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## Cycle Tour Path using the Integration of Fuzzy-AHP and ELECTRE in GIS Network Analysis

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### ABSTRACT

Cycle tourism can have many positive effects on the local economy, including good effects on the environment and the nature preserve, as well as the ability to spread good behaviours and habits. The technique addresses the challenges and opportunities in cycling infrastructure and tourism. It aims to determine the criteria for safe cycling paths, identify potential cycle tour paths using Fuzzy-AHP and GIS method, and analyse the suitability of these paths through the ELECTRE method. The objectives of this technique are to determine the degree of importance for factors influencing the design of cycling paths, to derive potential paths for cycling tour and to analyse the suitability of potential paths for cycling tours. This technique is intended to integrate Fuzzy-AHP and ELECTRE method within a GIS network analysis framework. The technique's findings reveal a systematic methodology integrating Fuzzy-AHP, Traveling Salesman Problem (TSP), and ELECTRE methods within GIS which facilitating the identification of the most suitable cycle paths for tourism purposes. This technique offers a visual representation of optimized paths and enhancing sustainable cycle tourism while promoting economic and environmental benefits for the local community. In conclusion, this technique highlights the importance of integrating advanced methodologies such as Fuzzy-AHP, TSP, and ELECTRE within GIS for identifying optimal cycle tour paths. By implement of these techniques, it can enhance cycle tourism experiences and offer valuable insights for policymakers and stakeholders seeking to develop and promote sustainable tourism initiatives centred around cycling.

**Keywords:** cycle tourism; ELECTRE; fuzzy-AHP; GIS; TSP.

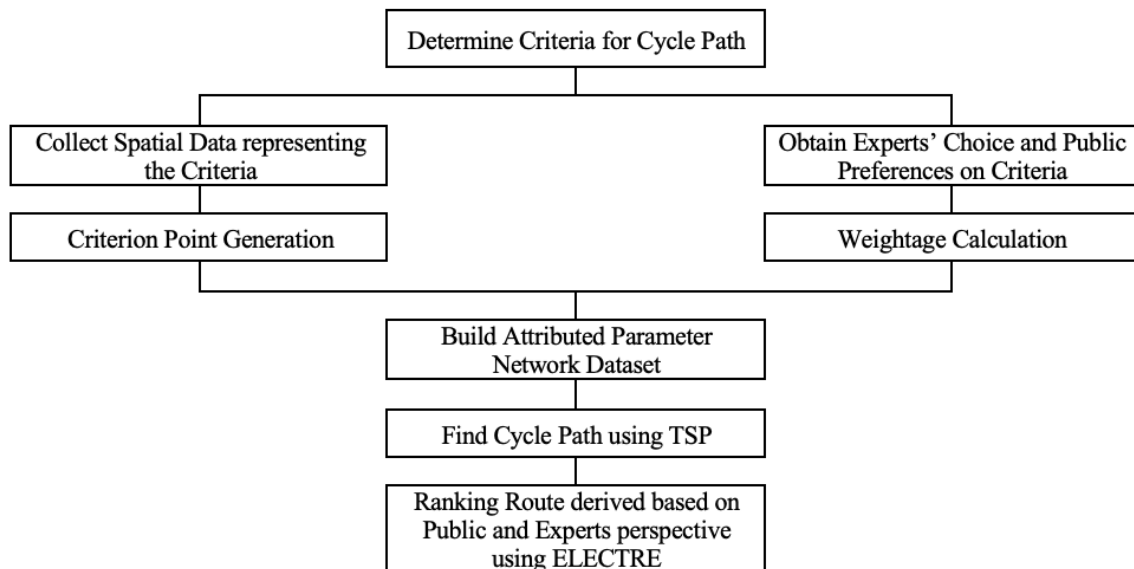
### 1. INTRODUCTION

In the last few decades, transport options that are good for the environment have become very important in urban planning and research. Non-motorized forms of transportation, like bicycle riding, are becoming more popular. This shows how important it will be in the future of sustainable transportation. Most people these days choose to settle in newly developed cities as the economy shifted from an agricultural to an industrial base, seeking employment and better living conditions. As a result, there is now more urban change, more road traffic accidents, more urban isolation, and more air pollution due to the intensive use of biodiversity. Thus, bicycles can be used for transportation, which not only cuts down on carbon emissions but also helps people stay fit by encouraging them to move around (Jamaludin et al., 2019). The aim is to integrate Fuzzy-AHP and ELECTRE in GIS network analysis to find cycling paths for tourism. The objectives are to determine the degree of importance for factors influencing the design of cycling path, to derive potential paths for cycling tour and to analyse the suitability

of potential paths for cycling tours. Problem statement that wanted to be solved are what are the degree of importance of the criteria used in determining the safety of cycling paths, how can the potential paths for cycle tours be derived and how can the suitability of the potential paths be analysed. Fuzzy-AHP method is selected for determining the weightage value for each criterion and sub-criterion which will be utilised to rank each one's importance. The process of conducting Fuzzy-AHP involves creating a hierarchical structure and designing and acquiring the expert's preferences. The ELECTRE method is a commonly used decision-making technique for conducting multi-criteria analysis. The ELECTRE method can be employed to evaluate and prioritise potential cycle path options based on different criteria in the context of designing a suitable path.

