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INDICATORS OF SERVICE QUALITY OF PUBLIC TRANSPORT

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Abstract. This article presents the findings in the field of public transport planning, routes network optimization and service demand affecting indicators as well as analysis of public transport indicators in Klaipėda City. It investigates a wide range of approaches to the evaluation process of service quality of public transport proposed by scientists and these field practitioners and defines the most significant indicators. The article encourages discussions for further research of defined indicators of public transport service and proposes its ranking from the most significant one. Findings are suggested being used for policymakers, planners or other researchers as the base for the evaluation of public transport service network in cities, also to evaluate the quality and compare the results among transport districts within the city limits. By knowing the core of the problem of the network of public transport service, it is possible to plan the changes and improve the service quality, therefore, ridership of the system.

Keywords: demand identification, public transport, public transport indicators, service quality, transport planning, GIS.

Introduction

Half of humanity (about 3.5 billion people) already lives in cities, and the number will continue to grow. With such expansion, specific problems emerge, for example, high pollution level, energy consumption, and people inequality. Sustainable development is an ultimate solution for these and other problems and assistance to disordered urban growth. The integrity and stability of the natural environment and the needs of future generations are as much important as current needs and development of modern society. According to United Nations organization, there are 17 goals to reach sustainable development and 11th of them is sustainable cities and communities. Facts and goals lead to the main topic of this article, transport infrastructure and its optimal planning as one of the essential features in every city. Public transport (hereafter – PT) plays an essential role in sustainable transport ecosystem. Planning optimal public transport network infrastructure significantly contributes to solving particular problems in cities, but it is a complicated task.

There are many books, articles, and other materials, which focus on public transport routes network indicators and their influence on user behaviour, demand increase or decrease, and operational costs. However, the problem is that there is no definition, which is the most significant ones and must be considered when planning a PT route or optimizing the existing PT network. Such contribution with public transport indicators would be a significant help and guide for transport infrastructure planners to optimize PT routes network, to determine whether PT operates efficient enough or it needs some improvements, modifications, and routes planning in some regions of the city.

This article aims to review the foreign and Lithuanian literature and exclude most essential indicators for the optimal PT network. Indicators are suggested being used as the basis for PT service network evaluation in cities. Analysis of public transport network of Klaipėda City presented as an example of the indicators evaluation.

1. Public transport indicators

In most of the literature sources, PT indicators and parameters are usually divided into two categories: qualitative and quantitative. Qualitative indicators show the benefits to passengers, while quantitative – more for PT operators.

According to Burinskienė, Paliulis and Ušpalytė-Vitkūnienė (2009) and Jurkauskas (2004) main qualitative indicators are the regularity of vehicles, frequency, travel time, safety, and travel transfer coefficient.

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Jurkauskas (2004) suggests these main quantitative indicators: number of passengers transported, run coefficient, the coefficient of passenger-shift, passenger travel time, number of passengers transported per hour and operating speed.

The choice of mode between private vehicles and PT is a complex of the decision process, which is influenced by various factors. Trip characteristics, such as for purposes of the trip, time of trip and regularity of trip, and demographic characteristics, such as age, gender, and income level, were shown to be significant factors in mode choice (Ye, Pendyala, & Gottardi, 2007). Many studies were conducted to determine the most significant performance indicators of PT services. Usually, the choice based on the goals and objectives of the authorities. However, different studies used variant performance indicators, so it is hardly be used to reach a generalized conclusion (Benjamin & Obeng 1990; Karlaftis, 2004). Findings have led some researchers to conclude that it is advisable to use a more concise yet reliable set of indicators to describe the public transport system performance (Karlaftis, 2004).

Loader and Stanley (2009) stressed that a minimum level of PT service quality must be provided before ridership levels increase.

A large variety of approaches to service quality has been developed in recent years regarding the complexity of the concept and the broad range of attributes required to evaluate PT service quality. For a long time, the performance evaluation of PT has been carried out from the perspective of service managers, based on the cost efficiency and cost-effectiveness of PT services and operations (Hensher & Daniels, 1995; Pullen, 1993). However, Service Quality (hereafter – SQ) had become a significant area of attention for practitioners, managers, and researchers, who have focused on the perspective of passengers. Offering high-quality PT services will encourage a modal shift from private modes to PT services and, consequently, it will promote more sustainable mobility (J. de Oña & R. de Oña, 2014).

