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A CASE STUDY ON NEW VEHICLE INVESTMENT FOR THE TOURIST TRANSPORTATION RENTAL BASED ON BWM AND SAW

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ABSTRACT

The rapid growth of the tourism industry, especially in Indonesia, has positively impacted various other sectors. This growth has indirectly spurred the development of supporting businesses, predominantly small and medium-sized enterprises (SMEs), such as tourist transportation rentals. Rising tourist demands for transportation necessitate that entrepreneurs in this industry adapt quickly, including investing in the latest vehicle units. However, investing in new vehicles is challenging, especially for small-scale rental owners. They must carefully calculate their investment, considering various potential risks. Therefore, this study recommends alternatives for new vehicle investments in tourist transportation rentals based on BWM and SAW. A case study on small-scale rental businesses in Yogyakarta has been selected. The data was collected in 2024. The results indicate that five criteria must be considered for new vehicle investments in tourist rentals: vehicle type (C_1), fuel consumption (C_2), engine specifications (C_3), rental price (C_4), product lifetime (C_5), and price (C_6). The optimal weights of these criteria are determined using BWM to rank five investment alternatives: KIZ, HIC, AVZ, BRI, and SGR. The findings suggest KIZ as the potential top investment priority, followed by AVZ, BRI, SGR, and HIC.

INTRODUCTION

Yogyakarta, renowned as a cultural city, relies on its tourism sector as a significant source of economic profit. In 2023, the tourism sector contributed as much as 34% to the economy of Yogyakarta region (Nuryadin & Purwiyanta, 2023). Furthermore, in the first hal of 2024, the

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sector experienced rapid growth, with the number of international tourist arrivals increasing by 7.62% (Badan Pusat Statistik Provinsi D.I. Yogyakarta, 2024). The flourishing tourism sector in this region, of course, positively impacts the social, cultural, infrastructural, and environmental aspects. The tourism sector's positive effect is evident in the increased regional income through tourist visits and the social connections fostered between residents and visitors at tourist destinations (Martín et al., 2019). This industry's growth notably benefits supporting businesses, such as tourist transportation rentals. The rapid development of this industry in Yogyakarta is partly due to relaxed regulations, allowing predominantly privately scaled businesses to thrive.

The rapidly growing tourist transportation rental industry in Yogyakarta is highly popular among the community due to its low initial capital requirement, easy access to bank loans, and high demand. This industry primarily caters to the transportation needs of tourists, whether for inter-city travel or accessing various tourist attractions (Hidayat, 2019). With the rise of the tourism sector in Yogyakarta, the challenges faced by tourist transportation rental businesses also increase. Modern tourists demand vehicle comfort, posing a significant challenge for predominantly privately managed rental services, especially due to limited capital and the risks associated with regular vehicle updates. Therefore, quantitative calculations are necessary to help business owners make logical decisions and mitigate risks. This research proposes a decision-making model for vehicle investment selection tailored to small-scale tourist transportation rental businesses.

The Multiple Criteria Decision Making (MCDM) technique was selected to address this investment issue. While investment problems are often tackled with economic approaches, some researchers have utilized MCDM perspectives differently. MCDM is a suitable alternative for investment issues as it encompasses top management decision-making and involves multiple factors or criteria, including investment alternatives. Various studies have applied MCDM methods: Askarifar et al. (2018) evaluated investment opportunities using BWM and TOPSIS; Fauzi & Laluma (2023) developed a decision support system for stock investments using AHP and PROMETHEE; Daghouri et al. (2019) assessed the impact of IT investments using AHP and TOPSIS; Çalık et al. (2019) used AHP and TOPSIS to rank foreign direct investments in Turkey. For vehicle investment issues, researchers have applied different MCDM methods: Ahmad Rizaldi, Yunita, et al. (n.d.) used AHP and TOPSIS for car rental purchase decisions; Suyanto et al. (n.d.) developed an AHP-based decision system for used car selection; Setiadi (2019) employed AHP and SAW. This research uses BWM and SAW for small-scale tourist transportation rental vehicle investments, a novel combination not previously explored. BWM, introduced by Rezaei in 2015, is known for its accurate weighting with simple mathematical computations (Alkolid et al., 2023) and is highly compatible when integrated with the straightforward SAW method, making this combination particularly applicable for decision-makers with limited quantitative decision-making knowledge.

