

Social-Ecological Urbanism as a Research Perspective to Analyse Transportation Inequalities in the Region of Łódź, Poland

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Abstract

The systems perspective enables the understanding of complex transformations which take place in urban regions. Social-ecological urbanism is an analytical methodology that integrates the systems perspective and unpacks relationships between the social-ecological and socio-technical subsystems of urban regions. In this article, we look for the most suitable approach to analysing the transformations of a tramway system and its impacts on public transportation inequalities in the metropolitan region of Łódź, Poland. As a departure point, we use the classic methods of communicative planning theory. The presented method uses a detailed case study analysis that carefully follows all the activities, stakeholders, and processes. We complement this approach by looking at the ongoing transformations of transportation equity through the lens of socio-ecological urbanism and by analysing the stakeholders' roles and attitudes within the process. Our analysis indicates the role of public participation in the process, which affected and strengthened the transformations. This approach is greatly enhanced by the application of the social-ecological urbanism framework, with its analysis of services performed by various system components. Understanding their specific roles helps in planning future redevelopment. Our key finding is the necessity of combining communicative planning methods with strategic planning of the systems transformation process.

Keywords

communicative planning; mobility; public transport; regional development; social-ecological urbanism; transportation equity

1. Introduction

Equal access to transportation opportunities is one of the conditions for well-functioning cities and regions. The commonly accepted solution is the provision of public transportation to densely populated urban centres (European Commission, 2020). However, the dispersal of development due to urban sprawl creates a situation where formerly functioning public transportation networks lack sufficient passengers to sustain operations. This, in turn, can lead to transportation inequalities.

This article investigates the potential of studying the transformation process through a case study of the changing tramway system in the metropolitan region of Łódź, Poland. The system faced the challenge of tram operation stoppages and has been recovering thanks to the involvement of local citizens. The citizens' reactions prevented potential inequality problems. Our study provides insights into the process organisation and the role the systems play as services for their users, which might be useful for future change management and allows us to evaluate the analytical methods.

The study of urban transformations has attracted significant attention from the scientific community, particularly as a theoretical framework to address the demands of climate change (Keith et al., 2023; Torrens et al., 2021; Wolfram, 2016). The systems perspective has enabled the incorporation of social studies theory into the discourse on natural and urban systems adaptation. This perspective recognises cities and regional development as complex adaptive systems, in which humans play a pivotal role. The systems perspective is gradually becoming a mainstream theoretical approach (Alberti, 2008; Keith et al., 2023). For example, Nobel-winning research by Ostrom (1990) showed that social and ecological systems benefit from management practices by many stakeholders, known as adaptive co-management. This study uses the theoretical apparatus of social-ecological urbanism, which is one of the analytical methodologies integrating a systems perspective (Barthel et al., 2013; Berghauser Pont et al., 2022).

In our research, we examine how co-adaptive management and monitoring by local stakeholders translates into the care for transportation equity. Using the case study methodology (Duminy et al., 2014; Flyvbjerg, 2006) and established methods to study the political mechanisms behind the transitions, i.e., communicative planning theory (Forester, 1999; Healey, 1997), we analyse and provide a thorough description of the transformation process. First, we identify the primary stakeholders and their contributions to the process. Then, we look at the services provided by the public transportation system. After examining the data, we compare them with reference case studies and put forward recommendations for improving the transportation system and point to potential paths for future research.

2. Background Research

Public transportation systems play a vital role in the intricate network of complex adaptive systems found in cities (Barthel et al., 2013; Estévez-Mauriz et al., 2017; Olsson et al., 2014; Torrens et al., 2021). The failure to consider transformation processes in urban systems can make them vulnerable, leading to disruptions and a lack of services for citizens (Keith et al., 2023). Accommodating disturbances improves the resilience of urban systems and, in the long run, improves service quality (Estévez-Mauriz et al., 2017; Folke, 2006; Folke et al., 2005). In the case of public transportation systems, this translates into more reliable and stable connections.

Barthel et al. (2013) introduced the concept of social-ecological urbanism as an analytical methodology integrating the systems perspective. Social-ecological urbanism focuses on relationships between various subsystems of cities and regions, both urban (social, spatial, infrastructural, and technological) and ecological (Barthel et al., 2013, pp. 27–29). Relations between the local community and transportation infrastructure are the consequence of services offered by the infrastructure, and, as our study shows, the local community becomes responsible for infrastructure maintenance. Ostrom (1990) argued that self-organisation entails enhanced monitoring and responsibility. Moreover, Ostrom's research indicates that implementing multi-stakeholder management practices, also referred to as adaptive co-management, holds great promise for positively affecting social and ecological systems, providing direction for the future of urban planning.

Applying the systems approach draws attention to the fact that cities and urban regions are not static, and that adaptation requires feedback loops and constant adjustment to changing conditions. In the process of adaptive co-management, a pivotal role belongs to groups and individuals, whose attitudes and behaviours toward the environment—both natural and human-made—directly affect changes (Barthel et al., 2013; Berghauser Pont et al., 2022). Therefore, to understand a problem, we need to acknowledge complex social relations. This requires a multilevel, flexible, and context-specific approach that reflects different life experiences and their influences on decision-making (Barthel et al., 2013; Berghauser Pont et al., 2022). In this approach, the transformation process, the main stakeholders, and the roles of the stakeholders become the key research focus.

After Barthel et al. (2013), we argue that public transport is one of the urban subsystems that strongly affect urban growth at a regional level. To limit the impact of suburban urbanisation on natural areas, the nodes of the public transportation system can function as the nodes for compact urban development (Calthorpe, 2011). Transportation equity emerges as a critical component and service for evaluating the integration of transportation systems in society. Public transport provides access to education, employment, services, and leisure. Promoting traffic safety and providing equal access to transportation is necessary to achieve equitable mobility solutions. Researchers classify transportation inequalities into two main categories: social and spatial (Lee et al., 2017). The first category refers to socio-demographic factors, such as gender, age, income level, or ethnicity. Vulnerable groups usually cannot afford individual vehicles. Therefore, their access to necessities is limited. Providing alternative mobility modes could help to solve this exclusion problem (Lee et al., 2017; Turrell et al., 2013; Zander et al., 2014).

Spatial equity refers to unequal access to diverse transportation modes (Lee et al., 2017). Development densities are critical factors for spatial equity. This is particularly relevant in suburban estates, where individual cars are often the only mode of transportation (Faskunger, 2013). Spatial equity also pertains to the environmental constraints on access to transportation. The key to successful policymaking lies in understanding the local spatial variables that affect mobility levels (Feuillet et al., 2015). In the most common situation, the combination of spatial and social inequity can be examined through a panarchy of scales, from regional to local. For example, one of the main constraints on people with disabilities using public transportation is the lack of accessibility of bus, tramway, or train stops, which may be due to a lack of lines, but also to the form of the physical environment (lack or poor quality of sidewalks), to the type of rolling stock, or to lack of proper transport information. Enhancing the accessibility of public transport for people with disabilities makes it available to everybody. It increases the ability and capacity of everyone to travel, not only marginalised groups (Haveman et al., 2013).

