline{x} = -1.06$) have the most negative mean impact scores, which indicates considerable potential for alleviating traffic congestion;
- Accidents: "Transport techniques and technology" ($\overline{x} = -1.27$), "Digitization" ($\overline{x} = -1.20$), and "Intelligent transport systems" ($\overline{x} = -1.06$) have the most negative mean impact scores, indicating a strong potential for reducing accidents;
- Emissions: "Electrification" ($\overline{x} = -1.59$), "Alternative fuels" ($\overline{x} = -1.29$), and "Transport techniques and technology" ($\overline{x} = -1.27$) have the most negative mean impact scores, indicating a strong potential for reducing emissions;
- Operational costs: "Development of transport infrastructure" ($\overline{x} = 1.29$), "Smart cities and communities' ($\overline{x} = 1.02$), and "Automation" ($\overline{x} = 0.84$) have the highest mean scores, implying that this trend will have the greatest impact on increasing operational costs;
- Infrastructure investments: "Automation" ($\overline{x} = 1.90$), "Alternative fuels" ($\overline{x} = 1.86$), and "Smart cities and communities" ($\overline{x} = 1.82$) have the most positive mean impact scores, indicating the highest expected impact on infrastructure investment.

Experts firmly believe in "Transport techniques and technology" as a trend that is expected to have a significant impact on all three negative aspects of transport: congestion, accidents, and emissions. On the other hand, "Smart cities and communities" are expected to have the greatest impact on operational and investment costs combined. Furthermore, "Electrification" is expected to have the largest impact on emissions; "Transport techniques and technology" is expected to have the predominant impact on accidents; and "Smart cities and communities" are expected to have the greatest impact on congestion. In relative terms, "Change in travel habits" is expected to have the most positive impact on congestion, accidents, and emissions, while the need for infrastructure investment is rather modest.

3.2.5. Interpretation of the Relationship Map

SPSS version 29 also allows the functionality to create relationship maps in the form of graphs, which enable the examination of connections between individual aspects for each trend. The strongest relationships illustrate the prevailing opinion of the survey cohort and consequently the most transformative changes in transport, according to the proposed survey.

The in-build algorithm counts the number of connections between nodes (in our case, −3, −2, −1, 0, 1, 2, and 3) of different colours (in our case, aspects: accidents, congestion, emissions, infrastructure investments, and operational costs) and returns a radius of a node that is proportional to the number of links (edges in the relationship map graph). In addition, the thickness of the links between the nodes is proportional to the number of identical answers. The relationship map graphs were created for all 12 trends using the following settings: the link size was 10 (the thickest link is 10 times wider than the thinnest), and the threshold for the presented link between two nodes was the existence of five connections between them. The node size is proportional to the number of links connected to a given node. According to the above, for each trend in the corresponding relationship map, the most significant relationships between different aspects correspond to the thickest links between two nodes (see the example below). Using these settings, the resulting graphs ensure clarity and readability for all 12 trends. For the sake of brevity, we present only a relationship map for the electrification trend (Figure 4); for other trends, we provide below just the main observations.

As seen from Figure 4 for the electrification trend, the strongest relationship is obtained between congestion and infrastructure investment. Since this is the link between −3 and +3, it indicates the inverse relation between emissions and infrastructure investment (thus, increasing electrification results in reducing emissions on the one hand and is conditioned by infrastructure investment on the other).

In examining the relationship maps between all emerging transportation trends and their impacts on key sectoral aspects, we can identify some groups of trends that encapsulate the key patterns between aspects observed in the dataset.

The first group encompasses "Electrification", "Automation", and "Intelligent Transport Systems". These trends are unified by a salient relationship between a pronounced decrease in emissions (−3) and an associated increase in infrastructure investments (+3). The trends within this group represent a paradigm shift towards environmentally sustainable transportation solutions that, while significantly reducing emissions, also require substantial infrastructure outlays. Notably, "Intelligent Transport Systems" differentiates itself within this grouping by additionally exerting a considerable negative impact on congestion (−3), highlighting its dual potential to enhance not only environmental sustainability but also traffic flow efficiency.