Beirão and Cabral (2007) findings indicated that the service needs designing in a way that accommodates the levels of service required by customers and by doing so attract potential users to increase public transport usage. Scientists added that whether service is unreliable, has a low frequency or lack of comfort; people are likely to shift to using cars because they misunderstand public transport as a viable alternative to them. Attributes like frequency and comfort are also highly valued by consumers, being key elements of consumer satisfaction (Friman & Gärling, 2001; Hensher, Stopher, & Bullock, 2003). Other attributes found having a significant negative impact on consumer satisfaction are travel time and fare level (Hensher et al., 2003).

Beirão and Cabral (2007) research have also defined most important indicators for different PT users according to their social status (worker, students). For instance, stated importance studies for bus services showed that in lines used predominantly by workers, some service attributes such as punctuality, frequency, bus driving security and information service are most important (Guirao, Garcia-Pastor, & Lopex-Lambas, 2016). Alternatively, ease of ticket purchase, onboard security and reliability are the most important attributes in predominantly transporting students (Eboli & Mazzulla, 2009). In turn, derived importance studies show that comfort is the most relevant attribute for riders over 65, while the sense of security and cleanliness are essential factors in determining travel satisfaction for women (dell'Olio, Ibeas, & Cecın, 2011; Yavuz & Welch, 2010).

Paulley, Balcombe, Mackett, Titheridge, Preston, Wardman, and White (2006) concentrated on the PT demand identification findings regarding the influence of fares, quality of service and income and car ownership. Researchers also added there is little doubt that a wide range of factors influences the demand for public transport, and there is plenty of empirical evidence as to what the relevant factors are, and which of them are more important than others. In different circumstances, it must always recognize that the results are subject to a considerable degree of uncertainty.

Urban Transport Green Paper (Commission of the European Communities, 2007) is European Commission document, which defines mobility issues in urban areas and the options to improve it. This document emphasizes that citizens expect public transport to cater for their needs, regarding quality, efficiency, and availability. Public transport has to be more than accessible but also frequent, quick, reliable, and comfortable to be attractive. Experience shows that an obstacle to a modal shift from private to public transport is often the low quality of service, slowness, and unreliability of public transport.

2. Defined indicators of public transport service

A considerable number of attributes have been used to evaluate service quality, i.e., Murray, Walton, and Thomas (2010) consider 166 attributes. Public transport quality depends on several factors (attributes) of the service. Some are quantitative (e.g., average travel time and its reliability; transit waiting time; monetary costs), while others are qualitative, whose effects on user behaviour are more difficult to assess (e.g., riding comfort, information, personal security) (Cascetta & Cartenì, 2014). Few studies have analysed both subjective (traveller satisfaction) and objective (transit performance) measures (Eboli & Mazulla, 2010; CEN, 2002; Nathanail, 2008; Tyrinopoulos & Aifadopoulou, 2008).

One of the primary documents, which specifies the requirement to define the target and measure the quality of service in public transport, and guides the selection of related measurement methods, is European standard EN 13 816 :2002, which was approved by CEN on 30 December 2001. Since 2002 it was also adopted as Lithuanian standard. The primary purpose of this document is to promote a quality approach to public transport operations and focus interest on needs and expectations of customers. Promotion of the quality and focusing on customers is done by specifying procedures most likely:

- to draw the attention of the responsible parties for matters to be considered;
- to lead to relevant and well-founded decisions particularly about the allocation of responsibilities;

– to enable customers, and others, to compare service quality claims from alternative suppliers, reliably;
– to contribute to the implementation of a process of continuous improvement.

It was written in this standard that it is adopted by:
– public transport services for which a single operator carries sole responsibility for all significant quality criteria or two or more parties share responsibilities, by an agreement;
– authorities in a tendering and contracting situation require that this standard provide the service.

Although the overall quality of public transport contains many criterions, EN 13 816:2002 standard generalizes and divides it into eight main categories:
– availability;
– accessibility;
– information;
– time;
– customer care;
– comfort;
– security;
– environmental impact.

Availability – extent of the service offered regarding geography, time, frequency and transport mode. Network indicators measure the possibility to go anywhere without difficulty (e.g., the share of existing and potential PT users with direct journeys, distance to boarding and alighting points, the area covered). Operation measures describe the quality of the services offered regarding appropriate frequency, schedule, and operating hours. Mode measures are access to services suitable to meet needs of customers or the share of customers living within a specific distance of boarding and alighting points of a given mode (Cascetta & Cartenì, 2014)

Accessibility – access to PT system including interface with other transport modes. Access is the degree when public transport is reasonably available to as many users as possible. A reasonable level of access to mobility services is unanimously considered an essential right in a democratic society.

