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Street Art Bukit Bintang by e-Scooter: Application of Fuzzy-AHP & GIS

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ABSTRACT

Cities are grappling with safety concerns surrounding e-scooters, leading to bans in some areas. However, there is a need to understand the best paths for e-scooter users, especially when main roads are unavailable or restricted. Decision-making methods like MCDA and GIS network analysis can help determine the best routes, considering various criteria and outcomes. This study aims to determine the best street art trail for e-scooters through the combined use of Fuzzy-AHP (FAHP) and GIS The objectives include identifying optimal pathway criteria, mapping potential trails using GIS, and assessing differences from other route planner applications. FAHP used to compute the criterion weights and these weights were integrated with GIS to establish a network model and identify the optimal e-scooter pathway using the TSP method. The final output is a map detailing optimal e-scooter route connecting street art in Bukit Bintang, featuring path information, street art locations, nearest train stations, and e-scooter rental stations. Following the derivation of the optimal path, analysis involved comparing it with existing trails from other navigation apps were made.

Keywords: e-scooter; fuzzy-ahp; GIS; network analysis; travelling salesman problem.

1. INTRODUCTION

E-scooters are a convenient and innovative mode of transportation for short trips and last-mile travel, but their rapid growth has raised concerns about functionality, application, riding behaviours, regulations, and security. Some cities have outlawed or suspended e-scooters due to insufficient research (Mat Nayan et al., 2021). Integrating e-scooters into urban infrastructure faces challenges like parking lots, designated lanes, and safety concerns. Understanding user routing preferences is crucial for optimizing infrastructure and services (Zhang et al., 2021). This study identifies criteria for creating optimal pathways using Spatial-Multicriteria Decision Analysis (MCDA), including methods like Fuzzy AHP to resolve imprecise semantics and enhance performance (Kim et al., 2020). A GIS network analysis and the Travelling Salesman Problem (TSP) are used to determine the most economical routes.

This study is significant for several reasons. It integrates MCDA and GIS techniques to identify optimal e-scooter pathways, providing a novel approach to urban transportation solutions which the Fuzzy AHP method enhances decision-making. Urban planners, transportation engineers, policymakers, and e-scooter companies can use these findings to design safer infrastructure, optimize routes, and ensure compliance with regulations. Additionally, optimizing e-scooter pathways promotes efficient urban transportation, improving mobility and social equity by providing a cost-effective mode of travel for underserved communities, thus potentially transforming urban transportation systems, and benefiting society.

2. METHODOLOGY

The research methodology used in the study is shown in Figure 1. The first stage is to determine the criteria that can be used in finding the optimal path for e-scooters accessing street art. The next stage is Data Collection. The data needed in this study are the rating of criteria that was obtained using Fuzzy-AHP technique and spatial data representing the criteria on the ground, road, and location of street arts. The third stage is Data Processing that involved of fuzzy pairwise comparison matrix to derive the weightage of criteria and GIS to create a network model which then were used in finding the e-scooter trail by using TSP. The fourth stage is Analysis site verification was conducted to make comparison of the found trail with the trails that could be found using other navigation or route planner apps. In addition, verification from experts were also conducted to ensure the trail found can be implanted in real-life. The last stage is the creation of a map visualizing optimal path for the e-scooter route connecting the location of street arts in Bukit Bintang. The map also shows location of other point of interests in the study area including rail-transit stations and the location of e-scooter rental stations so that users can plan for their journey when visiting the area.