The second group is characterised by the trend of "Digitization" alone, which shows a uniform reduction in congestion, accidents, and emissions (−2 for each), illustrating the multifaceted efficiencies enabled by digital technologies, suggesting an ability to enhance transportation systems in terms of safety, environmental impact, and traffic management without precipitating a proportional increase in infrastructure expenditure. This indicates the potential for digitalization to yield a high return on investment in the form of broad-ranging sectoral improvements.

The third group, consisting of "Smart Cities and Communities", demonstrates a marked reduction in both congestion and emissions (−3 for each). This group suggests a focus on leveraging technology within urban planning to optimise existing infrastructure thereby presenting a potentially cost-effective approach to addressing urban transportation challenges. Unlike the first group, this one does not correlate these benefits with a significant rise in infrastructure investments, indicating an optimisation of current resources rather than an addition of new ones.

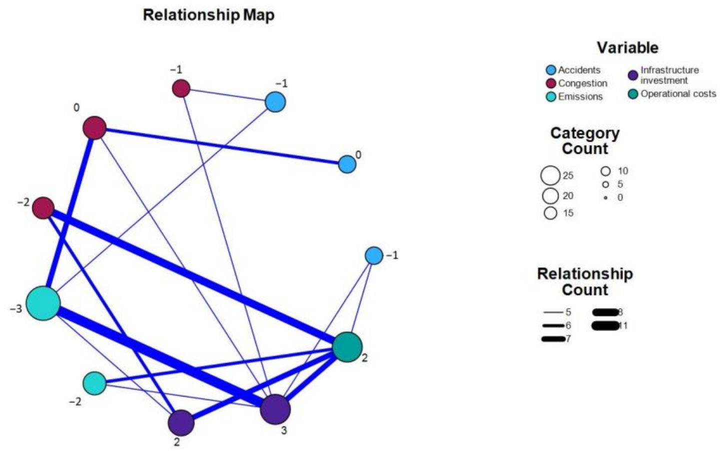

Figure 4. Relationship map for electrification trend.

The identification of these groups provides a reasonable framework for understanding how each trend interplays with different aspects of the transportation sector. This group analysis is instrumental for policymakers and urban planners as it identifies critical areas for targeted investments and research, guiding strategic decision-making towards the realisation of a more efficient, safe, and sustainable transportation future.

4. Discussion and Implications

The discussion is based on the main findings presented in the previous section and is consistent with the analysis of the relationships between the aspects analysed for the trends under consideration, highlighting the most uniform agreement among the experts regarding the developments to be expected for the Western Balkans in the future.

4.1. Discussion and Implications Based on the Expert Survey

The survey results show a clear expectation among experts that technology-driven trends such as "Transport techniques and technology", "Smart cities and communities", and "Digitalisation" will have the greatest positive impact when all three aspects (congestion, accidents, and emissions) are considered together. These trends are likely to be valued for their transformative potential, enabled by digital innovation and smarter infrastructures. On the other hand, these trends are expected to significantly increase investment in transport infrastructure at the same time. This conclusion is a clear signal to policymakers at the EU and Western Balkan levels that the greatest success in reducing the negative aspects of transport can only be expected if adequate funding and development of transport infrastructure are in place.

On the other hand, "Changing travel habits", "Increased regionalisation", and "New business and logistics models" are likely to have a positive impact on congestion, accidents, and emissions, while the need for infrastructure investment is relatively modest. These trends are so-called "soft" trends that can be implemented by changing the organisational aspects of transport processes. The introduction of these trends promises environmental and economic benefits without the need for large investments. It is suggested that policymakers in the EU and the Western Balkans give greater importance to these trends if they lack investment resources and want to promote sustainable transport.

Policymakers and industry leaders need to address the economic challenges associated with the introduction of green technologies by balancing environmental and safety improvements with financial realities. For the Western Balkans, this balance is crucial, as economic constraints can hinder rapid technological adaptation.

