

Engaging Citizens in Public Transit Choice: Insights from Vietnam and Italy

Martina Carra(✉), Roberto Ventura, and Benedetto Barabino

Department of Civil, Environmental, Architectural Engineering and Mathematics, University of Brescia, 25123 Brescia, Italy
martina.carra@unibs.it

Abstract. Recently, Multi-Criteria Decision-Making methods (MCDMs) have become increasingly relevant in public transport planning, offering structured ways to assess complex alternatives that involve both technical and human-centered criteria. Despite their widespread use, previous studies have often overlooked the involvement of citizens in the decision-making process. Moreover, the wide variety of available MCDMs can pose challenges in selecting the most appropriate method for a given context. To address these gaps, this study introduces an integrated framework that combines five MCDM techniques: AHP, SAW, TOPSIS, VIKOR, and PROMETHEE II. The approach incorporates both expert assessments and user preferences to provide a comprehensive assessment of transit alternatives. Applied to two case studies, Ho Chi Minh City (Vietnam) and Brescia (Italy), the framework highlighted how citizen input can meaningfully contribute to public transport planning while also enabling the comparison of methodological outcomes across diverse urban contexts. The proposed framework provides a flexible, transparent, and replicable tool for policymakers and transport planners aiming to evaluate and prioritize public transport solutions in both developing and developed countries.

Keywords: Decision-making · Public transport planning · Citizen participation

1 Introduction

Efficient transportation is a vital component of cities. It enables mobility, supports economic growth, and shapes the daily lives of people. Currently, mobility systems are increasingly strained in many developing cities, where private vehicles dominate. Congestion, air and noise pollution, and deteriorating public health are becoming common consequences. These issues are particularly severe in metropolis, where urbanization and centralized economic activities highly pressure on infrastructure and services [1]. As cities aim to become smarter, safer, and more sustainable, public transportation systems are emerging as key enablers of this transformation. Well-designed public transport reduces dependency on cars, improves air quality, enhances safety, and ensures equitable access to services [2]. However, choosing the most suitable public transport mode is a complex task. Each city faces unique challenges, ranging from demographic and spatial

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2026
O. Gervasi et al. (Eds.): ICCSA 2025 Workshops, LNCS 15899, pp. 294–305, 2026.
https://doi.org/10.1007/978-3-031-97663-6_26

characteristics to socio-economic and cultural factors. Therefore, any transport investment must consider both technical feasibility, local needs, and long-term sustainability [3, 4]. A challenge in transport planning is how to evaluate and prioritize alternative systems. Should a city invest in metro, bus rapid transit, trams, buses, etc.? Which solution offers the best balance among cost, efficiency, environmental impact, and user satisfaction? Researchers increasingly turn to MCDM methods to address these questions and support the decision-making process [5–7]. These are structured approaches used to compare and rank options based on a combination of quantitative and qualitative criteria.

MCDM methods are promising in the urban transport sector, where decision-making involves multiple stakeholders, conflicting objectives, and uncertainty. These methods enable for the inclusion of diverse evaluation criteria, such as travel time, cost, emissions, accessibility, comfort, and safety. Moreover, they can incorporate both objective performance indicators and subjective preferences from users and experts alike. Various MCDMs have been developed, each with different structures, assumptions, and applications. Broadly, they can be grouped into three categories [8]. *Value-based methods* (e.g., Simple Additive Weighting – SAW, Analytic Hierarchy Process – AHP, Multi-Attribute Utility Theory – MAUT) assign weights to each criterion and compute overall scores for each alternative based on additive models [9]. For instance, in SAW, alternatives are ranked by summing weighted scores across all criteria [10]. *Outranking methods* (e.g., ELECTRE, PROMETHEE) compare alternatives pairwise for each criterion to determine preferences [11–13]. Unlike value-based approaches, they do not require all criteria to be on the same scale and are better suited for handling vague or imprecise judgments. *Goal-based methods* (e.g., TOPSIS, VIKOR) assess how close each alternative is to an ideal solution [9, 10]. For instance, TOPSIS identifies the option with the shortest distance from the best-case scenario and the furthest from the worst-case. VIKOR uses compromise programming to balance performance and regret.