Factors that affect decisions in the field of transportation include fuel consumption, air pollution, and demand satisfaction. However, it is usually economic issues, such as transport cost and efficiency, that tend to dominate, while social and environmental elements are ignored (Cristiano & Gonella, 2019). Moreover, transforming infrastructure requires examining the spatial outcomes and their potential effects on social inequalities and user satisfaction (Lee et al., 2017). To address social issues and foster social cohesion, mobility policies must prioritise the well-being of the most vulnerable and marginalised sectors of society: the elderly, people with disabilities, children, and disadvantaged communities (Faskunger, 2013; Ravensbergen et al., 2022). Failing to address transportation underinvestment can lead to social equity issues and citizen protests. On the other hand, understanding local stewardship of transportation networks by analysing their services might enhance the design of future strategic transformation tools. Our efforts to analyse the selected case study of the transportation network on the regional scale of the Łódź metropolitan region contribute to current efforts to evaluate and further develop the methods of social-ecological urbanism.

3. Methodology

Our research applied the case study methodology, with an in-depth analysis of a single case and, as a reference, comparison with some elements of external case studies. The research flow is presented in Figure 1. We start with a quantitative evaluation of transportation spatial equity (step 1). This is followed by a detailed analysis of the political process behind the transformations (step 2). Next, we look at users groups and services provided by the transportation networks (step 3). We complete our study with a services comparison matrix, including reference case studies (step 4).

As background to the research, we performed a quantitative analysis to show the importance of the tramway network in the region for spatial equity. We calculated the extent of the urbanised land served by the tramway network. We used the data from the database of topographic objects. We calculated the gross building area value for all buildings. We based our calculations on the official estimates of the average number of persons per

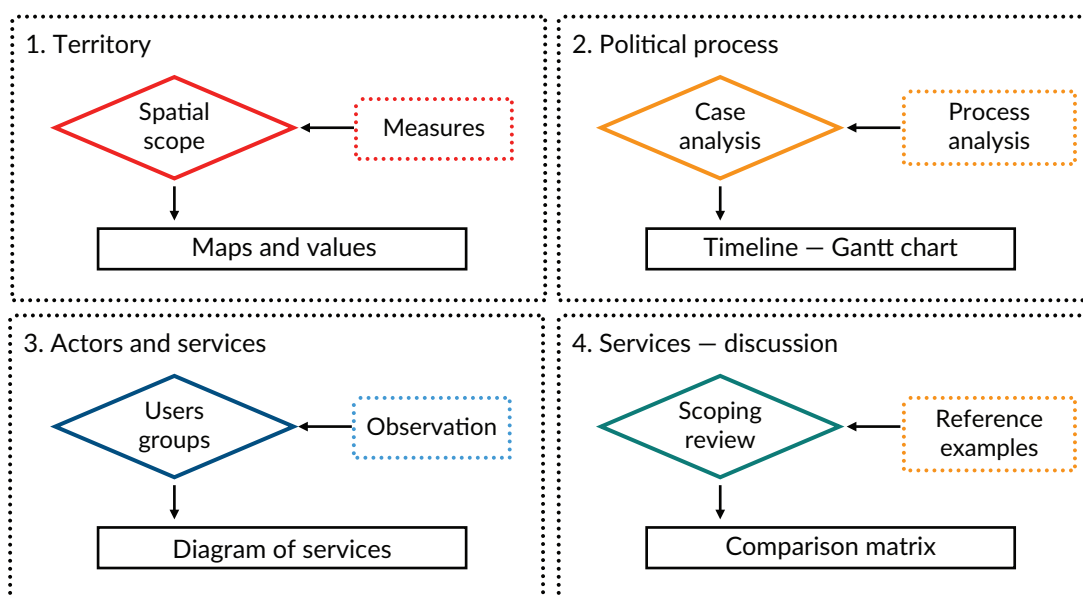


Figure 1. The research methodology.

household in the Łódź Voivodeship (2.24 persons) and the average usable area of flats in the Łódź Voivodeship (71.8 m²). Next, we divided the gross building area by the average usable area of a flat and multiplied that number by the average number of persons per household. Subsequently, we examined the accessibility of tram (and train) stops. We set a buffer 500 m from tram stops and 1000 m from train stops. Finally, we calculated the approximate number of residents living in the buildings located in the designated zones.

Following the methodology proposed by Forester (1999), among others, we performed a detailed analysis of all the activities that occurred in the process of transforming public transport accessibility in the last two decades. The choice of the case study method stems from the fact that it enables an in-depth understanding of ongoing processes in their specific context (Duminy et al., 2014; Flyvbjerg, 2006). Social processes are suitable for this type of analysis, contrary to the application of predictive theories and universal rules that often need to be revised for their characteristics (Flyvbjerg, 2006). The advantage of the case study method is its focus on the actual course of events and their background. The case study method is often used by practitioners who apply it to grasp a holistic picture of complex urban processes and relations (Duminy et al., 2014). The current case study exemplifies a unique category of local citizen stewardship to maintain transportation services and prevent spatial inequities. Therefore, it deserves a detailed analysis.

The research questions for the case study relate to transportation equity and its analysis through the lens of social-ecological urbanism. We aim to unpack the process in order to learn:

- RQ1: Who are the actors involved in the transformation process, and what are their motivations?
- RQ2: Which services are delivered by current transportation systems?
- RQ3: How can future transformations be shifted into more resilient pathways?

Media and communication play a vital role in connecting with the general public. In our analysis, we pay special attention to the communication processes accompanying the studied transformation (Healey, 1997). Press articles and media coverage strongly affected the course of events and made steps towards the restitution of the tram lines possible. Therefore, we trace these processes in detail. As a source, we used a collection of press articles dating from September 2013 to December 2023, published on the platform www.transport-publiczny.pl (Supplementary File). We structured the course of action using two criteria: (a) milestones and spatial extent and (b) critical stakeholder contributions.

Following Barthel et al. (2013), we also examined the services and the stakeholder groups who use these services. This way, we learned about the origins of local actors' infrastructure stewardship and identified the structure of local groups most endangered by transport deprivation. We compared the services to other case studies of transportation networks which discuss equity versus the implementation of tramway or light railway infrastructure.

4. Case Study

We apply the social-ecological urbanism framework (Barthel et al., 2013) to analyse the transformations of public transportation networks on a regional scale. The spatial scope of the research covers Łódź and the surrounding municipalities connected by tramlines (Figure 2):

- From the south: Ksawerów and Pabianice (line 41);
- From the west: Konstantynów Łódzki and Lutomiersk (line 43);
- From the north: Zgierz, Rural Municipality of Zgierz (RMoZ), and Ozorków (lines 45 and 46).

