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The Impact of Mass Events on Private and Public Transport

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Abstract. The organisation of mass events in urban centres is an indispensable aspect of contemporary society. Depending on the scale of the event, challenges may arise related to prior adaptation of the transport system, environmental pollution, or participant safety. The analysis of mass events in the city of Łódź, Poland, in 2024 enabled the assessment of their impact on both road traffic and public transport operations, as well as their spatial extent in relation to the analysed intersections and public transport stops. This study highlights the main issues that urban centres, and directly their residents, may face due to the organisation of mass events, regardless of whether they live relatively close to the event venue or in other parts of the city.

Keywords: mass events, transport system, Łódź, private transport, public transport.

Introduction

Events organised in urban areas constitute an integral element of social cohesion. They serve both recreational and cultural functions, thereby undoubtedly contributing to an improved quality of life and to opportunities for active leisure. Their spatial reach, in terms of participant origin, may vary in scale – from residents of the host city, through participants from across the country, to events that attract people from all over the world. When organising mass events, it is also necessary to take potential negative aspects into account. Setting aside issues of event safety, which have been extensively discussed in the literature (Zawartka, 2011; Eckes, 2012; Kaak, 2016; Popławski, 2016; Masys et al., 2023; Raccagni et al., 2025; Soulé & Lestrelin, 2025), attention should also be paid to the transport system. In many cases, it is not adequately prepared for traffic volumes significantly higher than those typically observed within a given city, nor for the increased passenger flows, particularly in the immediate vicinity of the venue hosting the mass event. The most substantial changes, as expected, are observed during long-duration mass events such as the FIFA World Cup, the Olympic Games (both Summer and Winter), as well as other international and inter-club tournaments (Pereira, 2018; Mohammed et al., 2025). For this reason, host cities for such events are selected several years in advance, allowing sufficient time for infrastructural preparation. Smaller-scale events should not be overlooked, as they can also significantly affect a city's transport system. The organisation of such mass events puts both the capacity and the resilience of the transport system to the test. A detailed analysis of this urban component may help to prevent more severe disruptions in the future,

as well as mitigate the effects of potentially disruptive actions, both unintentional – such as adverse weather conditions – and intentional, including sabotage or terrorist attacks.

The aim of this article is to examine how traffic intensity changes within selected subsystems of the urban transport system – namely private (individual) transport and public transport – at the analysed road intersections and public transport stops in relation to the organisation of one or two mass events occurring within a single day. The selected mass events analysed in this study involved more than 10,000 participants and can therefore be classified as small-scale events in comparison with international or global events. To achieve the research objectives, data obtained from public institutions for the year 2024 were used, including information on mass events, traffic volumes at intersections, and public transport data. The article consists of seven sections, in which the author reviews the literature on mass events and transport system research, presents the study area, discusses the results of the conducted analyses, and formulates conclusions and recommendations relevant to current transport planning.

Theoretical foundations

The Impact of Mass Events on the Transport System

The transport system as a whole consists of multiple components. A broad outline of its elements and the relationships between them has been presented in numerous contemporary studies (Cascetta, 2013; Auvinen & Tuominen, 2014; Ejdys, 2017; Rodrigue, 2020; Ficoń & Zięcina, 2023; van Wee et al., 2023). The available body of literature also includes works focusing on individual components of the transport system, which highlights the extensive scope of research and the significant influence of the transport system on the everyday functioning of society (Wiśniewski, 2015; Wang et al., 2018; Jevinger et al., 2024). Due to the specificity and availability of the research materials, the subsystems considered in this study are those related to individual (private) and public transport. They play a crucial role in the daily functioning of the city and, when properly managed and designed, also serve as a developmental backbone for urban centres.

With regard to contemporary studies on mass events in relation to transport systems, several strands of research can be identified that address different aspects of the impact of events on transport systems in the analysed urban areas. Apart from the safety aspect discussed in the introduction, which also relates to both analysed elements, the broader range of literature additionally addresses various other aspects. Some studies examine the impact of mass events on the environment due to increased traffic volumes in the analysed cities (Bae & McCullough, 2017; De La Cruz et al., 2019; Shaoning et al., 2021) whereas another group of studies presents research findings in the context of changes implemented to facilitate the organisation of mass events (Robbins et al., 2007; Villiers et al., 2019). Another group of studies presents a comprehensive approach to the design or adaptation of transport systems for the organisation of large-scale mass events (Currie, 2007; Currie & Shalaby, 2012; Lindau et al., 2016). Given that such events often cover extensive areas of urban territory, simulations and preliminary analyses are also conducted to assess how the transport system will respond to significant changes across multiple aspects in relation to the organisation of major events (Elkhouly et al., 2023). A particularly important aspect, especially in the context of contemporary efforts by cities

to optimise the public transport subsystem within the framework of sustainable development, is highlighted in studies addressing modal shifts during mass events. Expanding service offerings and creating dedicated transport lines to facilitate efficient travel to event venues is a crucial element of the transport system's resilience to such organised events (Mohammed et al., 2025).

Due to the smaller scale of the events analysed in this article, both in terms of duration and the number of participants, studies concerning modifications to the transport system or their environmental impact are considered unwarranted. Nevertheless, despite the limited scale of the mass events examined, it is possible to focus on and investigate their spatial reach within a relatively short time frame. Furthermore, such studies provide a foundation for assessing the resilience of urban transport systems to various events, both accidental and deliberate. Neglecting early issues, or failing to adapt the transport system to the requirements of mass event organisation, may exacerbate these problems during subsequent events or unforeseen occurrences. Both private (individual) and public transport play a crucial role depending on the accessibility of the venue where a mass event takes place. It is therefore important to examine which subsystem experiences a greater increase in traffic intensity, as the results may reveal problems across multiple aspects. These can range from an insufficiently developed public transport network, to poorly coordinated timetables, and extended travel times either to or from the event. From a planning perspective, it is particularly important to determine the spatial impact of smaller-scale, local mass events in order to identify which areas are affected by the externalities of the organised events. A comprehensive approach investigating the influence of mass events on urban mobility aims to highlight the consequences of event organisation and the potential for system adaptation for future mass events.

Mass events in the applicable legal framework

The concept of a mass event and the locations in which it may be organised are comprehensively defined in in the Polish Journal of Laws in the Act of 20 March 2009 on the Safety of Mass Events. They are distinguished into three types, the first of which is defined as an artistic and entertainment mass event and is described as *an event of an artistic or entertainment nature, or the organised public viewing of a television broadcast on screens or devices enabling an image with a diagonal exceeding 3 metres* (Act of 20 March 2009 on the Safety of Mass Events, p. 2). The second type comprises mass sporting events, *defined as mass events intended to involve sporting competition or to promote physical culture.* The final category distinguishes football matches from other sporting events as a separate type of event, *understood as a mass sporting event aimed at competition in the discipline of football, organised at a stadium or another sports facility where the number of places made available by the organiser – determined in accordance with building regulations and fire safety provisions – is not less than 1,000* (Act of 20 March 2009 on the Safety of Mass Events, p. 3). According to the Act, all of the above types of mass events may be organised in an indoor hall with a capacity of at least 500 persons for artistic and entertainment events and at least 300 persons for sporting events, in a stadium with a minimum capacity of 1,000 persons, or in an open area that is not a building, where the organiser is likewise able to accommodate at least 1,000 persons (Tab. 1).