METHOD

To determine the selected vehicle investment, there are three main stages: identifying the most influential criteria for determining the investment, calculating the criteria weights, and ranking the vehicle investment alternatives. For calculating the criteria weights, the BWM (Best-Worst Method) is employed. Subsequently, the obtained criteria weights are incorporated into the SAW (Simple Additive Weighting) ranking process. In this study, three decision-makers who are owners of transportation rental companies operating in Yogyakarta were involved. The subsequent stages of the BWM and SAW methods are explained as follows.

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The BWM method

The Best-Worst Method (BWM) is a multi-criteria decision-making method developed by Rezaei in 2015. This method is effectively used for evaluating a number of criteria or alternatives in a systematic and comprehensible manner (Alkolid et al., 2023). Adhering to the methodology outlined in BWM process, the first action is the selection of decision criteria to identify the most and least favorable criteria. This is followed by gathering evaluations from decision-makers to derive both the best-to-others (BO) and others-to-worst (OW) vectors (Rezaei, 2015). The concluding step involves determining the ideal weights by applying the Solver Add-in, which utilizes a min-max optimization model as described below:

$$min\ \xi \quad (1)$$

Subject to:

$$\left|\frac{w_B}{w_j} - \alpha_{Bj}\right| \leq \xi, for\ all\ j \quad (2)$$

$$\left|\frac{w_j}{w_w} - \alpha_{jw}\right| \leq \xi, for\ all\ j \quad (3)$$

$$\sum_j w_j = 1 \quad (4)$$

$$w_j \geq 0, for\ all\ j$$

In this model, ξ is the maximum deviation to be minimized for consistency. w_B, w_w, and w_j represent the weights of the best, worst, and other criteria, while α_{Bj} and α_{jw} are the decision-maker's preference values. The constraints ensure alignment between preferences and weight ratios, normalization of weights, and non-negativity.

The SAW method

The Simple Additive Weighting (SAW) method, also known as the weighted sum method, is one of the simplest and most widely used methods in multi-criteria decision-making processes. The SAW method is highly popular due to its simplicity and ease of application in practical scenarios (Ketut Ayu Purnama Sari, 2021). Despite its simplicity, it is crucial to pay attention to the selection of weights and the normalization process to ensure that the results accurately reflect the preferences of the decision-makers. To process SAW, following the acquisition of criteria weights using BWM, the subsequent step involves normalizing the decision matrix using equations (5) and (6), in accordance with the characteristics of the criteria. The SAW score (V_i) is calculated using equation (7). The SAW procedure follows (Rusliyawati et al., 2020).

$$r_{ij} = \frac{x_{ij}}{\max(x_{ij})} \text{ for beneficial criteria} \quad (5)$$

$$r_{ij} = \frac{\min(x_{ij})}{x_{ij}} \text{ for cost criteria} \quad (6)$$

$$V_i = \sum(w_j \times r_{ij}) \quad (7)$$

In the SAW method, r_{ij} represents the normalized performance of alternative *i* on criterion *j*, adjusted based on whether the criterion is beneficial or a cost. The final score V_i for each alternative is obtained by summing the products of normalized values r_{ij} and their respective weights w_j.

RESULTS AND DISCUSSION

Building a decision-making structure

The decision-making structure consists of criteria and alternatives. In this study, six criteria are considered for the decision on vehicle investment selection, namely type of car (C_1) (Ahmad Rizaldi, Yunita, et al., n.d.), fuel consumption (C_2) (Sari & Darmawan, 2021), engine

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specifications (C_3) (Setiadi, 2019), rental price (C_4), product lifetime (C_5) (Suyanto et al., n.d.), and price (C_6) (Andini, 2012).