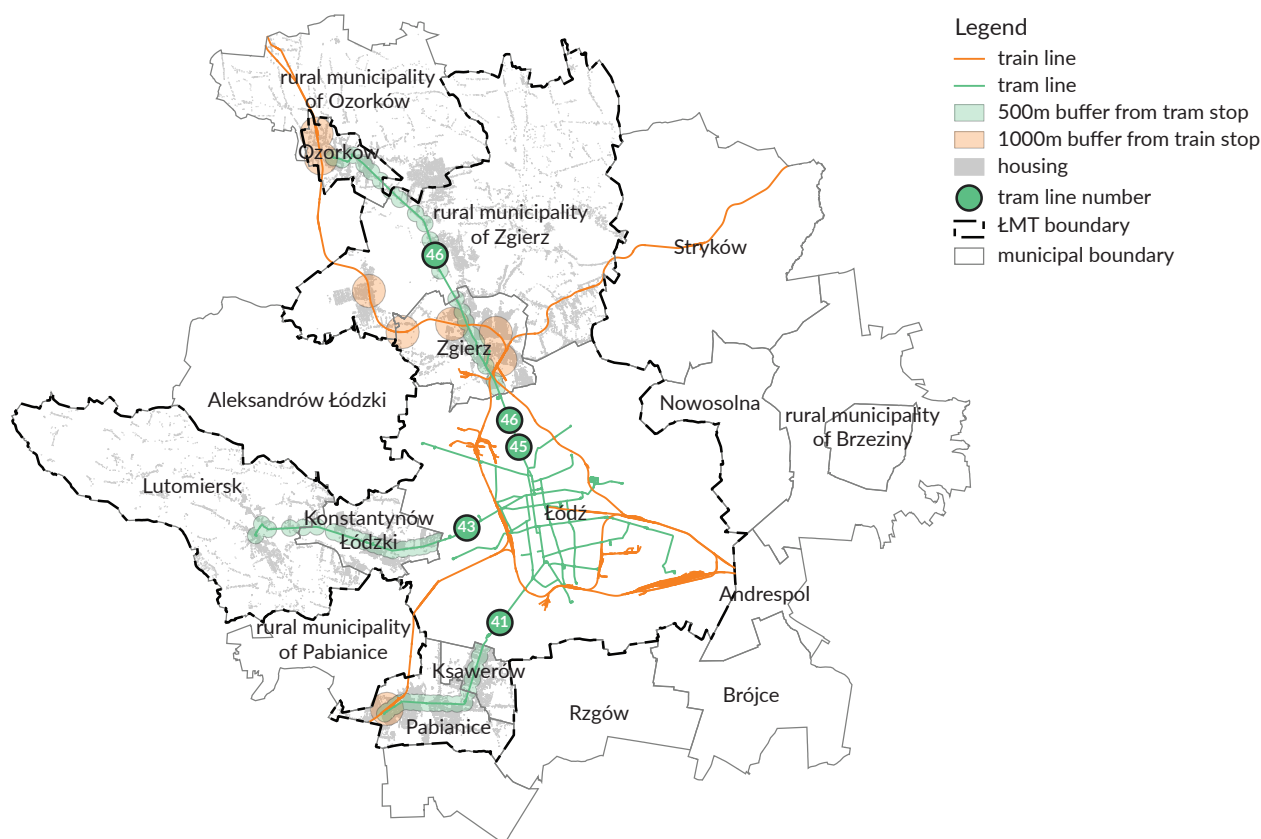


Figure 2. Spatial extent of the case study area, showing buffer zones used to calculate the number of inhabitants directly served by public transportation. The results are included in Table 1.

Table 1. Number of inhabitants served by trams and trains in the studied municipalities.

Municipality	Inhabitants	Inhabitants in buffer			
		Tram stop		Train stop	
		Number	% of all	Number	% of all
Zgierz	54,012	13,932	25.79%	27,677	51%
RMoZ	16,112	1,074	6.67%	1,847	11%
Ozorków	18,259	9,728	53.28%	5,797	32%
Konstantynów Łódzki	19,161	8,867	46.28%	—	—
Lutomiersk	9,386	1,323	14.10%	—	—
Ksawerów	7,652	2,108	27.55%	—	—
Pabianice	61,353	29,108	47.44%	13,162	21%
Total	185,935	66,140	35.57%	48,483	26%

Łódź and its neighbouring towns developed as textile industry centres at the beginning of the 19th century. Due to the collapse of textile production, the region has experienced significant depopulation and degrowth during recent decades. The Łódź metropolitan tramway system underwent a major disruption during the last 20 years. The lines were closed and reopened due to widespread public complaints. This was part of a larger process. Transportation management emerged as a pressing issue when Poland moved to a market economy in the second half of the 20th century. Problems related to the lack of adequately defined ownership and responsibilities resulted in the progressive decapitalisation and, often, closure of public transport networks. Since the availability of transportation infrastructure affects accessibility, spatial equity has become a significant challenge.

5. Results: Transformation Process

Public transportation in the Łódź region is provided by railway and tram systems complemented by a number of bus networks, some of them private. On a regional scale, the role of the railroad has increased in recent years due to the development of Łódź Metropolitan Railway. However, the number of railway stops is limited, and, owing to their original usage for freight, they are distant from the surrounding development. These conditions reduce the significance of rail on a local scale.

5.1. Tramway Transformations: Process Timeline

Trams have provided transportation in the Łódź metropolitan area for over a century. The first lines to Pabianice and Zgierz opened in 1901. This made Łódź the only region in Poland with a suburban tramway network. The network ran from Łódź in almost all directions, except east (Andrespol and Brzeziny). In the 1990s, two lines were liquidated: westward to Aleksandrów Łódzki (in 1991) and southward to Rzgów (in 1993). In 1993, the involved communities began a limited liability company to manage the infrastructure of the four remaining lines. Basic data on the characteristics of the tramway network are presented in Table 2, including the track length, tram frequency, and travel time to the centre of Łódź.

The lines were never extensively upgraded or renovated. The only interventions were roadway reconstructions and repairs to maintain passibility. The need for systemic maintenance is the greatest challenge for regional tramways. Due to their small budgets, suburban municipalities responsible for renovating and modernising the infrastructure cannot perform upgrades independently. Traffic sustenance also remains a challenge. At the same time, citizens perceive trams to be an essential transportation solution, providing access to basic services.

5.1.1. Phase 1: Łódź Metropolitan Tram Project

Following the method explained in Section 3, a timeline of activities that took place during the transformation of the tramway regional network is presented in Figure 3. In October 2014 [1], Łódź and the neighbouring municipalities (Konstantynów Łódzki, Ksawerów, Lutomiersk, Ozorków, Pabianice, and Zgierz) agreed on a project for building the Łódź Metropolitan Tramway. The investment continued the Łódź Regional Tram Zgierz–Łódź–Pabianice project realised in 2007–2008. The objective was a comprehensive modernisation of the suburban tram lines: renovating the infrastructure, including tracks and catenary network, installing a traffic control and passenger information system, procuring new low-floor rolling stock, and constructing integrated stops, transfer hubs, and depots. However, the challenges of inter-communal

Table 2. Characteristics of the tramway network in the Łódź region.

