COPRAS METHOD FOR SELECTING OPTIMAL PUBLIC TRANSPORTATION IN SURAKARTA TO SUPPORT SUSTAINABLE URBAN MOBILITY

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ABSTRACT

This study aims to identify the most suitable public transportation mode in Surakarta to support sustainable urban mobility by applying the Complex Proportional Assessment (COPRAS) method. The research considers six evaluation criteria, namely convenient user, user safety, accessibility and inclusivity, fee, time efficiency, and mobility, which reflect both service quality and efficiency aspects of urban transportation. The alternatives assessed include Batik Solo Trans (BST), van, pedicab, taxi and taxibike (online and manual), representing the main public transport modes available in the city. The methodology involves normalizing the decision matrix, applying the assigned weights to the criteria, and calculating the positive and negative significance values for each alternative, followed by determining their relative significance and utility values. The findings indicate that among the alternatives, van with 100,00 achieved the highest utility value, making it the most appropriate choice for enhancing public transportation services in Surakarta. The results demonstrate that the COPRAS methos provides a systematic and balanced approach for integrating benefit and cost criteria, offering practical insights for policymakers in developing to promote efficient, inclusive, and sustainable urban transportation systems.

KEYWORDS COPRAS, Public, Transportation, Sustainable, Mobility

INTRODUCTION

Surakarta is recognized as a city with urban areas situated in a strategically significant region for trade and services. The urban landscape, particularly within its strategic zones, has experienced substantial functional development (Zaenuddin et al., 2022). The government of Surakarta has supported population mobility through the provision of various public transportation modes (Diansari, Prio, et al., 2024). Various

modes of public transportation are available, including Batik Solo Trans (BST) buses, vans, pedicabs, taxis and taxibikes (online and manual), all of which serve to facilitate community mobility. However, rapid population growth and increasing economic activities have generated various challenges in urban development, particularly concerning urbanization, environmental issues (the escalation of exhaust emissions and the degradation of air quality), and traffic congestion (Carolin & Kurniati, 2025). This condition underscores the need for establishing a transportation system that ensures efficiency, safety, affordability, and environmental sustainability.

Sustainable development refers to the responsible utilization of natural resources to meet present needs without compromising the ability of future generations to meet their own. The rapid advancement of technology enables cities to adopt solutions that ensure their development remains sustainable (Devi Naily Fadlilah et al., 2024). The notion of sustainable urban mobility represents a crucial approach within modern transport planning, highlighting efficiency in travel alongside environmental protection, enhanced safety, and equitable access to mobility for all communities. In making travel decision, the community prioritizes several criteria, including safety, availability, comfort, travel time, and cost (Rizal et al., 2023). The selection of an appropriate public transportation mode constitutes a strategic approach to achieving the intended objective. A suitable mode of transport has the potential to encourage a modal shift from private to public transportation.

Although Surakarta offers a wide variety of public transportation modes, a comprehensive evaluation that considers key factors such as comfort, safety, cost, travel time, and accessibility has not yet been undertaken. The majority of existing studies on transportation mode choice in Indonesia have applied Multi-Criteria Decision Making (MCDM) approaches, including AHP, TOPSIS, and PROMETHEE. In contrast, the adoption of the COPRAS (Complex Proportional Assessment) method is still relatively scarce, particularly within the Surakarta context. The COPRAS method operates by considering both beneficial and non-beneficial criteria. Prior to implementing this method, it is essential to establish the set of alternative criteria in accordance with the decision-making requirements (Firmandana & Ramadhan, 2020). This method is capable of evaluating alternatives by incorporating both quantitative and qualitative criteria, while proportionally accounting for the relative weight assigned to each criterion. This method is regarded as accurate, as it facilitates the identification of the most suitable alternative in accordance with the established criteria (Lilis et al., 2020). Its application serves to provide insights into process variations and to support managerial decision-making in the pursuit of continuous process improvement (Diansari, Waluyono, et al., 2024).

Based on these issues, this study aims to identify the optimal public transportation mode in Surakarta by applying the COPRAS method, taking into account the criteria of comfort, safety, cost, travel time and accessibility. This study is expected to offer useful recommendations for local governments, transport service providers and the public, in orfer to help promote urban mobility that is sustainable, efficient, and environmentally friendly.

RESEARCH METHOD

The COPRAS (Complex Proportional Assessment) method assumes a direct and proportional relationship between the significance level and the utility of alternatives under conflicting criteria. It evaluates the performance of alternatives against various criteria while considering their respective weights. This method determines the optimal decision by taking into account both the ideal and the worst-case solutions (Ginting et al., 2020). This study employed an analytical research design using the COPRAS method to select alternative modes of public transportation in Surakarta. The data used in this study were

obtained from both primary and secondary sources. Primary data were collected through surveys and questionnaires distributed to 40 public transportation users with a purposive sampling technique using the criteria that users have used at least once in all public transportation modes in Surakarta. While secondary data were obtained from related literature. The assessment criteria comprised the dimensions of safety, security, comfort and accessibility (Rossetti & Tiboni, 2020).