This criterion includes internal and external interface and ticketing options. Ticketing indicators relate to the easiness of obtaining a service ticket and the overall fulfillment of ticketing selling services on and off-network. By Europe Union (hereafter – EU) legislation, availability of an integrated fare and its perceived quality was included as an important PT accessibility indicator.

However, most studies of public transport accessibility focus on proximity to stops and walking distances or time to reach them. In some studies accessibility is simply a transport measure captured by the number of public transport nodes within a respective radius or the proximity to the nearest transport node or measures of route density (Ong & Houston, 2002).

Information is also a significant factor, and the lack of it contributes as a barrier to use public transport. It is the systematic provision of knowledge about PT system to assist the planning and execution of journeys. According to Beirão and Cabral (2007) research, some infrequent users and non-users claim to lack information about the bus system and perceive public transport as difficult to use. Some car users say they would use the bus service if they had more information about PT service.

Providing greater access to service information and more interactive services (e.g., real-time timetable information) is a way to increase perceptions of individuals of control with public transport (Gardner & Abraham, 2007).

Paulley, Balcombe, Mackett, Titheridge, Preston, Wardman and White (2006) imply that even though it is relatively easy to discover who makes use of various information systems, there is little direct evidence of their effect on demand.

Time – aspects of time relevant to the planning and executions of journeys concerning trip length and adherence to schedule. Time indicator includes service regularity, average access, egress and interchange time, in-vehicle time, service punctuality, waiting times at boarding and alighting points, the number of inaccessible connections.

Travel time is a key factor when choosing a mode of transport. For work or school journeys, time importance is much higher. Beirão and Cabral (2007) analysis of PT users and non-users survey proved that respondents want to feel in control when travelling and this means brief waiting times, a quick journey and reliability. Also, there is a preference for a direct, frequent public transport service. Generally, people want their trip without change of the vehicles during their journey, unless the change is perceived as easy and fast. The problem is the uncertainty of when the transport will arrive (Konig & Axhausen, 2002). When the there is no pressure to be on time, like for leisure journeys, the value attached to time is lower.

Customer care – service elements introduced to effect the closest practicable match between the standard services and the requirements of any individual customer. It is the attitude of operators towards its customer, respect, and customer orientation, professional staff, and assistance at service interruptions and for customers needing help. The important measure is ticketing options, tickets flexibility and concessionary tariffs for people of different social status. Thøgersen (2009) notes that it is imperative that attributes such as access and frequency of the PT service are not prohibitively limiting to the use of public transit. While fare price support and encourage intentions to use PT, other quality attributes will determine whether such intentions are implemented and maintained.

Comfort – service elements introduced for the making of PT journeys relaxing and leisure. Ušpalytė-Vitkūnienė (2006) suggests this indicator is one of the priorities that have to be improved and usually named among top criterions from the passenger perspective. It defines fast and comfortable vehicles, well-equipped bus stops.

Cascetta and Cartenì (2014) elaborate that comfort includes seating and personal space, ride comfort, ambient conditions and aesthetic quality of terminals. For example, seating and personal space indicators are level of crowding, the percentage of seats free, seat comfort (the last two indicators are innovative concerning EU standards). Ride comfort indicators measure the quality of driving, while

ambient condition indicators evaluate cleanliness, air conditioning, and noise (the last two go beyond EU standards). The architectural and aesthetic quality of terminals (unlisted in EN 13 816:2002) is an essential measure of comfort, which influences user travel choices.

İmre and Çelebi (2017) have found that even though comfort level of PT systems is highly variable, depending on some factors, they particularly excluded crowd density in-vehicles during peak hour criterion. The scientist also implied that when the level of discomfort is higher than the acceptable level of passengers, the private car usage likely becomes more attractive than public transport because of its convenience and comfort.

In Foote's (2004) study of customer-focused improvements in the PT services of Chicago Transit Authority, results showed a 5% (or 15 million trips per annum) increase in ridership over five years after a sustained period of decline. Improvements focused on comfort-related issues such as vehicle cleanliness, safety and improved complaints handling (Redman, Friman, Gärling, & Hartig, 2013).