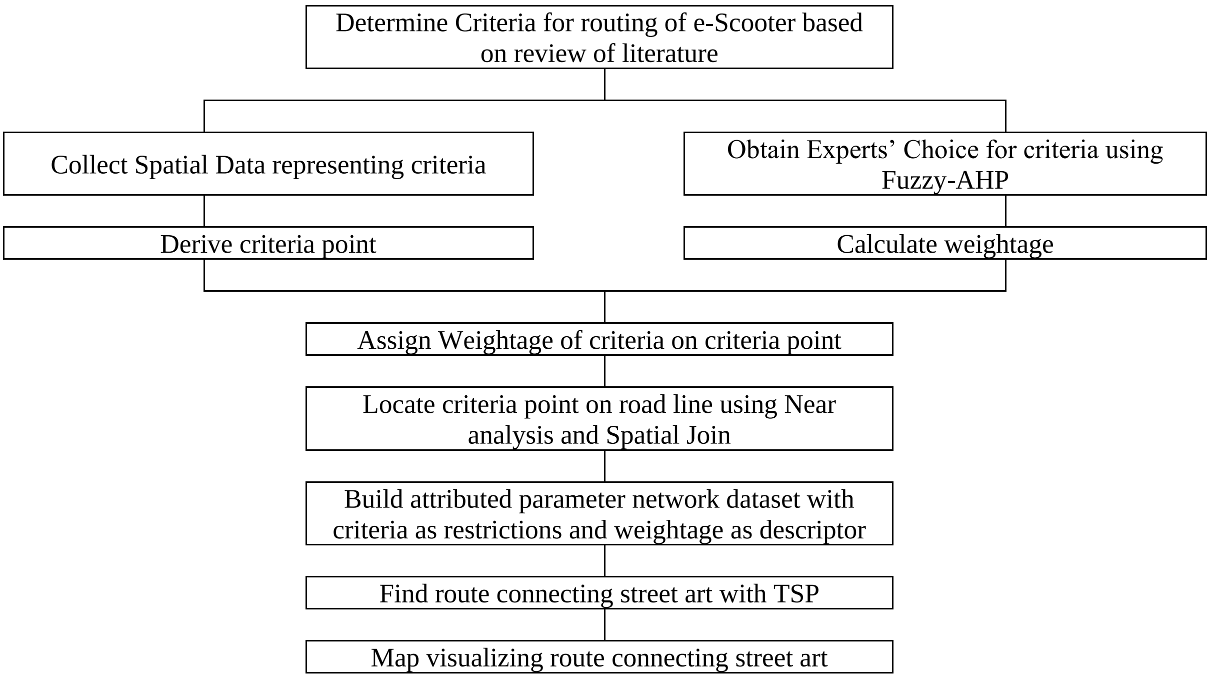

Figure 1. Methodology

3. RESULTS AND DISCUSSION

The map visualizing the optimal path of the e-scooter route connecting street art is shown in Figure 2 which is the product of assigning weightage to the criteria and generated by setting it as the attribute parameter for the network processing. Several elements to ease the map reading are included for better understanding, such as the locations of rail-transit stations, street arts, and attractions. Once the optimal route has been determined using the Travelling Salesman Problem (TSP), it was then analyzed. Based on the differences in distance and time taken in Table 1, it can be seen that the TSP method shows a lower distance and time taken. This difference in the distance and travel time may be affected by the parameters that have been set to provide the most efficient and accurate routes by both methods.

Table 1. Comparison of TSP method and Navigation Application

Comparison	TSP	Google Maps
Total Distance	1700 meters	1810 meters
Travel Time	11 minutes	23 minutes
Parameters	Path facility, Obstruction, Gradient, Traffic Speed	Traffic condition, Average vehicle speed, Travel time

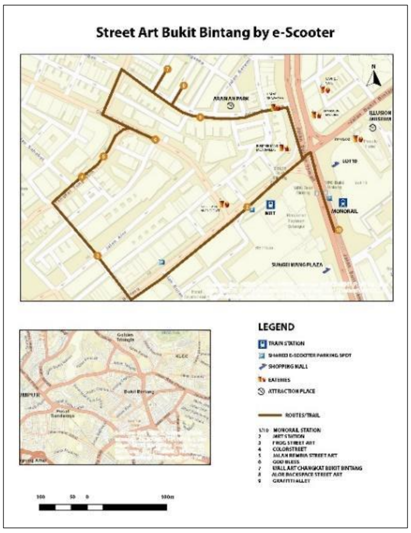

Figure 2. Map of e-Scooter Route connecting Street Arts in Bukit Bintang

4. CONCLUSION

In summary, the study achieved its goals by finding the best criteria for e-scooter paths, using GIS to find routes, and analysing the best paths to street art spots. In the future, we could consider more factors like surface condition and path width to make routes safer and more comfortable. These findings could be used as an aid or guide to improve city travel and enhance tourism experiences, providing a cost-effective mode of travel. Additionally, our research has potential commercial uses in both tourism and transportation industries, emphasizing its practical importance.

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