Table 1. Type and location of the mass event along with the minimum number of participants (according to the Act of 20 March 2009 on the Safety of Mass Events)

Type of mass event	Location		
	Stadium	Hall	Other open areas
	Minimum number of participants		
Artistic and Entertainment	1,000	500	1,000
Sporting events	1,000	300	1,000
Football matches	1,000	–	–

Study Area

Łódź, as one of the most populous cities in Poland, serves as the capital of the Łódzkie Voivodeship. Owing to its location in the central part of the country, it is well connected with virtually all other regions of Poland. The city is encircled by major motorways and expressways, including the A2 and S8 (running east-west) as well as the A1 and S14 (running north-south) (Fig. 1).

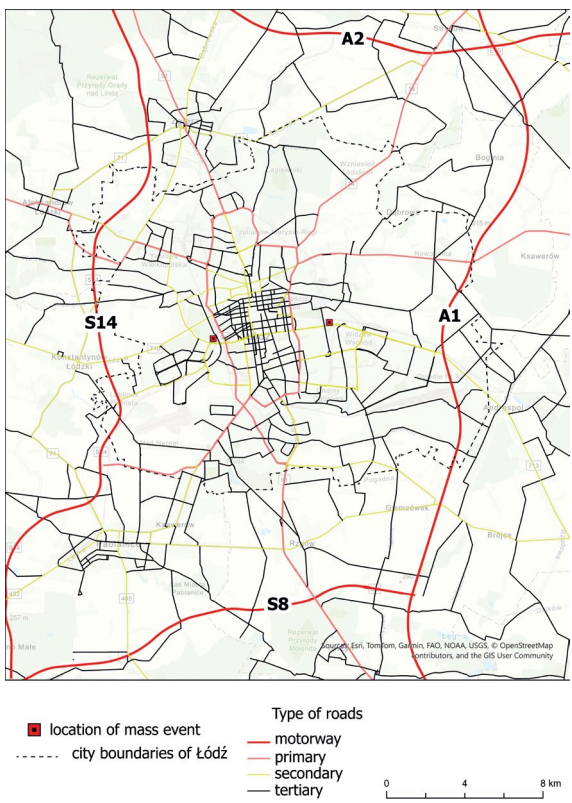

Fig. 1. The road network within the Łódź urban agglomeration
Own elaboration based on data obtained from the OpenStreetMap dataset (accessed on 13 December 2025).

Within the street network of Łódź, the most significant role is played by the national roads, which function both as connectors to the higher-order roads mentioned above and as components of the city's internal ring road system. It is also worth noting the arterial route connecting the eastern and western parts of the city, which passes through the central urban zone – the W-Z Route. The remaining roads function as local streets; however, due to the specific characteristics of the city and the limited number of multi-level junction investments, they are also extensively used in the daily mobility of Łódź residents. The layout of the street network, which in the central zone follows a grid pattern, results in substantial volumes of car traffic, leading to frequent road congestion. This is confirmed by the 2024 ranking of the most congested cities in the world, in which Łódź was ranked seventh (TomTom Traffic Index 2024). With regard to public transport operating within the city of Łódź, residents make use of buses, trams, and the agglomeration railway system (ŁKA). Within the study area, there are currently 19 tram lines and 57 bus lines, including 9 night services.

Within the city itself, numerous facilities serving sport and recreational functions are located, and a considerable number of mass events are held in these venues each year. Examples of such facilities undoubtedly include the two football stadiums and the multifunctional Atlas Arena, located on the eastern and western sides of the city respectively (Fig. 2).

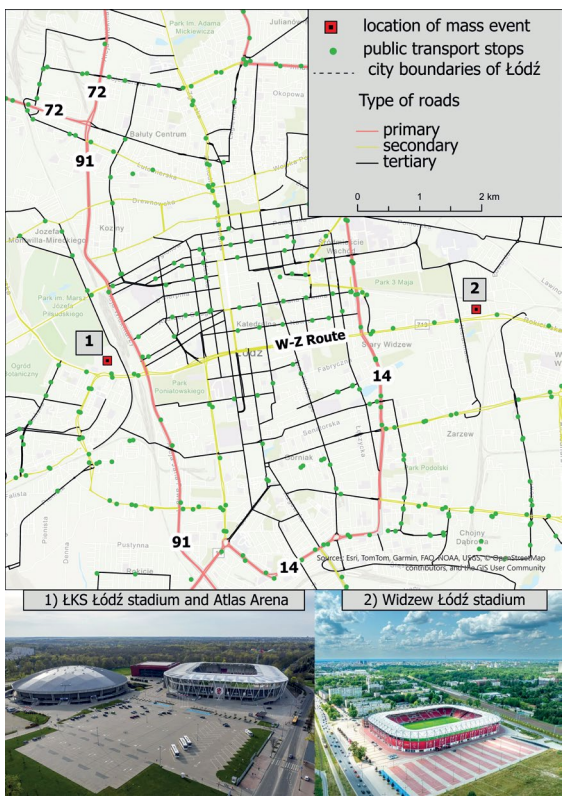

Fig. 2. Location of the analysed mass event venues in relation to the street network and public transport stops
Own elaboration based on data obtained from the Road and Transport Authority in Łódź and publicly available data from OpenStreetMap (accessed on 13 December 2025).

In the vicinity of the ŁKS Stadium and the Atlas Arena, which together form a sport and recreational complex in the western part of Łódź, numerous public transport stops are located, along with the Łódź Kaliska railway station, national roads, and the W-Z Route, resulting in good transport connectivity with other areas of the city. In the case of the Widzew Stadium, situated in the eastern part of the city, it is also worth noting the high availability of public transport stops and the Łódź Niciarniana railway station. However, in terms of the street network, the stadium is located somewhat away from the main roads, with the exception of the W-Z Route, to which it is directly adjacent. In 2024, a total of 185 mass events were held, of which 66 recorded attendance exceeding 10,000 participants. Seventeen mass events took place at the ŁKS Stadium, 18 at the Widzew Stadium, and 22 at the Atlas Arena (Fig. 3). The prominent role of these venues in hosting mass events is primarily due to the organisation of recurring events, including football matches, as well as the capacity of the Atlas Arena to accommodate large audiences for events of diverse thematic scope. The highest number of mass events took place during the summer and autumn periods. Due to the capacity of the venues, the maximum number of participants that could attend a mass event at these locations was 18,000. Near-full occupancy, approaching 100%, was observed for each event held at the Widzew Stadium.

