TRANSPORT PROBLEMS 2025 Volume 20 Issue 3
PROBLEMY TRANSPORTU DOI: 10.20858/tp.2025.20.3.06

Keywords: public transport quality; Customer Satisfaction Index (CSI); AI in public transport

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ASSESSING AND OPTIMIZING PUBLIC TRANSPORT SERVICES USING THE CUSTOMER SATISFACTION INDEX

Summary. Public transport is essential for people to commute to school, work, and family homes or to participate in various aspects of life [1]. The increasing standard of living translates into increased expectations regarding the comfort associated with transport [2]. In the era of customer orientation, listening to the customer's expectations and trying to meet them is essential. This article explores the practical implementation of the *Customer Satisfaction Index* (CSI) methodology in evaluating and improving the quality of public transport services based on pilot research conducted in a city with a population of less than 200,000. By identifying key factors that passengers value—namely, punctuality, comfort, and information accessibility—this study demonstrates how the CSI can serve as an evaluative tool and a framework for prioritizing corrective measures to enhance service quality. A significant contribution of this research is its illustration of the flexibility of the CSI methodology, which can be dynamically adapted and integrated with modern technologies, including mobile applications, AI-driven analytics, and real-time feedback systems. Such advancements increase the effectiveness of the CSI, allowing transport operators to make data-driven decisions and implement targeted improvements more efficiently. Furthermore, by supplementing the CSI with digital tools, transport operators can respond more quickly to changing passenger needs and operational challenges, fostering a more responsive and adaptive approach to public transport management. The findings provide actionable insights and a replicable framework that can inspire other cities to adopt and modify similar practices, regardless of size. By leveraging the prioritization capabilities of the CSI and its seamless integration with cutting-edge technologies, policymakers and transport operators can optimize resources and focus on the most impactful service enhancements. This study contributes to the broader discourse on sustainable urban mobility by linking traditional quality management tools to technological innovations. It also highlights the CSI's potential to evolve from a static assessment method into a dynamic instrument for continuous improvement, offering a way for cities worldwide to enhance public transport services while addressing the diverse needs of their passengers.

1. INTRODUCTION

In the pursuit of sustainable urban mobility, public transport systems are essential for reducing urban congestion, minimizing environmental impacts, and fostering inclusivity. However, the dynamic nature of transport services and evolving technological advancements present challenges in maintaining and improving service quality. Traditional quality management tools, such as the *Customer Satisfaction*

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Index (CSI), have proven valuable in evaluating service quality. Still, they have been criticized for being static and less adaptable to real-time and evolving challenges. This article addresses these limitations by exploring the potential of the CSI to develop into a flexible and integrative framework.

Through pilot research conducted in a city with fewer than 200,000 inhabitants, this study examines how the CSI can be combined with advanced digital tools, including mobile applications, artificial intelligence, and real-time data systems. These integrations enhance the CSI's evaluative capabilities and enable transport operators to prioritize actionable improvements dynamically. This approach ensures that transport services remain responsive to seasonal fluctuations and long-term trends in passenger needs and operational conditions.

This research underscores the versatility of the CSI, demonstrating how it can be seamlessly aligned with modern innovations to support decision-making processes. By prioritizing actions based on real-time feedback, transport operators can allocate resources more effectively and address the most pressing issues impacting service quality. This study emphasizes the importance of integrating traditional methodologies with contemporary tools to develop a comprehensive approach to quality management in public transportation.

Furthermore, this article highlights factors that influence transport service quality, including customer care, safety, and environmental considerations. By addressing these factors alongside an adaptable CSI framework, this study presents a practical pathway for cities of all sizes to enhance their public transport systems. Integrating the CSI into technological advancements provides transport operators with a forward-looking, scalable model for improving service quality while catering to diverse passenger needs in a dynamic urban environment.