Each method has advantages and limitations [9, 14]. While value-based methods are intuitive and easy to communicate, they may oversimplify complex trade-offs. Outranking methods better reflect human decision-making but may yield inconclusive or ambiguous rankings that are less transparent to non-experts. Goal-based models offer more flexibility but rely heavily on the definition of the "ideal" alternative.

MCDM methods have been widely used in public transport planning to: (i) select project alternatives, such as comparing different transport modes or technologies [15–17]; (ii) evaluate service quality [18, 19]; (iii) support planning by identifying the most efficient or user-preferred transport systems [20, 21].

Despite their usefulness, some key limitations remain in current research. (i) Comparative analysis of MCDM methods across different city types or contexts is lacking, making it difficult to identify recurring patterns or best practices. (ii) The best-performing alternative is not always the most feasible for implementation as contextual factors, such as funding, social acceptance, and long-term maintenance, are often under-considered [22]. (iii) Assessments tend to rely solely on expert opinions, with limited stakeholder engagement, a key point for legitimacy, acceptance, and successful implementation, as highlighted in the EU's SUMP principles [23, 24].

To overcome these challenges, this study proposes a hybrid MCDM framework that integrates five methods: AHP, SAW, TOPSIS, VIKOR, and PROMETHEE. It enables

decision-makers to: (i) combine the strengths of each method while mitigating individual limitations; (ii) cross-validate results across techniques to identify converging or diverging outcomes; (iii) incorporate both expert knowledge (via literature and technical standards) and user preferences (collected through surveys).

The framework is applied to two case studies representing different urban contexts, Ho Chi Minh City (Vietnam) and Brescia (Italy). By comparing outcomes in these cities, the study explores how the decision-making tools may lead to different conclusions depending on the urban scale, transport needs, and stakeholder priorities.

The results highlight the relevance of an integrated participatory approach for selecting public transport systems that are technically valid, economically viable, socially accepted, and environmentally sustainable. Involving citizens improves the quality of the decision and helps build trust, reduce resistance, and encourage public transport adoption. In the context of smart, safe, and healthy cities, this approach offers a transparent, adaptable, and user-inclusive decision support model that is data-driven for evidence-based planning and focused on sustainable and equitable mobility. It provides valuable insights and practical tools for urban planners, transport authorities, and policymakers aiming to build more livable cities.

2 Methodology

This study applied an integrated methodology to support the selection of the most appropriate public transport system across different urban contexts. The framework consists of three main steps, as shown in Fig. 1.

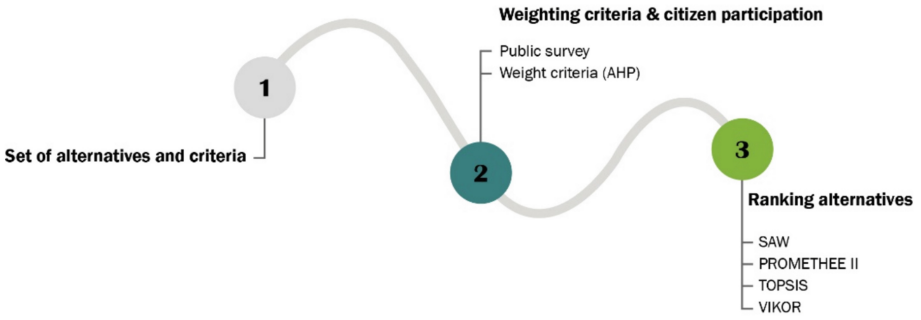

Fig. 1. The structure of integrated methodology.