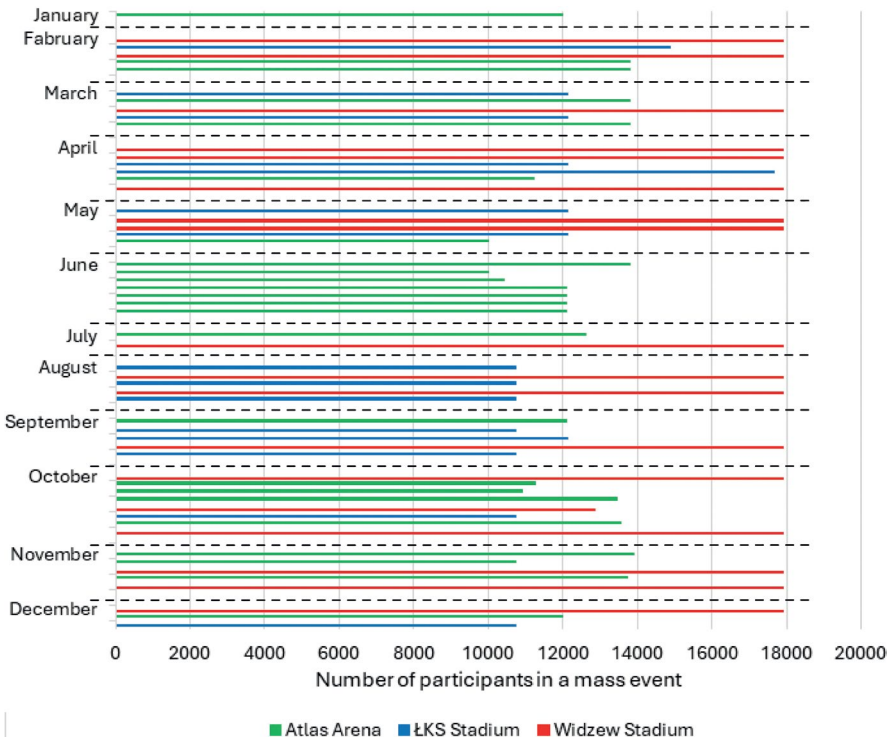

Fig. 3. Number of participants in mass events at the selected venues in 2024
Own elaboration based on data obtained from the Łódź City Office.

Source materials and research methods

To obtain the research results, it was necessary to collect materials covering both detailed information on mass events held within the city of Łódź in 2024 and data on the operation of public transport and traffic volumes in the study area. Data indicating the specific date and duration of each mass event, together with the exact number of participants, were obtained from the Department of Crisis Management and Security of the Łódź City Office, while data strictly related to transport issues were provided by the Road and Transport Authority of the City of Łódź. ArcGIS Pro software was used to present the research results in the form of cartographic outputs, employing layers showing the locations of the analysed public transport stops and intersections, which were also obtained from the resources of the Road and Transport Authority and the Office of the City Architect of Łódź. In addition, open data from the Head Office of Geodesy and Cartography and the OpenStreetMap data portal were used to represent the administrative boundaries of the city of Łódź and the street network. The remaining layers presented in the cartographic outputs were created by the author.

In describing the research methodology, it is necessary to begin with the selection of the mass events included in the analysis. From a total of 185 events, nine mass events were selected in which the number of participants exceeded 10,000 (Tab. 2).

The selected events make it possible to determine how the transport system responds when one or two mass events take place on the same day, both on weekdays and at weekends. The selected dates, both the reference dates without mass events and the remaining ones, were chosen in such a way that the intervals between them were as short as possible in order to minimise the risk of variation due to weather conditions. Among the days with two mass events, those were selected on which the events took place at both the Widzew Stadium and the Atlas Arena or the ŁKS Stadium. These are the venues where mass events with over 10,000 participants most frequently occur. Moreover, days were selected on which no other factors that could potentially distort the research results were present, including public holidays or other mass events within the city of Łódź, To strengthen the reliability of the conducted research, a chi-square test was performed for both the traffic volume data at intersections and the public transport data. The table presenting the results, together with a more detailed description, is provided in the chapter devoted to the research findings. Based on data obtained from the Łódź City Office, the author confirmed that the analysed events were the only ones organised on those days within the city. Moreover, no other events that could potentially distort the results, such as demonstrations or strikes, were recorded.

Table 2. Selected days for analysis in 2024

Type of day	Date	
	Tuesday	Saturday
Without a mass event	08th October	23rd November, 14th December
With one mass event	09th December	09th November
With two mass events	15th October	30th Novmeber, 07th December

The analysed public transport stops and intersections cover virtually the entire area of the city of Łódź. Nevertheless, for further analysis using a hexagonal grid with a cell area of 1 km², the study area was limited to the locations of intersections in order to enable a comparison of the results between the two types of transport (Fig. 4)

The entire research process consisted of a sequence of individual steps (Fig. 5). After identifying the specific days selected for analysis and obtaining data on traffic volumes at intersections and public transport usage, data editing was carried out in order to standardise the datasets. Subsequently, percentage changes in traffic volumes were calculated for the two-hour periods before and after a mass event, as well as differences between the entry-exit balance on the reference day and the corresponding entry-exit balance of public transport at a given stop on days when one or two mass events took place. Using columns indicating the identification numbers of individual intersections and public transport stops, the tabular data were joined to the attribute tables of the intersection and stop layers in the ArcGIS Pro software. In order to ensure that the results presented in the cartographic outputs were as clear as possible without distorting the research findings,

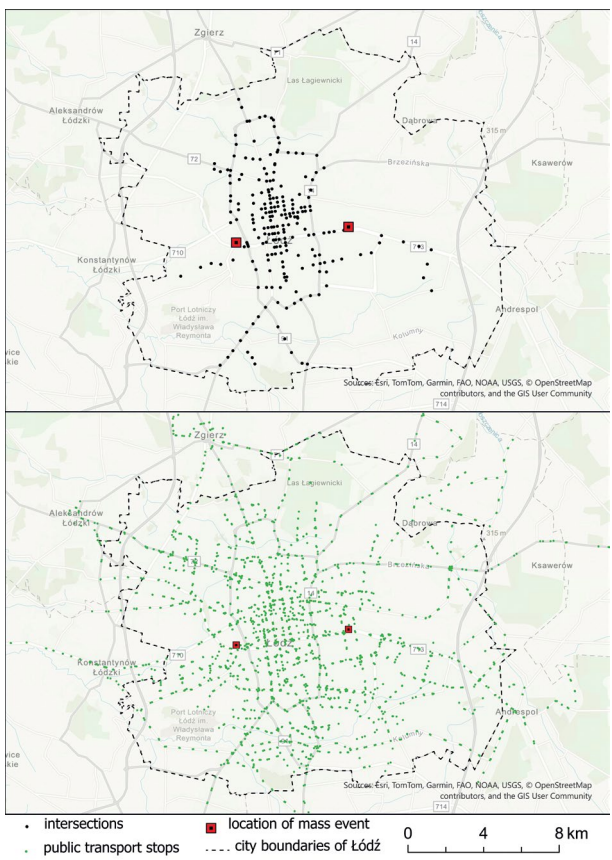

Fig. 4. Location of the analysed public transport stops and intersections
Own elaboration based on dataset sources of the Road and Transport Authority and the Office of the City Architect of Łódź.