2. TRANSPORT SERVICE QUALITY CRITERIA

The quality of transport services is difficult to define due to these services' dynamic development and the increasing number of new technological applications that have been developed over the years [3]. In transport services, "quality" is defined as the degree to which customers' requirements are met, with punctuality and cost often being the most essential requirements. The quality of public passenger transport services is understood as a set of quality criteria and appropriate measures for which the service provider declaring compliance with the standard is responsible. The quality of transport services depends on several factors. To determine them, the following aspects should be taken into account:

- **customer care** − the friendly attitude of staff towards passengers and the appearance of staff [4],
- **safety -** monitoring of the vehicle interior and bus stops, and the good technical condition of buses [5],
- **ecology** − low noise level, ecological drive [2].

Taking the above aspects into account, the communication needs of passengers can be determined [6]. The most important of them are as follows:

- **obligatory** − the daily use of public transport to get to work or school at specific times
- **relatively obligatory** − constant movement (not necessarily daily) undertaken at any time, in connection with one's profession, business trips,
- **optional** − depends on the individual needs of passengers,
- **incidental** − related to matters or health care.

The starting point for defining the scope of features that characterize the level of quality of transport services is to treat the quality of these services as a set of features seen by transport organizers. Due to significant discrepancies in defining these features, many analyses of definitions have been made over the years. A few of them are listed below [7]:

- **quality-forming factor** − any properties of the analyzed object that can be used to shape its quality,
- **quality feature** − measurable or immeasurable, called a metric,
- **quality assessment** − estimation of the state of a quality feature,

- **quality criterion** − a component for determining the collective state of quality,
- **quality pattern** − an ordered record of a set of quality criteria called a quality standard.

When analyzing the concept of quality of transport services, the following types of quality can be distinguished [8]:

- **postulated** − expresses the expectations of service recipients about transport services, defined as transport demands, which include safety, speed, punctuality, mass scale, cheapness, directness, availability, regularity, and comprehensiveness of transport services,
- **offered** − should most often be higher than the quality expected by service recipients. In this way, you can create demand for new services or solutions,
- **implemented** − the implemented quality is often lower than the offered quality, perhaps due to poor process organization, weather conditions, or covered roads.

When determining the quality of public transport, the following aspects are most often taken into account:

- **travel comfort** − number of seats, air conditioning, smooth ride, luggage space, lighting, the possibility of making small purchases,
- **security** − lighting, protection against robberies, monitoring, availability of protection,
- **information system** on routes, timetables, connections, and transfer options,
- **comprehensiveness** − availability of ticket offices, information points,
- **time -** travel according to the timetable.

The quality of transport services should not be expressed using a single criterion because it is multifaceted. When one criterion is used, an erroneous result of the observation can be obtained. The quality of public transport services can be assessed using many determinants. The most important of them include [9]:

- availability of services,
- courtesy and respect towards passengers,
- information about services,
- safety,
- trust and honesty in relationships,
- reliability and dependability of service provision,
- competences of service providers,
- knowledge of the needs of the service recipient,
- responsibility and sensitivity to consumer needs,
- type and condition of the service provider's facility.

Improving infrastructure is necessary to encourage residents to use public transport [5]. This applies in particular to:

- **bus stops** − creating bus stop bays and access to bus stops, installing bus stop shelters with seats,
- **transfer hubs** − improving access to transfer stops and equipping them with devices that enable onward travel (e.g., ticket machines).

3. CSI METHODOLOGY IN PUBLIC TRANSPORT

The CSI was used to assess passenger satisfaction with public transport services provided by the *Municipal Transport Company* (MZK) [9]. This method is widely used to determine customer satisfaction with a company's services or products. Customer satisfaction is critical to identifying why customers stop using a company's services, choose competitors, or remain loyal. CSI methodologies such as the following have been adapted into regional frameworks:

- the *European Customer Satisfaction Index* (ECSI)
- the *American Customer Satisfaction Index* (ACSI).

While these frameworks acknowledge regional specificities, their true strength lies in their capacity to be adapted to local conditions and meet passengers' diverse needs [10].

The CSI method is a structured approach to measuring and analyzing customer satisfaction. It assesses individual characteristics important for satisfaction and the overall experience of a product or service [11]. The CSI method answers the following key questions:
- *What are customers' expectations of the product/service?*
- *Which of these expectations are the most important to the customer?*
- *To what extent does the product/service meet these expectations?*
- *Which elements are worth investing in and developing, and which are overly developed?*

The CSI is based on a customer satisfaction survey, and the results are averaged to determine an overall satisfaction index [12]. This index can be expressed as a number or percentage, allowing comparisons between companies in the same industry [13].

