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Assessing Public Transport Quality Using AHP and SUTI Indicator 4: A Case Study of the Sustainable Mobility Plan in Wrocław, Poland

Izabela Dziaduch [1,*] and Piotr Peternek [2]

[1] Department of Logistics, Wroclaw University of Economics and Business, 53-345 Wrocław, Poland
[2] Department of Econometrics and Operational Research, Wroclaw University of Economics and Business, 53-345 Wrocław, Poland; piotr.peternek@ue.wroc.pl
* Correspondence: izabela.dziaduch@ue.wroc.pl

Abstract: Wrocław is the most congestion-challenged city in Poland. Improving the appeal of public transport over private car use could be an effective remedy for the city's notorious congestion problems. This article evaluates public transport service quality in Wrocław from the passengers' perspective. The quality assessment focused on two key areas: the quality of service that passengers expect (preference evaluation) and the quality they perceive are delivered by the transport organiser and operator (satisfaction evaluation). Both passenger preferences and satisfaction were assessed based on 14 selected transport service attributes, referred to as quality attributes. To carry out this analysis, the Analytic Hierarchy Process (AHP) method and the SUTI Indicator 4 (Public Transport Quality and Reliability), which is part of the Sustainable Urban Transport Index (SUTI), were employed. Data were collected via a survey questionnaire with a sample of 500 bus and tram users in the city. Statistical analysis of the data were performed using functions and commands available in Microsoft Excel. The resulting SUTI Indicator 4 values (42.6% for bus services and 45.9% for tram services) suggest that Wrocław residents are moderately satisfied with the current public transport system. The study reveals that the transport organiser and operator should prioritise attributes related to travel time, as their fulfilment levels are shown to be either low or moderate. Therefore, in order to encourage more car users to switch to public transport in Wrocław, emphasis should be placed on solutions that ensure punctual departures and provide passengers with greater confidence in reaching their destinations on time.

Keywords: sustainable urban mobility; public transport; service quality; AHP; SUTI Indicator 4

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1. Introduction

European cities, notwithstanding their differences, encounter similar challenges in transport and mobility for their residents [1]. According to a PricewaterhouseCoopers (PwC) analysis [2], these challenges include congestion, road safety, and air pollution. A response to these urban issues is sustainable mobility [3], which advocates for reducing the use of private cars [1,4] in favour of public transport as the predominant mode of travel in urban areas [5]. Sustainable urban mobility poses a considerable dilemma for local authorities, as they must devise solutions that enhance the competitiveness of public transport relative to private vehicles. One effective strategy is improving the quality of services provided by public transport systems [6]. These services should be attractive enough to bring about a permanent shift in travel preferences [7]. Therefore, it is imperative to evaluate the degree to which public transport services meet society's needs, taking into account residents' opinions. The feedback from residents regarding the importance and effectiveness of specific service attributes is pivotal for making the necessary adjustments to improve satisfaction and quality of life, in line with the principles of sustainable development.

Table 1 illustrates the features that characterise the quality of public transport services, as proposed by various authors.

Table 1. An overview of the general features that define the quality of public transportation services, as identified by various selected authors.

Lp.	Quality Features (First Level)	Reference						
		[8]	[9]	[10–12]	[13,14]	[15]	[16]	[17]
1	Availability	+	-	-	-	-	+	-
2	Accessibility	+	-	-	-	-	-	-
3	Information	+	-	-	-	-	-	-
4	Time	+	-	-	-	-	-	-
5	Customer care	+	-	-	-	-	-	-
6	Comfort	+	-	-	-	+	-	+
7	Security	+	-	-	-	+	+	+
8	Environmental impact	+	-	-	-	+	+	-
9	Frequency of the service	-	+	-	-	-	-	-
10	Punctuality	-	+	-	-	-	-	-
11	Comfort and cleanliness of vehicles	-	+	-	-	-	-	-
12	Convenience of stops/stations	-	+	-	-	-	-	+
13	Availability of information	-	+	-	-	-	-	+
14	Personnel courtesy	-	+	-	-	-	-	-
15	Fare level	-	+	-	+	-	-	-
16	Service quality	-	-	+	+	-	-	+
17	Transport quality	-	-	+	+	-	-	-
18	Tractability	-	-	+	+	-	-	-
19	Convenience	-	-	-	-	+	-	-
20	Operating	-	-	-	-	+	-	-
21	Travel time	-	-	-	-	-	+	-
22	Journey standard	-	-	-	-	-	+	-
23	Rolling stock use index	-	-	-	-	-	+	-
24	Level of integration of public urban transport system	-	-	-	-	-	+	-
25	Reliability	-	-	-	-	-	+	+
26	The profitability of the urban public transport system	-	-	-	-	-	+	-
27	Investment costs	-	-	-	-	-	+	-

The "+" sign indicates that a given feature was mentioned in the corresponding literature, while the "-" sign indicates that the feature was not mentioned.

The authors, in their analyses, employ a specific set of features to evaluate the quality of public transport services, tailored to the scope of their research. However, there is no consensus among scholars regarding which features define this quality or the number of such features. Many studies present these quality features within a hierarchical framework, where lower levels offer greater detail. The number of hierarchy levels varies across studies. In the articles [12,15], there is a two-level hierarchical separation of features. In [12], the highest level of the hierarchy is created by 5 quality features, which are explained by 10 detailed features. In [15], the quality of services is assessed through 17 quality features, grouped into 5 categories. In the works [8,10,11,13,14], a three-level hierarchical division of quality features is used. The PN-EN 13816 standard [8] identifies eight quality features from the customer's perspective, representing the most general level of service attributes. The second and third levels, which detail the first level, contain 30 and 101 features, respectively. In [10,11], the highest level of the hierarchy is created by 3 quality features, which are described by 11 detailed features. The third level of the division of features concerns 4 features designated at the second level. Approximately 10 detailed features explain these features. On the other hand, the quality of services assessed from the perspective of 4 general features can be found in [13,14]. The authors claim that 4 out of 14 quality features distinguished at the second level should be considered in detail from the point of view of 10 features (third level). In contrast, studies such as [9,16,17] do not utilise a hierarchical structure, opting instead to list only general features.

It is important to highlight that some quality feature names presented in Table 1, such as time and travel time or comfort and cleanliness of vehicles, are often considered synonymous. However, they possess distinct meanings, which can lead to confusion when assessing service quality without a hierarchical framework. For example, travel time could be viewed as a component of the broader feature time, and it can be further refined by attributes such as punctuality, frequency of service, or reliability.

Moreover, the features that determine the quality of public transport services generally pertain to specific elements of the transport network, including stops, routes, and vehicles. Given the lack of a universal set of features for evaluating service quality from a passenger's perspective, we have decided to assess public transport service quality in Wrocław using 14 general quality features (Table 4). The selection of these features was informed and purposeful, based on their relevance to specific components of the public transport network and their significance to all stakeholders involved—passengers; operators; and municipal authorities.

The hierarchy of service quality attributes, which identifies the most and least important factors for residents when choosing public transport, can be established through various methodologies. Several studies have analysed the methods used in this area. In [18], the authors examine various sustainability evaluation methods for public transport in Latin American cities. They identify three main types of approaches: Assessment Indicators Models and Indicator Systems, Non-Parametric Performance Evaluation Models, and Multi-Criteria Decision-Making (MCDM) approaches [19–21] focus exclusively on multi-criteria methods, highlighting the significant importance of this approach. They also note that one widely used technique within this framework is the AHP, a key multi-criteria decision-making method. This method is frequently applied to urban transport problems, including the ranking of criteria for assessing public transport service quality [10,11,13,14,17,22–25], selecting options for integrated public transport systems [16], and choosing modes of urban passenger transport [26–29]. An extensive review of AHP applications for solving transportation problems can be found in [30]. Noteworthy are articles that employ hybrid approaches combining different methods as well as fuzzy methodologies. In [31], the authors use the interval-valued spherical fuzzy AHP to reconcile the conflicting interests of passengers, non-passenger citizens, and local municipality representatives while simultaneously determining the importance of selected public transport characteristics in the Turkish city of Mersin. The parsimonious spherical fuzzy AHP is applied in [32] to rank quality criteria for bus transport in Dublin. In [33], the authors seek an optimal transport solution in Budapest, using quality indicators of public transport through a hybrid approach based on magnitude-based fuzzy AHP. However, AHP is not the only methodology employed for optimising transport quality. In [34], fuzzy TOPSIS is used to identify the best-evaluated quality variables in Bus Rapid Transit systems in Brazil. In [35], the authors compare three methods—AHP; BWM (Best-Worst Method); and the Full Consistency Method—to determine the importance of quality features. The PROMETHEE method is utilised in [36] to evaluate public transport service quality in Budapest. In [37], ELECTRE and AHP methods are combined to assess integrated urban public transport systems. Additionally, ref. [11] compares the Analytical Network Process (ANP) and AHP to optimise the public bus transport system in Budapest. Thus, MCDM approaches offer a wide array of methods, with extensive applications in the field of public transport quality assessment.

