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Transport Infrastructure and Public Transport: an Early Result of Survey

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Abstract

It is clear that public transport plays an important role in urban transport systems. To such an extent that the importance of public transport is often reflected in the parameters of transport infrastructure and public space. These parameters usually stem from the need to accommodate different types of vehicles and corresponding facilities. Public transport operators and regional public transport coordinators may have different infrastructure requirements depending on the types of vehicles they operate. These requirements are central to this research. The authors have developed a questionnaire that focuses on the infrastructure needs of public transport from the point of view of the aforementioned organizations. The research focuses on buses and trolleybuses and is geographically limited to the Czech Republic. This paper presents some results of the survey and partial conclusions. In a future paper we would like to delve deeper into this issue and describe selected links between transport infrastructure and public transport in a more precise and holistic way.
KEY WORDS: *public transport, transport infrastructure, road design, traffic calming, public transport operators, public transport coordinators*

1. Introduction

The sustainable mobility paradigm is among other things built upon the notion of a reverse hierarchy. This represents a shift from the "traditional" functionalistic hierarchy which is centred around car users. The reverse hierarchy stipulates that the pedestrians and cyclists should be at the top of the hierarchy and car users at the bottom [1]. This leaves public transport situated between these two positions. The role of public transport in the sustainable mobility paradigm and sustainable urban development is of significant importance. However, there is a limited body of research regarding the links between public transport, transport infrastructure and road design. A lot of experience and knowledge can be retrieved from public transport operators/companies and regional public transport coordinators. The authors of this article developed a questionnaire which is focused on a road design and other related aspects of urban transport from the perspective of the aforementioned organisations. The questionnaire is structured into several categories (more on this in the section 3 Methods):

- Design of the main transport area;
- Design of the integrated area and of the public transport stops;
- Traffic management;
- Technical state of the transport infrastructure;
- Terminals.

The authors hypothesise that certain elements of the road design may lead to a flawed road network, which in turn compromises the quality of the public transport system and influences factors such as punctuality. This article presents the preliminary results of the survey. Information obtained from public transport operators and regional transport coordinators may provide insight into this matter. Such information can be employed to optimise road design in a manner that is more public transport-friendly, while also enhancing the harmonious integration of pedestrians and cyclists. This is one of the key objectives of the sustainable mobility paradigm. Furthermore, the survey results can assist in identifying common issues across organisations engaged in public transportation. The findings of the survey are primarily relevant at the national level. Nevertheless, some of the conclusions drawn from the survey can be also applied at the transnational level.

2. State of the Art

In the Czech Republic, the main requirements and parameters for road transport infrastructure, including public transport vehicles, are defined in the Czech Technical Standard (CSN) 73 6110 – Design of urban roads [2]. However, this article does not limit itself to the current legislative recommendations; instead, it focuses on the experiences of the aforementioned organisations. This could potentially result in the CSN 73 6110 being revised according to the acquired data. The following paragraphs present a selection of literature that addresses related topics.

Some of the articles dealing with public transport in urban areas address the network design problem, but they do not specifically address road design [3, 4]. Therefore, even if they deal with the road network, they focus on the effective routing of public transport from a topological point of view. There are also articles that focus on the urban transportation network design problem as a whole, for example [5].

Other articles focus very specifically on urban road design, but even if they recognise the role of public transport, they rarely deal with the point of view of public transport operators and regional public transport coordinators [6-8]. In recent years, numerous cities have adopted this stance and initiated the creation of street design manuals. As illustrative examples, the Oslo Street Design Manual [9] and the New York Street Design Manual [10] can be cited. These manuals are typically consulted with local public transport operators. However, they do not generally incorporate surveys that consider the perspectives of multiple public transport organisations from across the country.

It is evident from the previous paragraphs that numerous studies have already addressed urban planning research. Topics such as urban mobility and sustainable planning in cities are also frequently discussed. However, the topic of infrastructure requirements from public transport operators and regional public transport coordinators has not yet been fully explored. There is scope for further research in this area. A significant proportion of studies on urban mobility focus on the utility of street space for pedestrians and cyclists. Nevertheless, public transport vehicles are also an indispensable element of urban traffic in sustainable cities. This is also evident in the wider metropolitan region.

