"Environmental Engineering" 10th International Conference
Vilnius Gediminas Technical University
Lithuania, 27–28 April 2017
http://enviro.vgtu.lt

eISSN 2029-7092 / eISBN 978-609-476-044-0

Article ID: enviro.2017.115
DOI: https://doi.org/10.3846/enviro.2017.115

A Method for Evaluating Tram Stops Based on Passenger Expectations and the Needs of Disabled Persons

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Abstract. Criteria against which assessment is carried out the operation of public transport generally refer to specific elements of the network of public transport, such as lines, vehicles, bus stops, etc. Criteria for evaluation and their types can be many and they can have diverse nature (Saaty 1995). The main aim of this study was to develop a method for evaluating tram stops based on passenger expectations and the needs of disabled persons. This consisted in developing the list of items to be evaluated and principles of assessment. The proposed method was verified in selected sites, and the results of the assessment are discussed in the paper. The surveyed sites were tram stops in the city of Olsztyn in north-eastern Poland. The main aim was achieved through detailed goals, including definition of the concept of municipal transport, description of infrastructure components that influence the quality, attractiveness and safety of the analyzed tram stops, presentation of evaluation indicators and the relevant criteria, and description of evaluation principles.

Keywords: municipal transport, public transport, tram stops.

Conference topic: Sustainable urban development.

Introduction

Contemporary public transport is defined as a system of transport services that is planned and managed by the municipal authorities with the involvement of public transport vehicles to accommodate local transport needs (Szołtysek 2007). Public transit (also called public transport or mass transit) includes various services that provide mobility to the general public, including buses, trains, ferries, shared taxi, and their variations (Litman 2017). In Europe, the share of public transport in municipal travel has decreased significantly in recent years. The factors that could contribute to the popularity of municipal transport include: safety, traveling comfort, modern rolling stock, separate roads, roadways or lanes for public transport, modern stop and station platforms, and passenger information systems (Brzeziński, Rezwow 2007). Municipal transport includes passenger and cargo traffic (Saniuk, Witkowski 2011). Passenger traffic is part of a vertical classification system, whereas territorial units such as area and market are part of a horizontal classification system (Kołodziejski, Wyszomirski 2002). The definition of municipal transport is closely linked with passenger transport, and it is often referred to as public transport (Starowicz 2007). According to other authors, the process of transporting large numbers of people across small distances is referred to as collective, municipal, public, local, urban and passenger transport (Gadziński 2010). A different classification exists in Polish transport geography which makes a distinction between transport and communication. According to Lijewski, transport is the sector of the national economy responsible for the movement of persons and cargo, whereas communication has a somewhat broader definition, and it includes transport as well as the distribution of information by means of post, the Internet and television (Lijewski 1977). Such a multitude of definitions necessitates an analysis of the complex transport process. Municipal transport is one of the key elements of urban life, therefore, the relationships between public transport and urban functions should be investigated in greater detail (Wyszomirski 2002).

Organization of municipal transport to cater to the needs of disabled passengers

Accessibility of transport is not always a priority in transport planning and implementation. There can be barriers in the physical environment and delivery of services that render transport inaccessible. The principle of the UN Convention on the Rights of Persons with Disabilities (CPRD) brings new momentum to ensuring accessibility in the delivery of transport infrastructure and services. The CRPD recognizes that obstacles and barriers to indoor and outdoor public facilities and buildings and the physical environment should be removed to ensure equal access by people with disabilities and all members of society (Babinard *et al.* 2012). The provisions of the United Nations *No.37/53 of 3 December 1982* World Program of Action concerning Disabled Persons constitute the major guidelines for developing urban policies in many countries. In line with objective 5 of the above program, all nations should include in their general development plans immediate measures for the prevention of disability, for the rehabilitation of disabled persons and for the equalization of opportunities (Wysocki 2007). The entity responsible for the organization and operation of a municipal transport system should provide all passengers with access to fast and safe transport services within a city's administrative boundaries and in its direct surroundings. People who can afford a car and are able to drive or can afford to hire somebody to drive them to common destinations seldom have difficulty achieving Basic Access. For example, a survey of Americans aged 65 or older found that non-drivers make 15% fewer trips to the doctor; 59% fewer shopping trips and restaurant visits; and 65% fewer trips for social, family and religious activities compared with their peers (Bailey 2004). To face the increasing numbers of people with disabilities in the next decade, the Syndicat Mixte de Transport en Commun de l'agglomération clermontoise (SMTC) transportation union of Clermont-Ferrand (France) launched the Mobi+ project, which aims to improve the accessibility (services) to urban public transportation to meet the requirements of Disabled, Wheelchair and Blind (DWB) people by adopting advanced information & communication technologies (ICT) and green technologies (GT) concepts. In order to facilitate the accessibility to urban public transportation for people with disabilities different improvements must be carried out jointly to vehicles (buses, tramways, trains, subways, etc.), infrastructure and information (Haiying *et al.* 2012).