Municipality	Distance to Łódź centre (km)	Track length (km)	Tram line	Opening year	2001		2012–2018		2024		Type of tracks
					Frequency (min)	Time to Łódź centre (min)	Frequency (min)	Time to Łódź centre (min)	Frequency (min)	Time to Łódź centre (min)	
Zgierz	10.0	3.0	45	1901	10–20	30	24	43	20	30	double
		6.4				43		57			
RCoZ	17.1	12.6	46	1922	16–32	59	24	83	–	–	single
Ozorków	24.3	10.6				69		95			
Konstantynów Łódzki	9.4	11.6	43	1910	30	38	22–80	50	–	–	single
Lutomiersk	16.9	7.7	43	1929	60	55	60–90	81	–	–	single
Ksawerów	10.4	3.4	41	1901	20	35	20–49	25*	24	21*	double
Pabianice	13.7	7.7	41			60		47*		41*	double

Note: * last stop not in the centre of Łódź.

agreements and design delays postponed the implementation of the project, which was initially planned for 2018–2020. The main problems included obtaining a sufficient grant, over-scaling, and the coordination of activities. The communities at first declared their participation in co-financing [2,3] but later abandoned it altogether [4]. In the end, only the Łódź section was renovated. The planned extensions to Pabianice, Zgierz, and Ozorków were never implemented.

In early 2017 [6], Łódź authorities proposed to abandon the modernisation of the tram lines and replace them with electric buses on dedicated lanes. The authorities argued that this solution was faster and cheaper to implement. Moreover, it could be financed by the EU. All the stakeholders were against this proposal, including the municipalities, the political opposition, and local NGOs. The authorities of neighbouring municipalities pointed out the lack of cost estimates, issues with the designated bus lanes (spatial and legal), and insufficient development of Electric Vehicle technology. Protesters also pointed to the experience of Western Europe, where, after their removal in the 70s and 80s, tram lines are currently being reconstructed. Due to the opposition, the concept of electric buses was abandoned.

5.1.2. Phase 2: Separate Actions

In the years that followed, the activities of all involved municipalities were conducted separately.

5.1.2.1. Line 41: Route Through Ksawerów to Pabianice

The tram line to Pabianice was launched in 1901 and extended in 1905, 1924, and 1968. In 2011, thanks to the extended route, increased frequency, and the addition of carriages, the number of passengers increased by 67% compared to before the extension. The route was used by about 9,000 passengers daily and about 2.6 million annually (“Pabianice: Tramwaj coraz popularniejszy,” 2013).

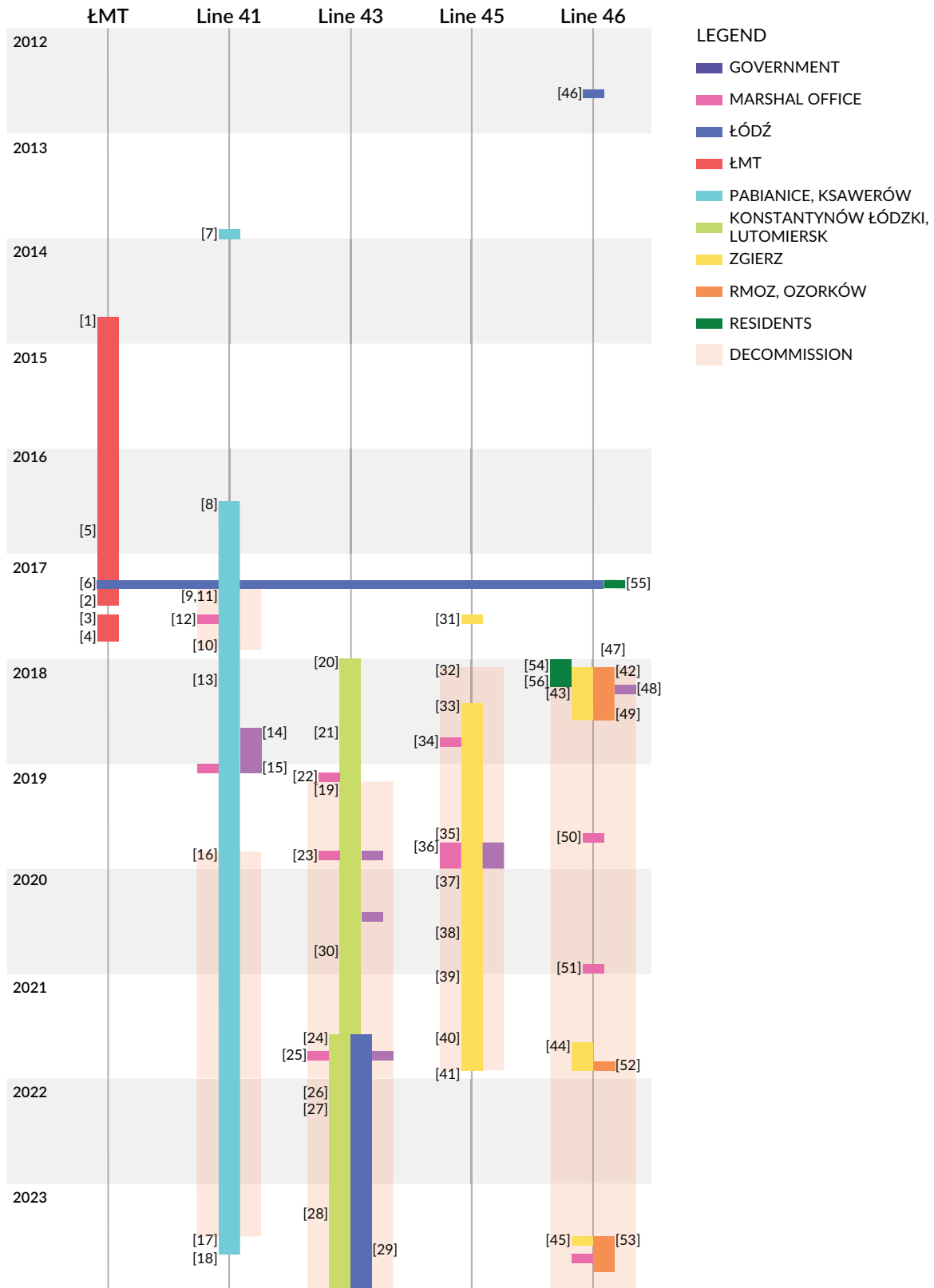


Figure 3. Gantt chart timeline of all the activities during the transformation of the tramway regional network. Major events and milestones are numbered in brackets and referred to in the text. Note: ŁMT stands for Łódź Metropolitan Tram.