Table 1

Indicators in the method of CSI

in $_{and}$: importance rate, *and*: of the element	CSI index (customer satisfaction)	CSI max: maximum attainable CSI index	Percentage index of the CSI
$w_i = \frac{\sum_{j=1}^{K} w_j}{\sum_{i=1}^{N}\sum_{j=1}^{K} w_{ij}}$	$CSI = \sum_{i=1}^{N} w_i * C_i$	$CSI_{max} = \sum_{i=1}^{N} w_i * C_{imax}$	$CSI_{\%} = \frac{CSI}{CSI_{max}} * 100\%$

Notes (legend): *j*: another client; *K*: the sum of customers surveyed; *i*: the number of following requirements; *N*: the number of subjects requirements; w_i: the importance of the parameter (weight); c_i: the evaluation of customer satisfaction with the *i* (requirements); $C_{i\,\max}$: the maximum possible rating of *i* (requirement); $CSI_{\%}$: CSI value expressed in %; and $CSI_{\max}$: the maximum obtainable CSI index.

4. ARTIFICIAL INTELLIGENCE AS A TOOL FOR ENHANCING CSI ANALYSIS

Artificial intelligence (AI) plays a crucial role in effectively managing public transport service quality, providing dynamic solutions to enhance operational efficiency. Advanced machine learning algorithms can systematically analyze extensive datasets comprising vehicle location data, traffic density, and real-time passenger feedback. Such analytical frameworks facilitate accurate delay predictions, identify transport infrastructure bottlenecks, and optimize routing strategies, reducing travel times and improving user satisfaction [14].

A salient implementation of AI in urban transportation systems is the integration of vehicle monitoring technologies with mobile applications, which allow passengers to track public transport vehicles in real time. For example, Singapore's transport management system utilizes data from cameras and sensors to dynamically adjust the number of cars deployed on specific routes based on prevailing demand conditions [15]. Artificial intelligence is crucial in enhancing traffic management by systematically analyzing real-time data collected from sensors, cameras, and historical traffic patterns. This analytical approach facilitates traffic flow optimization, mitigates congestion, and proposes alternative routes, thus significantly improving overall transportation efficiency [16]. Moreover, AI significantly enhances travel comfort by evaluating passenger sentiments through feedback mechanisms embedded within mobile applications. This functionality enables rapid responses to reported concerns, as AI-driven systems can automatically propose schedule adjustments when unforeseen disruptions, such as roadwork or adverse meteorological conditions, occur [14]. AI is crucial in intelligent transport systems because it integrates real-time data with predictive analytics. This enhances traffic management, reduces congestion, and improves safety through the use of innovative algorithms and machine-learning techniques [17].

AI offers a range of transformative solutions that can revolutionize public transport systems by addressing key challenges such as resource optimization, passenger satisfaction, and operational efficiency. Below are some AI applications that could enhance the quality and reliability of public transportation services [18].

Integrating artificial intelligence into public transport systems goes beyond immediate operational improvements and offers substantial long-term advantages. These advantages include cost optimization, enhanced sustainability, and the creation of more efficient and environmentally friendly urban mobility networks. Below are key areas where AI can have a lasting, positive impact on public transportation.

Table 2

Practical AI applications in public transport

REAL-TIME MONITORING SYSTEMS	PREDICTIVE ANALYTICS	PASSENGER SENTIMENT ANALYSIS
– AI-powered mobile applications enable passengers to access real-time information on bus cleanliness, seating availability, and delays, thereby improving the user experience and enhancing trust in public transportation systems. – Real-time dashboards equipped with AI algorithms allow operators to allocate resources dynamically, effectively mitigating issues such as overcrowding, equipment malfunctions, or service disruptions.	– Machine learning models utilize historic traffic patterns and environmental data to forecast delays, enabling transport operators to adjust schedules proactively and improve service reliability. – Predictive maintenance powered by AI identifies potential vehicle malfunctions, reducing downtime and optimizing fleet performance.	– AI tools analyze feedback gathered from digital platforms, including mobile applications and online surveys, to identify trends in passenger satisfaction and prioritize service enhancements based on empirical data.