The degree to which public transport providers fulfil service quality criteria is typically measured using methods such as Servqual [38–42], the Customer Satisfaction Index (CSI) [7,43–46], or Indicator 4, Public Transport Quality and Reliability, which is part of the Sustainable Urban Transport Index (SUTI) [17,47,48].

Wrocław is the most congested city in Poland [49]. The elevated levels of transport congestion in the city are partly due to the low competitiveness of public transport relative to private vehicles. As stated in Section 4.3 of the Sustainable Development Plan for Public Transport in Wrocław for the period 2016–2022, the role of public transport services is waning, despite increasing expenditures on subsidies for these services [50]. This finding

calls for an investigation into the underlying factors behind this trend. It is crucial to ascertain the importance of quality attributes for residents, as well as the extent to which these attributes are fulfilled by the transport organiser, the City of Wrocław, and the main operator delivering public transport services in the city: the Municipal Transport Company (Miejskie Przedsiębiorstwo Komunikacyjne Sp. z o.o. we Wrocławiu, MPK Sp. z o.o., Ostroleka, Poland). The City of Wrocław is mandated under the Public Transport Act of 16 December 2010 [51] to conduct public consultations in this regard. However, the outcomes of these consultations are only advisory and not binding for local authorities when developing, for example, the sustainable development plan for public transport. In addition to these plans [50,52], there exists a substantial corpus of scholarly work evaluating public transport in Wrocław, e.g., [7,53,54]. Nevertheless, a review of the literature reveals that there have been no studies on the quality of Wrocław's public transport services using the AHP method and SUTI Indicator 4. This research gap has served as the primary impetus for addressing this issue in the present article and has guided the formulation of the objective, which is to evaluate the quality of public transport services in Wrocław versus the level of quality expected by passengers (preference assessment) and perceived by them as being delivered by the operator and transport organiser (satisfaction assessment). For the purpose of this article, we formulated the following research questions:.

The first research question: which public transport quality attributes are most important to passengers?

The second research question: which public transport quality attributes are passengers most satisfied with?

The third research question: which services—tram or bus—are passengers more satisfied with?

The answers to these three research questions are crucial for guiding the actions of transport providers and city authorities to ensure the appropriate quality of services.

The appraisal of Wrocław's public transport passengers' preferences, which involved determining the importance of quality attributes, was conducted using the AHP method. Concurrently, the evaluation of passenger satisfaction, which concentrated on pinpointing quality attributes requiring intervention from the transport organiser and operator, was carried out using SUTI Indicator 4.

Public transport services in Wrocław are provided by MPK Sp. z o.o., which utilises buses and trams. Consequently, these two modes of transport, namely bus and tram services, were subjected to quality assessment.

2. Research Methodology

2.1. AHP

The AHP method is among the most widely employed multi-criteria decision-making techniques in practice [55]. It was developed by Thomas L. Saaty in the 1970s to meet the demand for a straightforward tool that could assist decision-makers in the decision-making process. At that time, there was no clearly established procedure, and the validity of criteria was often determined arbitrarily [56].

The AHP method fundamentally comprises two phases, which can be further divided into seven distinct stages [57]. The first phase involves structuring the problem by creating a hierarchical model [57,58]. At the top of the hierarchy is the main goal, followed by sub-criteria (sub-goals) and evaluation criteria below it. At the bottom of the hierarchy are the decision alternatives being assessed. Typically, the number of levels of sub-criteria and evaluation criteria does not exceed two, although a more complex structure can be developed if necessary. The second phase of the AHP method boils down to evaluating the decision alternatives with respect to the established criteria and sub-criteria. In this phase, it is essential to determine the importance of each decision criterion, which makes it possible to assign weights, thereby prioritising the more significant criteria and reducing the influence of less relevant ones. This stage involves assigning a weight to each element of the hierarchical structure, which is based on the opinions of the decision-makers involved.

These opinions are expressed through pairwise comparisons of elements at each level of the hierarchy, taking into account their relative positions within the structure. Saaty [59] recommended conducting these pairwise comparisons using a nine-point relative rating scale (dominance scale) (Table 2).

Table 2. Saaty scale.

Intensity of Importance	Definition	Explanation
1	Equal	Both activities contribute equally to the objective
2	Weak or slight	Intermediate importance between 1 and 3
3	Moderate	Experience and judgement slightly favour activity i over j
4	Moderate plus	Intermediate importance between 3 and 5
5	Strong	Experience and judgement strongly favour activity i over j
6	Strong plus	Intermediate importance between 5 and 7
7	Very strongly or demonstrated	Activity i is favoured very strongly over j; its dominance is demonstrated in practice
8	Very, very strong	Intermediate importance between 7 and 9
9	Extreme	The evidence favouring activity i over j is of the highest possible order of affirmation
Reciprocals of above activity	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	A logical assumption

It should be noted that the preferences derived from the pairwise comparisons are presented in a so-called comparison matrix. This matrix defines preferences by comparing the criteria in the row with the criteria in the column. When comparisons are made in reverse order, reciprocal values are used. For example, if the criterion in row 1 is strongly preferred over the criterion in column 2, the value 5 appears at the intersection of row 1 and column 2, while the reciprocal value 1/5 appears at the intersection of row 2 and column 1. The pairwise comparison matrix (A) thus takes the following form (Equation (1)),

$$A = [a_{ki}] = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ a_{21} & 1 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & 1 \end{bmatrix} = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ \frac{1}{a_{12}} & 1 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \dots & 1 \end{bmatrix} \quad (1)$$

where:

a_{ki}—the importance of the k-th criterion/alternative (row k) in relation to the i-th criterion/alternative (column i).

Saaty also introduced criteria for evaluating the consistency of the preference matrix. Ideally, the matrix should be consistent, meaning it must account for transitive relationships, enabling the verification of the subjective judgements or comparisons made by the decision-maker. To evaluate the consistency of the comparison matrix, Saaty recommended calculating the consistency index (CI) using Equation (2),

$$CI = \frac{\lambda_{max}}{n-1} \quad (2)$$

where:

λ_{max}—the largest eigenvalue of the pairwise comparison matrix,
n—the number of elements being compared.

The higher the value of the consistency index, the greater the inconsistency in the preference matrix. To determine the threshold beyond which the preferences are deemed unacceptable, the consistency ratio (*CR*) is computed. This ratio incorporates not only the decision-maker's pairwise comparisons but also the average values of random comparisons. Since the decision-maker comparisons should diverge significantly from random comparisons, the *CR* is calculated as follows (Equation (3)),

$$CR = \frac{CI}{RI} \tag{3}$$

where:

RI—the tabulated average of consistency indices for random comparisons.

A matrix is considered consistent when the *CR* is low, with an acceptable threshold typically being $CR < 10\%$ [60,61].

A preference matrix that satisfies this consistency criterion forms the basis for calculating the weights (or importance) of individual elements in the hierarchy. The literature outlines several methods for deriving the weight vector, ranging from simpler and widely used approaches like arithmetic or geometric means to Saaty's right-hand eigenvector method (for further details, see e.g., [59,61,62]). From a formal standpoint, weights derived through averaging methods are regarded as reasonable approximations, though ideally, they should be obtained by calculating the largest eigenvalue of the preference matrix and its corresponding eigenvector, which represents the desired weight vector.

The weight vector obtained through any of these methods enables the identification of the most important priorities (criteria). It is important to note that when decisions involve multiple decision-makers, their preferences must be aggregated. There are basically three main approaches: the first relies on achieving consensus among all decision-makers; the second aggregates preferences at the final stage by combining the global preference (weight) vectors derived individually by each decision-maker; and the third aggregates partial preferences at each hierarchical level. In the latter two approaches, the geometric mean is typically used for aggregation [63,64].

2.2. Indicator of Public Transport Quality and Reliability

The indicator called Public Transport Quality and Reliability is one of the ten key components of the SUTI, known as SUTI Indicator 4. It measures passenger satisfaction in relation to their specific needs, assessing whether the service meets their expectations [9].