Security – a sense of personal protection experienced by customers, derived from the actual measures implemented and from an activity designed to ensure that customers are aware of those measures. Indicator concern subjective perception of security (e.g., freedom from crime) and some more objective statistics (e.g., rates of reported crime against passengers). It includes a low rate of PT involved accidents, security improvements in bus stops (particular attention to ones, which exists in peripheral areas).

According to Ušpalytė-Vitkūnienė (2006) from the statistics of Lithuania point of view, comparatively low number of traffic accidents of Lithuanian cities in PT service sector proves that the situation of security is not the reason for not choosing PT as a way of transportation. For example, in 2003 traffic accidents where PT was involved reached 11.8% of all accidents in Vilnius City.

Environmental impact – effect of the environment resulting from the provision of PT services. Increased use of PT means less pollution of the environment using private vehicles. Decreased exhaust gases and noise as well as reduced traffic in the city center. The optimal public transport routes network and frequency contribute to improving this indicator.

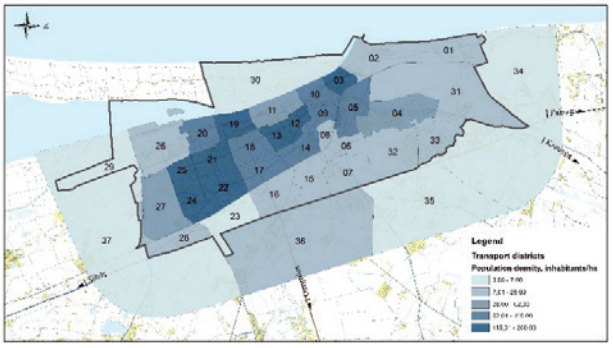
However, literature study has proved that environmental concerns about car use are usually irrelevant in the travel mode choices for the PT customers. The argument adds to the studies, which suggest that even though information about the negative environmental effects of the car use raises some awareness, it is usually insufficient to change behaviour (Anable, 2005; Hagman, 2003). However, there is some evidence that the incorporation of environmental concern measures provides additional beliefs that targeted to change behaviour (Anable, 2005).

3. Analysis of public transport in Klaipėda City

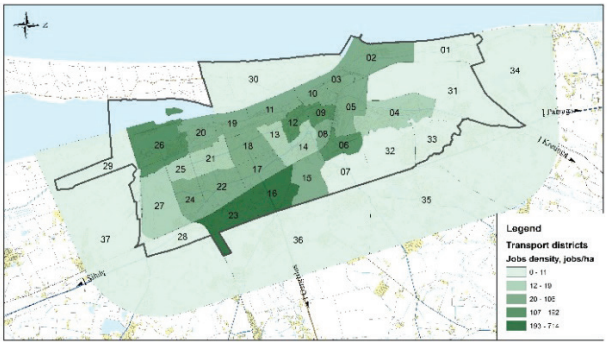
Klaipėda, the third largest city of Lithuania, is situated in the Western part of the country. The linear structure of the streets network, formed along the seaport, forms a clear urban structure of the Klaipėda City. Structure of cities allows successful organization of the PT service network and prevents traffic flows in the inner streets of the living blocks (Juškevičius, Valeika, Burinskienė, & Paliulis, 2006). The primary object of the research is the case of Klaipėda City and its peripheral areas as especially here, because of the intensive urban sprawl, arising from the central public transport accessibility and service problems.

The primary public transport type in Klaipėda City is buses. Klaipėda serviced by 32 city routes (including regular and express) and 16 suburban routes, which merge into the PT network of the city. Public transport network provides access to the services for the residents of peripheral areas.

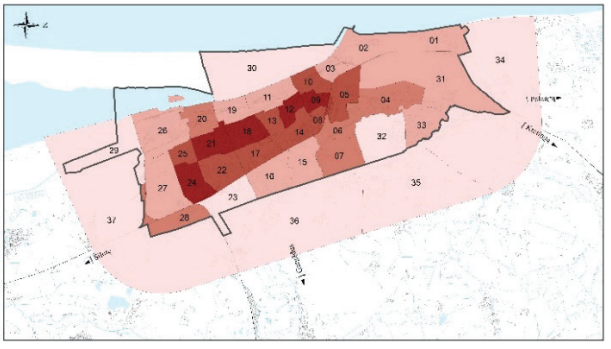
Four indicators were chosen for the analysis of public transport of Klaipėda City: population density, jobs density, PT density (Figure 1) and PT accessibility.