The Pabianice authorities declared they would invest in tramline 41 in 2013 [7]. In 2016, they began preparations [8]. In 2017 [9, 10], an emergency stoppage of tram traffic occurred, ended by an ad hoc repair. This incident highlighted the importance of the tramway for commuters. In 2017 [11], Pabianice and Ksawerów applied for Regional Operational Program (ROP) funds to finance infrastructure modernisation, construction of tram and bus stops, separation of tram and bus lanes in the centre of Pabianice, an intelligent transport system, and bicycle infrastructure. The project received a high score for integrating various modes of transport, including trams, buses, and bicycles. The ROP funding covered over half of the required sum [12]. Implementation became a challenge for the small municipality of Ksawerów, since its contribution to the project amounted to one-fourth of its budget. The actual costs of the line 41 reconstruction significantly exceeded the planned budget [13]. The government provided local municipalities with additional funds [14, 15]. The municipalities of Pabianice and Ksawerów had to cover the remaining costs. Due to the modernisation works, tram traffic on line 41 stopped in 2019 [16], only to resume in 2023 [17, 18], after nearly four years. The current frequency during weekdays is 24 minutes. Over half of services are run by low-floor rolling stock. In addition, Pabianice launched a new bus line connecting the city's largest housing estate to the tram [18].

5.1.2.2. Line 43: Route to Konstancynów Łódzki and Lutomiernsk

The tramline from Łódź to Konstancynów Łódzki was opened in 1910 and extended to Lutomiernsk in 1929. The route to Lutomiernsk was also a tourist attraction, because it ran through scenic landscapes. In the early 2000s, tram carriages covered the distance in about 60 minutes. In 2017, due to speed restrictions introduced in response to the poor state of the infrastructure, the trip took about 80 minutes. In 2019 [19], tram traffic was stopped entirely.

The lack of progress on the Łódź Metropolitan Tram project led to Konstancynów Łódzki and Lutomiernsk launching their own initiatives. In 2018 [20], Konstancynów decided to modernise a large share of the catenary and the trackbed, as well as to add a traffic control system and bus shelters. The Łódź Marshal Office provided funding [21, 22, 23]. Additional funds came from the government. To reduce investment costs, in 2021 [24], Konstancynów entered an intercommunal agreement with Łódź on the joint implementation of modernisation. In addition to the refurbishment of tracks and networks, the project included stops adapted to the needs of disabled people. At the end of 2021 [25], the investment received co-financing from the European Regional Development Fund and the state budget. The municipalities completed the formal preparations in early 2022 [26,27]. Renovation of the tracks in Konstancynów Łódzki was completed in 2023. Due to delays [28,29], the project in Łódź was finished in the first half of 2024, and the tram to Konstancynów resumed services in July 2024.

In 2016 [5], legal, organisational, and economic problems forced the Lutomiernsk authorities to turn to the Łódź Marshal Office for assistance. The provincial authorities granted permission to the municipalities to apply for funds. In 2020, Lutomiernsk announced it would apply for funding [33]. However, the lack of support from Konstancynów caused the municipality to drop out.

5.1.2.3. Line 45: Route to Zgierz

The tram line to Zgierz (3 km, double-line tracks) was launched in 1901, as one of the first two lines in the agglomeration. Since then, the infrastructure has only had minor repairs. In 2017 [31], Zgierz authorities

applied for funding to reconstruct part of the railway track (1.9 km) shared by lines 45 and 46, as well as to build stops, bicycle infrastructure, and parking for bicycles and cars. In February 2018 [32], when lines 45 and 46 were halted, the municipality announced the replacement of tracks on the most worn-out shared section. Before the local elections, NGOs and politicians mobilised the authorities of Zgierz, the RCoZ, and the Ozorków municipality to take action in an open letter. In 2018 [33, 34], Zgierz successfully applied for ROP 2014–2020 funds to finance the modernisation. Since all bids exceeded the intended budget, the government and the Łódź Marshal Office promised to provide the missing funds before the parliamentary elections in 2019 [35, 36, 37]. Repairing the entire section of line 45 was necessary to resume tram traffic. In 2020 [38], Zgierz signed a contract to modernise the section of the line from the fork to the tram terminal. In 2021 [39, 40], Zgierz successfully re-applied for ROP 2014–2020 funds. Finally, tram traffic to Zgierz resumed in December 2021 [41], which increased the popularity of public transport on the Zgierz–Łódź route. The current frequency of trams during weekdays is every 15 minutes. In 2023, low-floor rolling stock was introduced on the line (Figure 4).

Tram line 46 ceased operating in 2018 [42]. The resulting difficulties in transport services to the northern part of Zgierz provoked protests by residents. In response, the authorities launched a bus line [43]. Because modernisation of line 46 remained uncertain, the Zgierz municipality considered renovating part of the infrastructure, either by purchasing two-way rolling stock or constructing a tramway loop. In 2021 [44], Zgierz authorities announced they would seek EU funding to modernise a section of line 46 within the city.

5.1.2.4. Line 46: Route to Ozorków

The tram line to Ozorków operated for 90 years, beginning in 1922. In 2012 [47], the carrier MPK-Łódź announced the liquidation of the line. The maintenance of line 46 caused problems because long route



Figure 4. Example of a low-deck 45 tram in Zgierz.

sections (8 km) ran through the Rural Municipality of Zgierz, which has a low population density. Ozorków managed less than 5 km of the route. Between 2003 and 2013, the travel time in the non-urban section increased by almost 20%, from 49 minutes in 2000 (from the border of Łódź) to 63–70 minutes in 2017. After further speed restrictions were imposed in December 2017 [48], the journey from the border of Łódź extended to 90 minutes (115 minutes from the centre of Łódź).

In 2018 [49], the authorities of the RCoZ, Zgierz, and Ozorków secured funds from the state budget. However, they could not agree on the legal formula for the renovations [50]. The Łódź Regional Assembly passed the 2021 budget [51, 52], which included funds for tram line 46. At the end of 2021 [53], Ozorków, the RCoZ, and Zgierz announced they would apply jointly for EU funding, with no results as of 2023. In 2023 [54], Ozorków demolished the tramway loop because of ownership issues. The tram route remains, and the road renovation project leaves a reserve for the tramway.

5.1.3. Community Involvement

NGOs have been reporting on the need for infrastructure improvements since 1998. Throughout the entire process, they have published statements in local media. They have also coordinated multiple demonstrations and gatherings to rally the public and local leaders to take action. The Association for the Defence of Suburban Tram Transportation in the Łódź Region (SOPKTRŁ) argued that the lack of maintenance and the resulting decline in quality was a deliberate policy to dampen demand. They also argued that decommissioning the tram would mean higher travel costs. Similarly, the Civil Affairs Institute and the citizens' movement Łódź is Ours highlighted the many years of neglecting infrastructure maintenance, claiming that traffic stoppages could have been prevented if repairs had been carried out regularly. At the beginning of 2018 [54], SOPKTRŁ, the Pro Kolej Foundation, and the Civil Affairs Institute appealed to the municipalities to take action. They recalled that, since 2012, MPK-Łódź has regularly reported on the poor condition of the infrastructure. They sent petitions to all local authorities along tram lines 45 and 46. SOPKTRŁ was the main organizer of protests against liquidation of the suburban trams, e.g., [55, 56]. One of their proposals was to involve a private entity, which would renovate and run services on the line. However, this would mean the privatisation of public transport. The tram issue also became a topic in the 2018 local government election campaign in Ozorków.