According to UN ESCAP [9] the data required to calculate this indicator is gathered through a survey questionnaire that contains a set of eight features (frequency of the service, punctuality (delay), comfort and cleanliness of vehicles, safety of vehicles, convenience of stops/stations, availability of information, personnel courtesy, and fare level) defining the quality of public transport services.

However, the recommended set of features is not obligatory and can be modified as necessary. Respondents rate the degree to which each attribute is fulfilled using either a five- or seven-point Likert scale. SUTI Indicator 4 is calculated as the ratio of responses that indicate some level of satisfaction (on a five-point scale, these are categories 4 and 5, while on a seven-point scale, these are categories 5, 6, and 7) to the total number of responses. The resulting level of passenger satisfaction is expressed as a percentage and should ideally fall between 30% and 95% [9]. To aid the interpretation of SUTI Indicator 4, five percentage bands have been established, each corresponding to a descriptive category, as shown in Table 3.

Table 3. Interpretation of SUTI Indicator 4 based on responses from the five-point Likert scale.

Value Range	Interpretation
0% $\leq$ SUTI Indicator 4 $\leq$ 20%	The passenger is very dissatisfied with the quality features provided by the service.
20% < SUTI Indicator 4 $\leq$ 40%	The passenger is dissatisfied with the quality features.
40% < SUTI Indicator 4 $\leq$ 60%	The passenger is moderately satisfied with the quality features.
60% < SUTI Indicator 4 $\leq$ 80%	The passenger is satisfied with the quality features.
80% < SUTI Indicator 4 $\leq$ 100%	The passenger is very satisfied with the quality features.

3. Research Tool

The research tool was a bespoke survey questionnaire. In addition to an introduction and demographic questions, respondents were asked to assess public transport service quality in two aspects: its importance and the level of fulfilment. Fourteen features that determine the quality of this form of transport were evaluated (Table 4), and these features can be classified into four main categories. The first category includes attributes related to travel time: accessibility (A1), frequency (A2), regularity (A3), directness (A4), speed (A5), punctuality (A6), reliability (A7), journey time (A8), and integration (A13). The second category pertains to travel comfort and includes information (A10) and comfort (A12). The third group focuses on cost-related factors, comprising travel cost (A11) and investment cost (A14). The final category concerns passenger safety, both on board and at stops, represented by the general attribute safety (A9).

Table 4. Quality attributes of public transport services with interpretation.

Code of Attributes	Quality Attributes	Definition	Reference
A1	Accessibility	Distance to get to a stop in order to use a given transport network (temporal and spatial)	[8,10–14,16,53,65–67]
A2	Frequency	The number of rides made on the same line within a specified time interval	[8–14,65,66,68–72]
A3	Regularity	Equal intervals between consecutive departures on the same line	[8,69]
A4	Directness	Connection without the need to transfer	[10–14,65–67,69,70,72]
A5	Speed	Driving time, including stopping at stops	[10–14,70]
A6	Punctuality	Compliance of departures with the schedule	[8,9,15,53,65,66,68–71]
A7	Reliability	Getting to a particular destination at the appointed time	[8,10–17,66–68,70]
A8	Travel time	Time to get to the stop + time to wait for the arrival of the means of transport + transit time + time of any transfers + time to reach the destination	[8,10–14,16,53,65–69]
A9	Safety	Safety while waiting at the bus stop and during transit (e.g., monitoring system in vehicles, monitoring system and lighting of bus stops, proper technical condition of vehicles, experience and skills of drivers, separated lanes for public transport vehicles)	[8–14,16,17,67,69–72]
A10	Information	Availability and communication of information related to travel route planning (e.g., schedules, fare tariffs, ticket outlets, announcements about changes in the transport network), and travel route signage (visual or audio information at stops or inside vehicles)	[8–14,17,53,65–70]
A11	Travel cost	Fare + any additional fees (e.g., for carrying luggage, pets)	[9,13,14,53,65,67–71]
A12	Comfort	Conditions of waiting at the stop and staying in the vehicle, e.g., cleanliness, seating, degree of congestion, ergonomics	[8–17,53,65,67,68,70]
A13	Integration	Synchronisation of fares and schedules of different transport lines on common sections	[16]
A14	Investment cost	The cost associated with the construction, expansion, reconstruction of nodal infrastructure (e.g., bus stops, transfer nodes), line infrastructure (roads), and the purchase of rolling stock	[16]

To gauge the relative importance of one feature over another, a five-point numerical scale was employed. In this scale, 1 indicated equivalence between the features, 2 represented a slight preference, 3 denoted a significant preference, 4 indicated a very strong preference, and 5 signified a complete preference for one feature over the other. The questions were not repeated, and their number was consistent with the guidelines of the AHP

method. Table 5 provides an excerpt from the survey questionnaire used to compare two features that define the quality of services.

Table 5. Section of the survey questionnaire comparing features of public transport service quality.

Quality Feature	Degree of Preference									Quality Feature
A1. Accessibility	5	4	3	2	1	2	3	4	5	A2. Frequency
A1. Accessibility	5	4	3	2	1	2	3	4	5	A3. Regularity
A1. Accessibility	5	4	3	2	1	2	3	4	5	A4. Directness
...	5	4	3	2	1	2	3	4	5	...

The extent to which the service quality-defining features were met was evaluated using a five-point Likert scale, where 1 corresponded to a very low level of fulfilment, 2 to a low level, 3 to a moderate level, 4 to a high level, and 5 to a very high level.

The survey was distributed to residents of Wrocław who regularly use the public bus and tram services provided by MPK Sp. z o.o.

4. Analysis of Results

4.1. Sample Respondents

A total of 500 respondents participated in the study assessing the quality of public transport services in Wrocław. Each mode of transport, buses and trams, was evaluated by 250 participants. The detailed sociodemographic characteristics of the sample are presented in Tables 6 and 7.

Table 6. Sociodemographic characteristics of bus users in Wrocław.

Variable	Subgroup	Number of Individuals	Share of Total [%]
Gender	Woman	145	58.0
	Man	105	42.0
Age	≤18	1	0.4
	19–26	50	20.0
	27–39	105	42.0
	40–59	68	27.2
	≥60	26	10.4
Occupational status	Student	28	11.2
	Working person	192	76.8
	Unemployed	11	4.4
	Pensioner	19	7.6

Table 7. Sociodemographic characteristics of tram users in Wrocław.

Variable	Subgroup	Number of Individuals	Share of Total [%]
Gender	Woman	149	59.6
	Man	101	40.4
Age	≤18	4	1.6
	19–26	54	21.6
	27–39	103	41.2
	40–59	70	28.0
	≥60	19	7.6
Occupational status	Student		16.4
	Working person		68.8
	Unemployed		7.2
	Pensioner		7.6

The study had a higher proportion of female respondents compared to males. The largest group of participants was aged 27 to 39, and the vast majority were employed. Notably, a considerable proportion of respondents were frequent users of public transport, with around 34% travelling by public transport at least once a week.

4.2. Hierarchical Evaluation of Quality Features Using the AHP Method

Since respondents provided their answers on a 1–5 scale, these were converted to the Saaty scale by utilising only the odd-numbered values. The rescaling process is summarised in Table 8.

Table 8. Conversion of respondents' answers to the Saaty scale.

Respondents' Answers	Saaty Scale Values
1	1
2	3
3	5
4	7
5	9

In the next step, the responses from 250 participants were aggregated to create a single pairwise comparison matrix. This was conducted by calculating the geometric mean of the rescaled responses (comparisons) for each feature. The resulting preference matrices for bus and tram transport services are shown in Supplementary Tables S1 and S2, respectively.

There is a clear "flattening" of the results, indicating significant variability in the evaluations. Consequently, it was necessary to re-examine the responses collected during the analysis. Since 14 features were compared, producing 91 pairwise comparisons, descriptive statistics are omitted here. Instead, box plot diagrams summarising these comparisons are provided in Supplementary Figures S1 and S2. These diagrams illustrate standard box plots, with the whiskers representing the boundaries of the distribution and quartiles displayed within the box. The arithmetic mean is marked with an "x", while outliers are represented by dots. It is evident that all pairwise comparisons of quality features were rated using the full range of the scale (from 1/9 to 9). This confirms that respondents' evaluations of each pair of features were highly varied. Additionally, the comparisons of different feature pairs show noticeable disparities in the ratings.