A – population density



B – density of jobs



C – public transport density

Figure 1. Public transport indicators in Klaipėda

The density of population in the built-up area counted with GIS tools by using Department of the Statistics of Lithuania population data and spatial GIS database information. The average density of population in the transport district of Klaipėda City is 63 inhabitants/ha. The most densely populated, which means the most compact are 21st, 22nd, 24th, and 25th transport districts near Smiltelė and Statybininkų streets axis, here live 45% of total inhabitants of Klaipėda City. However, in the peripheral areas of Klaipėda City, the number of population density is more than 10 times lower than within the city limits and moderately reaches only 4.4 inhabitants/ha.

The highest density of jobs is in 6th, 9th, 12th, 16th, 23rd and 26th transport districts (in the central part of Klaipėda, in the southern part of Klaipėda City near the harbour and Lypkių district). Here concentrate almost half (48.8%) of all job places of Klaipėda City. The average jobs density in peripheral areas hardly reaches 4.25 jobs/ha. Workplaces have a high attraction rate for everyday trips, so it is essential that access to these places would be convenient not only by car but also comfortable and fast by public transport.

Public transport route density represents the number of bus lines between origin and destination. Also, whether it is a direct or indirect route when considering travelling by bus. It reflects the possibility of different travel directions and different destinations. Šeštokas and Juškevičius (1973) proposed such values of optimal PT routes density in transport districts for:

- buses 2–3 km/km^2;
- trolleybuses ≤1.5 km/km^2;
- trams 0.8–1.0 km/km^2;
- metro 0.4 km/km^2.

The accessibility to PT has been assessed with ArcGIS program by creating buffer zones around the existing PT stops. The reach limit was taken within a radius of 500 m from stops (Figure 2). Level of accessibility was estimated by subtracting the green and water areas of a total area of the districts.

Ušpalytė-Vitkūnienė (2006) defines accessibility meanings of covered built-up areas by public transport:

- 90 to 100% of the area regarded as fully accessible;
- 70–90% of the area is well-accessible;
- 50–70% of the area is accessible;
- 30–50% of the area is little accessible;
- up to 30% of the area is not accessible.

Most of the territories in Klaipėda City are entirely or well-accessible by public transport. Accessibility level meets appointed requirements of Lithuanian regulations – 500 m radius must be provided for not less than 80% of the built-up area of the city. Only one out of thirty-seven transport districts is little accessible (district 34–46.7%), and two districts are not accessible (district 29–28.1% and district 37–17.1%). Most of the built-up areas which are not entirely or well-accessible are the districts in the peripheral area of the city. Not surprisingly, since single and duplex dwelling-houses is spread here, the territories do not have a definite shape and structure due to the dynamics of chaotic development.

Comparison of the population, jobs, PT density and PT accessibility indicators highlighted the problematical areas of PT accessibility. Also, there are areas where there is no accessibility, but at the same time, there are no inhabitants or jobs places.