2.1 Step 1. Defining Alternatives and Criteria

The first step identifies a set of public transport alternatives and assessment criteria. Alternatives are derived from an extensive literature review, ensuring that each one represents a viable solution within the scope of urban mobility planning. Alternatives range across different performance levels, from basic to high-capacity systems, and reflect various degrees of investment, sustainability, and technological advancement. A set of

criteria is also defined to assess these options meaningfully. They represent alternative characteristics such as cost, efficiency, and environmental impact. Criteria may be split into sub-criteria to make the decision process more structured and manageable, i.e., to ensure that alternatives can be measured, compared, and prioritized effectively. While many studies do not categorize alternatives to prevent bias, this framework explicitly includes such classification to illustrate that lower-performance options may sometimes be more appropriate, depending on the context. This helps decision-makers remain open to a broader range of solutions and avoid over-prioritizing high-end systems that may not align with local needs or resources [11].

2.2 Step 2. Weighting Criteria and Citizen Participation

The second step determines the relevance of the assessment criteria by applying the AHP. This widely applied MCDM method decomposes complex decisions into simpler pairwise comparisons within a hierarchical structure.

Citizens and experts are involved through surveys via Google forms and the AHP-OS platform. Specifically, AHP-OS enables participants to provide immediate feedback on their response consistency, enabling them to revise their judgments and improve the reliability of their input. Generally, AHP is applied using the expert's judgment. However, this study also includes citizens' input in the weighting process to reflect broader stakeholder values and ensure greater transparency and social legitimacy, e.g., affordability vs environmental impact when choosing public transportation.

Once responses are collected, AHP processes the pairwise comparisons to derive a normalized weight $\widehat{w}_j$ for each criterion and sub-criterion. Let D and J be the sets of participants and criteria, respectively. For each participant $d \in D$, a pairwise comparison matrix $A_{j,d}$ is built. The relative importance of criterion $j \in J$ compared to another $k \in J$ is expressed as a ratio $a_{jk,d}$. Weights are computed using the geometric mean method and normalized as follows:

$$\widehat{w}_{j,d} = \frac{(\prod_{k \in J} a_{jk,d})^{1/|J|}}{\sum_{j \in J} (\prod_{k \in J} a_{jk,d})^{1/|J|}} \tag{1}$$

To ensure coherence in judgments, the AHP checks the Consistency Ratio (CR) for each matrix [25] as follows:

$$CR_{J,d} = \frac{\left(\lambda_{maxJ,d} - |J|\right)}{RI \cdot (|J| - 1)} \tag{2}$$

where λ_{max} is the eigenvalue of the matrix, and RI is a random index based on the number of criteria. In this study, a relaxed threshold of CR ≤ 0.15 was adopted to accommodate non-expert participants (compared to the standard 0.10 used for experts) [26, 27]. Valid responses are then aggregated into a final group judgment using the Weighted Geometric Mean Aggregation method, ensuring that all valid judgments contribute proportionally to the final result [28]. To obtain the overall weight for each terminal node in the decision hierarchy, the sub-criteria weights were multiplied by their respective parent criteria weights. This provided a comprehensive ranking of all elements involved in the evaluation process.

2.3 Step 3. Ranking Alternatives

The third stage ranks the alternatives using four widely used MCDM methods: SAW, TOPSIS, VIKOR, and PROMETHEE II. Let I be the set of alternatives. Each method builds a decision matrix based on the performance of each alternative $i \in I$ containing performance values x_{ij} for each alternative $i \in I$ and criterion $j \in J$. When data are qualitative, they are translated into numerical values using predefined scales. Next, the decision matrix is normalized into a utility matrix $\hat{x}_{ij}$, , considering whether the criterion is a benefit (to be maximized) or a cost (to be minimized). The weights $\widehat{w}_j$, computed in the previous step, are then applied to reflect the relevance of each criterion. The normalized and weighted values are subsequently used to compute a global score G_i for each alternative, which reflects its overall suitability. Finally, the global score determines the rank from most to least appropriate alternative.