3. Methods

The authors of this article conducted a survey using the questionnaire they had developed. The survey was conducted online using the Google Forms interface. A list of suitable respondents was compiled, comprising 27 public transport operators and regional public transport coordinators. These respondents were sent a link to the questionnaire via email, which also explained the research background and intentions. Out of the 27 potential respondents, 10 completed the survey. In the subsequent research, the authors intend to conduct a second round of the survey with a larger number of respondents. The survey was conducted anonymously, although respondents were requested to indicate for which organisation the questionnaire was being completed. The authors also inquired about the job position within the organisation, although the response was not mandatory. All respondents did, however, answer this inquiry. The authors did not specify which positions were eligible to respond to the survey, as it was deemed preferable to allow the organisation to make this determination. It was expected that the organisation would select the most appropriate person (according to the description of the survey) to complete the questionnaire. A number of different positions appeared in the relevant question: head of marketing department, head of transport technology department, head of transport engineering department, transport and marketing specialist, manager of transport department, clerk of the transport conception department, timetable planner and director of organisation. All positions were deemed suitable by the authors of this article.

The questionnaire itself consists of 5 sections:

- Design of the main transport area – in this part questions regarding the width of lanes, traffic calming measures and dedicated bus lanes were asked.
- Design of the integrated are and of the public transport stops – in this part questions regarding the type of stops, Kassel kerb, equipment on stops and state of parking and urban greenery were asked.
- Traffic management – in this part questions regarding the operation of public transport in pedestrian and shared zones were asked.
- Technical state of the transport infrastructure – in this part question regarding the technical state of the infrastructure and punctuality were asked.
- Terminals – in this part questions regarding the design of terminals and public transport nodes were asked.

The survey included both quantitative and qualitative questions in each of the aforementioned sections. The former were employed when respondents were rating different transport measures and solutions, whereas the latter were used to address more specific problems that could be encountered during the operation of public transport vehicles in urban areas and in general cases.

4. Results

The authors anticipated that the responses to questions regarding the minimum and ideal lane width (see Fig. 1) when public transport is factored in would be relatively similar. However, there was a notable divide between the minimum required lane width and the ideal lane width. In the case of arterial roads, the majority of respondents (50 %) indicated a minimum lane width requirement of at least 3 m, while 70 % of respondents considered an ideal width of 3,5 m to be appropriate. No respondents believed that a width of 3 m would be optimal. In contrast, with regard to access roads, 40 % of respondents indicated a minimum lane width requirement of at least 3 m, while 30% specified at least 3,25 m. 80 % of respondents considered the optimal lane width for urban access roads to be 3,25 m or 3,5 m, whereas only one respondent (10 %) believed that 3 m was sufficient. In response to the question of why they had answered as they had, the respondents cited a number of reasons. These included the safety of the drivers, better conditions for articulated vehicles, less strain on the drivers (when the lane is wider), better conditions for passing vehicles, less effect on the speed of the public transport vehicle (when the lane is wider), and also factors such as traffic flow compositions or traffic intensities. In one case, the respondent replied that they had no particular requirements for lane width as they employed professional drivers who were up to the challenge.