The next step in the analysis involved verifying the preference matrices obtained. First, the consistency index was calculated, yielding values of 0.0049 for bus transport and 0.004 for tram transport. Following this, the consistency ratio was determined, with values of 0.0031 for buses and 0.0026 for trams. As both figures are well below the commonly accepted threshold of 0.1, the matrices can be deemed consistent, which permits the calculation of weightings for the various quality features. The importance (weight) values for the quality features of bus and tram transport services are illustrated in Figure 1.

The hierarchy of importance for bus transport quality features closely mirrors that of tram transport. Attributes relating to travel time, such as accessibility (A1), frequency (A2), regularity (A3), punctuality (A6), reliability (A7), and travel time (A8), were identified as the most important by respondents (consistently placed among the top six). The cost of travel (A11) also holds significance, coming in eighth for bus transport and seventh for tram services. In contrast, safety during waiting and travel was deemed less important, ranking ninth for bus and eighth for tram transport. Features associated with comfort, such as information availability (A10) and overall comfort (A12), occupy the 12th and 11th positions in the overall ranking and were considered of relatively low importance. Finally, the cost of infrastructure investments—such as the construction; expansion; or renovation of stops and the purchase of new vehicles (A14)—was rated as the least important factor. This is un-surprising, as investment costs are more relevant to transport operators than to passengers.

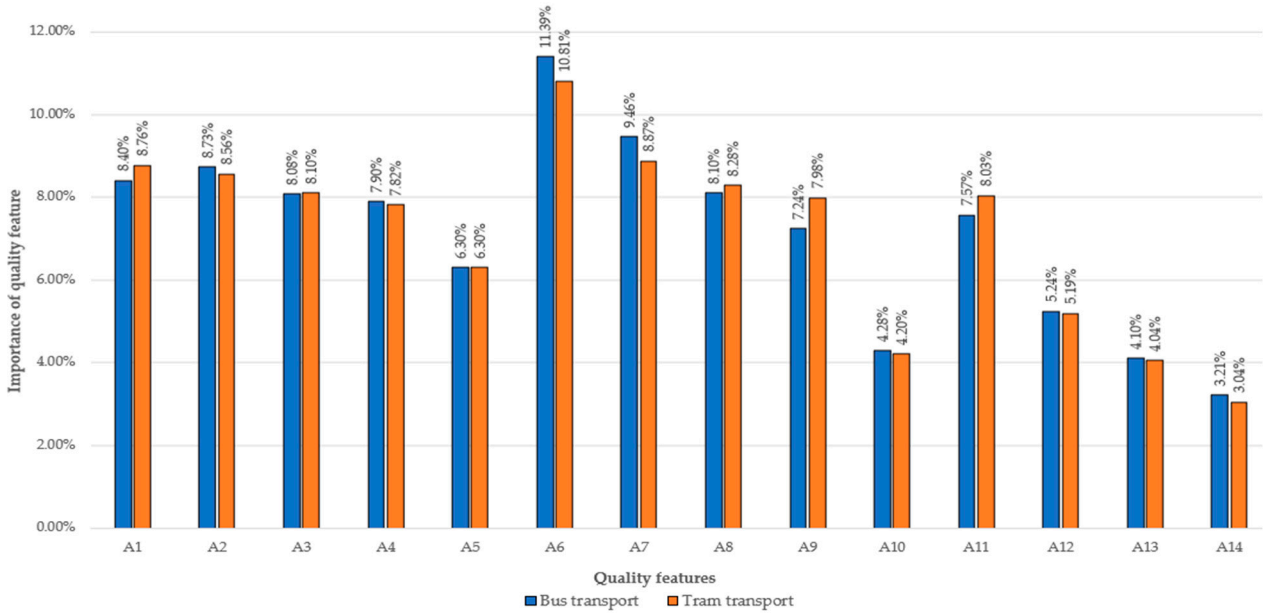


Figure 1. Weight values for quality features determine the public transport services in Wrocław from the passengers' perspective.

4.3. Satisfaction Levels for Quality Features According to SUTI Indicator 4

The survey results suggest that both the transport organiser and service provider need to implement specific measures to improve the performance of most of the 14 quality attributes evaluated (Figures 2 and 3). For bus services, it is apparent that only three attributes—accessibility (A1); safety (A9); and information availability (A10)—received a higher proportion of satisfied respondents than dissatisfied ones. A similar trend is seen for tram services, where respondents expressed satisfaction not only with accessibility (A1), safety at stops and during travel (A9), and information availability (A10), but also with tram frequency (A2).

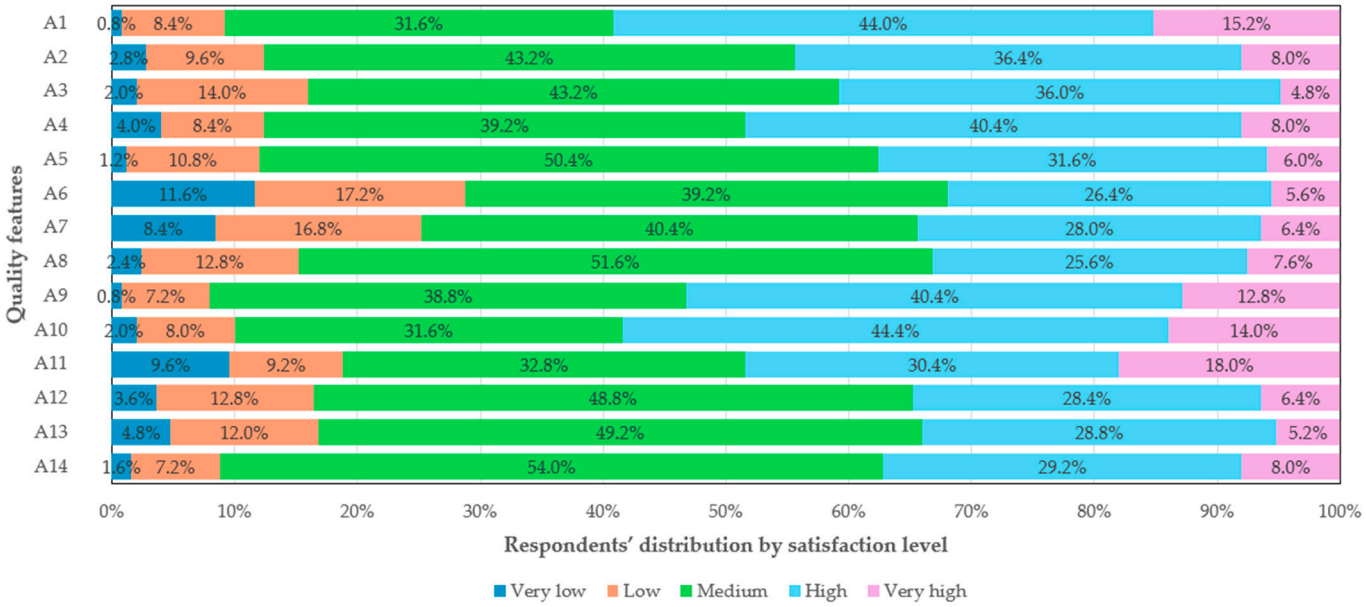


Figure 2. Proportion of respondents assessing bus services, categorised by satisfaction levels for each quality attribute.

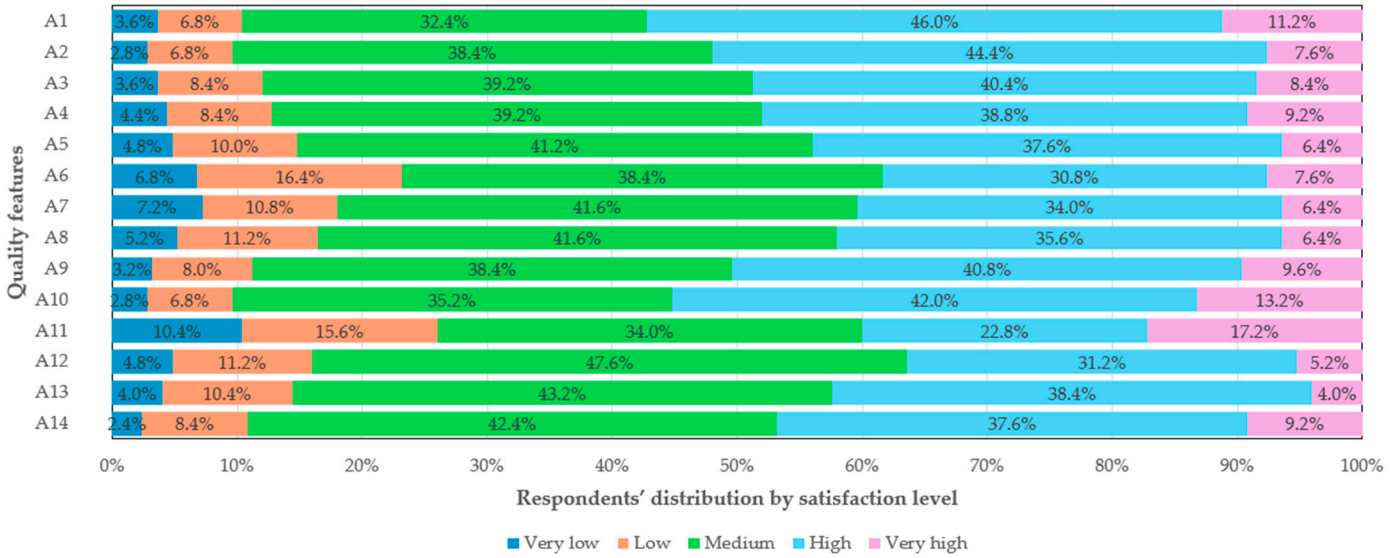


Figure 3. Proportion of respondents assessing tram services, categorised by satisfaction levels for each quality attribute.