Description of the evaluation method

Conventional travel models can be improved to better incorporate active travel ("Model Improvements" VTPI 2009). Tram stop infrastructure was evaluated to determine the stop's technical condition and its accessibility for disabled passengers. The proposed method was developed with the use of a scaling technique that relies on a point-based system. In this approach, the evaluated spatial features are expressed by a single number which denotes the overall quality of the analyzed area or site (Babicz-Zielińska *et al*. 2008). The proposed method supports an evaluation of 10 quality criteria. Every quality criterion is described verbally and with points on a scale of 0 to 2 (Jędryka, Kozłowski 1986). The main advantage of the proposed method is that the evaluated criteria are summed up and expressed by a single number (Babicz-Zielińska *et al.* 2008).

The point scale should meet the following criteria:

– every point on the scale should adequately depict the quality of the evaluated element,
– every element should be evaluated with the same number of points on a scale of 0 to 2,
– the scale should be linked with quality classes,
– every point on the scale should have a non-ambiguous definition of quality (Baryłko-Pikielna 1975).

The reliability of the obtained results is determined by the appropriate definition of quality levels and the evaluating personnel's ability to correctly interpret the results (Gawędzka, Jędryka 2001). The proposed 4-point scale consists of the following quality levels:

– level I; highest quality ($1.500 \leq x \leq 2.000$);
– level II; high quality ($1.000 \leq x < 1.500$);
– level III; average quality ($0.500 \leq x < 1.000$);
– level IV; low quality ($0.000 \leq x < 0.500$).

Indicators, criteria and evaluation principles

The analyzed infrastructure components in tram stops were ranked based on an analysis of the relevant literature, legal regulations, own experiences and the results of a questionnaire survey. The questionnaires listing 40 infrastructure components in tram stops were filled out by 100 municipal transport experts. The results were used to select 10 most important components which were referred to as evaluation indicators in the study. The results were processed statistically to calculate the weights for every component. The weights were expressed by a single number which was used in observations of the evaluated site to demonstrate differences in the significance of each observation. The criteria associated with every indicator were described verbally and with the use of points. The evaluation indicators, the relevant criteria and the relevant number of points are presented in Table 1 which constitutes a simplified evaluation chart.

Table 1. Simplified evaluation chart

A	B	C	D	E	F
Indicator	Weight	Criteria	Points	Score	Weight* Score
Tram stop shelter: design and materials	0.1058	Frame structure, walls made of transparent material	2		
		Frame structure, walls made of non-transparent material	1		
		no shelter	0		
Platform size	0.1042	Platform supports free movement of passengers with baby carriages or passengers in wheelchairs	2		

End of Table 1

A	B	C	D	E	F
Indicator	Weight	Criteria	Points	Score	Weight* Score
		Platform supports free movement only of passengers without baby carriages or wheelchairs	1		
		Platform does not support free movement of passengers	0		
Technical condition of platform surface	0.1038	Platform surface in pristine condition, fully accessible to wheelchairs	2		
		Platform surface requires repair or replacement of missing elements, wheelchair access is difficult	1		
		Platform surface requires replacement, no wheelchair access	0		
Tactile paving for sight impaired passengers	0.1032	Tall curb	2		
		Low curb	1		
		None	0		
Direct access from platform to tram for passengers traveling with carriages or wheelchairs	0.0999	Direct access from platform to tram for passengers traveling with carriages or wheelchairs	2		
		No direct access from platform to tram for passengers traveling with carriages or wheelchairs	1		
		No access	0		
Tram stop lighting	0.0994	Lighting in enclosure and its immediate vicinity	2		
		Lighting in enclosure only	1		
		No lighting	0		
Timetable	0.0989	Displayed digitally with voice messages	2		
		Displayed in print with waterproof cover, available in braille	1		
		Displayed in print with waterproof cover	0		
Sign with the name of the street and/or stop and stop number	0.0960	In contrasting colors, legible	2		
		Poor legibility	1		
		None	0		
Surveillance camera	0.0949	In the enclosure and its immediate vicinity	2		
		In the enclosure only	1		
		None	0		
Ticket vending machine	0.0939	Polish and English interface	2		
		Polish interface	1		
		None	0		
			Total		
4-point scale					
Level I. Highest quality ($1.500 \le x \le 2.000$)			Evaluation class:		
Level II. High quality ($1.000 \le x < 1.500$)			Site (address):		
Level III. Average quality ($0.500 \le x < 1.000$)			Date of evaluation:		
Level IV. Low quality ($0.000 \le x < 0.500$)			Evaluation by:		