Each method follows a different computational logic. SAW aggregates performance by summing all weighted normalized values [Eq. 3]. It is straightforward and intuitive but may oversimplify complex decisions. TOPSIS compares each alternative's distance from an ideal best $\Delta^+{}_i$ and an ideal worst $\Delta^-{}_i$ solution. Alternatives are ranked based on their relative closeness CC_i to the ideal solution, making the method useful when both optimality and risk minimization are relevant [Eq. 4]. VIKOR identifies a compromise solution, balancing between the collective satisfaction (group utility S_i) and regret R_i of individuals who are most affected by poor performance on specific criteria. A parameter $\beta = 0.5$ is used to weigh these two aspects equally, although it can be adjusted according to decision-makers preferences [Eq. 5]. PROMETHEE II is an outranking method that performs pairwise comparisons between alternatives. It calculates positive $\varnothing^+(i)$ and negative $\varnothing^-(i)$ preference flows to reflect how much each alternative outranks or is outranked by others. The resulting net flow score offers insight into dominance relations among the options, which is especially useful for visual analysis [Eq. 6].

$$G_{SAW,i} = \sum\nolimits_{j \in J} \widehat{w}_j \hat{x}_{ij} \tag{3}$$

$$G_{TOP,i} = CC_i = \frac{\Delta_i^-}{\Delta_i^- + \Delta_i^+} \tag{4}$$

$$G_{VIK,i} = \beta \frac{S_i - S_{min}}{S_{\max} - S_{min}} + (1 - \beta) \frac{R_i - \mathrm{R}_{min}}{R_{\max} - \mathrm{R}_{min}} \tag{5}$$

$$G_{PRO,i} = \emptyset(i) = \emptyset^+(i) - \emptyset^-(i) \tag{6}$$

While SAW, TOPSIS, and PROMETHEE generate positively oriented rankings (where higher scores indicate better alternatives), VIKOR produces a negatively oriented score, where lower values reflect more balanced and satisfactory options.

This combined approach enables for comparison and validation of results across methods, offering robust insights into the most appropriate public transport alternatives.

3 Results

The method was applied in two different urban contexts to explore how public transport systems can be selected more effectively. Ho Chi Minh City (Vietnam), with its rapid growth and ageing infrastructure, faces major challenges in handling its daily traffic. In

contrast, Brescia is a mid-sized Italian city where a metro system already supports part of the network, but further expansion is needed. By applying the assessment framework, the research offers useful insights for cities with different scales and needs.

3.1 Step 1. Defining Alternatives and Criteria

In Step 1, criteria were grouped into two main categories: Individual criteria (IC), which reflect the needs and preferences of public transport users, and Provider-public criteria (PP), which relate to broader considerations relevant to service providers and the public interest (Table 2). *ID* were assessed by users via survey, as they pertain to elements that influence passengers' choices in everyday travel. Six criteria and related sub-criteria were identified from existing study [18, 30, 31]: (i) vehicle-related (comfort, capacity), (ii) safety (at stops, onboard, of vehicle), (iii) travel time (access, waiting, in-vehicle), (iv) availability (operating hours, ticket characteristics), (v) reliability (punctuality, tracking), and (vi) directness (connectivity, transfers, stop distance). In contrast, the *PP criteria* were intended to capture strategic planning concerns. Among these, two sub-criteria were selected: (i) investment cost and (ii) city development, according to [29].

The transport modes alternatives were classified by performance level following [30] framework: low (Regular Buses, trams), medium (Bus Rapid Transit, Ligh Rail Transit), and high (metro, Automatic Light Rail Transit). Categories informed the selection of alternatives for the two case studies. The alternatives for Ho Chi Minh City included RB, BRT, LRT, and Metro. For Brescia, the selection comprised RB, BRT, ALRT, and Tram, aligning with lower demand and different infrastructural contexts. Each alternative was characterized through a mix of quali-quantitative criteria. Technical data were drawn from official sources/reports, while qualitative performance was evaluated using a linguistic scale based on prior research [31]. Finally, assumptions were standardized to ensure comparability; e.g., access times were longer for high-performance modes, assuming greater walking distances in exchange for faster services.