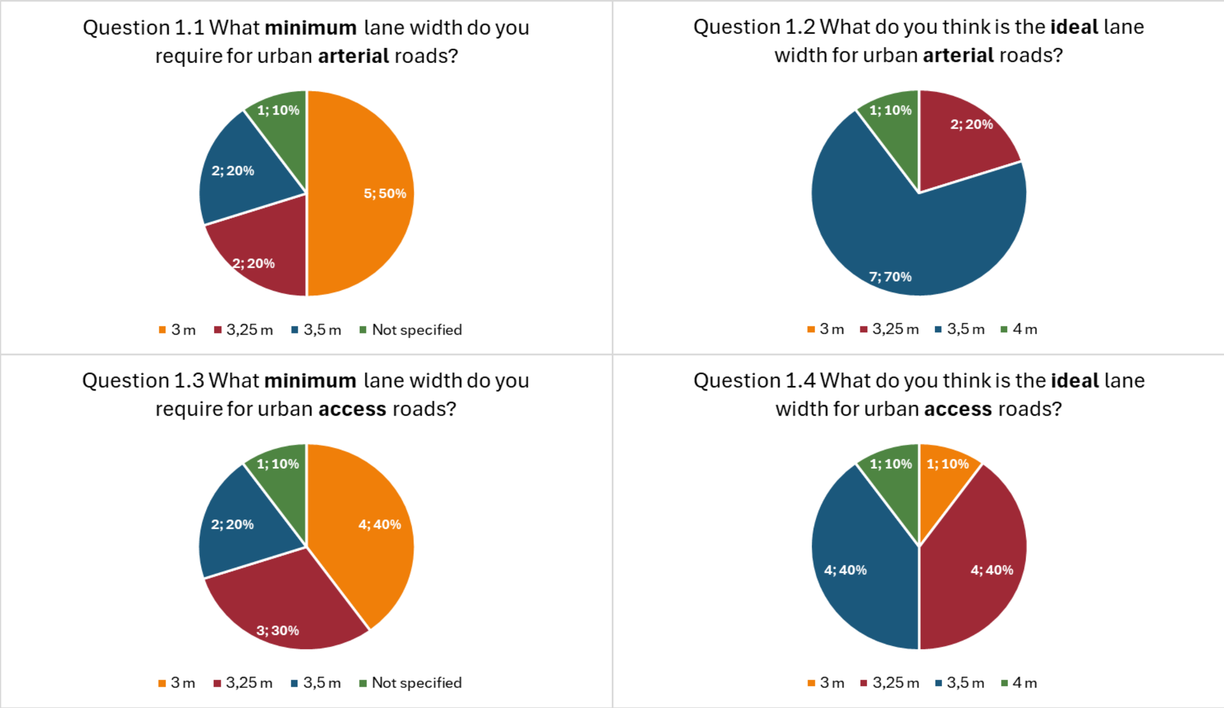
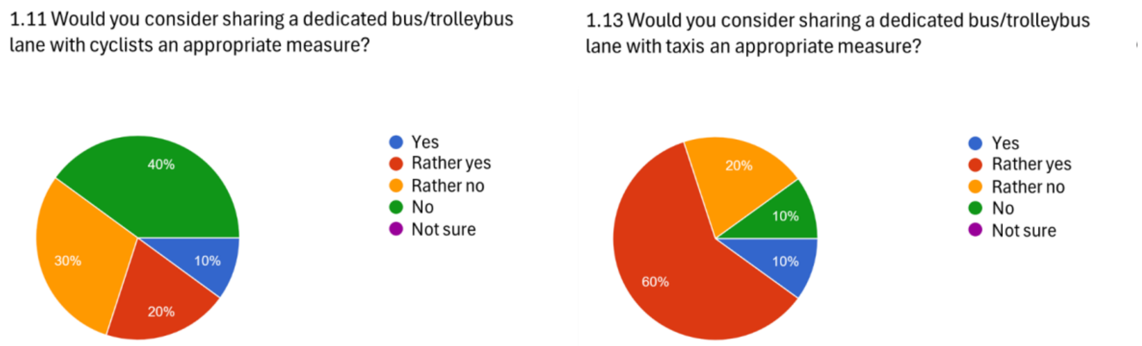


Fig. 1 Questions about the width of the lane and the results of the survey

In question 1.6 of the survey, respondents were asked to rate on a scale of 1 to 5 (with 1 representing the worst and 5 representing the best) how they generally perceive selected traffic calming measures. The authors of the article selected 10 traffic calming measures for this question (and provided illustrative pictures). These included the following: a long speed table (often integrated with a crosswalk), a short speed bump, a speed cushion (one larger), speed cushions (two smaller), road narrowing on one side, road narrowing on both sides, road widening with an island, a raised intersection, a mini roundabout and a modal filter with a rising bollard allowing the passage of public transport vehicles. As anticipated, the most highly rated measure was a modal filter with a rising bollard, with 60 % of respondents assigning a score of 5 to this measure, 30 % a score of 4, and 10 % a score of 2. Road widening with an island was also a popular measure, with 20 % of respondents rating it 5, 50 % rating it 4, and 10 % rating it 3. The least favourably rated traffic calming measure was the speed bump, with 70 % of respondents rating it 1 or 3. The long speed table was also poorly received, with only 10 % of respondents rating it 5 and 70 % rating it 1 or 2. The results for speed cushions were more evenly distributed, with 30 % of respondents scoring it 5 or 4 points, 40 % scoring it 1 or 2 points, and 30 % remaining neutral (scoring it 3 points). In the second case (two smaller cushions), 40 % of respondents considered the solution to be rather good (4 or 5 points), 50 % deemed it a poor solution (1 or 2 points), and 10 % was neutral about it. Both the mini roundabout and the raised intersection were considered to be suboptimal solutions, with the raised intersection scoring slightly better.