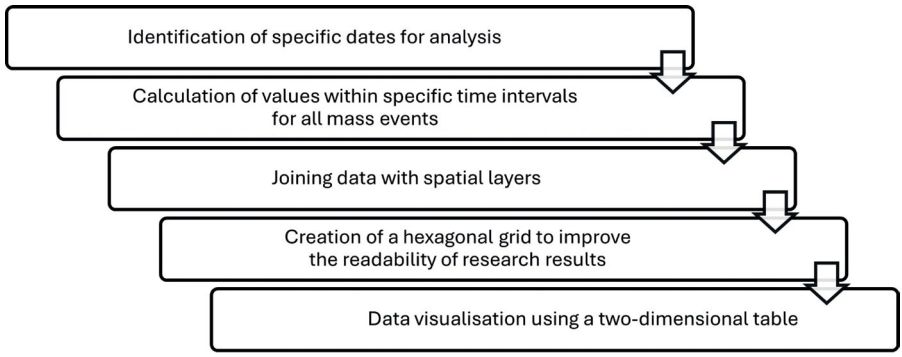

Fig. 5. Steps undertaken to obtain the research results

a hexagonal grid with a cell size of 1 km² was created within the area where the analysed intersections occur. The final stage of the analysis involved presenting the results using a two-dimensional table available as one of the symbology options.

Several limitations arose in the preparation of the research results, relating both to the collected data and to the overall situation in the city of Łódź. Firstly, the obtained data on public transport operating within the study area were provided based on 64 vehicles, which does not represent the full fleet in operation. Accordingly, the results are collected exclusively from the most important routes of the given bus lines operating within Łódź. Nevertheless, these data do not undermine the significance of the present study, as the analysed routes and lines were not subject to change. Furthermore, frequent road maintenance occurs within the city, and due to numerous delays, it is difficult to determine the exact start and end dates of each maintenance project. However, due to the fact that the analysed groups cover a relatively short time period, this does not undermine the importance of the research findings, but it should be taken into account when interpreting the results. Regarding the traffic volume studies, the obtained data were collected based on the number of vehicles passing through intersections in 15-minute intervals; however, this does not perfectly capture the phenomenon of congestion in the area. Nevertheless, higher values at certain intersections may indicate greater traffic volumes. The final and most significant limitation in the context of research on human mobility related to the organisation of mass events is the lack of access to data on pedestrian movement, as well as data on taxi trips and services provided by other private passenger transport companies. Additionally, the rapidly expanding use of shared mobility solutions in urban areas – such as app-based electric scooters, public bike systems, and car-sharing services – should also be taken into account.

Research results and discussion

To calculate differences in hourly distributions between the baseline day and the days on which one or two mass events occurred, Pearson's chi-square test was applied. For each pair of days, a contingency table was constructed, where rows represented the scenarios and columns corresponded to five time categories. The test statistic was calculated using the following equation:

$$x^2 = \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

where:

O_{ij} – observed frequencies
E_{ij} – expected frequencies.

The expected frequencies were computed using the second equation presented.

$$E_{ij} = \frac{R_i C_j}{N}$$

where:
R_i – total frequency in the i-th row
C_j – total frequency in the j-th row
N – total number of observations.

In this case, the number of degrees of freedom (df) was equal to 4. Due to the relatively large sample sizes, the author complemented the analysis by calculating Cramér's *V* coefficient in order to assess the strength of association, the formula for which is presented below.

$$V = \sqrt{\frac{x^2}{N \cdot \min(r - 1, c - 1)}}$$

where:
r – number of rows in the contingency table
c – number of columns in the contingency table.

As mentioned in the methodology chapter, prior to conducting the study, a chi-square test was performed and Cramer's *V* coefficient was calculated to illustrate the impact of mass events on the transport system (Tab. 3).

In the context of the Tuesday data, changes in the hourly distribution are more pronounced in public transport than in road traffic, particularly between one and two mRi-Rass events. For the "no event vs. two events" comparison, the effect size is very similar in both modes; however, for "no event vs. one event" and "one event vs. two events," public transport exhibits a stronger change in the hourly structure than road traffic. The results for Saturdays indicate that road traffic is noticeably more "sensitive" to mass events on Tuesdays than on Saturdays; however, public transport is clearly more dependent on the number of mass events on Saturdays than on Tuesdays. All presented values indicate that the differences between days with and without mass events are statistically significant. The effect is more pronounced in the public transport data, while with respect to the day of the week, the greatest effect is observed on Tuesdays.

Traffic volumes at intersections were presented both in absolute values and as percentages relative to the reference data set at 100 (Fig. 6-9). In both cases, changes are observable across individual time intervals, both before the start of the mass event and after its conclusion.

Table 3. Values of the conducted chi-square test and Cramer's V coefficient in 2024

Tuesdays	08th October		09th December		15th October	
	Traffic volume	Public transport	Traffic volume	Public transport	Traffic volume	Public transport
08th October	–		χ^2 = 1044.87 Cramér's V = 0.0148	χ^2 = 60.74 Cramér's V = 0.032	χ^2 = 4196.78 Cramér's V = 0.0292	χ^2 = 58.36 Cramér's V = 0.030
09th December	χ^2 = 1044.87 Cramér's V = 0.0148	χ^2 = 60.74 Cramér's V = 0.032	–		χ^2 = 3455.07 Cramér's V = 0.0261	χ^2 = 189.94 Cramér's V = 0.055
15th October	χ^2 = 4196.78 Cramér's V = 0.0292	χ^2 = 58.36 Cramér's V = 0.030	χ^2 = 3455.07 Cramér's V = 0.0261	χ^2 = 189.94 Cramér's V = 0.055	–	
Saturdays (1)	23th Novmeber		09th November		30th November	
	Traffic volume	Public transport	Traffic volume	Public transport	Traffic volume	Public transport
23th Novmeber	–		χ^2 = 438.69 Cramér's V = 0.010	χ^2 = 41.11 Cramér's V = 0.032	χ^2 = 725.20 Cramér's V = 0.013	χ^2 = 684.12 Cramér's V = 0.121
09th November	χ^2 = 438.69 Cramér's V = 0.010	χ^2 = 41.11 Cramér's V = 0.032	–		χ^2 = 2107.65 Cramér's V = 0.022	χ^2 = 646.01 Cramér's V = 0.111
30th November	χ^2 = 725.20 Cramér's V = 0.013	χ^2 = 684.12 Cramér's V = 0.121	χ^2 = 2107.65 Cramér's V = 0.022	χ^2 = 646.01 Cramér's V = 0.111	–	
Saturdays (2)	14th December		09th November		07th December	
	Traffic volume	Public transport	Traffic volume	Public transport	Traffic volume	Public transport
14th December	–		χ^2 = 1089.62 Cramér's V = 0.0177	χ^2 = 13.70 Cramér's V = 0.0182	χ^2 = 1162.70 Cramér's V = 0.0182	χ^2 = 19.73 Cramér's V = 0.0214
09th November	χ^2 = 1089.62 Cramér's V = 0.0177	χ^2 = 13.70 Cramér's V = 0.0182	–		χ^2 = 3390.30 Cramér's V = 0.0310	χ^2 = 39.08 Cramér's V = 0.0299
07th December	χ^2 = 1162.70 Cramér's V = 0.0182	χ^2 = 19.73 Cramér's V = 0.0214	χ^2 = 3390.30 Cramér's V = 0.0310	χ^2 = 39.08 Cramér's V = 0.0299	–	