The value of SUTI Indicator 4 for bus transport was 42.6%. Respondents' satisfaction with how well the public transport provider meets quality standards ranged from 32.0% to 59.2% (Figure 4). Upon analysing SUTI Indicator 4 for individual attributes, we find that passengers of MPK Wrocław were most satisfied with the accessibility of stops (59.2%) and information availability (58.4%), while they were least satisfied with the punctuality of vehicle departures (32.0%) and overall journey time (33.2%).

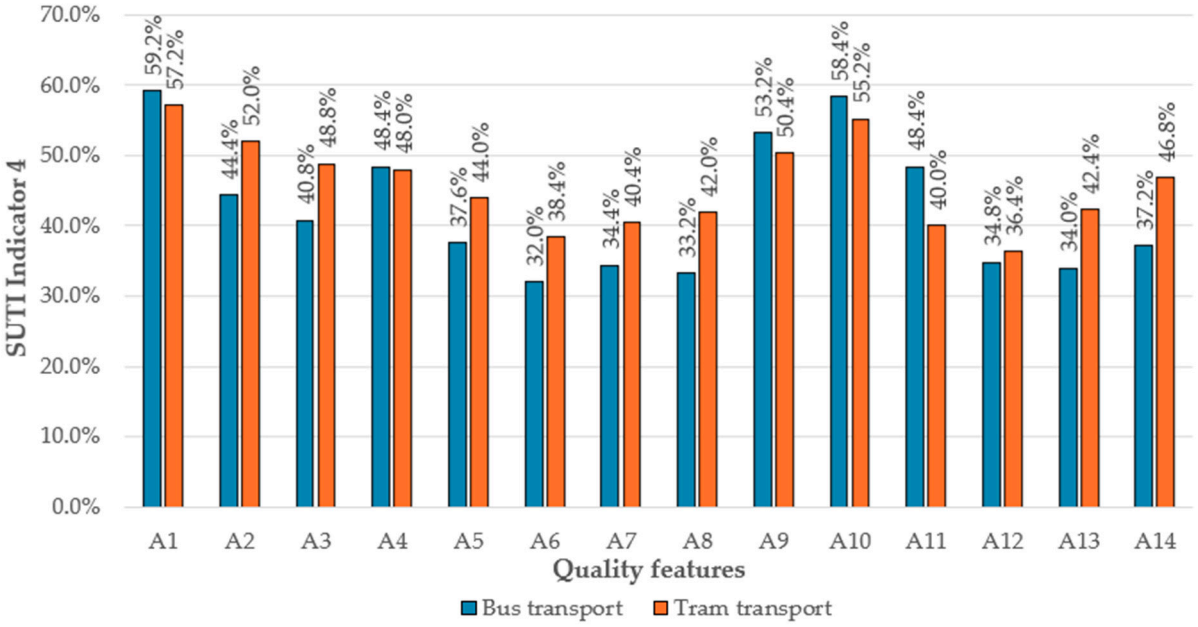


Figure 4. SUTI Indicator 4 values for individual quality attributes.

For tram services, the value of SUTI Indicator 4 stands at 45.9%. Respondents' satisfaction with tram services ranged between 36.4% and 57.2% (Figure 4). The highest satisfaction was recorded for the accessibility of stops (57.2%) and information availability (55.2%), while the lowest levels of satisfaction were with the comfort of waiting at stops and during the journey (36.4%), as well as the punctuality of vehicle departures (38.4%).

5. Conclusions and Discussion

The values obtained for SUTI Indicator 4 (42.6% for bus services and 45.9% for tram services) indicate that the residents of Wrocław are, on average, moderately satisfied with the current operation of public transport in the city.

When we evaluate the extent to which specific attributes of public transport are fulfilled, it becomes apparent that there is no attribute for which respondents reported being very dissatisfied, satisfied, or very satisfied. When it comes to bus services, respondents expressed dissatisfaction with seven attributes: punctuality (A6), travel time (A8), integration (A13), reliability (A7), comfort (A12), investment costs (A14), and speed (A5). The remaining attributes were assessed as being met by the provider at an average level. In contrast, residents indicated dissatisfaction with only two attributes of tram services: comfort (A12) and the punctuality of tram departures (A6). For the other 12 attributes, respondents conveyed moderate satisfaction with the performance of the service provider. Therefore, both the transport organiser and the operator should implement targeted measures to enhance the fulfilment of all assessed quality attributes across both modes of transport. This recommendation is further underscored by the fact that none of the examined attributes determining service quality achieved a fulfilment level of 90% or above.

Furthermore, the research findings reveal a disconnect between the degree of fulfilment of these attributes and passenger expectations, as respondents place the highest value on punctuality (A6) and the reliability of public transport (A7). Punctuality, which relates to the timely departure of vehicles from stops, is crucial in ensuring that passengers arrive at their destinations as scheduled. Thus, it is not surprising that these attributes significantly impact passengers' evaluations of public transport and its overall popularity. Numerous factors affect the reliability and associated punctuality of public transport services. Some of these factors fall within the purview of the Wrocław City Office and the transport operator, while others do not. For example, drivers and conductors are unable to influence traffic flow or unforeseen events, such as adverse weather conditions, detours, or roadworks. However, the transport organiser and the operator can make adjustments to aspects such as timetables, route planning for specific lines, the allocation of dedicated lanes and bus lanes, and improvements to the overall flow of public transport vehicles. To encourage residents who currently rely on personal vehicles to switch to public transport, the service provider must promptly undertake appropriate measures to improve the aforementioned attributes. Despite several initiatives already implemented to modernise various elements of the urban infrastructure with the goal of improving reliability [73], the research findings indicate that the city continues to struggle with meeting this particular attribute.

At present, the service provider is investing in new vehicles and modernising the existing fleet [73]. These efforts aim to:

- enhance the comfort of travelling by public transport;
- improve accessibility for individuals with mobility impairments;
- reduce the negative environmental impact of public transport on climate change.

Nevertheless, this study reveals that comfort is not a top priority for passengers. Respondents rated travel costs as a more significant concern than comfort. The majority of those surveyed (69.2%) were aged between 27 and 59—a demographic that is not eligible for free travel or discounted fares on public transport. It was primarily this group that highlighted cost as a key determinant of service quality. It is, however, important to note that Wrocław boasts the largest group of residents eligible for free public transport among Poland's major cities [74].

In summary, the current state of public transport falls short of meeting residents' expectations. The Wrocław City Office, in collaboration with the transport operator, should prioritise the attributes that matter most to the public, particularly those influencing journey time. Research indicates that satisfaction with these attributes is rated as low to moderate. Therefore, in order to persuade more car users in Wrocław to transition to public transport, efforts must first focus on ensuring timely departures and providing passengers with confidence that they will reach their destinations within the expected time.

The articles that attempt to determine the importance of public transport quality attributes in various cities indicate geographical and possibly cultural differences in the results. In [75], where transport in the city of Tehran was analysed, the BWM method was used to determine the importance of attributes. In this study, the most important quality features of public transport were comfort, accessibility, safety, and security. In a similar study [76], also conducted in Tehran and using the AHP method to assess the importance of quality attributes, the most important features were considered to be suitability, safety, and waiting time.