Table 3

Long-term benefits of AI in public transport

COST OPTIMIZATION	SUSTAINABILITY AND ENVIRONMENTAL IMPACT
AI enables more efficient route planning, resource allocation, and predictive maintenance, significantly lowering transport operators’ costs.	By improving fleet usage and minimizing unnecessary trips, AI helps lower carbon emissions and supports global initiatives for sustainable urban mobility.

AI technologies can significantly enhance public transportation systems by improving service quality, operational efficiency, and sustainability. Integrating AI-driven tools into the CSI framework supports critical operations such as real-time vehicle tracking, passenger flow monitoring, and traffic management. These tools enable precise predictions of traveler behavior, including travel times, demographics, and mode choices, which are essential for tailoring services to passengers’ needs. Moreover, AI facilitates dynamic adjustments in timetable scheduling, fare collection, and traveler communication, enhancing service reliability and passenger satisfaction, as reflected in improved CSI metrics.

5. MOBILE APPLICATION DEVELOPMENT INTEGRATED WITH THE CSI

The rapid advancement of mobile technologies provides significant opportunities to enhance the quality of public transportation services by integrating the CSI into mobile application functionalities.

These applications facilitate dynamic, real-time service quality monitoring while actively engaging passengers in evaluating and enhancing urban transport services [15].

A proposed mobile application could include several features designed to empower passengers to do the following:

- **evaluate key service components** − users could assess critical service elements, including punctuality, travel comfort, and information availability,
- **report service issues -** passengers could report concerns such as delays, cleanliness deficiencies, or overcrowded conditions on vehicles,
- **receive real-time notifications** − users would receive immediate updates regarding schedule changes, delays caused by roadwork, or adverse weather conditions.

The proposed application could incorporate several additional functionalities:

- **Dynamic service evaluations** − passengers could evaluate each trip by identifying key issues such as delays or overcrowding. This feedback would enable transport operators to monitor service quality in real-time and prioritize areas for improvement.
- **Personalized user experiences** − by analyzing individual user preferences based on previous route selections, travel times, and preferred modes of transportation, the application could provide tailored suggestions for optimal routes and travel times.
- **Real-time alerts -** the application would automatically notify passengers of delays due to roadwork or adverse weather, and it could propose alternative routes to reduce inconvenience.
- **Immediate satisfaction assessments** − passengers would be prompted to complete brief surveys or rate service quality immediately following their trips. The data they provide could be analyzed to identify trends and address significant issues impacting passenger satisfaction.
- **Integration with urban data** − the application could utilize open urban data, such as scheduled roadwork, current traffic conditions, and weather forecasts, to generate more accurate delay predictions and facilitate improved route planning.
- **Incentives for public transportation use -** a loyalty program embedded within the application could reward passengers for consistently using public transportation by offering benefits such as redeemable points for monthly tickets.
- **Infrastructure issue reporting** − users could report infrastructure-related problems, including damaged bus stops, unclear signage, or inadequate service frequency. This functionality would enable operators to address concerns more effectively and enhance overall infrastructure quality.
- **Integration with other modes of transport** − the application could be designed to interface with bike-sharing systems, e-scooters, or walking route planners, thereby providing a holistic approach to urban mobility.
- **Travel time prediction functionality** − by utilizing historical data and real-time analysis, the application could provide users with expected travel times while considering current road and weather conditions.

This application's innovation lies in integrating the CSI metric into the user interface, which would facilitate the collection of comprehensive data on passenger expectations and experiences. This data, analyzed in real time, could inform the development of priority matrices for quality improvement initiatives. For example, if passengers frequently report punctuality issues during specific peak times, the application could generate analytical reports for operators and recommend necessary timetable adjustments [18].

Existing applications, such as "Next Bus" in London, exemplify these solutions. They enable passengers to monitor the real-time location of buses and assess service quality [19].