More pronounced changes are visible in the charts showing percentage variations in relation to the duration of mass events. In all cases, both before and after the analysed event, the values for days with mass events are higher than the baseline values. For the analysed Tuesdays, the largest change is observed at the conclusion of the second mass event after 11 pm. For the remaining events, values in the two-hour periods before and after the event range between 100 and 120 per cent. An identical situation was observed for the analysed Saturdays (23, 9, and 30 November 2024), where traffic volumes at intersections also increased to over 120% following the conclusion of the final event. However, it should be taken into account that both events ended within a 30-minute interval, which may have had a significant influence on the magnitude of the increase. In the context

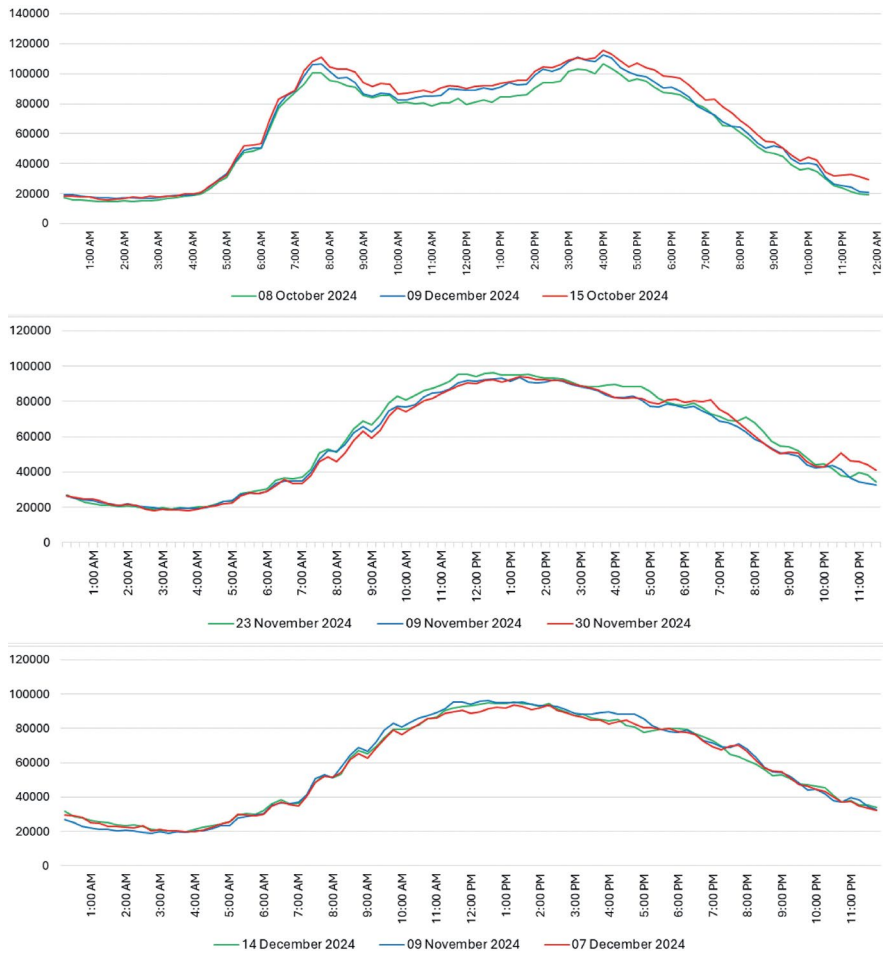

Fig. 6. Absolute traffic volume values at intersections across the analysed days
Own elaboration based on data from the Road and Transport Authority of the City of Łódź.

of the second set of analysed Saturdays (14 and 7 December and 9 November 2024), the values in all cases do not exceed 120%; however, increases are still observable both before and after the conclusion of the event. The above results confirm the earlier conclusions drawn when discussing the chi-square test and Cramer's V coefficient, which indicated greater sensitivity of road traffic on Tuesdays compared to Saturdays.

To more accurately illustrate the impact on the transport system, it is necessary to compare the traffic volume results with those from public transport. While traffic volumes were presented as percentages, due to the low values of the public transport data showing entries and exits at the analysed stops, these values needed to be presented in a different format. To represent these values, the expression (entries – exits from the baseline data) – (entries – exits from event data) was used. This approach allowed for the determination of whether the number of passengers alighting at a given stop increased,