In [31], which analysed transport quality in the city of Mersin, Turkey, the most important attributes were considered to be safety, information before travel, and physical comfort. In [33], a study conducted in Budapest using the FAHP method, the most important attributes were travel time, frequency of lines, and access time. It seems that the specificity of cities and geographical regions largely determines the needs related to public transport. It is not possible to establish a set of universal public transport quality attributes that could apply to cities worldwide. As a result, the degree to which public transport providers fulfil passengers' needs will also vary.

When comparing results, reference should be made to cities that are geographically close to the region. The issue of public transport quality is one of the most fundamental challenges for the functioning of many cities in Poland (e.g., Kraków, Kielce, Gdańsk, Bydgoszcz, Warsaw, and Białystok). It can be observed that the general level of passenger satisfaction with the services provided by carriers in these cities is unsatisfactory [65,66,68,70–72]. Passengers expect improvements in various quality attributes. These are:

- in Krakow: frequency and punctuality [68];
- in Kielce: travel cost and travel time [65];
- in Gdańsk: travel time and information [66];
- in Bygoszcz: comfort and reliability [70];
- in Warsaw: travel cost and punctuality [71];
- in Białystok: travel cost and information [72].

A comparative analysis of which individual quality features of public transport are fulfilled by companies providing public transport services in various cities in Poland allows for identifying the strengths and weaknesses of public transport in Wrocław. The strengths of Wrocław include the following features: availability and communication of information related to travel route planning (e.g., schedules, fare tariffs, ticket outlets, announcements about changes in the transport network), and travel route signage (visual or audio information at stops or inside vehicles), travel cost, and safety during waiting and travel. On the other hand, the weak points include: the comfort of waiting at stops and during the journey, as well as the punctuality of vehicle departures.

Passengers using public transport services in various cities in Poland generally agree on the most important features determining service quality: punctuality and reliability. It is worth emphasising that these features were also considered the most important by passengers of Wrocław's public transport. Despite this similarity, the approach to conducting service quality studies—particularly regarding the selection and number of features; as well as the method for determining perceived and preferred quality—differs across the mentioned cities. In the articles [65,66,68,70–72], 6 to 16 general quality features were studied, and they were not divided into more detailed attributes. However, when determining the ranking of features' importance or their level of fulfilment, the appropriate share of responses corresponding to a given value on the Likert scale was most often used.

Therefore, it is not possible to directly compare the quality of public transport services in Wrocław with those in other cities in Poland. Such comparisons will be possible only when the set of attributes and the method for quantifying service quality are identical. Regardless of the method used to carry out research on the quality of public transport services, they are necessary for changes to occur in the field of transport in cities. As indicated in e.g., [65], in order to improve the travel cost feature, the Kielce City Card was introduced, which includes a section tariff and a Passenger Information System. In

addition, roads were built and rebuilt along with the technical infrastructure, and new bus lanes were built because this was to improve the degree of fulfilment of the travel time feature.

The findings from this research carry both theoretical and practical significance. For both the transport organiser and service provider, these insights offer valuable guidance on where to direct efforts to improve service quality. Sustainable development of cities is also impossible without efficiently operating and well-planned public transport. In [77], the authors, after conducting their research, indicate public transport as one of 12 factors influencing the proper design of Green Cities. Similarly, the authors of [78] point to the important concept of TOD (Transit-Oriented Development), additionally indicating that while economic development is usually a factor in improving many aspects of life, transport in cities is a factor that rather worsens the situation. Admittedly, SUTI Indicator 4 is unlikely to ever reach 100%. The pursuit of improved fulfilment of these key attributes may encounter obstacles, such as financial limitations on the part of the organiser or technical constraints faced by the operator. Thus, it is vital to find a compromise between the needs of the city's residents and the capabilities of both the transport organiser and service provider. This does not change the fact, however, that the quality of public transport plays a critical role in shaping the quality of life for those who rely on it, as well as in the broader socioeconomic development of the city. For this reason, local authorities should harness the full range of available legal, economic, and regulatory tools to ensure an adequate standard of transport services within the city.

6. Future Work and Limitations

The problem of public transport quality is multidimensional and involves various stakeholder groups, often with conflicting needs. In our research, we focused on only one of these groups, but we plan to conduct in-depth interviews with both transport providers and those responsible for organising public transport in Wrocław. Future plans also include further research on passenger groups and expanding the study to other major cities in Poland. An additional issue not addressed in this study is technological progress, which will likely change communication methods, passenger information systems, and transportation options, such as the use of autonomous vehicles [79].

The study has several limitations. It was conducted only in Wrocław, so the results cannot be generalised to other cities or countries. The CAWI (Computer-Assisted Web Interviewing) method was used to gather data, which has its own specific limitations. Although the study was conducted by a professional public opinion research institute, the sample was purposive. We focused on individuals using public transport, so the sample is not representative of the entire population. This should be taken into account when interpreting the study's results.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su162411182/s1, Table S1: Quality feature preference matrix for all respondents assessing bus transport; Table S2: Quality feature preference matrix for all respondents assessing tram transport; Figure S1: Comparison of responses for all respondents evaluating bus transport across all pairwise comparisons; Figure S2: Comparison of responses for all respondents evaluating tram transport across all pairwise comparisons.

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References

1. Kłos-Adamkiewicz, Z. Plany zrównoważonej mobilności miejskiej jako element polityki transportowej. In *Biała Księga Mobilności 2015*; Zając, A.P., Ed.; Transport Publiczny; Stowarzyszenie Transportu Publicznego; Nextbike; Zespół Doradców Gospodarczych TOR: Warszawa, Poland, 2015; pp. 26–34.
2. Smart Cities: Mobility Ecosystems for a More Sustainable Future. Available online: https://www.pwc.com/gx/en/issues/reinventing-the-future/smart-mobility-hub/sustainable-mobility-ecosystems-in-smart-cities.html (accessed on 25 August 2024).
3. Mercik, A. Elektromobilność w autobusowym transporcie publicznym organizowanym przez Górnośląsko-Zagłębiowską metropolię jako narzędzie realizacji idei zrównoważonej mobilności. *Pr. Kom. Geogr. Komun. PTG* **2020**, *23*, 18–33. [CrossRef]
4. Civitas Prosperity—Poradnik—Opracowanie Planu Zrównoważonej Mobilności Miejskiej (SUMP). Available online: https://www.pois.gov.pl/media/72913/SMG_Ekspert_Civitas_Prosperity_Poradnik_2019_03_18_podglad_v1.pdf (accessed on 27 August 2024).
5. Strategia Zrównoważonego Rozwoju Transportu do 2030 Roku. Available online: https://www.gov.pl/web/infrastruktura/projekt-strategii-zrownowazonego-rozwoju-transportu-do-2030-roku2 (accessed on 27 August 2024).
6. Plan Zrównoważonej Mobilności dla Miejskiego Obszaru Funkcjonalnego Wrocławia (PZM MOFW). Available online: https://www.wroclaw.pl/zielony-wroclaw/files/dokumenty/110825/PZM_MOFW.pdf (accessed on 25 August 2024).
7. Dziaduch, I. Wrocław public transport passengers' satisfaction survey by means of CSI and IPA. *Ekon. I Sr.* **2023**, *84*, 149–171. [CrossRef]
8. *PN-EN 13816*; Transport. Logistyka i Usługi. Publiczny Transport Pasażerski. Definicje, Cele i Pomiary Dotyczące Jakości Usług. Polski Komitet Normalizacyjny (PKN): Warszawa, Poland, 2004.
9. Sustainable Urban Transport Index (SUTI). Data Collection Guideline. Available online: https://www.unescap.org/sites/default/files/SUTI%20Data%20Collection%20Guideline%20_%202019%20update.pdf (accessed on 27 August 2024).
10. Duleba, S.; Mishina, T.; Shimazaki, Y. A dynamic analysis on public bus transport's supply quality by using AHP. *Transport* **2012**, *27*, 268–275. [CrossRef]
11. Moslem, S.; Solieman, H.; Oubahman, L.; Duleba, S.; Senapati, T.; Pilla, F. Assessing Public Transport Supply Quality: A Comparative Analysis of Analytical Network Process and Analytical Hierarchy Process. *J. Soft Comput. Decis. Anal.* **2023**, *1*, 124–138. [CrossRef]
12. Al-Zibaree, H.K.Y.; Konur, M. Fuzzy Analytic Hierarchal Process for Sustainable Public Transport System. *J. Oper. Intell.* **2023**, *1*, 1–10. [CrossRef]
13. Moslem, S.; Alkharabsheh, A.; Ismael, K.; Duleba, S. An Integrated Decision Support Model for Evaluating Public Transport Quality. *Appl. Sci.* **2020**, *10*, 4158. [CrossRef]
14. Alkharabsheh, A.; Moslem, S.; Duleba, S. Evaluating Passenger Demand for Development of the Urban Transport System by an AHP Model with the Real-World Application of Amman. *Appl. Sci.* **2019**, *9*, 4759. [CrossRef]
15. Bubalo, T.; Rajsman, M.; Škorput, P. Analytic Hierarchy Process in the Function of Evaluation of Transport Service Quality in Bus Company. *Int. J. Traffic Transp. Eng.* **2021**, *11*, 1–16. [CrossRef]
16. Nosal, K.; Solecka, K. Application of AHP method for multi-criteria evaluation of variants of the integration of urban public transport. *Transp. Res. Procedia* **2014**, *3*, 269–278. [CrossRef]
17. Go, J.D.M.; King, G.A.K.; Vergel, K.B.N. Applying AHP on the Sustainable Urban Transport Index Indicator 4 to Assess the Quality and Reliability of Public Utility Jeepneys and Buses in Metro Manila. In Proceedings of the 28th Annual Conference of the Transportation Science Society of the Philippines, Virtual, 25 November 2022.
18. Velasco Arevalo, A.; Gerike, R. Sustainability Evaluation Methods for Public Transport with a Focus on Latin American Cities: A Literature Review. *Int. J. Sustain. Transp.* **2023**, *17*, 1236–1253. [CrossRef]
19. Camargo Pérez, J.; Carrillo, M.H.; Montoya-Torres, J.R. Multi-Criteria Approaches for Urban Passenger Transport Systems: A Literature Review. *Ann. Oper. Res.* **2015**, *226*, 69–87. [CrossRef]
20. Yannis, G.; Kopsacheili, A.; Dragomanovits, A.; Petraki, V. State-of-the-Art Review on Multi-Criteria Decision-Making in the Transport Sector. *J. Traffic Transp. Eng. (Engl. Ed.)* **2020**, *7*, 413–431. [CrossRef]
21. Mardani, A.; Zavadskas, E.K.; Khalifah, Z.; Jusoh, A.; Nor, K.M.D. Multiple Criteria Decision-Making Techniques in Transportation Systems: A Systematic Review of the State of the Art Literature. *Transport* **2016**, *31*, 359–385. [CrossRef]
22. Kriswardhana, W.; Hayati, N.N.; Kusdiyanto, A.R. Factors Affecting the Interest of Urban Public. *Transport Users in Jember. IOP Conf. Ser. Earth Environ. Sci.* **2022**, *1000*, 012012. [CrossRef]
23. Moslem, S.; Duleba, S. Application of AHP for evaluating passenger demand for public transport improvements in Mersin, Turkey. *Int. J. Eng. Inf. Sci.* **2018**, *13*, 67–76. [CrossRef]