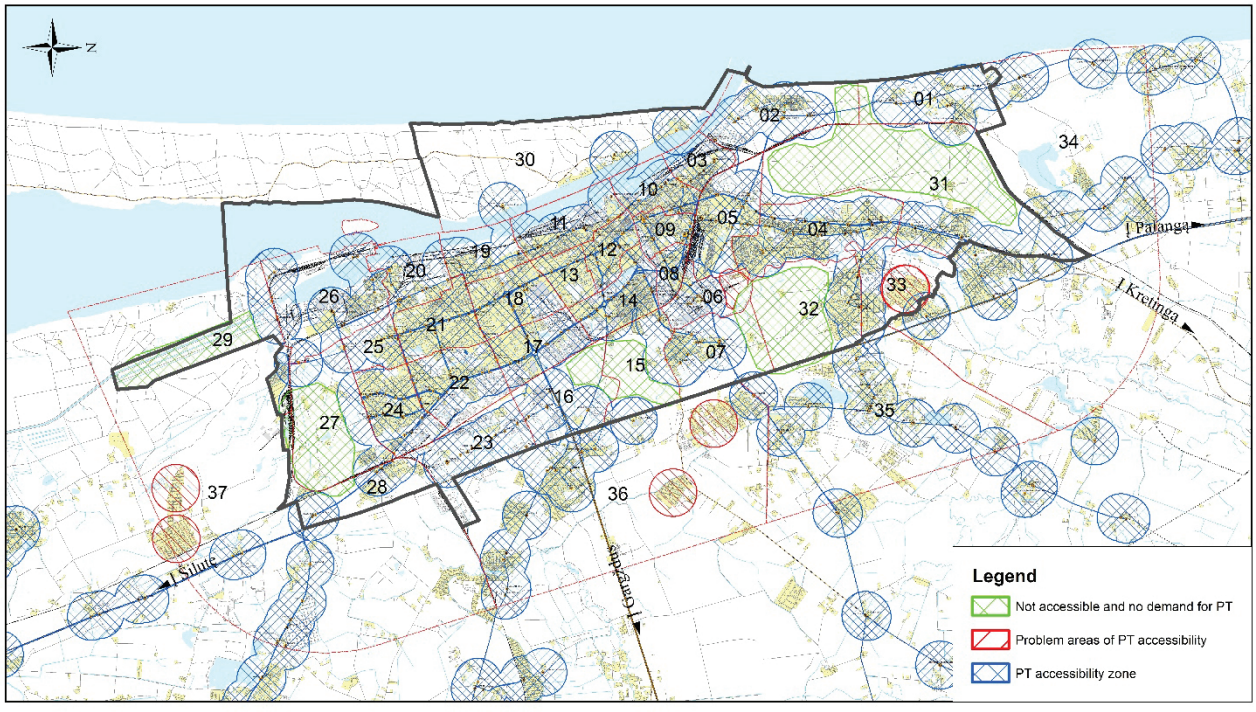


Figure 2. Public transport accessibility in Klaipėda City

Discussions and conclusions

Most of the literature emphasizes the importance of quality of public transport with particular attention to the areas and inhabitants that lack public transport services. Analysis of the literature indicated that operators must be guided by criterions, which are firstly important to people and ensure useful service. As a result, public transport operators, as well as other companies, have to improve service quality, which they provide continually. It is important to find out whether provided service meets the expectations of the users and satisfying their needs. Moreover, service is related to the quality – a set of criterions having a direct influence on perceived and delivered value. It is important to understand the quality as a set of service of features, which allows the operator to meet the expressed or implied needs of the user.

Such indicators are mostly mentioned in public transport service quality and demand researchers: frequency, time, accessibility, comfort, reliability, operating speed, profitability, price per passenger, and some passengers per kilometre.

To sum up, such criterions have been chosen as most noted and most important ones: availability, accessibility, information, time, comfort and security. It is recommended to rank these criterions, and according to that investment in service quality of public transport, improvement needs prioritizing.

Defined criterions are recommended using for analysis of the level of services of public transport in transport districts of any city. Identification of these criterions used as a tool to identify the demand and better plan and operate the network of public transport routes. Comparison of the indicators performed between the transport districts or even benchmarking the public transport performance of different cities.

The analysis of the public transport of Klaipėda proved that public transportation in the peripheral zone not sufficiently developed and not all inhabited, expanding territories have access to the city by public transport. Two of the four peripheral districts considered as not accessible (district 37–17.1%) or little accessible (district 34–46.7%) and needs improvement. The case of the Klaipėda City has shown that the chosen four indicators are the most significant and related to each other and in the future for the analysis of the PT service level should be used jointly.

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VIEŠOJO TRANSPORTO PASLAUGŲ KOKYBĖS RODIKLIAI

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Santrauka

Šiame straipsnyje pristatyti viešojo transporto planavimui, maršrutų tinklo optimizavimui bei šios paslaugos poreikiui įtakos turintys veiksniai (rodikliai) ir taip pat viešojo transporto veiksnių (rodiklių) analizė Klaipėdos mieste. Jame nagrinėtas įvairių mokslininkų ir šios srities specialistų požiūris į viešojo transporto paslaugų kokybės vertinimą ir išskirti svarbiausi rodikliai. Straipsnyje skatinama diskusija dėl tolesnio viešojo transporto rodiklių tyrimo ir siūloma juos įvertinti pagal svarbumą. Siūloma, kad politikos formuotojai, planuotojai ar kiti tyrėjai rodiklius taikytų kaip pagrindą viešojo transporto paslaugų tinklui vertinti miestuose, taip pat įvertintų tinklo kokybę ir palygintų rezultatus tarp miesto transportinių rajonų. Nustačius viešojo transporto tinklo problemas, galima planuoti pokyčius ir pagerinti paslaugų kokybę, kartu padidinant sistemos naudojimą.

Reikšminiai žodžiai: GIS, paslaugų kokybė, poreikio nustatymas, transporto planavimas, viešasis transportas, viešojo transporto indikatoriai.