3.2 Step 2. Weighting Criteria and Citizen Participation

The Step 2 weighting criteria through AHP, informed by a public survey distributed across both case studies. 174 responses were collected, 157 from Ho Chi Minh and 17 from Brescia, reflecting the population sizes of the two cities. Moreover, individual criteria were weighted based on survey responses, while the Provider-public criteria weights were derived from previous studies due to their technical nature.

The results showed that in Ho Chi Minh, a larger share of importance was placed on public and strategic dimensions (60.4%), while in Brescia, users gave slightly more weight to individual and user-centered criteria (47%). The most relevant criteria across both cases included Travel time and Directness (Table 2), suggesting that users favor transport options that offer save time and connected experiences. In contrast, Availability and Vehicle comfort or capacity criteria were rated less critical. City development emerged as the highest priority for the Provider-public criteria, followed by Investment cost. This highlights the significance of long-term urban benefits in the public transport decision-making process (Table 1).

Table 1. Set and normalized weights of the criteria.

Categories	Criterion	#	Sub-criterion	Overall normalized weight	
				Ho-Chi-Min	*Brescia*
Individual	Vehicle	1.1	Comfortability	0.027	0.032
		1.2	Passenger capacity	0.014	0.017
	Safety	2.1	On board	0.034	0.040
		2.2	At stops	0.022	0.026
		2.3	Of vehicle	0.021	0.025
	Travel time	3.1	Access time	0.033	0.039
		3.2	Waiting time	0.019	0.022
		3.3	In-vehicle time	0.028	0.033
	Availability	4.1	Operating hours	0.040	0.047
		4.2	Ticket	0.018	0.021
	Reliability	5.1	Regularity	0.040	0.047
		5.2	Tracking availability	0.024	0.029
	Directness	6.1	Transfer	0.031	0.037
		6.2	Integration	0.030	0.036
		6.3	Distance	0.016	0.019
Provider-public	Investment cost	7.1	-	0.128	0.138
	City development	7.2	-	0.476	0.392

3.3 Step 3. Ranking Alternatives

The final step applied four MCDM methods to rank the public transport alternatives for each case study.

Each method involved the construction of a decision matrix, where the performance of each transport mode was assessed against each sub-criterion. Qualitative values were translated into numerical scores using established linguistic scales to enable normalization and comparison.

Results were largely consistent across the different methods. In Ho Chi Minh City, Metro emerged as the top-ranked solution in all four approaches. The gap between Metro and other alternatives was significant, reaffirming its suitability in a high-density urban environment. In Brescia, ALRT and Tram alternated in the top positions depending on the method used. According to SAW and PROMETHEE II, ALRT was the most preferred, while TOPSIS and VIKOR gave a slight edge to the Tram. However, the differences in scores between these two options were marginal. The VIKOR method also applied additional acceptance criteria to assess whether the best-ranked alternative

Table 2. Decision matrix.

#	Unit	±	RB		BRT		LRT	Metro	ALRT	Tram
			*	**	*	**	*	*	**	**
1.1	–	+	A	A	G	G	E	O	E	G
1.2	space/h/line	+	3000	3000	6000	6000	10000	50000	17000	10000
2.1	–	+	A	A	VG	VG	VG	O	O	VG
2.2	–	+	A	A	VG	VG	VG	O	O	G
2.3	–	+	A	A	G	G	VG	O	O	VG
3.1	Mins	–	5	5	10	10	10	10	10	10
3.2	Mins	–	20	15	10	12	10	5	6	9
3.3	Mins	–	42	25	29	15	18	10	10	16
4.1	Hours	+	16	16	17	18	19	19	18	18
4.2	$	–	0.5	1.4	1	1.4	2	2	1.4	1.4
5.1	–	+	G	A	VG	VG	VG	O	E	VG
5.2	–	+	A	G	VG	E	VG	O	O	E
6.1	–	–	2	2	1	1	1	1	1	1
6.2	Times	+	O	O	G	G	A	O	G	G
6.3	Km	+	0.2	0.2	0.3	0.4	0.5	1.2	0.5	0.5
7.1	Mil-$/km	–	1	1	11.5	10	45	100	78	31
7.2	–	+	A	A	G	VG	VG	O	E	E

* Ho Chi Min case and ** Brescia case; + (Benefit) and - (Cost); A (Average), G (Good), VG (Very good), E (Excellent), O (Outstanding).

could be considered a valid compromise. Metro clearly satisfied both conditions in Ho Chi Minh, confirming its dominance. In Brescia, Tram and ALRT failed to meet all the compromise criteria, suggesting that both should be considered as co-leading options (Table 3).