24. Moslem, S.; Duleba, S. Analytic hierarchy process evaluation of public transport system in Budapest, Hungary. In Proceedings of the ICTTE: International Conference on Traffic and Transport Engineering 2018, Belgrade, Serbia, 27–28 September 2018; pp. 660–665.
25. Zhang, X.; Liu, H.; Hu, M.; Mao, C.; Shi, J.; Meng, G.; Wu, J. Evaluation of passenger satisfaction of urban multi-mode public transport. *PLoS ONE* **2020**, *15*, e0241004. [CrossRef]
26. Akhrouf, M.; Medjamia, H.; Bessou, M. An AHP-based approach to selecting a priority public transportation mode for investment. *Int. J. Anal. Hierarchy Process* **2023**, *15*, 1–23. [CrossRef]
27. Dudek, M.; Solecka, K.; Richter, M. A multi-criteria appraisal of the selection of means of urban passenger transport using the Electre and ahp methods. *Tech. Trans.* **2018**, *115*, 79–93. [CrossRef]
28. Mayo, F.L.; Taboada, E.B. Ranking factors affecting public transport mode choice of commuters in an urban city of a developing country using analytic hierarchy process: The case of Metro Cebu, Philippines. *Transp. Res. Interdiscip. Perspect.* **2020**, *4*, 100078. [CrossRef]
29. Rivero Gutiérrez, L.; De Vicente Oliva, M.A.; Romero-Ania, A. Managing Sustainable Urban Public Transport Systems: An AHP Multicriteria Decision Model. *Sustainability* **2021**, *13*, 4614. [CrossRef]
30. Moslem, S.; Saraji, M.K.; Mardani, A.; Alkharabsheh, A.; Duleba, S.; Esztergar-Kiss, D. A Systematic Review of Analytic Hierarchy Process Applications to Solve Transportation Problems: From 2003 to 2022. *IEEE Access* **2023**, *11*, 11973–11990. [CrossRef]
31. Duleba, S.; Kutlu Gündoğdu, F.; Moslem, S. Interval-Valued Spherical Fuzzy Analytic Hierarchy Process Method to Evaluate Public Transportation Development. *Informatica* **2021**, *32*, 661–686. [CrossRef]
32. Moslem, S. A Novel Parsimonious Spherical Fuzzy Analytic Hierarchy Process for Sustainable Urban Transport Solutions. *Eng. Appl. Artif. Intell.* **2024**, *128*, 107447. [CrossRef]
33. Moslem, S.; Tezel, B.T.; Ovgu Kinay, A.; Pilla, F. A Hybrid Approach Based on Magnitude-Based Fuzzy Analytic Hierarchy Process for Estimating Sustainable Urban Transport Solutions. *Eng. Appl. Artif. Intell.* **2024**, *137*, 109112. [CrossRef]
34. de Aquino, J.T.; de Melo, F.J.C.; Jerônimo, T.d.B.; de Medeiros, D.D. Evaluation of Quality in Public Transport Services: The Use of Quality Dimensions as an Input for Fuzzy TOPSIS. *Int. J. Fuzzy Syst.* **2019**, *21*, 176–193. [CrossRef]
35. Pamučar, D.; Stević, Ž.; Sremac, S. A New Model for Determining weight Coefficients of Criteria in MCDM Models: Full Consistency Method (FUCOM). *Symmetry* **2018**, *10*, 393. [CrossRef]
36. Oubahman, L.; Duleba, S. A Comparative Analysis of Homogenous Groups' Preferences by Using AIP and AIJ Group AHP-PROMETHEE Model. *Sustainability* **2022**, *14*, 5980. [CrossRef]
37. Kiciński, M.; Solecka, K. Application of MCDA/MCDM Methods for an Integrated Urban Public Transportation System—Case Study, City of Cracow. *Arch. Transp.* **2018**, *46*, 71–84. [CrossRef]
38. Kokku, R.; Almotawa, A.; Vijai, P. Measuring Commuters' Perception on Service Quality Using SERVQUAL in Public Transportation. *Int. J. Mark. Stud.* **2011**, *3*, 21–34. [CrossRef]
39. Valenzo-Jiménez, M.A.; Lázaro-López, D.A.; Martínez-Arroyo, J.A. Application of the SERVQUAL model to evaluate the quality in the transportation service in Morelia, Mexico. *DYNA* **2019**, *86*, 64–74. [CrossRef]
40. Kewate, S.R.; Gandhewar, V.R. Perception-Satisfaction Based Quality Assessment of Public Transportation Services using SERVQUAL Model. *J. Propuls. Technol.* **2023**, *44*, 871–895. [CrossRef]
41. Muthupandian, K.S.; Vijayakumar, D.C. Measurement of passengers service quality in public transportation: Servqual analysis. *Bus. Plus* **2012**, *1*, 1–9.
42. Luke, R.; Heyns, G.J. An analysis of the quality of public transport in Johannesburg, South Africa using an adapted SERVQUAL model. *Transp. Res. Procedia* **2020**, *48*, 3562–3576. [CrossRef]
43. Sinha, S.; Shivanand Swamy, H.M.; Modi, K. User Perceptions of Public Transport Service Quality. *Transp. Res. Procedia* **2020**, *48*, 3310–3323. [CrossRef]
44. de Oña, J.; de Oña, R. Quality of service in public transport based on customer satisfaction surveys: A review and assessment of methodological approaches. *Transp. Sci.* **2015**, *49*, 605–622. [CrossRef]
45. Thongam, S.; Arunkumar Singh, Y. Customer Satisfaction Index (CSI) and Importance Performance Analysis (IPA) Methods for Intermediate Public Transport System in Imphal, Manipur. *Int. Res. J. Adv. Eng. Hub* **2024**, *2*, 416–424. [CrossRef]
46. Poliaková, A. CSI Index of Customer's Satisfaction Applied in the Area of Public Transport. *Res. Pap. Fac. Mater. Sci. Technol. Slovak Univ. Technol.* **2015**, *23*, 141–150. [CrossRef]
47. Sustainable Urban Transport Index for Asian Cities. Available online: https://uncrd.un.org/sites/uncrd.un.org//files/11th-est_ps6-2_bgp.pdf (accessed on 19 November 2024).
48. Sustainable Urban Transport Index: Measuring Sustainability of Urban Mobility. Available online: https://plataformaurbana.cepal.org/sites/default/files/2022-06/Sustainable%20Urban%20Transport%20Index,%20Measuring%20Sustainability%20of%20Urban%20Mobility%20.pdf (accessed on 19 November 2024).
49. Traffic Index. Available online: https://www.tomtom.com/traffic-index/wroclaw-traffic/ (accessed on 27 August 2024).
50. Plan Zrównoważonego Rozwoju Publicznego Transportu Zbiorowego dla Wrocławia na Lata 2016–2022. Available online: https://www.wroclaw.pl/strategia-rozwoju-wroclawia-2030/files/plan-transportowy/plan-transportowy-wroclawia.pdf (accessed on 27 August 2024).