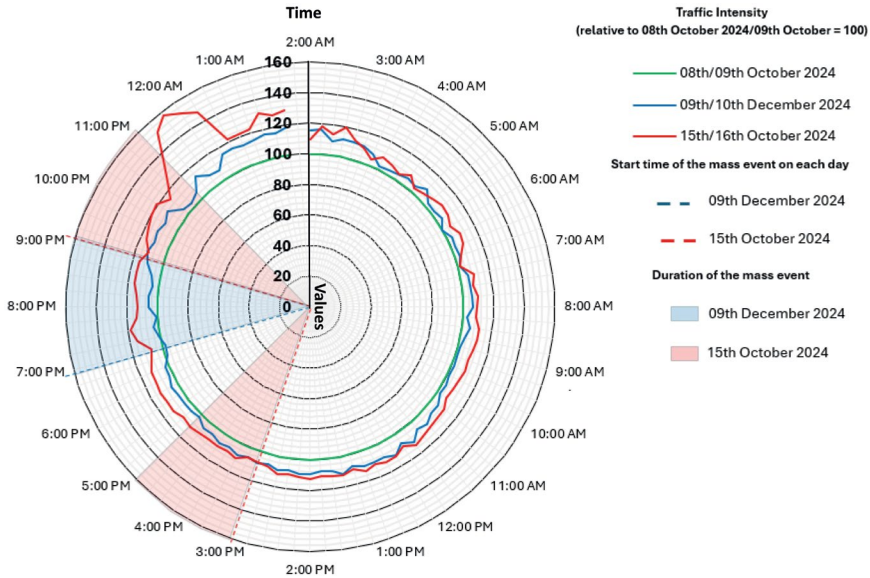

Fig. 7. Changes in traffic volumes at intersections on the analysed Tuesdays

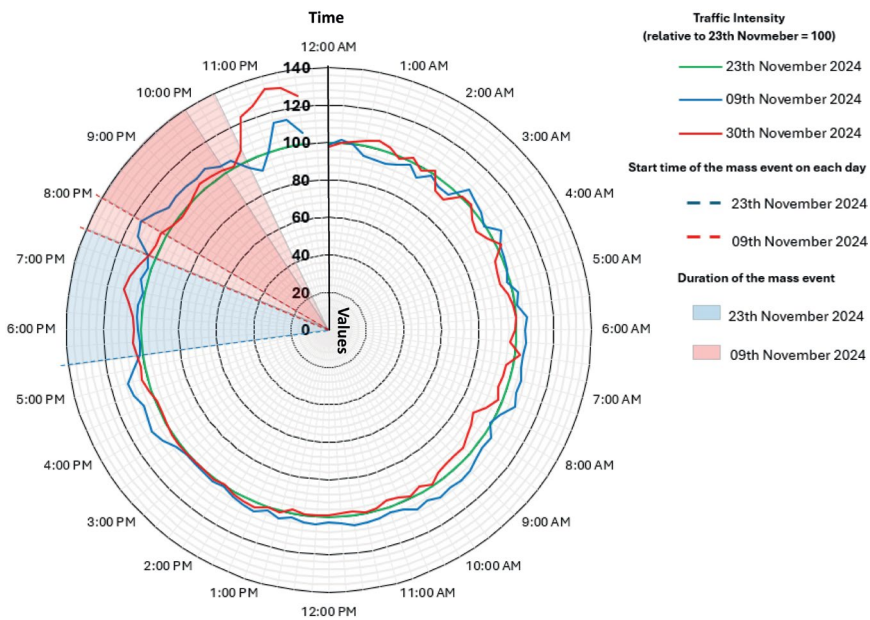

Fig. 8. Changes in traffic volumes at intersections on the analysed Saturdays (1)

which is important before a mass event, and the number of passengers boarding, which is significant after the event. When joining the point layers of intersections and public transport stops to the hexagonal grid, the values for the points in each layer were averaged

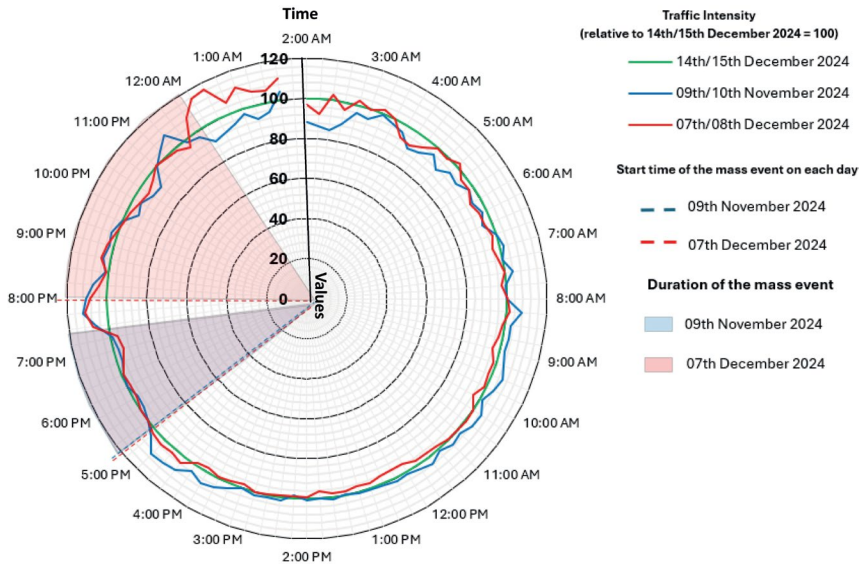

Fig. 9. Changes in traffic volumes at intersections on the analysed Saturdays (2)

within each cell. The results were presented using a 4 × 4 two-dimensional table, where each colour indicates values within the respective intervals of the X and Y axes.

In the case of a Tuesday with one mass event, while there are no significant deviations before the event, an increase in values is visible after its conclusion in the vicinity of the event location (Fig. 10). This increase extends both to the western part of the city towards the Retkinia district and southwards along the national road. In the context of the first event on 15 October 2024, an increase in transport system load is visible both in the vicinity of the Widzew Stadium and in the central part of the city, which may be related to the timing of the mass event. The presented results show a high load on the W-Z Route, as well as in the southern and western parts of the city. In the northern part of Łódź, the values are lower. The values for the second event of that day, despite being limited in terms of post-event traffic data, indicate a significant increase mainly along the city's main arteries, forming the internal ring road. It is also worth noting that the increased traffic before both the first and second events of the day extends in some areas far from the event locations.

The results for the first set of Saturdays show a strong impact on the transport system from two mass events occurring at similar times in two different locations within Łódź, namely the Atlas Arena and the Widzew Stadium (Fig. 11). Before the start of both events, a significant increase in transport system load is noticeable not only in the vicinity of the venues but across the entire analysed area. In the period following the conclusion of both events, a greater impact is observed after the football match at the Widzew Stadium. On a day with a single mass event, the transport system is similarly loaded both before and after the event; however, the impact also extends across most of the analysed area.

The most recent results, also concerning Saturday mass events, show a slightly lower impact of the events on the transport system load (Fig. 12). In the case of a day with

a single mass event, it should be noted that this is the same day analysed in the previous map, and the time interval between this date and the baseline date differs slightly. The organisation of football matches at the Widzew Stadium has a very similar impact on the transport system in the analysed area, both in December and in November. In contrast,