The majority of respondents (90 %) expressed a positive sentiment towards dedicated bus lanes, while a smaller proportion (10 %) exhibited a relatively positive attitude. Conversely, only 30 % of respondents expressed a willingness to share bus lanes with cyclists (see Fig. 2). However, 70% of respondents were comfortable with sharing the bus lane with taxis (also Fig. 2), noting that the taxi service is also part of the public transport system, but some mentioned that the use needs to be balanced (for example with regards to capacity).



a b

Fig 2. Results of the questions regarding the dedicated lane sharing: a – cyclists; b – taxi

Questions 2.1 and 2.2 dealt with the design of bus stops on arterial roads and access roads respectively (see Figs. 3 and 4 for results). In both cases, the respondents considered the bus stop in a dedicated bus lane to be a good solution. As anticipated, the respondents considered the bus stop in a bus bay to be a good solution, particularly on arterial roads. However, they believed it to be reasonably appropriate even on access roads. In contrast, the semi bus bay was considered a very good solution only on access roads, while on arterial roads the positive response was substantially weaker. The opinions on the bus stop in a lane were quite divided in the case of arterial roads, while they were supported in the case of access roads. Interestingly, the bus bulb stop and the stop with an elevated platform were considered good solutions on access roads, while on arterial roads the respondents were strongly divided.

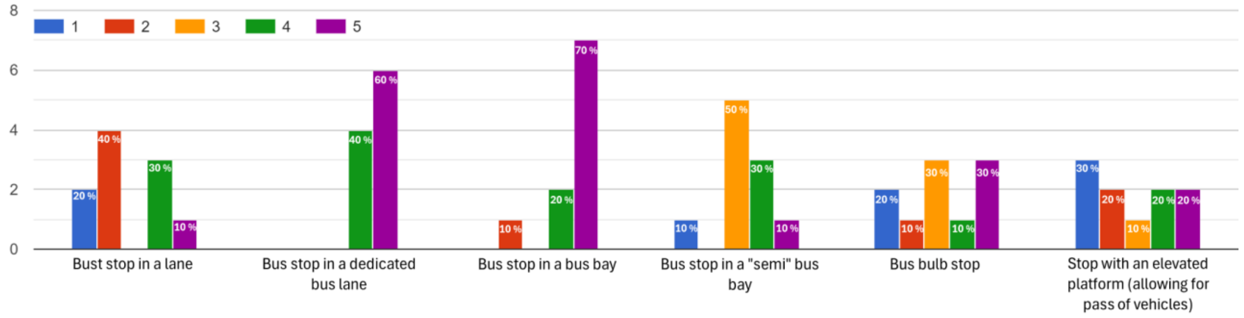


Fig. 3 Results of the question 2.1 regarding the design of stops on arterial roads