Evaluations should be performed in line with the following principles:

- evaluations should be conducted with the use of the indicators and the relevant criteria described in this study,
- the data required for the evaluation should be obtained during field surveys and entered into the simplified evaluation chart (with a description of the evaluated indicators and the relevant criteria).

Verification of the proposed method in a selected research site

The city of Olsztyn received municipal rights in 1353, but it began to thrive only in 1890 when Olsztyn was connected to a railway line. Rapid technological progress increased the demand for electricity in the city. The municipal power grid in Olsztyn was expanded in the early 19th century, and it supported the development of tram lines. The construction of the first tram line began around 1905 when Olsztyn was the capital city of 25,000 administrative districts. The first two lines connected the city center with the Main Railway Station in Olsztyn. A chronological list of major events during the construction of the first two tram lines is presented below: on 15 December 1907, line No. 1 with a length of 2.3 km (Main Railway Station – St. John's Bridge on the Łyna River) and line No. 2 with a length of 2.4 km (1 Maja Street – Jakubowo) were launched; on 19 April 1908, line No. 1 was extended to the Roosevelt Square; on 9 December 1909, the second segment of Line No. 1 with a length of 2.7 km (St. John's Bridge to the depot opposite the Western Railway Station) was commissioned for use; in 1910, the operator introduced tickets and employed conductors. The first trams were small vehicles with only 18 seats and standing room for 14 passengers on an outdoor platform. Olsztyn had a population of 33,000 when the first tram line was launched; in 1930, line No. 1 was extended to Przyjaciół Avenue. The segment between Jagiełły St. and the Western Railway Station was closed, and a new route running from Grunwaldzka St., via a tunnel and Bałtycka St. to Przyjaciół Avenue was built; in 1934, trams ran every 7.5 minutes on average in line No. 1 and every 15 minutes in line No. 2. The average speed was 11.5 km/h; on 2 January 1939, the Municipal Transport Company launched a trial omnibus line running between the city center and the Mazurskie Housing District; in 1943, tram line No. 2 was converted to a trolleybus line. Olsztyn also had cargo trolleybuses transporting coal to a heat generation plant; in 1945, when Olsztyn was occupied by the Soviets, the Regional Board for Local Industry decided to revive the equipment left behind by the Germans and reinstate public transport in the city. The State Mechanical Plant overhauled old tramcars. Traction lines were repaired, and the damaged tram depot on Wojska Polskiego St. was rebuilt. In late April 1946, the first post-war tram line from Lake Długie to the Main Railway Station was launched. It had a length of 3.3 km, and trams ran every 54 minutes on average. in early May 1946, the Directorate of Municipal Service Companies established the Municipal Transport Company headed by Ludwig Zaleski. The new company employed 30 staff members. In late May 1946, a second vehicle was introduced in line No. 1. On 28 June, the second tram line from the City Hall to the Leśny Stadium was launched. The line had a length of 2.3 km, and trams ran every 27 minutes on average; in 1947, Olsztyn had three public transport lines with 6 tramcars and 3 trolleybuses; In 1958, municipal transport lines in Olsztyn had a combined length of 43 km, including 6 km of tram lines. A total of 8 lines, including 2 tram lines, were in operation. The passenger throughput for all lines was 16 million. on 20 November 1965, tram lines in Olsztyn were decommissioned (Śrutkowski 2007).