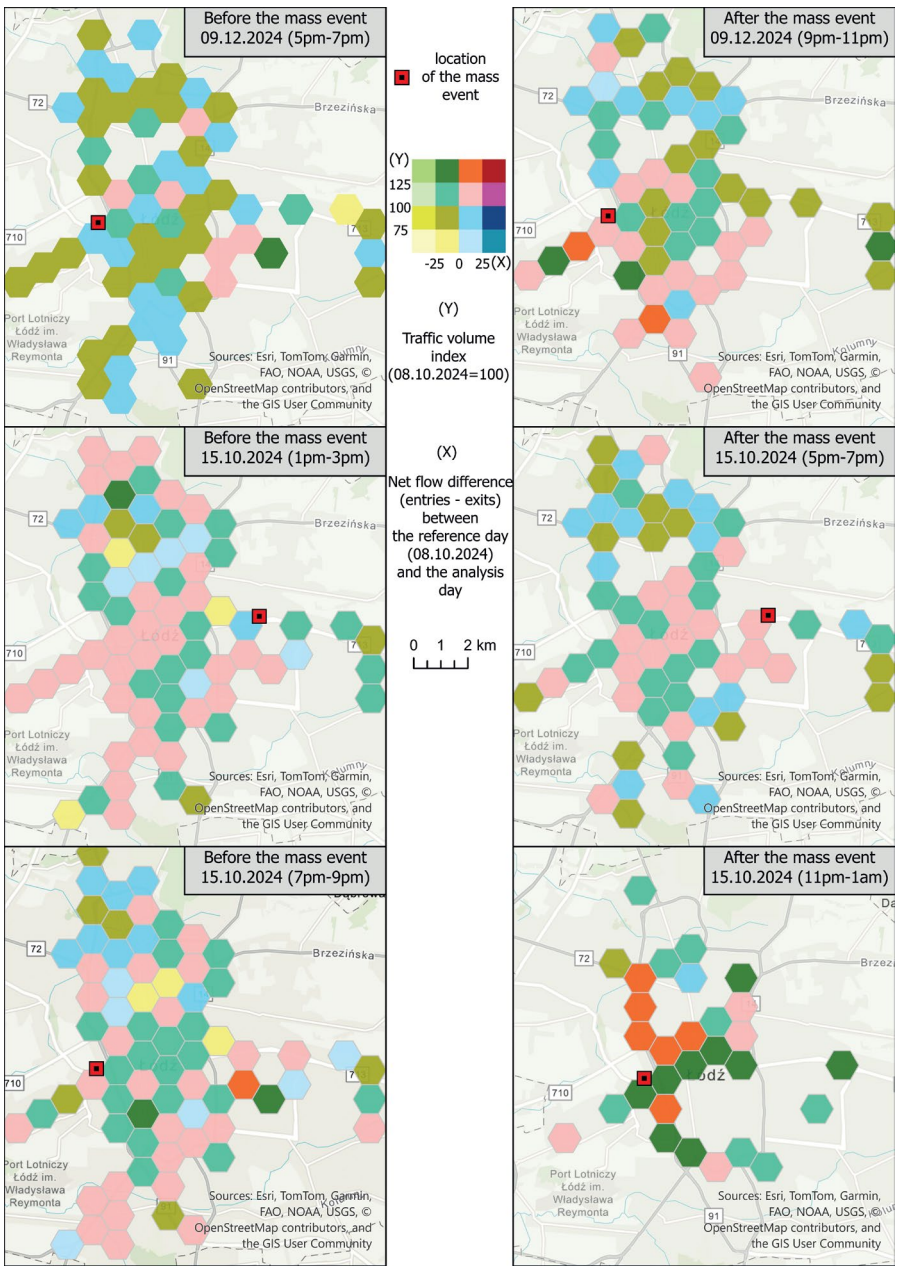

Fig. 10. Results based on values from Tuesdays presented using a two-dimensional table

the event held at the Atlas Arena on the same day was nationwide in nature, which is evident in the map inset showing the period after the event's conclusion, where the highest values occur along the shortest route leading out of the city – towards the road connecting to the S14 expressway.

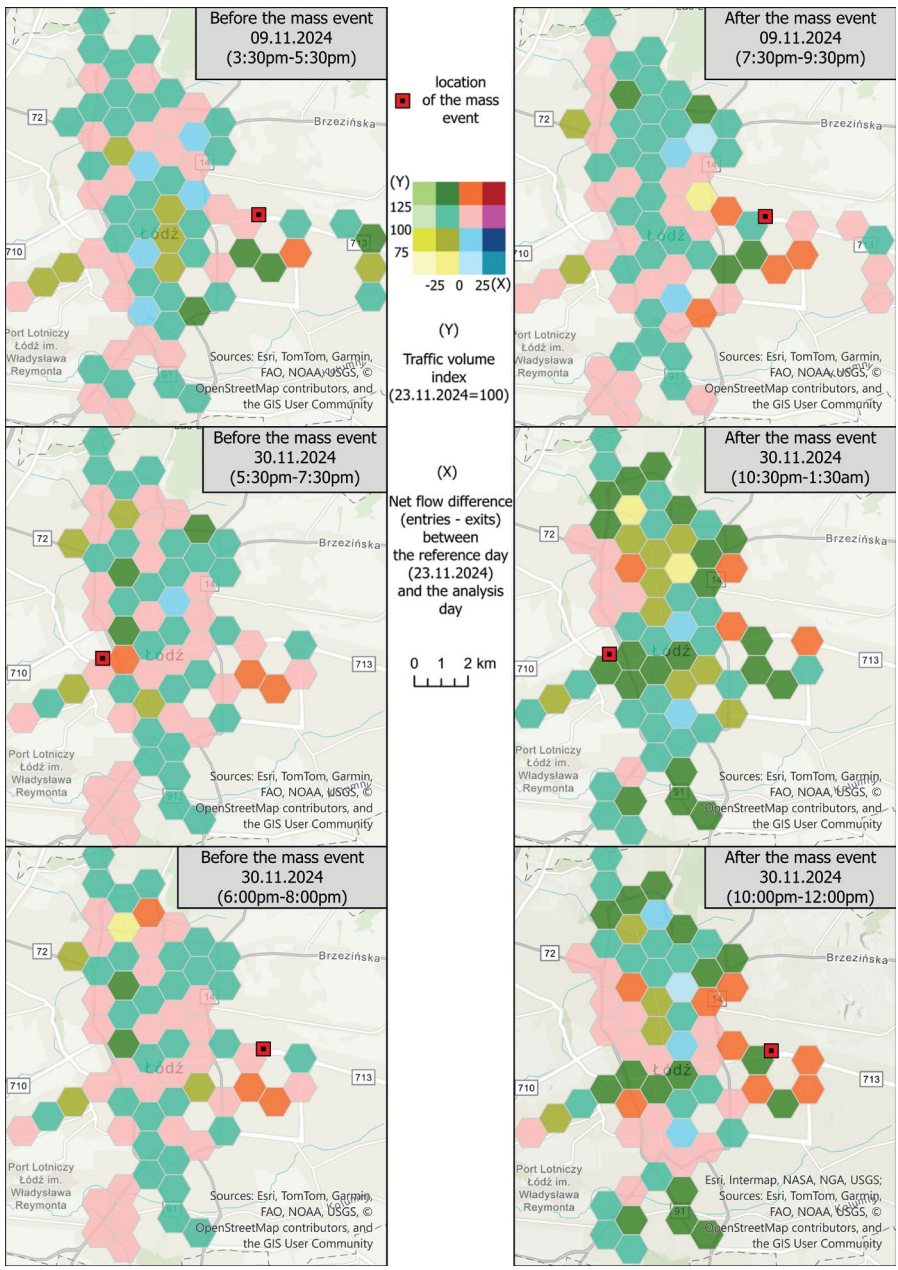

Fig. 11. Results based on values from Saturdays (1) presented using a two-dimensional table