Finally, the experts have not identified any positive impact of the analysed trends on operating costs. One would expect new technologies to reduce operating costs. This finding is particularly true for regions such as the Western Balkans, where technological adaptation requires significant adjustments and business opportunities are expected in the long-term.

4.2. Comparison of Differences among the Literature Review and Expert Survey

When synthesising the comparative analysis between the literature review and the experts' responses, several key differences and similarities become apparent.

The literature review shows a broad spectrum of potential impacts across transportation trends, with a focus on technological and infrastructural developments. The scientific discourse points to a comprehensive shift towards environmentally friendly technologies, highlighting a spectrum of outcomes from "Electrification", "Digitization", and "Automation". The expert survey, on the other hand, places more emphasis on the practical implications and real-world feasibility of these trends, particularly focusing on the immediate and tangible impacts such as emissions reductions and the need for extensive infrastructure investments. A clear difference is that the experts emphasise the immediate need for infrastructure investment to support the adoption of advanced transportation technologies. In the literature, this tends to be discussed in the context of long-term strategic planning, while the experts emphasise it as an urgent, near-term concern, possibly reflecting their experience on the ground and their direct involvement with the current state of the sector.

Both the literature and the expert survey agree that advanced technologies play an important role in the transformation of the transportation sector. There is a consensus that trends such as "Intelligent Transport Systems", "Smart Cities and Communities", and "Digitization" have the potential to significantly reduce congestion and emissions. This consensus underlines the collective recognition of the value that these technologies have in creating more sustainable and efficient transportation systems. Another similarity is the recognition of the environmental benefits of the transition to "Alternative Fuels" and "Electrification". Both sources agree that these trends are capable of reducing emissions, which is critical to achieving sustainability goals in transportation.

4.3. Importance of Selected Trends for the Western Balkans

When looking at the 12 transportation trends discussed, their relevance for the Western Balkans hinges on the region's priorities, such as EU integration, economic development, and environmental sustainability. "Electrification" and "Intelligent Transport Systems" are particularly relevant, given the region's goals to align with EU environmental standards and to modernise its transportation infrastructure. "Electrification" addresses the urgent need for sustainable transport solutions, while "Intelligent Transport Systems" can significantly improve traffic management and safety, which is crucial for the region's growing transport networks.

Furthermore, the development of "Smart Cities and Communities" is highly relevant, considering the urbanisation trends and the need for efficient, tech-driven city planning in the region's expanding metropolitan areas. Emphasising smart solutions can lead to an improved quality of life and better integration into European urban networks.

Finally, "Increased Regionalization" reflects the Western Balkan countries' efforts to strengthen local economies and reduce dependence on distant markets by strengthening intra-regional connectivity and supply chains. This trend is in line with the region's strategic goal of creating a more self-sufficient and resilient economic structure.

These trends are characterised by their alignment with the Western Balkans' development path and the region's efforts to align with broader European standards while addressing its own transport and economic challenges.

4.4. Limitations, Applicability, and Recommendations for Future Research

The main limitation of the study is the fact that the survey was only conducted among a specific group of experts in a specific region. To improve the methodology, a Europe-wide survey could be conducted to allow comparisons based on different levels of infrastructure development. This survey should involve different stakeholders from the public and private sectors to understand the different perceptions that are crucial for the development of strategies and policies, practical solutions, and the implementation of new technologies and approaches.

Experts specialising in specific areas of transport (accidents, congestion, and emissions) could deepen the study and provide a more detailed understanding of the significance of individual trends. The results of this study can serve as a basis and guide for further, in-depth research.

Given the rapid development of technology and the fast pace at which new trends emerge, it is essential to constantly update the methodology to take into account new, emerging trends and phase out those that have become established.

5. Conclusions

This study provides an important roadmap for regions such as the Western Balkans and other regions with similar dynamics, guiding them through the complex transition towards more sustainable and efficient transport systems. Drawing on extensive expert opinions and data, the findings emphasise the need for strategic investment and policy adjustment to ensure that the transition to an advanced transportation framework is environmentally, economically, and socially sustainable.