The municipal system in Olsztyn features 35 bus lines that constitute its backbone. Tram lines were built to cater to the city's growing demand for public transport, and they have a total length of 11.1 km. (the main line has a length of 7285 m; the side line to the Kortowo campus of the University of Warmia and Mazury in Olsztyn has a length of 1903 m; the side line to Wysoka Brama (High Gate, Old Town) has a length of 792 m; the service line to the depot has an estimated length of 1100 m. The main line and the service line have two tracks. The side line to Wysoka Brama (High Gate) has two tracks on Piłsudskiego Street and one track on 11 Listopada Street. The side line to the Kortowo campus has one track with one switch. The line has a total track length of 10 km with 20 stops. The Olsztyn tram network is the only Polish network without a terminal loop. For this reason, it is also the only Polish line that relies exclusively on double-ended tramcars. At present, there are three tram lines in Olsztyn: Line No. 1: JAROTY – Witosa – Płoskiego – Sikorskiego Ave. – Obiegowa – Żołnierska – Kościuszki – Piłsudskiego Ave. – 11 Listopada – WYSOKA BRAMA-HIGH GATE (trams run every 7.5-30 minutes); Line No. 2: JAROTY – Witosa – Płoskiego – Sikorskiego Ave. – Obiegowa – Żołnierska – Kościuszki – MAIN RAILWAY STATION (trams run every 15-30 minutes); Line No. 3: KORTOWO – Tuwima – Sikorskiego Ave. – Obiegowa – Żołnierska – Kościuszki – MAIN RAILWAY STATION (trams run every 15–20 minutes).

The proposed method was verified in tram stops serving tram line No. 1. A total of 13 tram stops were surveyed on 14 October 2016. The results were recorded in simplified evaluation charts (Table 1). The collected data were used to perform the final evaluation based on the indicators and criteria described in this study (Table 1). Every infrastructure component was awarded points that best matched its condition (evaluation criteria), and the number of points was multiplied by the weights given in column B of Table 1. The results for 10 indicators were summed up, and based on the final outcome, the evaluated feature was assigned to a given quality class. Pooled results are presented in Table 2.

Table 2. Pooled evaluation results

Stop	Line destination: Wysoka Brama (High Gate) – Kanta Street			
	Points	Class	Remarks	
Wysoka Brama/High Gate	1.8704	I	no digital timetable	-
Centrum/City Center	1.8704	I		-
Skwer Wakara/Wakar Square	1.8704	I		-
Szpital Wojewódzki/Regional Specialist Hospital	1.8704	I		-
Pstrowskiego-Sikorskiego Streets	1.8704	I		-
Dywizjonu 303/No. 303 Polish Fighter Squadron Street	1.7436	I		no ticket vending machine
Galeria Warmińska/Warmia Shopping Arcade	1.8704	I		-
Auchan Hypermarket	1.7436	I		no ticket vending machine
Andersa Street	1.7436	I		no ticket vending machine
Sikorskiego-Wilczyńskiego Streets	1.8704	I		-
Płoskiego Street	1.7436	I		no ticket vending machine
Witosa Street	1.8704	I		-
Kanta Street	1.8704	I		-

The results of the study (Table 2) indicate that tram stops serving line No. 1 in Olsztyn are characterized by high quality infrastructure. Four of the analyzed stops were not equipped with ticket vending machines. Random distribution of ticket vending machines is not recommended.

Conclusions

Traditional urban public transportation systems worldwide are generally designed for a healthy population and rarely take into account the needs of people with disabilities. The United Nations estimates that between 6 and 10% of the population in developing countries and some 400 million people worldwide have a disability. They cannot provide an effective access service for people with disabilities, especially for disabled, wheelchair and blind passengers. Moreover, the devices of urban public transport are important factors in reducing poverty and can facilitate the participation of disabled people in the processes of economic, social and political (Roberts, Babinard 2012). The aim of this study was to propose a method for evaluating tram stops based on passenger expectations and the needs of disabled persons and to present the results generated by the developed method in selected research sites. The obtained results supported the formulation of the following conclusions: improving the quality of services encourages the use of public transport; it is necessary to develop methods to assess the quality of transport services; developed method is uniwersal, allows the assessment offered transport services in all countries; the proposed method is suitable for evaluating all types of tram stops in the European Union; the development of similar evaluation methods for bus lines would facilitate comprehensive assessments of point infrastructure in stops serving municipal transport passengers in any city; the results obtained with the use of the proposed method enable to identify missing or neglected infrastructure components in tram stops; the evaluated tram stops are characterized by modern shelter design that blends into the surroundings as well as the availability of infrastructure that contributes to the comfort and safety of disabled passengers and passengers traveling with baby carriages; the results of the evaluation can be used to plan repairs and introduce suitable measures to improve the quality of passenger infrastructure in tram stops.

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