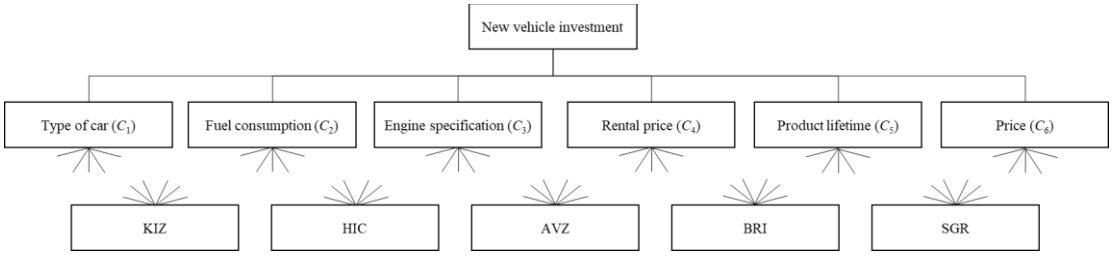

Figure 1. A decision-making structure for new vehicle investment

These six criteria are formulated based on literature studies for similar cases. Subsequently, decision-makers choose five car investment alternatives according to market interest, namely KIZ, HIC, AVZ, BRI, and SGR. The decision-making structure constructed is as shown in Figure 1.

Calculating criteria weights using BWM

To calculate the weights of the criteria using the Best Worst Method (BWM), the decision-makers first identify the best and worst criteria. The best criterion is understood as the top-of-mind criterion to fulfill the needs of tourists. The owner decides that the type of car is the best criterion, and the price of the car is the worst criterion. Once these two criteria are established, the BO (Best to Others) vector and the OW (Others to Worst) vector can be constructed based on Saaty's 1-9 scale.

$$\{a_{B1}, a_{B2}, a_{B3}, a_{B4}, a_{B5}, a_{B6}\}^C = \{1,2,5,4,3,6\}, \{a_{1W}, a_{2W}, a_{3W}, a_{4W}, a_{5W}, a_{6W}\}^C = \{6,5,2,3,4,1\}$$

Utilizing the BWM (Best Worst Method) solver developed by Rezaei (Rezaei, 2015), the optimal weights for each criterion are 0.379 for C_1, 0.221 for C_2, 0.088 for C_3, 0.110 for C_4, 0.147 for C_5, and 0.053 for C_6. The order of the criteria based on optimal weights is C_1> C_2>C_5>C_4>C_3> C_6. The three primary criteria – type of car, fuel consumption, and product lifetime – evidently influence the rental price. This is a crucial consideration for decision-makers, particularly individual entrepreneurs with limited financial resources, to make investment choices based on car type, fuel consumption, and lifetime. This is because the rental price offered to tourists can be projected to determine the extent of profit and the duration for return on investment. The car price becomes the last priority in deciding on the purchase of new vehicle investments, as the five offered alternatives have different levels of acceptable rental prices for tourists. The price of the car can be concluded to be linearly related to the rental price.

Calculating the ranking of investment alternatives using SAW

After obtaining the criteria weights, the final stage is the ranking of the best vehicle investment options. As previously explained, there are five vehicle investment alternatives in this study: KIZ, HIC, AVZ, BRI, and SGR. To calculate using the Simple Additive Weighting (SAW) method, a score matrix for each criterion for all alternatives needs to be first established. In this study, each alternative will be rated using a scale of 1 – 5 for all criteria, where 1

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indicates the lowest assessment and 5 indicates the best assessment. The evaluation matrix for all alternatives is displayed in table 1.

The evaluations for all alternatives are based on the profile of each vehicle, gathered using promotional media information from each vehicle manufacturer. For example, KIZ is a newly released vehicle in 2023 with the advantage of highly efficient fuel consumption due to its hybrid engine. With various features also possessed by KIZ, the rental price offered is relatively high compared to other vehicle alternatives. This contrasts with the SGR vehicle profile, which has a smaller engine capacity, is fuel-efficient, and can accommodate passengers up to three rows. The SGR alternative is offered at a very low rental price because it is not recommended for long-distance travel (only for in-city tourist destinations). Meanwhile, the HIC alternative has a different market segmentation from the other four alternatives, where HIC is only offered for tour groups of 14 passengers. This also impacts the score profile of HIC.