4 Discussion and Conclusion

The application of multiple MCDM methods across two contrasting city contexts highlights several insights regarding public transport planning and method suitability. In Ho Chi Minh City, all methods consistently ranked the Metro as the top alternative. This result aligns with expectations. Previous studies have similarly found metro and light rail options preferable in megacities, emphasizing their capacity to meet large-scale demand efficiently [29, 31]. Although all four methods produced similar rankings overall, VIKOR showed a slight shift, placing BRT above LRT. This divergence is likely due to VIKOR's focus on balancing group utility and individual regret, which may highlight relative performance differences overlooked by traditional methods. In contrast, Brescia

Table 3. Global scores and ranking.

Method	Case	#	Bus	BRT	LRT	Metro
SAW	Ho-Chi-Min	G_{saw}	0.371	0.385	0.480	0.831
		Rank	4	3	2	1
	Brescia	G_{saw}	0.425	0.581	0.795	0.713
		Rank	4	3	1	2
TOPSIS	Ho-Chi-Min	G_{top}	0.247	0.339	0.503	0.756
		Rank	4	3	2	1
	Brescia	G_{top}	0.368	0.690	0.632	0.785
		Rank	4	2	3	1
VIKOR	Ho-Chi-Min	G_{vik}	1.000	0.359	0.393	0.000
		Rank	4	2	3	1
	Brescia	G_{vik}	1.000	0.251	0.124	0.039
		Rank	4	3	2	1
PROMETHEE II	Ho-Chi-Min	G_{vik}	-0.343	-0.104	-0.008	0.455
		Rank	4	3	2	1
	Brescia	G_{vik}	-0.487	0.046	0.223	0.219
		Rank	4	3	1	2

presented a more complex scenario with no dominant alternative. While TOPSIS and VIKOR identified the Tram as the most balanced option, SAW and PROMETHEE II favored ALRT. However, the performance gap between the two modes was minimal across all methods, suggesting that both could be considered viable solutions. This variability reflects the challenges of decision-making in medium-sized cities, where several alternatives can perform similarly across criteria [22, 29, 32]. Moreover, it demonstrates how different MCDM approaches may yield slightly different preferences depending on the evaluation focus. Interestingly, the regular bus system was consistently ranked last in both case studies. Its lower performance confirms existing evidence about the limited potential of basic transit modes in addressing contemporary urban mobility challenges.

The comparison of methods also provides insight into which tools are most suitable for different contexts. In straightforward situations like Ho Chi Minh, where one mode clearly outperforms others, any of the four methods can provide useful guidance. However, in more nuanced cases like Brescia, VIKOR and PROMETHEE II are recommended. VIKOR's adjustable parameter (β) enables for tailored assessments based on stakeholder preferences, while PROMETHEE II enables flexible preference modeling and visual comparisons of alternatives. Still, even these robust methods rely on the quality and clarity of input data.

In this study, citizen participation through the AHP survey proved challenging, especially in Brescia, due to the complexity of pairwise comparisons and the survey length. Several participants found it difficult to evaluate abstract criteria, leading to inconsistent

data. This highlights the need for future research to explore simplified, user-friendly tools for involving non-experts in complex decision processes. Furthermore, the conversion of qualitative criteria into numerical values remains a potential source of imprecision. More structured approaches to quantifying indicators like "city development" would enhance the robustness of results. Breaking this down into measurable sub-criteria, e.g., real estate growth, user modal shift, or long-term environmental benefits, could lead to more accurate assessments.