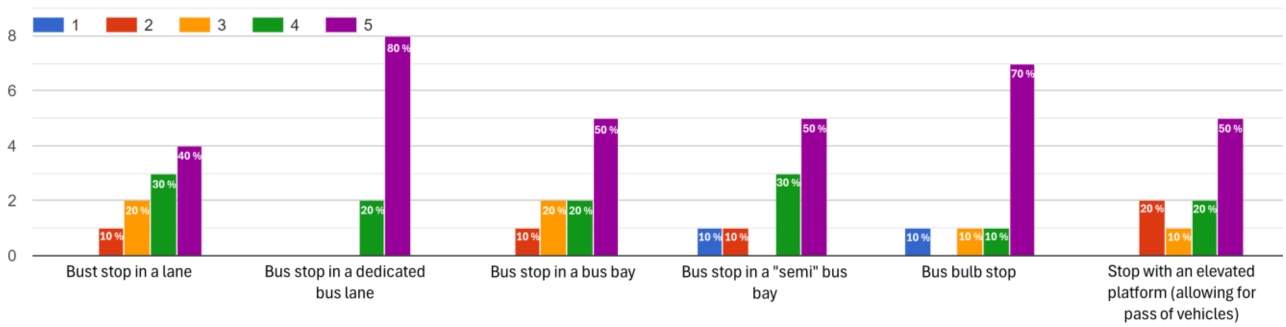
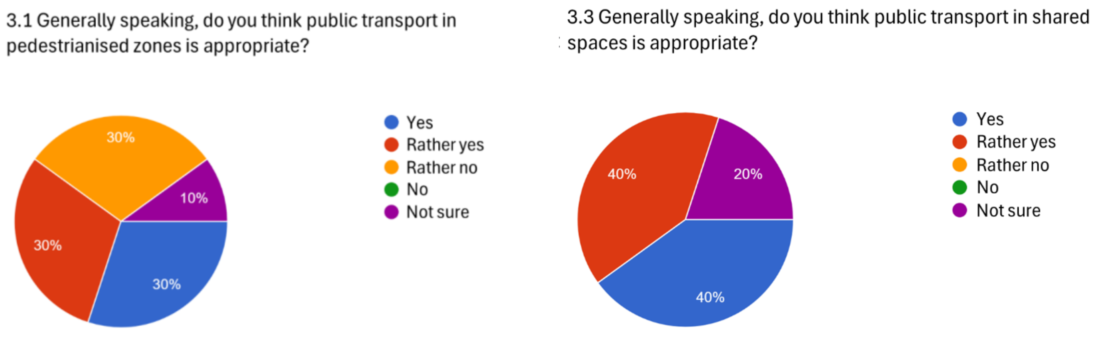


Fig. 4 Results of the question 2.2 regarding the design of stops on access roads

In questions 3.1-3.4, respondents were asked to express their professional opinion on the operation of public transport in pedestrian zones and shared spaces (see results in Fig. 5). The majority of respondents indicated that they could imagine public transport vehicles in pedestrian zones, although they argued that the disorganized flow of pedestrians may present a barrier. Additionally, respondents expressed concern regarding the safety of this solution. In one case, the respondent mentioned that there are also psychological barriers, namely that people cannot imagine shared traffic between public transport vehicles and pedestrians, and that politicians lack the will to implement the necessary changes. In the case of shared spaces, the majority of respondents indicated that public transport operations were supported, although 20% of respondents selected the "not sure" option. Furthermore, they expressed similar concerns regarding the flow of pedestrians and the overall safety of the traffic. The authors anticipated this result, as it corresponds to the shared space character and current experience in the Czech Republic. The concept of shared space was introduced into the legislation relatively recently.



a b

Fig 5. Results of the questions regarding the traffic organisation in: a – pedestrian zones; b – shared spaces

The majority of respondents (80 %) indicated that the technical state of the infrastructure has an impact on the delay of buses and trolleybuses. Among those 80 % of respondents who indicated that the technical state of the infrastructure affects travel time, 50 % stated that it increases travel time by 6-10 %, 20 % stated that it increases travel time by 1-5 %, and 10 % stated that it increases travel time by 30 %. Furthermore, 60 % of respondents indicated that they believe that the technical state of infrastructure does influence the possibility of introducing reliable interval-based public transport. In contrast, 30 % of respondents indicated that they believe that this is not the case, while 10 % indicated that they are unsure.

5. Discussion and Conclusions

The opinions on the optimal lane width for public transport are relatively stable, particularly in the case of arterial roads. However, there is a significant divergence of opinion between organisations regarding the requirements for transport infrastructure. The authors hypothesise that this may be due to the experiences and approach of individual organisations and relevant municipalities when planning and implementing transport infrastructure.