5.1.4. Other Measures: Replacement Communication

During the shutdown of tram lines, Łódź has provided substitute bus transport. The bus rides typically take longer than tram rides, even though the trams had speed limits imposed due to the poor technical condition of the infrastructure. Delays of up to an hour are common on the bus route to Ozorków, due to heavy traffic jams especially during rush hours. The tramway had the advantage of running on a separate track. In some cases, however, the introduction of substitute transportation is perceived positively by passengers. For example, on the route to Lutomiersk, the bus covers the route much faster than the tram. The replacement buses often use shorter routes, forcing passengers to change itineraries. Travel comfort declined, due to the lower capacities of buses. Some vehicles lack a ticket machine, which presents problems for some passengers, especially in rural areas. Moreover, not all temporary bus stops are adequately paved; some are located at pedestrian crossings or bicycle paths.

5.2. Process Analyses: Spatial Transformations and Access to Transportation Modes

So far, our case study analysis has focused on the roles, attitudes, and behaviours of political stakeholders. This approach follows the recommendations for case study research (Duminy et al., 2014; Flyvbjerg, 2006; Forester, 1999). From the perspective of social-ecological urbanism, we examined stakeholders' attitudes at multiple levels (Folke et al., 2005). We now focus on spatial segregation, because the first step in tackling mobility inequalities is to promote equal travel access for all (Haveman et al., 2013).

In the initial phase of the process, the Łódź Metropolitan Tram project, with the cooperation of municipalities under an inter-municipal agreement, offered a promising solution to the issue of degraded infrastructure and possible shutdowns of tram services. However, this joint initiative failed. The failure was due to several external factors, including lack of support from higher-level authorities (the Łódź Marshal Office and the government) and unfavourable legislative conditions (no metropolitan law). Internal factors included varying degrees of involvement and motivation on the part of municipalities, the unfair distribution of costs (long stretches of tramway routes run through poorer municipalities with smaller populations), and lack of coordination. Due to the lack of progress, there were increasing speed restrictions and suspensions of trams. These internal and external factors encouraged or forced some local authorities to seek solutions independently.

Actions to restore the trams were initiated by the largest and wealthiest local authorities (Pabianice, Zgierz, Konstantynów Łódzki), involving smaller municipalities (Ksawerów) only when they were necessary for the success of the entire investment. Poorer local governments (Lutomiersk, the Rural Municipality of Zgierz) were left without support, and with disproportionately large outlays to renovate the infrastructure relative to their populations and budgets. Smaller rural communes often have no alternative means of public transport, which can lead to exclusion of vulnerable groups of inhabitants. The lack of renovation of infrastructure by the smaller communities (RCoZ) also affected the ability of larger administrative units (Ozorków) to provide tramway transportation. These interdependencies, which result from the spatial relationships of municipalities, are presented in the schematic maps shown in Figure 5.

5.3. Process Analyses: Communication

Analysing the process from the point of view of ongoing communication (Forester, 1999; Healey, 1997) also brings valuable insights. The involvement of local NGOs should be emphasized, since they played an essential role in the process, putting pressure on local governments to take action. NGOs arranged protests, collected signatures for petitions, and drew attention to the social costs of lowering the quality of public transport and halting tram traffic. However, at no stage were they formally involved in the process. The lack of public consultation should be highlighted. The process should have included instances of active public involvement. Instead, the residents were treated as passive customers.

The protests by NGOs and residents together with media pressure were critical factors which fuelled the advancement of works of restoration of the tramway network. Media involvement is reflected in the numbers and dates of articles collected in Supplementary File. Interest in the process grew (Figure 6) in proportion to the lack of progress on the joint project. Most articles appeared during the period 2017–2018, when the joint initiative fell apart, tram courses stopped, and individual municipalities took action on their own. During this