To conclude, this study offers an integrated MCDM framework that blends expert input with citizen opinion to support transport planning in diverse urban settings. Applying the approach in both a metropolis and a medium-sized city demonstrates how contextual differences shape mobility needs and influence decision outcomes. The research contributes to the literature in several ways. It emphasizes the value of including citizen perspectives in decision-making, which are often underrepresented in traditional MCDM applications. It also shows how method selection matters, mainly when alternatives perform similarly, and offers practical guidance on choosing the most appropriate MCDM method based on scenario complexity. Moreover, this is one of the first studies to apply such methods to Vietnam's urban transit system, adding valuable regional insight to the global conversation on transport planning. Finally, it provides a replicable model for other cities, particularly in developing countries, facing similar challenges and leading to smarter, more sustainable, and citizen-oriented urban mobility systems.

Nevertheless, the model should be considered a support tool, not a prescriptive solution. Future studies should seek to improve data accuracy, expand public participation through more intuitive interfaces, and incorporate additional criteria related to construction impacts, operational constraints, and technological developments. An expert-only survey for technical parameters is also advisable to avoid inconsistencies in weight attribution.

Acknowledgments. This study was partially funded by the University of Brescia within the Grant "CUP: D75F21002920001" PON R&I 2014–2020 (FSE REACT-EU). Special thanks to Phan Nguyen Minh Tan for their preliminary work carried out as part of his thesis.

CRediT Authorship Contribution Statement. Conceptualization: B.B.; Methodology: All; Formal analysis: M.C., R.V.; Data curation: M.C., R.V.; Visualization: All; Writing-Original Draft: All; Writing-review & editing: All; Supervision: B.B.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

References

1. Lee, S., Lee, S., Lee, Y.I.: Innovative public transport oriented policies in Seoul. Transportation **33**, 189–204 (2006)
2. Barabino, B.: Transit bus route network design: a model and its application in a real network. WIT Trans. Built Environ. **107**, 369–382 (2009)