The research emphasises the importance of a balanced approach to managing the benefits and challenges of emerging trends, particularly those related to green technologies and new infrastructure. These trends promise significant improvements in emissions reduction, safety, and congestion management, but they also entail considerations of higher operational costs and significant infrastructure investments.

For the Western Balkans, this transition represents both an opportunity and a challenge. The opportunity lies in potentially making the leap to an advanced transport system, positioning the region as an important player in sustainable transport solutions, enhancing global competitiveness, and contributing to climate change mitigation. However, the challenge lies in careful planning and resource allocation to manage the financial implications and ensure equitable access to these systems.

The crucial role of policymakers and stakeholders in this transition is evident. Policies that promote the adoption of environmentally sustainable technologies and support infrastructure development are essential. Innovative financing mechanisms, such as public–private partnerships and leveraging European Union funds, are especially relevant for Western Balkan countries in the context of EU integration. In addition, capacity building and workforce development are vital for the adoption of new technologies and systems. This includes not only technical training but also fostering a culture of innovation and adaptability within the transport sector.

In summary, this study provides a comprehensive guide for regions such as the Western Balkans to strategically shape the transition towards a sustainable transport system. By balancing environmental, economic, and social considerations and making informed policy decisions and investments, these regions can effectively harness the potential of emerging transport trends to build a more sustainable, efficient, and inclusive future.

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Appendix A

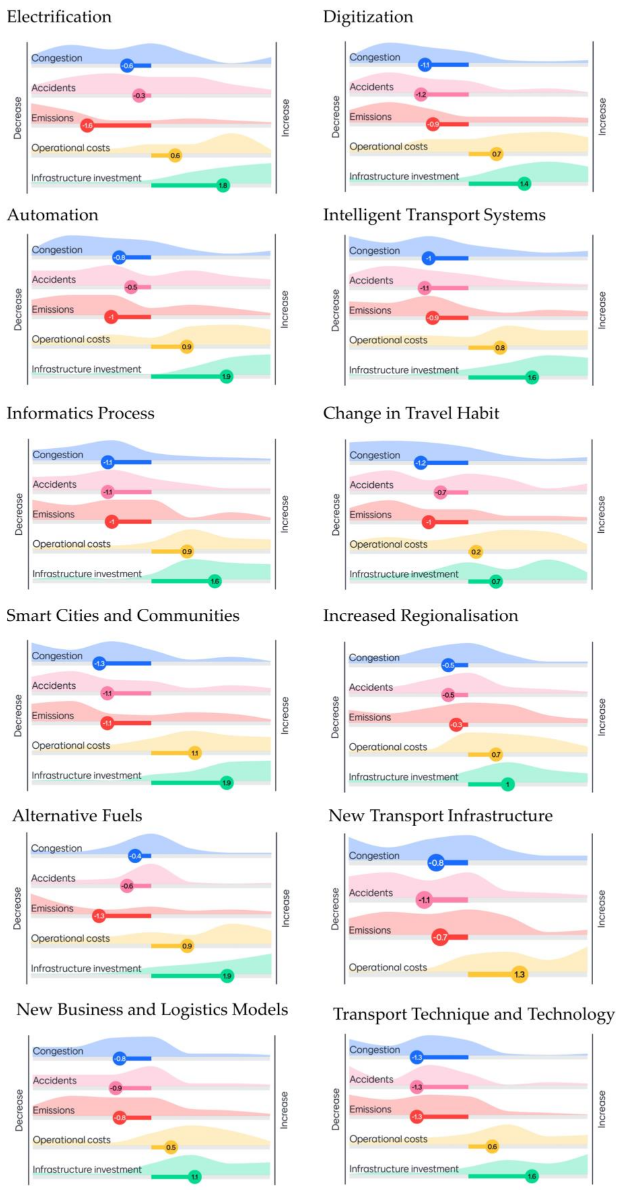

Figure A1. Graphical results of the Mentimeter survey.

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