In comparison with other studies examining the impact of mass events on transport systems, numerous similarities can be observed; however, differences in the scale of the analysed events should be taken into account (Szarata & Drabicki, 2016; Villiers et al., 2019; Cerqueira et al., 2021). When examining the impact of mass events on the

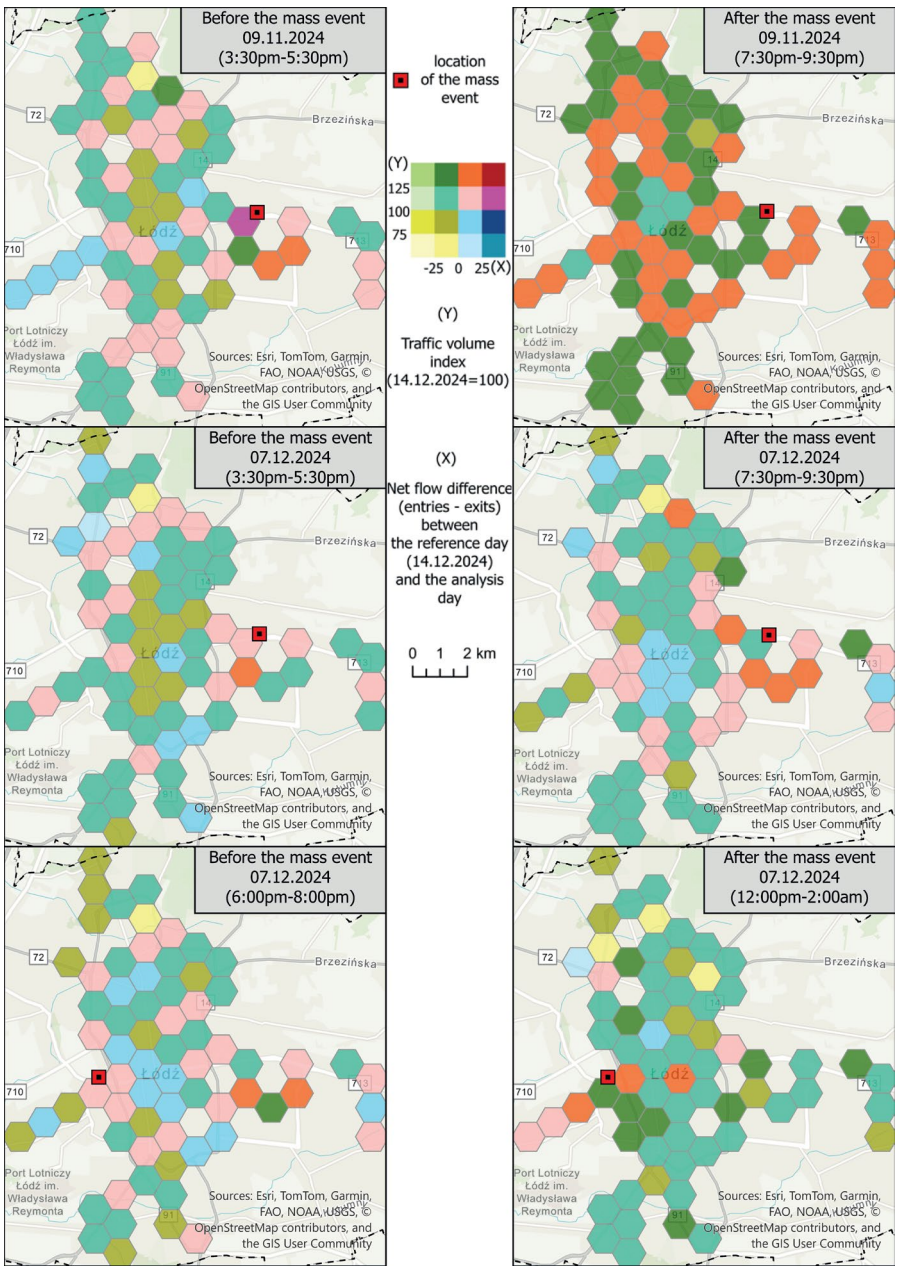

Fig. 12. Results based on values from Saturdays (2) presented using a two-dimensional table

transport system, numerous variables play a role. These range from the level of interest in the event, through weather conditions and participants' travel preferences, to the capabilities of the transport system itself in facilitating the movement of people attending the event. The integration of these factors would provide a multifaceted approach for future research on this topic.

Conclusions

The following results clearly demonstrate the impact of mass event organisation on the transport system. Due to the limited development of high-capacity roads in Łódź and the general layout of the street network, congestion is experienced by road users both before and after events across a significant portion of the analysed area. Regardless of whether the event was held in the eastern or western part of the city, positive changes in traffic volumes are similar. Naturally, higher values are observed in the late evening due to the typically lower urban traffic; however, it should be noted that the highest absolute values occurred before and after events taking place in the afternoon or during the evening hours. In comparative terms between the analysed days, Tuesdays show a greater impact on traffic volumes when considering both private and public transport.

The obtained results clearly highlight the need to respond to and implement changes in the transport system of Łódź, especially considering that the analysed mass events do not belong to the largest-scale category. The city, as an entity responsible for development planning and strategy, should take into account the occurrence of unpredictable events that have a significant impact on urban functioning. At present, several strategic documents have been adopted for both the city of Łódź and its metropolitan area: Sustainable Urban Mobility Plan for the Łódź Metropolitan Area 2030 (with a perspective to 2040) (Plan, 2024), Sustainable Development Plan for Public Transport in the City of Łódź until 2025 (Plan, 2022), Łódź City Development Strategy 2030+ (Strategia, 2021). The main objectives include efforts to increase the role of public and bicycle transport within the framework of sustainable development policy, in line with broadly accepted European policy. The future development of the transport system in Łódź will not only improve the quality of life for its residents but also enable the organisation of larger-scale mass events. This would have a positive impact not only on the city's image but also on its economic aspects.

The present study highlights the importance of analysing changes in transport system subsystems (private and public transport), even at the smallest scale. While changes are more evident during the organisation of international events or events with a much larger number of participants – where the focus is primarily on proper system design and adaptation – smaller-scale events may induce more marginal changes. Nevertheless, these changes still fall within the responsibilities of both event organisers and municipal authorities, who are obliged to oversee the ongoing development of the urban centre. For the organisation of future mass events, it is essential to enhance the role of public transport, including potential modifications to accommodate events, as well as initiatives promoting travel to the event venue using public transport or other modes consistent with sustainable development policies.

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