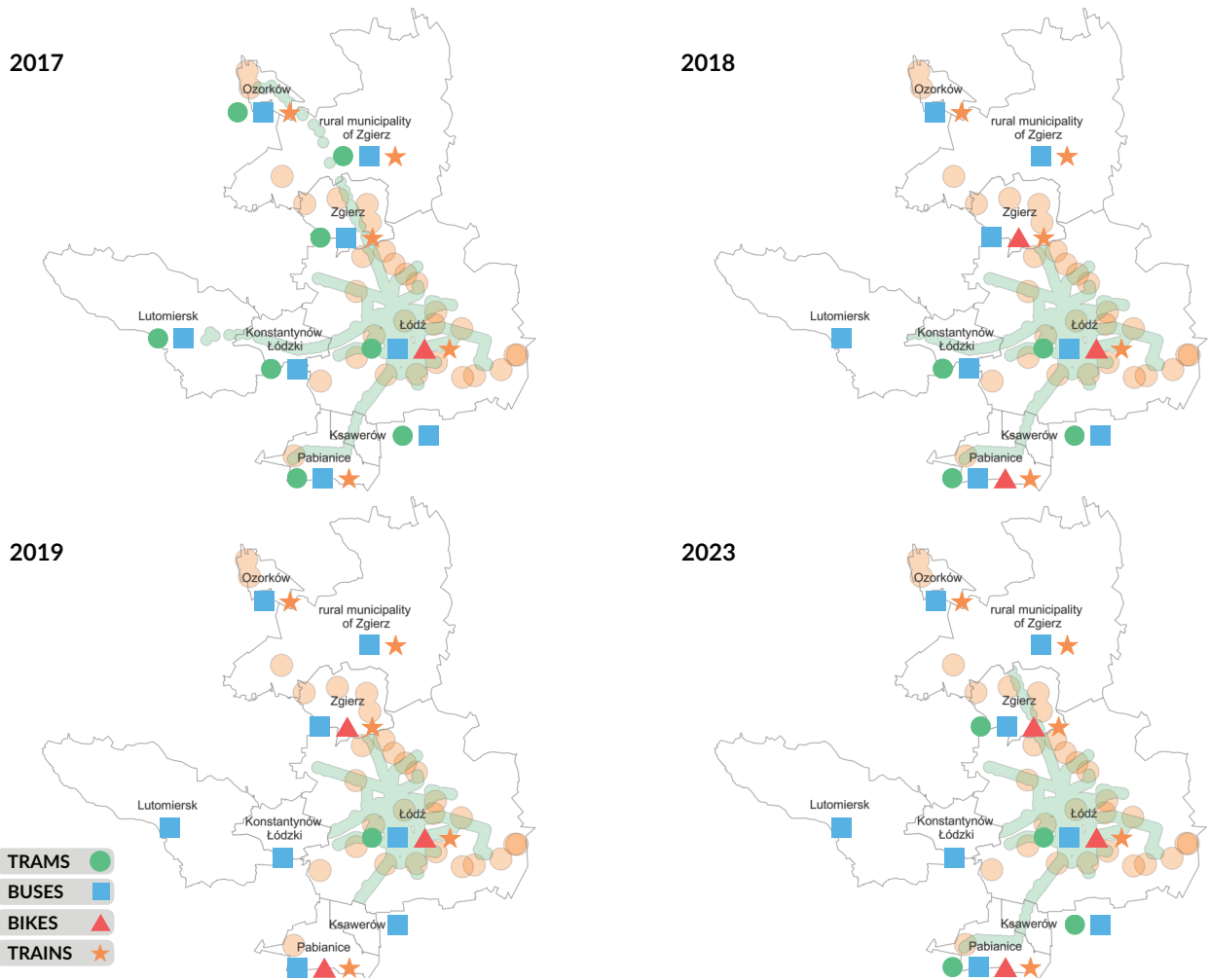


Figure 5. Maps representing the four phases of the redevelopment process: 2017 (before the closure), 2018 (first closures), 2019 (lack of tram services in several municipalities), and 2023 (return of services). Symbols indicate the availability of specific modes of public transportation in each of the administrative units.

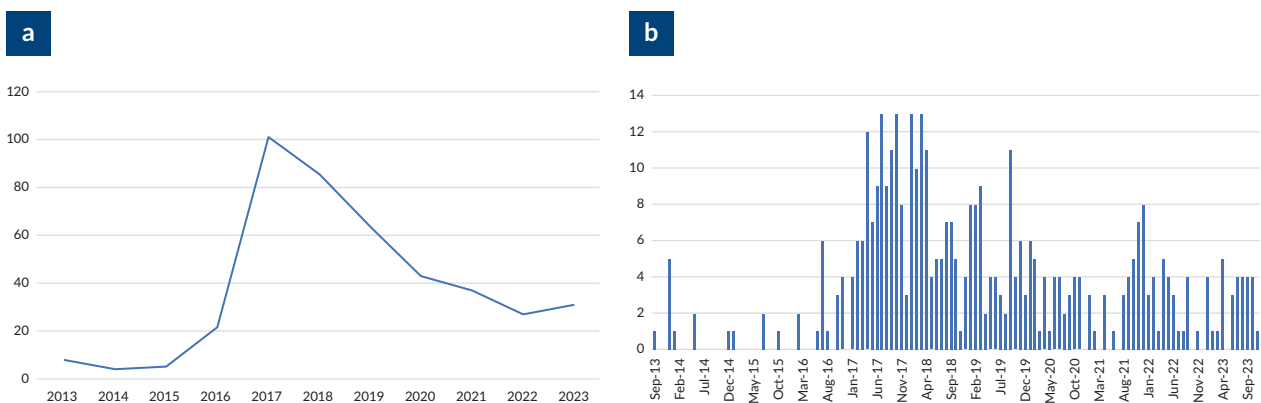


Figure 6. Number of press articles per year (A) and per month (B).

time, the media played an essential role by putting pressure on the authorities to do something. Examining the process timeline presented in Figure 4, we see that the topic of suburban trams only entered the public debate when the threat of traffic disruption became a real issue. Political factors are also evident. We see that the involvement of local- and higher-level authorities increased before the local elections in 2018 and the parliamentary elections in 2019.

6. Services Analysis and Discussion

In this section, we summarise the main threats outlined in the previous sections and address the research questions posed in Section 3. Figure 7a, modelled on an evaluation by Barthel et al. (2013), provides a detailed answer to the first research question (RQ1) by identifying the users of the transportation systems who are actors involved in the transformation process (Figure 7a, column 1). We associate the actors with the modes of transportation they use (Figure 7a, column 2). We also look at the representation of various age and sex groups in the Łódź region (Figure 7b). The juxtaposition of the two schemes provides an overview of the main groups using public transportation: commuters/students. There are also numerous elderly users, primarily female, who often have no other option than to use public transportation for individual commutes.

The motivations of specific user groups are closely tied to the services delivered by the transportation system (RQ2), which are listed in Figure 7a (column 3). The primary role of suburban trams in the Łódź metropolitan area is to provide access to labour markets, education, and services. Moreover, they play a role in ensuring integration within the region. The costs associated with decreased quality of the services (e.g., longer journey times) or the removal of connections are passed on to passengers. Higher costs mainly affect marginalised groups, such as the poorest, children, and older people, who often have no alternative modes of transport. This

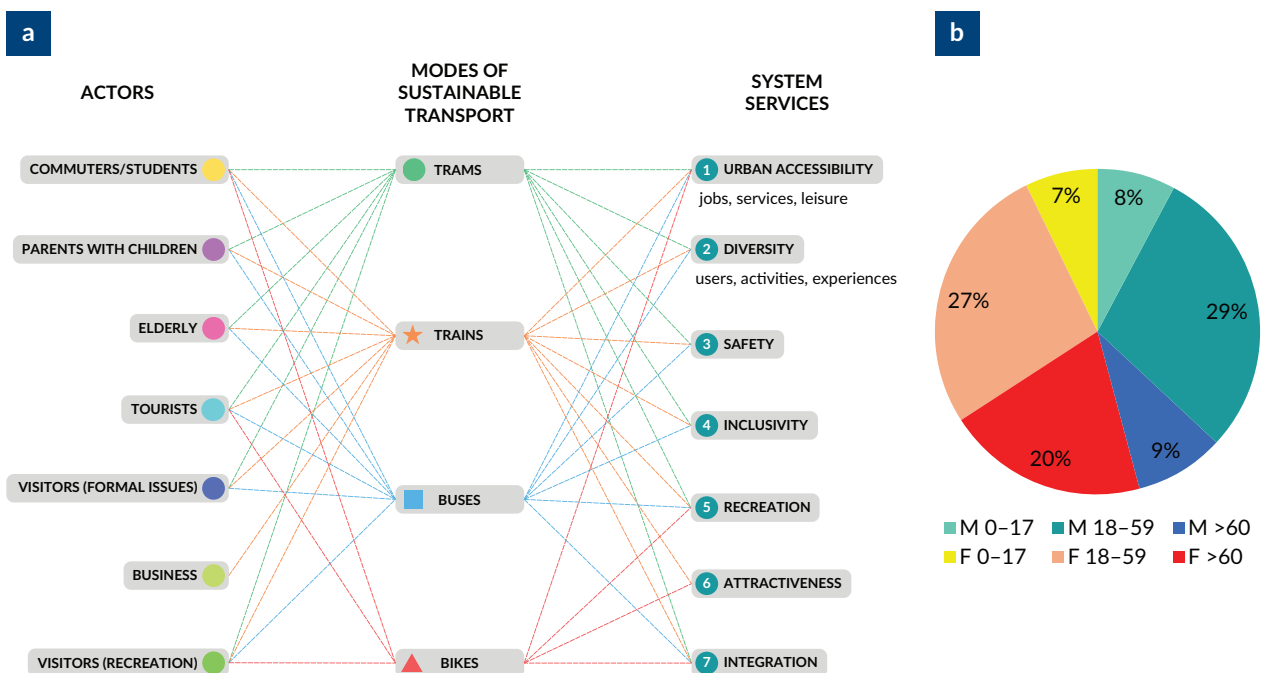


Figure 7. Visualizations of the main groups using public transportation: (a) social processes and relationships between stakeholders during the transformation of tramway systems in the Łódź Metropolitan Area; (b) social composition in the Łódź region.