Table 1. The evaluation score for each alternative

Vehicles	**C_1**	**C_2**	**C_3**	**C_4**	**C_5**	**C_6**
KIZ	4	5	5	1	4	1
HIC	2	1	1	2	5	2
AVZ	5	2	2	3	3	3
BRI	3	3	4	4	2	4
SGR	1	4	3	5	1	5

After obtaining the profile of each vehicle, the next step is to rank the best alternative for investment using SAW. The SAW calculation is in accordance with equation (7). In SAW calculations, it is very important to consider whether criteria are in the beneficial or non-beneficial group. In this study, criteria C_1, C_3, C_4, and C_5 are categorized into the beneficial criteria group, while criteria C_2 and C_6 are in the non-beneficial group. Naturally, the maximum value of non-beneficial criteria is determined based on the smallest score. Table 2 shows the results of the SAW calculation. As can be seen, it can be concluded that the KIZ alternative has the potential to be the top priority for investment, followed by AVZ, BRI, SGR, and HIC. This study's findings are in line with the actual situation in the transportation rental business that the HIC segment differs from the other four alternatives, which tend to serve small tourist groups (2 – 4 people). While HIC also has a very high market interest potential currently, its consumer segmentation is recommended for groups of 12 – 14 people. Of course, although the rental price offered by HIC can be very high compared to the other four alternatives, business owners also need to consider other consequences such as fuel consumption, vehicle age, and car price.

Table 2. The SAW score and ranking for all alternatives

Vehicles	**C_1**	**C_2**	**C_3**	**C_4**	**C_5**	**C_6**	**V_i**	**Rank**
KIZ	0.303	0.221	0.088	0.022	0.118	0.010	0.764	1
HIC	0.152	0.044	0.017	0.044	0.147	0.021	0.427	5
AVZ	0.379	0.088	0.035	0.066	0.088	0.082	0.689	2
BRI	0.228	0.132	0.071	0.088	0.059	0.042	0.621	3
SGR	0.075	0.177	0.053	0.110	0.029	0.053	0.498	4

The prioritization of KIZ as the top-ranked investment option reflects its strong overall performance across the selected criteria, particularly in aspects such as engine specification (C3), product lifetime (C5), and rental feasibility (C4). The relatively high SAW score (0.764)

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demonstrates that KIZ offers a well-balanced value proposition, making it suitable for the operational needs and customer expectations in Yogyakarta's tourism rental sector. Meanwhile, AVZ and BRI follow as the next best options, likely due to their efficiency in cost-related factors such as fuel consumption and base price, without significantly compromising on other technical features.

On the other hand, the lower scores of SGR (0.498) and HIC (0.427) suggest a more limited alignment with the prioritized investment criteria. While SGR may appeal as a low-cost option, its trade-offs in power and durability could pose long-term operational challenges. As for HIC, despite its potential in serving large tourist groups, the trade-off between higher rental price and higher operational cost, especially fuel consumption (C2), appears to affect its ranking significantly when considered alongside other criteria. This reinforces the importance of not only targeting high market demand but also ensuring that operational sustainability is well accounted for in investment decisions.

This study successfully recommends that for small-scale tourist vehicle rental businesses, the four offered alternatives are very suitable and affordably invested for the owner, with the KIZ alternative being the top priority. However, the AVZ, BRI, and SGR alternatives also have a greater chance of successful investment because, in the market, these three alternatives are highly sought after by tourists both for the rental price offered and also for features, fuel consumption, and the relatively suitable age of the vehicles.

CONCLUSION

This study has recommended the best investment for personally managed vehicles using the BWM and SAW approaches. Although practitioners often lack specialized knowledge in decision-making theory, the model proposed in this research offers an easy-to-understand approach for small-scale rental entrepreneurs, particularly in the tourism sector. Among five types of vehicles, KIZ (Vi = 0.764) was the optimal choice for investment in a tourist vehicle rental business. The ranking of alternatives is based on six key criteria—vehicle type (C1), fuel consumption (C2), engine specifications (C3), rental price (C4), product lifetime (C5), and price (C6). However, this study is limited to five vehicle alternatives and does not consider external factors such as inflation, seasonal demand shifts, or fluctuations in fuel prices. Future research may consider incorporating a broader range of alternatives and contextual factors to enhance the model’s applicability and robustness in dynamic market conditions.

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