The steps of the COPRAS method are as follows:

1. Developing a decision matrix

$$D = A_1\ A_2\ \vdots\ A_m\ [X_{11}\ X_{12}\ \dots\ X_{1n}\ X_{21}\ X_{22}\ \dots\ X_{2n}\ \vdots\ X_{m1}\ \vdots\ X_{m2}\ \vdots\vdots\ \dots\ X_{mn}\ ] \quad (1)$$

2. Matrix normalization

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \quad (2)$$

3. Determining the weighted normalized decision matrix

$$d_{ij} = r_{ij}.w_j \quad (3)$$

4. Calculation of the maximizing and minimizing indices for each alternative
   Positive values for benefit criteria

$$S_i^+ = \sum_{j=1}^{n} y_{+ij} \quad (4)$$

   Negative values for cost criteria

$$S_i^- = \sum_{j=1}^{n} y_{-ij} \quad (5)$$

5. Determine the relative significance or relative priority of each alternative

$$Q_i = S_i^+ + \frac{S_{min}^- \sum_{i=1}^{m} S_i^-}{S_i^- \sum_{i=1}^{m} \frac{S_{min}^-}{S_i^-}} \quad (6)$$

6. Calculate the quantitative utility (U_i) for each alternative

$$U_i = \left(\frac{Q_i}{Q_{max}}\right).100\% \quad (7)$$

7. Ranking

RESULT AND DISCUSSION

To solve the problem above using the COPRAS method, the process will follow the steps provided. The research method is described as:

A. Criteria Data

The criteria data serve as a benchmark in determining the appropriate mode of public transportation, playing a crucial role in supporting sustainable urban mobility in Surakarta.

Table 1. Criteria Data

Code	Criteria	Weight	Type of Criteria
C1	Convenient user	0,3	Benefit
C2	User Safety	0,2	Benefit
C3	Accessibility and Inclusivity	0,1	Benefit
C4	Fee	0,1	Cost
C5	Time Efficiency	0,2	Benefit
C6	Mobility	0,1	Benefit

Table 1 presents the list of decision-support criteria, each assigned a weight, and classified into two types: cost and benefit. The total weight of the six criteria equals 1,00.

B. Alternative Data

The alternative data serves as a vital component in developing a decision support system aimed at identifying the most appropriate public transportation mode in Surakarta. The following section outlines the alternative data of public transportation modes available in the city.

Table 2. Alternative Data

Code	Alternative
A1	Batik Solo Trans (BST)
A2	Van
A3	Pedicab
A4	Taxi and Taxibike (Online and Manual)

Table 2 provides a list of alternatives, designated from A1 to A4. These alternatives are identified based on the various types of public transportation modes operating in Surakarta.

C. COPRAS

The following presents the assessment process using the COPRAS (Complex Proportional Assessment) method.

1. Developing a decision matrix

D = [
[3.3, 3.7, 3.4],
[3.4, 4.4, 3.6],
[3.3, 3.3, 13],
[3.5, 3.1, 15],
[3.1, 3.1, 13],
[3.3, 3.0, 3.6],
[3.7, 3.8, 4.1],
[3.0, 3.2, 13],
[3.3, 3.3, 13],
[2.8, 2.8, 14]
]

2. Matrix normalization

r_ij = [
[0.25, 0.25, 0.26],
[0.26, 0.30, 0.27],
[0.25, 0.25, 0.24],
[0.21, 0.23, 0.23],
[0.25, 0.23, 0.26],
[0.28, 0.29, 0.30],
[0.23, 0.24, 0.25],
[0.24, 0.21, 0.23]
]

3. Determining the weighted normalized decision matrix

Table 3. Weight Normalized

Alternative	Weight Normalized					
	Criteria					
	C1	C2	C3	C4	C5	C6
A1	0,07	0,05	0,03	0,03	0,05	0,03

A2	0,08	0,06	0,03	0,03	0,06	0,03
A3	0,07	0,05	0,02	0,02	0,05	0,02
A4	0,07	0,04	0,02	0,02	0,05	0,02
Weight	0,30	0,20	0,10	0,10	0,20	0,10
Atribute	Benefit	Benefit	Benefit	Cost	Benefit	Benefit

4. Calculation of the maximizing and minimizing indices for each alternative

Table 4. Maximizing and Minimizing Indices for Each Alternative

Alternative	S_i^+	S_i^-
A1	0,22	0,03
A2	0,25	0,03
A3	0,22	0,02
A4	0,21	0,02

5. Determine the relative significance or relative priority of each alternative

Table 5. The Relative Significance

Alternative	Q_i
A1	0,25
A2	0,27
A3	0,24
A4	0,24

6. Calculate the quantitative utility (Ui) for each alternative

Table 6. Quantitative Utility

Alternative	U_i
A1	90,37
A2	100,00
A3	88,95
A4	86,59

7. Ranking

Table 7. Ranking

Alternative	Ranking
A1	2
A2	1
A3	3
A4	4

Overall, the findings demonstrate that the COPRAS method effectively differentiates among the available alternatives and identifies the optimal public transportation mode. There results highlight the method's potential as a decision-support tool for improving sustainable urban mobility in Surakarta.

CONCLUSION

This study has demonstrated that the application of the COPRAS method provides a structured and comprehensive framework for selecting public transportation modes in Surakarta. By incorporating both benefit and cost criteria, the method enables a balanced assessment that highlights the most suitable transportation option for improving mobility within the city. The findings suggest that selecting the optimal public transportation mode is essential not only for enhancing efficiency and accessibility but also for promoting sustainable urban mobility. The assessment of public transportation modes in Surakarta was carried out using six evaluation criteria, namely convenient user, user safety, accessibility and inclusivity, fee, time efficiency, and mobility. The alternatives examined

in this study consist of Batik Solo Trans (BST), van, pedicab, taxi and taxibike (online and manual), representing the main modes of transport operating within the city.

The ranking results indicate that alternative 2 (van) obtained the highest utility value of 100,00 and is therefore considered the most suitable mode, followed by alternative 1 (Batik Solo Trans/BST) with 90,37; alternative 3 (pedicab) with 88,95; alternative 4 (taxi and taxibike both online and manual) with 86,59. These findings highlight that selecting the optimal public transportation mode from the results of this research may serve as a valuable reference is essential for enhancing efficiency and accessibility while also supporting sustainable urban mobility in Surakarta.

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