To further illustrate the potential of mobile applications, a comparison between **London's *"Next Bus"*** app and **MZK Bielsko-Biała's *"Kiedy przyjedzie"*** highlights their functionality and differences in user engagement. While both aim to improve passenger experiences, their design and technological features vary significantly.

Table 4

Next Bus and *Kiedy przyjedzie* app comparative analysis

Feature	***Next Bus*** (London) 	***Kiedy przyjedzie*** (Bielsko-Biała) 	**Advantage**
Real-time bus arrivals	Uses GPS tracking for precise, real-time updates	Provides real-time arrivals, but data may not always be GPS-accurate.	More reliable and accurate data is available on *Next Bus*
Search by stop ID and name	Allows users to search by both bus stop name and unique ID	Typically limited to searching by predefined stop names or lines	More straightforward navigation in *Next Bus*
Location-based services (GPS)	Detects nearby stops automatically via GPS	Limited or less sophisticated location-based functionality	Greater convenience in *Next Bus*
Coverage	Extensive, covering hundreds of routes across a major city	Limited to Bielsko-Biała's public transport network.	Broader network coverage in *Next Bus*
User interface design	Intuitive and optimized for a seamless user experience	Functional but less polished in design	Better usability in *Next Bus*
Advanced customization	Provides features like favorite stops, route planning, and notifications	Limited customization options	More personalized in *Next Bus*

This comparison emphasizes how technological advancements can enhance the usability and scope of transport applications. The *Next Bus* app demonstrates the benefits of integrating GPS tracking, advanced customization, and broader coverage, while *Kiedy przyjedzie* highlights opportunities for growth in localized transport networks.

Similar applications successfully incorporate functionalities that engage passengers, such as the ability to rate travel conditions or report issues. This immediate feedback loop allows operators to take prompt actions, enhancing short-term operational efficiency and long-term user satisfaction [15].

A key feature of the proposed solution is its ability to address seasonal challenges, such as roadwork and adverse weather conditions, which significantly impact the quality of transport services. The application can aid decision-making and prioritize actions by continuously collecting passenger data. For instance, it could increase vehicle frequency on the busiest routes during peak periods [14].

The *Next Bus* application is one of many enhancements to public transport services, yet other applications incorporate even more advanced functionalities. These include real-time data on vehicle crowding, the availability of spaces for strollers, bicycles, and wheelchairs, as well as other factors critical for passenger comfort and accessibility.

Applications like *Citymapper* provide detailed insights into congestion levels, enabling passengers to select less crowded routes [19]. At the same time, tools such as *TransitArt* integrate journey planning, interactive route maps, and accessibility features designed for individuals with disabilities. These advancements illustrate the growing potential of mobile technologies to simultaneously enhance passenger experiences and provide transport operators with essential tools to address a broader spectrum of travel needs [20].

In Poland, programs such as *Accessibility 2030+* emphasize the importance of integrating modern technologies, including 5G, into public transport systems to meet the diverse requirements of passengers, such as families with children and individuals with disabilities. Such innovations underline the role of public transport applications in creating more inclusive, efficient, and user-centered solutions [21].

By incorporating functionalities like real-time crowding data, accessibility features, and personalized travel options into the CSI framework, these technologies offer actionable insights for transport operators. This integration enhances passenger satisfaction and aligns services with contemporary urban mobility users' dynamic and varied expectations.

6. RESEARCH PROCESS

The CSI method was employed to assess passengers' satisfaction levels with the *Municipal Transport Company* (MZK) services in Bielsko-Biała.

The research was conducted in December 2024, during a period of intensive renovation of the city's road infrastructure, which directly impacted the functioning of public transportation, particularly in terms of punctuality and delays. The use of the CSI method enabled a detailed assessment of the quality of transport services by analyzing key criteria, including travel comfort, safety, clarity of timetables, punctuality, and the ratio of drivers to passengers. The results were averaged and presented in the form of importance indicators and ratings, which allowed the creation of a matrix visualizing areas requiring improvement.