## 2. METHODOLOGY

Figure 1 shows the methodology employed for this study. It incorporates the integration of Fuzzy-AHP and ELECTRE in GIS Network Analysis to find the cycle path that fits the need and demand of end users, based on perspective of public and experts.



**Figure 1.** Methodology

Firstly, the aim of finding the most suitable route for cycle tour paths was determined by implementing the spatial MCDA and GIS network analysis. The crucial step at the beginning stage is to determine the selection of criteria for designing cycle path which this study will concern on four (4) main criteria which are safety, connectivity, attractive and built environment.

The next step is to gather spatial data including all the criteria that been chosen based on previous study which are Safety (represented on ground using Speed, Pavement Marking and Street Lighting), Connectivity (represented on ground using Accommodation, Rest Area, Parking Spot and Public Transport Stops/Station), Attractive (represented on ground using Waterscape and Scenic Point) and Built Environment (represented on ground using Historical Area, Manufacturing Area, Cultural Area). The criteria were verified by the experts which relates to the field.

Then, Fuzzy-AHP approach will be used to get the weightage value for each criterion and sub-criteria in this technique framework. Thus, this technique will use the Fuzzy-AHP approach to calculate the weightage value which needs complex computations between each criterion and sub-criteria. In order to ensure greater results, the evaluation of cycle path safety will involve three (3) parties which are from industry professionals, academics, and public users who are actively engaged in cycling.

For spatial data editing, there will be the usage of proximity analysis which near tools will be used as in to get the Near X and Near Y coordinates of the criteria on road data. Then, do the spatial join as in to combine the road data with the criteria. The relationship used is one-to-many relationships. Then, continue by doing the summary statistical as in to obtain the final weightage for every road. Next, build the network model by using the road data that been spatial join before. Continue the step with attribute settings by choosing the restriction that been preferred. Then, implement the TSP (Traveling Salesman Problem) method as in to obtain the loop of cycle tour path. Afterwards, the ELECTRE will be used to outrank the three (3) alternatives of cycle path that been produced by using different weightage value from the different judgment of experts.

### 3. RESULTS AND DISCUSSION

The first results consist of the weighting of main criterion and sub-criteria which been determined using Fuzzy-AHP method. The second result that been obtained relates to the potential cycle path that has been scaled from three (3) different perspectives (industry, academia, and the public). Next, the most suitable cycling path had been determine using the ELECTRE method. The findings reflect that all objectives had been achieved. First, the criteria and sub-criteria found from previous studies had been verified by the expert (Industry and Academia). Also, this technique had considered the perspectives from the Public. Their weightage surprisingly Attractive is the most important criteria. Due to the purpose of tourism, Scenic Point is the highest rank from the overall sub-criteria. After the Attractiveness, Safety is also considered as the second most important criteria for the cycling path to be designed. Therefore, with this, the first objective of this technique had been achieved. The second objective is about deriving potential paths for cycling tour. By using TSP method, the cycling paths were found. And lastly, the suitability of potential paths for cycling tours had been obtained. The cycling path were chosen out of three (3) different alternatives whereby the Academia alternatives is the 1st rank among the other alternatives which it helps in achieving the third objectives.

### 4. CONCLUSION

In conclusion, the integration of Fuzzy-AHP and ELECTRE within GIS network analysis has proved to be a valuable technique for identifying optimal cycle tour paths. The findings from the valuable technique for identifying cycle tour paths are presented and analysed. The optimal routes are determined based on weighted criteria (safety, connectivity, attractive and built environment). The weightage value can be determined through expert judgment. The final output will produce the highest ranked path that meet the balance between the criterion which may offering cyclists diverse and enjoyable routes while considering practical constraints. The ELECTRE method reveals the validity of the chosen paths relate to the criteria weightage which providing confidence in the decision-making process. Moving forward, further research can

build upon these findings to enhance the methodology and address specific challenges in cycle path design, ultimately contributing to the promotion of cycling as a healthy, eco-friendly mode of transportation and recreation.

## **REFERENCES**

Jamaludin, S. A., Borhan, M. N., Mat Yazid, M. R., & Tuan Yaakub, N. M. I. (2019). Analysing Bicycle Route Potential Towards Sustainable Transport in Ipoh City.