The authors had anticipated that the short speed bump would not be a favoured traffic calming measure. However, the relatively low popularity of speed cushions (a variant with two smaller cushions) was not expected. When speed cushions are done right, they should not interfere with buses or trolleybuses operation thanks to their larger wheel gauge. Some respondents also mentioned this in open questions. The reason for their relative unpopularity might be because of experiences with poor technical execution. Long speed tables were also poorly scored. This is understandable, given that they possess multiple qualities, but they are not an optimal solution for urban roads where public transport operates. In one case, the respondent stated that long speed tables are dangerous both for vehicles and pedestrians. The claim that speed tables are dangerous for pedestrians does not align with other experiences and may be a result of the experience with poor technical execution. In general, horizontal traffic calming measures (such as narrowing or widening) were more favourably received than vertical measures.

The majority of respondents (70 %) indicated that sharing the dedicated bus lane was not a viable solution. This may be attributed to past negative experiences or a general concern for safety. However, a notable number of respondents noted that the suitability of the measure is contingent upon the technical execution and local conditions. This implies that the implementation of proper technical execution and the provision of information may result in a partial improvement in the perception of the measure.

It is notable that there is a considerable level of support for public transport vehicles in pedestrian zones, despite concerns being raised about the safety and effectiveness of such a solution. With regard to shared spaces, there is still some uncertainty, but the majority of respondents indicated that they believed shared spaces to be favourable towards public transport operations. This could be reinforced through the provision of appropriate information to stakeholders and relevant organisations.

The proportion of respondents (80 %) who indicated that the technical state of the transport infrastructure affects the delay of public transport vehicles was also noteworthy. Nevertheless, a number of respondents were adamant that this was not the case. This should be subjected to further investigation in order to ascertain precisely which infrastructural issues are responsible for causing delays and the possibility of introducing reliable interval-based public transport.

The presented study is subject to several limitations. Firstly, the survey elicited only a modest response, with public transport coordinators being overrepresented (70% of respondents). Secondly, the study was geographically limited to the Czech Republic and organisations operating within its borders. Nevertheless, the authors of the article believe that this pilot study demonstrates the potential for broader research in this area.

In the future, the authors intend to broaden the scope of organisations surveyed and to examine more closely the selected links between transport infrastructure and public transport. It may also be necessary to conduct similar research outside the Czech Republic.

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References

1. **Banister, D.** 2008. The sustainable mobility paradigm, Transport Policy 15(2): 73-80. https://doi.org/10.1016/j.tranpol.2007.10.005
2. Úřad pro technickou normalizaci, metrologii a státní zkušebnictví. 2010. ČSN 73 6110 – Projektování místních

komunikací včetně změny Z1 (CSN 73 6110 – Design of urban roads including the amendment Z1).
3. **Cipriani, E.; Gori, S.; Petrelli, M.** 2012. Transit network design: A procedure and an application to a large urban area, Transportation Research Part C: Emerging Technologies 20(1): 3-14. https://doi.org/10.1016/J.TRC.2010.09.003
4. **Beltran, B.; Carrese, S.; Cipriani, E.; Petrelli, M.** 2009. Transit network design with allocation of green vehicles: A genetic algorithm approach, Transportation Research Part C: Emerging Technologies 17(5): 475-483. https://doi.org/10.1016/j.trc.2009.04.008
5. **Farahani, R.Z.; Miandoabchi, E.; Szeto, W.Y.; Rashidi, H.** 2013. A review of urban transportation network design problems, European Journal of Operational Research 229(2): 281-302. https://doi.org/10.1016/J.EJOR.2013.01.001
6. **Zhou, Z.; Zhou, S.; Zha, W.** 2015. Humanized Transportation Design Research Based on the Sustainable Development of Urban Roads, ICTE 2015 - Proceedings of the 5th International Conference on Transportation Engineering, 2930-2935. https://doi.org/10.1061/9780784479384.373
7. **Brundell-Freij, K.; Ericsson, E.** 2005. Influence of street characteristics, driver category and car performance on urban driving patterns, Transportation Research Part D: Transport and Environment 10(3): 213-229. https://doi.org/10.1016/j.trd.2005.01.001
8. **Gössling, S.; Schröder, M.; Späth, P.; Freytag, T.** 2016. Urban Space Distribution and Sustainable Transport, Transport Reviews 36(5): 659-679. https://doi.org/10.1080/01441647.2016.1147101
9. Agency for Urban Environment (2020). Street Design Manual for Oslo.
10. New York City Department of Transportation. 2020. Street Design Manual New York City Department Of Transportation. ISBN: 978-0-578-64419-6