The study included a sample of 71 respondents, representing different age and socio-economic groups, to ensure the reliability and representativeness of the results. Due to the limited sample of 71 respondents, the study was a pilot study that examined the potential of the CSI method to support the prioritization of corrective actions in public transport services. The multi-faceted nature of the determinants of transport service quality makes this method particularly promising in identifying key areas requiring improvement. The survey consisted of two parts: the first assessed the importance of individual criteria, and the second assessed the degree of their implementation.

A fragment of the questionnaire is presented below:

Section 1 – criterion validity

Please assign an appropriate weight to each of the following characteristics using a scale from 1 to 5, where:

- **1** means that the criterion is of little importance,
- **5** means that the criterion is essential.

Table 5

Sample fragment of the criteria validity questionnaire

How important is it to you?	**1**	**2**	**3**	**4**	**5**
Driving comfort (e.g., number of seats, smooth ride, air conditioning)					
Security (e.g., vehicle monitoring, lighting, the technical condition of buses)					

Section 2 - assessment of criterion fulfillment

Please rate the level of implementation of each of the following features using a scale from 1 to 5, where:

- **1** means an insufficient grade,
- **5** indicates an excellent rating.

Table 6

Sample fragment of the criteria assessment questionnaire

What is your opinion?	**1**	**2**	**3**	**4**	**5**
Driving comfort (e.g., number of seats, smooth ride, air conditioning)					
Security (e.g., vehicle monitoring, lighting, the technical condition of buses)					

First, respondents were asked to determine how important a given criterion was to them and then to evaluate it. Table 7 presents the answers to this question.

Table 7
Summary of results from the question regarding the importance of a given criterion

Criterion/Criterion Validity	1	2	3	4	5
01 Driving comfort	0	2	8	31	30
02 Security	0	0	4	16	51
03 Bus cleanliness	1	0	6	33	31
04 Driver-to-passenger ratio	0	4	9	19	39
05 Bus departure times	0	0	3	15	53
06 Ticket price	3	2	8	18	40
07 Readability of timetables	2	2	7	27	33
08 Bus delays	0	0	11	25	35
09 Amenities	6	8	9	25	23
10 Frequency of courses	0	0	3	29	39
11 Bus capacity	0	2	8	25	36

Table 8 presents the results obtained from assessing a given criterion.

Table 8
Summary of results evaluating a given criterion

Criterion/Criterion Assessment	1	2	3	4	5
01 Driving comfort	0	3	34	27	7
02 Security	0	0	21	39	11
03 Bus cleanliness	2	5	25	33	6
04 Driver-to-passenger ratio	2	10	24	31	4
05 Bus departure times	1	13	26	24	7
06 Ticket price	6	18	24	19	4
07 Readability of timetables	1	2	16	33	19
08 Bus delays	5	18	26	17	5
09 Amenities	1	6	32	28	4
10 Frequency of courses	4	10	32	22	3
11 Bus capacity	1	14	30	22	4

The values of the indicators were calculated as arithmetic means based on the respondents' answers for individual ratings (1, 2, 3, 4, 5). The average rating from the surveys on the questions about importance and assessment was calculated for each criterion. The criteria and assigned indicators are as shown in Table 9.

The importance (X-axis) and rating (Y-axis) can be used to create a CSI matrix, providing a visualization of which areas need improvement (e.g., high importance and low rating). Criteria with high importance but low ratings (e.g., ticket prices, delays, driver-to-passenger ratio) should be improved first. Further analysis is based on the following characteristics quality maps (Fig. 1).

Table 9

Criteria and assigned indicators

CRITERION	VALIDITY (mean)	RATE (mean)
1. Comfort	4.3	3.5
2. Security	4.7	3.9
3. Cleanliness	4.3	3.5
4. Driver-to-passenger ratio	4.3	3.4
5. Departure times	4.7	3.3
6. Ticket price	4.3	3.0
7. Readability of timetables	4.3	3.9
8. Delays	4.3	3.0
9. Amenities	3.7	3.4
10. Frequency of courses	4.5	3.1
11. Bus capacity	4.3	3.2

SATISFACTION	High	FACTORS REQUIRING IMPROVEMENT IN THE SHORTEST POSSIBLE PERIOD	FACTORS REQUIRING MAINTENANCE AND MONITORING
	Low	FACTORS REQUIRING IMPROVEMENT IN THE LONG TERM	MINOR FACTORS THAT DO NOT REQUIRE INVESTMENT
		Low	High
		IMPORTANCE OF FEATURES	

Fig. 1. Quality map

Fig. 2 below graphically presents the CSI indicator. The numbers in the matrix correspond to the criteria listed in Table 6, with each point representing a specific criterion in the order provided in the table.