3. Dulce, F., Murillo-Hoyos, J., Caicedo, E.: Comparative analysis of the performance, environmental impact, and costs of electric, combustion, and gas buses in an operating context of a mid-sized city of an emerging country. Transport. Res. Interdisc. Perspect. **25**, 101113 (2024)
4. Kronprasert, N., Talvitie, A.: Use of reasoning maps in evaluation of transport alternatives: inclusion of uncertainty and "I Don't Know": demonstration of a method. Transportation **42**, 389–406 (2015)
5. Beria, P., Maltese, I., Mariotti, I.: Multicriteria versus cost benefit analysis: a comparative perspective in the assessment of sustainable mobility. Eur. Transp. Res. Rev. **4**(3), 137–152 (2012)
6. Marleau Donais, F., Abi-Zeid, I., Waygood, E.O.D., Lavoie, R.: A review of cost–benefit analysis and multicriteria decision analysis from the perspective of sustainable transport in project evaluation. EURO J. Decis. Processes **7**(3–4), 327–358 (2019). https://doi.org/10.1007/s40070-019-00098-1
7. Samani, Z.N., et al.: Advancing urban healthcare equity analysis: integrating public participation GIS with fuzzy best-worst decision-making. Sustainability **16**, 1745 (2024)
8. Carra, M., Pavesi, F.C., Barabino, B.: Sustainable cycle-tourism for society: Integrating multi-criteria decision-making and land use approaches for route selection. Sustain. Cities Soc. **99**, 104905 (2023)
9. Broniewicz, E., Ogrodnik, K.: Multi-criteria analysis of transport infrastructure projects. Transport. Res. Part D: Transp. Environ. **83**, 10235 (2020)
10. Ciardiello, F., Genovese, A.: A comparison between TOPSIS and SAW methods. Ann. Oper. Res. **325**(2), 967–994 (2023)
11. Yannis, G., Kopsacheili, A., Dragomanovits, A., Petraki, V.: State-of-the-art review on multi-criteria decision-making in the transport sector. J. Traffic Transport. Eng. **7**(4), 413–431 (2020)
12. Brans, J.P., Vincke, P., Mareschal, B.: How to select and how to rank projects: the promethee method. Eur. J. Oper. Res. **24**(2), 228–238 (1986)
13. Brans, J.P., De Smet, Y.: PROMETHEE methods. Int. Ser. Oper. Res. Manag. Sci. **233**, 187–219 (2016)
14. Velasquez, M., Hester, P.T. An analysis of multi-criteria decision making methods. Int. J. Oper. Res. **10**(2) (2013)
15. Hamurcu, M., Eren, T.: Electric bus selection with multicriteria decision analysis for green transportation. Sustainability **12**(7), 2777 (2020)
16. Borghetti, F., Carra, M., Besson, C., Matarrese, E., Maja, R., Barabino, B.: Evaluating alternative fuels for a bus fleet: an Italian case. Transp. Policy **154**, 1–15 (2024)
17. Manzolli, J.A., Trovão, J.P., Antunes, C.H.: Scenario-Based Multi-criteria decision analysis for rapid transit systems implementation in an urban context. ETransportation **7**, 100107 (2021)
18. Moslem, S., Alkharabsheh, A., Ismael, K., Duleba, S.: An integrated decision support model for evaluating public transport quality. Appl. Sci. **10**(12), 4158 (2020)
19. 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 **10**(3), 1520–1530 (2022)
20. Le Pira, M., Inturri, G., Ignaccolo, M., Pluchino, A.: Analysis of AHP methods and the Pairwise Majority Rule (PMR) for collective preference rankings of sustainable mobility solutions. Transport. Res. Procedia **10**, 777–787 (2015)
21. Güner, S.: Measuring the quality of public transportation systems and ranking the bus transit routes using multi-criteria decision making techniques. Case Stud. Transp. Policy **6**(2), 224 (2018)

22. Ventura, R., Bonera, M., Carra, M., Barabino, B., Maternini, G.: Evaluating the viability of a tram-train system: a case study from Salento (Italy). Case Stud. Transp. Policy **10**(3), 1945–1963 (2022)
23. Taylor, B.D., Morris, E.A.: Public transportation objectives and rider demographics: are transit's priorities poor public policy? Transportation **42**, 347–367 (2015)
24. Rupprecht Consult (ed.): Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan, Second Edition (2019)
25. Saaty, T.L.: The Analytical Hierarchy Process: Planning, Priority Setting, Resource Allocation. McGraw-Hill, New York (1980)
26. Carrara, E., Ciavarella, R., Boglietti, S., Carra, M., Maternini, G., Barabino, B.: Identifying and selecting key sustainable parameters for the monitoring of e-powered micro personal mobility vehicles: evidence from Italy. Sustainability **13**(16), 9226 (2021)
27. Wedley, W.C.: Consistency prediction for incomplete AHP matrices. Math. Comput. Model. **17**(4–5), 151–161 (1993)
28. Grošelj, P., Zadnik Stirn, L., Ayrilmis, N., Kuzman, M.K.: Comparison of some aggregation techniques using group analytic hierarchy process. Expert Syst. Appl. **42**(4), 2198–2204 (2015)
29. Lee, D. J. A multi-criteria approach for prioritizing advanced public transport modes (APTM) considering urban types in Korea. Transportation Research Part A **111** (2018)
30. Vuchic, V.R.: Urban Transit Systems and Technology. Wiley, Hoboken (2007)
31. Nassereddine, M., Eskandari, H.: An integrated MCDM approach to evaluate public transportation systems in Tehran. Transport. Res. Part A **106**, 427–439 (2017)
32. De Aloe, M., Ventura, R., Bonera, M., Barabino, B., Maternini, G.: Applying cost–benefit analysis to the economic evaluation of a tram-train system: evidence from Brescia (Italy). Res. Transport. Bus. Manag. **47**, 100916 (2022)