51. Ustawa z Dnia 16 Grudnia 2010 r. o Publicznym Transporcie Zbiorowym (Dz.U. 2011 nr 5 poz. 13). Available online: https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20110050013/T/D20110013L.pdf (accessed on 27 August 2024).
52. Plan Zrównoważonego Rozwoju Publicznego Transportu Zbiorowego Wrocławia na Lata 2023–2027. Available online: https://www.wroclaw.pl/rozmawia/jaki-bedzie-plan-transportowy-wroclawia (accessed on 27 August 2024).
53. Adamiczka, H. Analiza i ocena stanu obecnego oraz perspektywy rozwoju komunikacji miejskiej we Wrocławiu. *Pr. Nauk. Uniw. Ekon. Wrocławiu* **2015**, *408*, 11–35. [CrossRef]
54. Wrocławianie Narzekają na Korki i Komunikację Miejską, Chcą Nowych Dróg. Available online: https://archiwum.wroclife.pl/nasze-miasto/komunikacja-we-wroclawiu-raport/ (accessed on 27 August 2024).
55. Subramanian, N.; Ramanathan, R. A review of applications of Analytic Hierarchy Process in operations management. *Int. J. Prod. Econ.* **2012**, *138*, 215–241. [CrossRef]
56. Forman, E.H.; Gass, S.I. The analytic hierarchy process: An exposition. *Oper. Res.* **2001**, *49*, 469–486. [CrossRef]
57. Jan, R.U.; Usman, M.; Abrar, M.F.; Ullah, N.; Asshad, M.; Ali, S. Scaling Agile Adoption Motivators from Management Perspective: An Analytical Hierarchy Process Approach. *Sci. Program.* **2021**, *3*, 4522273. [CrossRef]
58. Arslan, M.; Kang, S. Determining the Significance Level of Vocabulary Teaching Tools and Activities in Teaching Turkish as a Foreign Language through Analytical Hierarchy Process. *J. Educ. Black Sea Reg.* **2019**, *4*, 138–159. [CrossRef]
59. Saaty, T.L. The analytic hierarchy process (AHP). *J. Oper. Res. Soc.* **1980**, *41*, 1073–1076.
60. Saaty, T.L. Relative measurement and its generalization in decision making why pairwise comparisons are central in mathematics for the measurement of intangible factors the analytic hierarchy/network process. *RACSAM-Rev. Real Acad. Cienc. Exactas Fis. Naturales. Ser. A Mat.* **2008**, *102*, 251–318. [CrossRef]
61. Trzaskalik, T. Wielokryterialne wspomaganie decyzji. Przegląd metod i zastosowań. *Zesz. Naukowe. Organ. I Zarządzanie/Politech. Śląska* **2014**, *74*, 239–263.
62. Prusak, A.; Stefanów, P. *AHP—Analityczny Proces Hierarchiczny. Budowa i Analiza Modeli Decyzyjnych Krok po Kroku*, 1st ed.; C.H. Beck: Warszawa, Poland, 2014; pp. 209–244.
63. Saaty, T.L.; Shang, J.S. Group decision-making: Head-count versus intensity of preference. *Socio-Econ. Plan. Sci.* **2007**, *41*, 22–37. [CrossRef]
64. Saaty, T.L.; Vargas, L.G. The possibility of group choice: Pairwise comparisons and merging functions. *Soc. Choice Welf.* **2012**, *38*, 481–496. [CrossRef]
65. Mikulska, A.; Starowicz, W. Analiza preferencji i satysfakcji pasażerów transportu publicznego w Kielcach. *Transp. Miej. Reg.* **2015**, *3*, 23–29.
66. Kaszubowski, D. Badanie jakości usług transportu zbiorowego na nowej trasie tramwajowej w dzielnicy Gdańsk Południe. *TTS Tech. Transp. Szyn.* **2013**, *10*, 49–60.
67. Mężyk, M.; Zamkowska, S. Podnoszenie jakości usług w przewozach pasażerskich. *TTS Tech. Transp. Szyn.* **2004**, *11*, 21–27.
68. Kołodziej, G.; Starowicz, W. Analiza jakości transportu zbiorowego realizowanego przez prywatnych przewoźników na trasie Alwernia–Kraków. *Transp. Miej. Reg.* **2017**, *8*, 18–24.
69. Romanowicz, A. Analiza jakości przewozów w komunikacji autobusowej w gminie Skawina. *Czas. Techniczne. Bud.* **2011**, *3*, 131–140.
70. Landowski, B.; Małkowska, M. Jakość przewozów w miejskim transporcie zbiorowym na przykładzie wybranej aglomeracji miejskiej. *Logistyka* **2005**, *4*, 1959–1967.
71. Górecka, A.; Perłowska, A. Jakość usług transportu zbiorowego w Warszawie w ocenie pasażerów. *Ekon. Organ. Logistyki* **2017**, *2*, 31–38. [CrossRef]
72. Milenkiewicz, B.J.; Halicka, K. Ocena jakości usług w transporcie zbiorowym na przykładzie Białostockiej Komunikacji Miejskiej. *Econ. Manag.* **2011**, *4*, 76–86.
73. MPK Wrocław: Projekty Unijne i Krajowe. Available online: https://mpk.wroc.pl/o-mpk/projekty-unijne (accessed on 27 August 2024).
74. Bezpłatna Komunikacja na Wybory oraz Ulga 50% dla Osób z Umiarkowaną Niepełnosprawnością. Available online: https://miejscawewroclawiu.pl/bezplatna-komunikacja-na-wybory-oraz-ulga-50-dla-osob-z-umiarkowana-niepelnosprawnoscia/ (accessed on 27 August 2024).
75. Shabani, A.; Shabani, A.; Ahmadinejad, B.; Salmasnia, A. Measuring the Customer Satisfaction of Public Transportation in Tehran during the COVID-19 Pandemic Using MCDM Techniques. *Case Stud. Transp. Policy* **2022**, *10*, 1520–1530. [CrossRef]
76. Nassereddine, M.; Eskandari, H. An Integrated MCDM Approach to Evaluate Public Transportation Systems in Tehran. *Transp. Res. Part A Policy Pract.* **2017**, *106*, 427–439. [CrossRef]
77. Zaidi Hassim, J.; Romana Harjiyatni, F.; Sri Wibawanti, E.; Zamre Mohd Zahir, M.; Helmi Md Said, M.; Grace Emmanuel, K. Effective Toolbox for Sustainable Urban Planning of Real Estate Development: A Systematic Review. *Kurd. Stud.* **2024**, *12*, 1889–1916.

78. Suzuki, H.; Cervero, R.; Iuchi, K. *Transforming Cities with Transit: Transit and Land-Use Integration for Sustainable Urban Development*; World Bank: Washington, DC, USA, 2013. [CrossRef]
79. Zakeri, S.; Konstantas, D.; Sorooshian, S.; Chatterjee, P. A Novel ML-MCDM-Based Decision Support System for Evaluating Autonomous Vehicle Integration Scenarios in Geneva's Public Transportation. *Artifcial Intell. Rev.* **2024**, *57*, 310. [CrossRef]

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