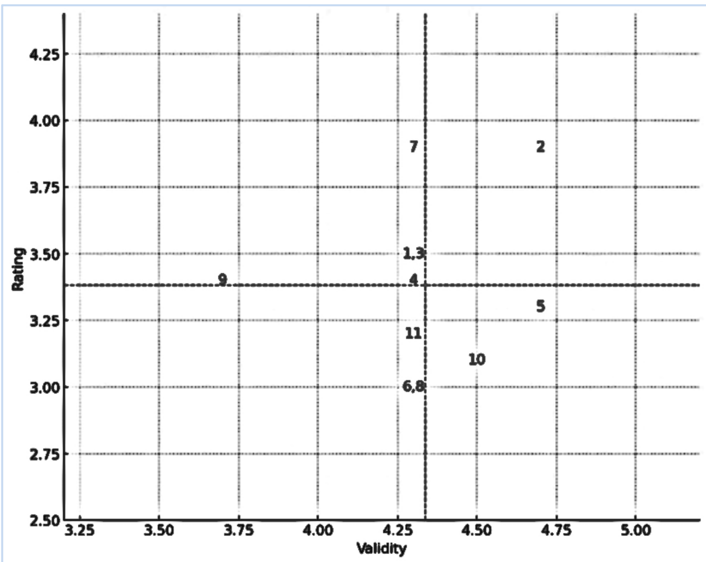

Fig. 2. CSI matrix for evaluating MZK Transport Services in Bielsko-Biała

Further analysis of the CSI index shows that:

- safety, facilities for mothers with children and disabled people, and comfort should be improved as a priority,
- ticket prices can be improved, but this can be done at a later date,
- the readability of timetables and cleanliness in buses should be maintained,
- irrelevant features include criteria classified as the weakest points of MZK—namely, departure times, driver-to-passenger ratio, frequency of journeys, delays, and bus capacity.

An interesting observation is that cities worldwide have adapted the *Customer Satisfaction Index* (CSI) methodology by incorporating particularly relevant criteria for their passengers. For example, research conducted in Imphal, India, included additional attributes such as the availability of shelter and seating at stops, the comfort and cleanliness of seats, space for luggage and goods, and the reliability of vehicle maintenance. These expanded criteria reflect passengers' diverse needs and demonstrate the CSI framework's flexibility to address local challenges [22].

These factors could further enhance the framework's ability to meet passenger expectations. The additional criteria could also serve as proposals for improving the application of the CSI in other cities, enabling a better response to passengers' needs and expectations:

- availability of shelter and seating at stops,
- comfort and cleanliness of seats during travel,
- space for luggage and goods carried by passengers,
- maintenance reliability of vehicles,
- enhanced safety measures at stops and in transit.

7. CONCLUSIONS

The current research underscores the dynamic and multifaceted nature of public transport quality. It highlights the critical role of tools like the CSI in systematically evaluating and improving service delivery. The following key conclusions and recommendations can be drawn from the findings:

1. **Improving services in Bielsko-Biała** – the study identified several actionable recommendations to enhance the quality of services provided by MZK in Bielsko-Biała:
   - **reducing delays and increasing punctuality** – timetables should be adjusted to actual road conditions, and critical infrastructure repairs should be prioritized. Implementing intelligent traffic management systems can further improve service reliability.
   - **enhancing travel comfort** – modernizing the bus fleet with air conditioning, increased seating, and facilities for people with disabilities should be prioritized.
   - **improving passenger information** – developing a mobile application with real-time timetables, delay notifications, and a journey-planning function can significantly enhance the passenger experience.
   - **adapting services to diverse needs** – public consultations and regular surveys should be conducted to effectively address the requirements of seniors, parents with children, and individuals with disabilities.
2. **Insights from passenger satisfaction** – satisfaction with public transport correlates with usage frequency. Infrequent users report higher satisfaction, while regular users encounter more quality issues related to delays and comfort. Addressing the concerns of frequent users is crucial for overall service improvement.
3. **The versatility of the CSI method** – the CSI method is a robust and flexible tool for evaluating transport service quality that is capable of adapting to changing passenger expectations and operational realities. By prioritizing key factors such as punctuality, comfort, and accessibility, the CSI enables efficient resource allocation and targeted improvements.
4. **Integrating AI and digital tools** – incorporating AI and mobile technologies into the CSI framework significantly enhances its capabilities. AI-powered tools can collect and analyze real-time feedback,

predict service disruptions, and optimize resource allocation. These innovations foster a proactive approach to improving passenger satisfaction and operational efficiency. A proposed pilot study could be initiated to meticulously evaluate the effectiveness of AI-driven tools in enhancing public transportation quality. This study would specifically investigate their impact on CSI metrics, including punctuality, comfort, and cleanliness. The methodology could also involve deploying AI-enabled mobile applications to capture real-time passenger feedback and applying predictive analytics to optimize schedules and resource allocation. The assessment would compare CSI scores before and after these interventions to provide empirical evidence of the benefits of integrating AI technologies into public transport systems.

5. **Dynamic adaptation to passenger needs** − mobile applications like *Next Bus* and *Citymapper* demonstrate how real-time data on vehicle crowding, accessibility, and travel conditions can improve the passenger experience. By incorporating these features into the *Customer Service Interface*, transport systems can quickly respond to passenger needs and prioritize essential issues, such as space availability for strollers, wheelchairs, and bicycles.
6. **Comprehensive quality assessment −** the CSI method facilitates a holistic evaluation of service quality by capturing various criteria. Its ability to distinguish between priority factors and less urgent ones ensures that improvement efforts remain focused and impactful, optimizing service delivery for the most significant benefit to passengers. Expanding CSI metrics through advanced technological features presents tremendous opportunities to enhance public transport services and address diverse passenger needs. This approach could include the following:
   - **crowding and accessibility -** incorporating indicators such as vehicle crowding levels and the availability of spaces for strollers and wheelchairs into the CSI framework ensures a more comprehensive evaluation of service quality.
   - **real-time technologies -** leveraging IoT sensors and AI-powered applications to gather dynamic data on passenger experiences, such as real-time seat availability and congestion levels, enables operators to respond proactively to deficiencies.
   - **dynamic surveys -** utilizing post-trip surveys through mobile applications to collect immediate feedback from passengers fosters continuous improvement in service delivery.
   - **personalized passenger experiences –** enhancing engagement by providing tailored notifications, route suggestions, and real-time updates creates a more user-centric public transport system.

   Expanding CSI metrics to include these elements can promote greater inclusivity, operational efficiency, and passenger satisfaction, positioning the framework as a vital tool for modern public transportation management. Furthermore, analyzing user feedback on platforms like Google Play can provide transport operators with essential insights into passenger concerns and unmet needs. These reviews often highlight critical issues that may be overlooked, such as the absence of multilingual options or specific functionality deficiencies. By addressing these identified gaps, operators can implement targeted enhancements that align their services with passenger expectations.
7. **Future directions for public transport management** – integrating modern technologies with the CSI framework transforms it into a proactive management tool rather than a static evaluation method. This evolution supports the development of sustainable, inclusive, and passenger-centric transport systems. Continued investment in AI, IoT, and flexible strategies will further enhance the efficiency and quality of public transport services.

The research demonstrates that the quality of public transport services evolves dynamically and requires innovative approaches for continuous improvement. When integrated with AI and advanced digital technologies, tools like the CSI can provide actionable insights to identify priority areas, allocate resources effectively, and adapt swiftly to changing passenger needs. By focusing on key quality factors and leveraging real-time data, decision-makers can create responsive and efficient public transport systems that meet the expectations of diverse urban populations.

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Received 14.03.2024; accepted in revised form 19.08.2025