affects both the diversity of users and the inclusivity of services. This is a prevalent issue in Poland, where 13.8 million Polish citizens are affected by transport exclusion. The liquidation of public transport services was one of the consequences of these systemic changes that occurred during the transition from a centrally planned economy to a market-oriented economy after the fall of communism in 1989 (Dulak & Jakubowski, 2018). This problem is most pronounced in predominantly rural areas with lower densities. There, long walks along congested routes increase the risks of traffic accidents and other dangers for non-motorised groups.

For the purposes of comparison and to enable more comprehensive answers to RQ2 and RQ3, we took the extra step of comparing the services in the Łódź tram network to reference cases (Table 3). The reference case studies included seven regional transportation systems that use either tramways or light railways. In the reference case studies, the trams are usually integrated with other transport systems, providing intermodal access. For instance, in the Kassel region in Germany, the multimodal light rail and regional railway systems provided significantly higher accessibility and attractiveness at the regional scale (Hamiduddin & Hickman, 2018). As a result, the development of the tramway system positively affects the local economy (Hamiduddin & Hickman, 2018; Sari, 2015). Enabling everyday commuting and, in particular, accessibility to employment opportunities is one of the primary roles provided by public transportation. This is also the case in the Łódź region. The stable tramway connection not only provides access to jobs for current residents of the suburbs but can also bring new inhabitants there, making the area more attractive, improving the social mix, and increasing density (Sari, 2015). Here, the Łódź region may grasp an opportunity, since it fulfils the basic condition needed for using the tramway system as an element strengthening its compact settlement network, which is the overlap of public transportation stops and settlement nodes.

Another important result of a well-functioning tramway system is an increase in the value of local real estate. This is not limited to transaction prices but also affects rent values (Gadziński & Radzimski, 2016). An essential outcome is the development of urbanity. Examples are given by the case of the tramline in Constantine (Algeria), which connects major commercial establishments and universities (Harkat et al., 2022), and by the case of urban rehabilitation in Medellin (Colombia; Reyes-Schade et al., 2022). Opening more mobility options to residents also means adapting infrastructure, i.e., stops and vehicles, to the needs of people with reduced mobility, such as older people, people with disabilities, or parents with prams. More

Table 3. Services provided by tramways and light rail systems in case studies used as references for the current research.

Services	Reference case studies							
	Łódź, Poland	Melbourne, Australia ¹	Bordeaux, France ²	Medellin, Colombia ³	Karlsruhe, Germany ⁴	Constantine, Algeria ⁵	Poznań, Poland ⁶	Albano, Sweden ⁷
1. Accessibility	X	X	X	X	X	X	X	X
2. Diversity	X	X	X	X	X	X	X	X
3. Safety	X					X		
4. Inclusivity	X	X	X	X	X	X		X
5. Recreation	X							X
6. Attractiveness			X	X	X	X	X	X
7. Integration	X		X	X	X	X		X

Sources: ¹ Lope and Dolgun (2020), ² Sari (2015), ³ Reyes-Schade et al. (2022), ⁴ Hamiduddin and Hickman (2018), ⁵ Harkat et al. (2022), ⁶ Gadziński and Radzimski (2016), ⁷ Barthel et al. (2013).

inclusive systems become attractive solutions for these otherwise excluded groups (Lope & Dolgun, 2020). This is already visible in Pabianice (since 2013) and Zgierz, where part of the rolling stock has been replaced by low-deck carriages. Recreation is another service which draws two-way traffic. Scenic landscapes or natural forest areas attract tourists and visitors, as was the case with line 43 to Lutomiersk before it was closed. Recreation in turn becomes an engine for territorial development, as exemplified in the case of the Albano university campus in Stockholm (Barthel et al., 2013).

The process analysis in Sections 5.1–5.3 suggests that the relationships that have developed over time between users and the infrastructure have become a factor that stabilizes the system's core elements and enhances its resilience. This conclusion is supported by the observation that public involvement, as evident in numerous press articles and subsequent political engagement, consistently occurred whenever there was a threat of tram closure. Protests occurred despite the absence of formal procedures for public engagement. This can be understood as a reaction to the possible loss of services provided by the transportation system—in our case, tramlines. This observation confirms that the management practices of various stakeholders—adaptive co-management—enhance the system's resilience (Ostrom, 1990).

7. Conclusions

We have applied the social-ecological urbanism perspective to analyse the transformation of the tramway network and public transportation inequalities in the metropolitan region of Łódź, Poland. This analysis was conducted using the case study methodology and by performing an in-depth analysis of the redevelopment of four tram lines. We looked at the activities and contributions of all stakeholders and the communication processes. We also analysed the role of the tram network in providing services to the public. The findings offer a fresh perspective on understanding the spatial and societal elements of enhancing mobility on a regional level. The schema elaborated in Figure 7a provides a useful matrix for describing other similar public transport redevelopment processes. Our main observation is that the tramway system forms a nexus of services that become part of citizens' everyday lives. This nexus strengthens the system's resilience by impelling collective actions. In our analysis, we paid special attention to the communication processes accompanying the studied transformation (Healey, 1997). Press articles and media coverage were found to have strongly affected the course of events and made steps towards the restitution of the tram lines possible. In the future, similar measures, including more formal, top-down citizen involvement, could lead to further improvements in the system. This could bring additional system benefits—e.g., by attracting new residents, or by providing recreation options in locations served by the tramline.

We intend to extend the proposed analytical framework further, by applying it to the redevelopment of similar urban systems. Analysing urban services in this way can provide valuable insights for formulating legal instruments and policies. Our future objective is to provide benchmarks for strategic redevelopment processes aimed at eliminating mobility inequalities in regions where such procedures may be necessary. Our study of the transformation of the tramway system in Łódź demonstrates that the strategic redevelopment of processes of such spatial extent and significance, involving many actors, requires a more conscious process design. In particular, one of the challenges for the future is the need to propose more conscious information policies.

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Conflict of Interests

The authors declare no conflict of interests.

Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

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