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The Fuzzy Analysis on Prioritised Criteria to Select Green Transport Service: A Case of Gen Z Students in Haiphong

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Abstract: In the context of global climate change and increasing environmental pollution, the development of green transportation has become a key objective towards sustainable development. Within this landscape, Generation Z emerges as a population group with a strong influence on consumer trends and shaping social behavior. However, Gen Z's choice of green transportation services is still influenced by such various factors as cost, convenience, infrastructure, technology, and brand image. The study aims to evaluate the priority levels of criteria for selecting green transportation services within practical significance, helping transportation businesses and policymakers build more effective strategies in the process of green growth. This study applies the Fuzzy Analytical Hierarchy Process (FAHP) method in R software along with a survey scope of 49 Gen Z students studying at the Vietnam Maritime University in Haiphong. The results show that the three most important factors are travel time, quality, and reliability, while the other least perceived ones are service cost, social norm, and green brand. It contributes empirical materials to Gen Z's green consumption behavior in the local context as theoretical meanings. Also, practical meanings go to some recommendations for companies and policymakers to build core strategies to attract more customers as well as follow the green growth.

Keywords: Fuzzy method, green transport, generation Z, hierarchical analysis process, Haiphong, multi-criteria decision-making.

1. INTRODUCTION

In the context of global climate change and increasing environmental pollution, the development of green transport has become one of the key goals towards sustainable development [1]. Green transport is defined as the way to reduce emissions by conventional fuels used in both good and passenger movements [2]. Current transport activities account for a large portion of total global greenhouse gas emissions with statistics showing that road transport has very high emissions compared to the COP28 targets; this is particularly evident in urban areas due to high traffic density and transportation demand [3]. There are two ways to achieve green transport: technical (alternative battery electric or hybrid-powered vehicles), non-technical (stricted transport levels by policies) [2]. In Vietnam, the green growth strategy for the period 2021–2030 emphasizes the need to reduce emissions in the transport sector by encouraging the use of green vehicles, applying digital technologies, and promoting sustainable consumption awareness among the population [4].

Within this picture, Generation Z – those born between 1997 and 2012 – emerges as a population group with a strong influence on consumer trends and shaping social behavior. Gen Z is seen as tech-savvy, environmentally conscious, and inclined to support sustainable products and services [5]. Many recent studies show that this generation has a higher level of awareness and intention to use environmentally friendly transportation compared to previous generations [6] [7]. However, Gen Z's choice of green transportation services is still influenced by various factors, such as cost, convenience, infrastructure, technology, and brand image [8].

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Research article

Table 1.The transferred scale of fuzzy numbers.

Importance	Likert scale	Fuzzy number
Perfect	9	(8, 9, 10)
Absolute	8	(7, 8, 9)
Very good	7	(6, 7, 8)
Fairly good	6	(5, 6, 7)
Good	5	(4, 5, 6)
Preferable	4	(3, 4, 5)
Not bad	3	(2, 3, 4)
Weak advantage	2	(1, 2, 3)
Equal	1	(1, 1, 1)

Source: [27].

Identifying and evaluating the priority levels of criteria influencing the decision on choosing green transportation services has practical significance in designing policies to encourage and guide sustainable consumer behavior, and developing service models suitable for the younger generation. In Vietnam, Gen Z constitutes a-tenth labour force, projected to 25 percent of the country population in 2025, which essentially substitutes older workers at present and supplements future workforce as well [9] [10]. If the year 2026 is a life stone, Gen Z is in the age group 15-29 whose are mostly students. As considerably key opinion leaders (KOLs) in the future eco-friendly society, however, they do not intend to use green transport services. It is necessary for green transporters and policymakers to understand why they show this behaviour, then implement more effective strategies.

The study goals to identify prioritised criteria to select green transport services by Gen Z students. It applies Fuzzy Analytic Hierarchy Process (FAHP) method within 49 Gen Z university students in Haiphong city (Vietnam). The research contributes both theoretical and practical meanings: (i) supplementing empirical materials to Gen Z's green consumption behavior in the local context; (ii) providing recommendations to promote the development of green transportation services.

2. CRITERIA TO SELECT GREEN TRANSPORT SERVICE

Creating the better world to live belongs to Gen Z belief. As their strong personality, they have high awareness of the globally social problems, then lead green consumer values and positive attitudes toward the environment [10]. That drives their environmental perception or intention to choose low-emission transportation. This perception is also depicted as the pro-environmental behaviour that allows Gen Z focus on natural ecosystem conservation [7]. Social norms also play a moderating role in their decision to choose the green transportation. Gen Z is sociological so that they are easily impacted by the surrounding environment [10]. When the environment-related human activities increase, Gen Z will perceive, mimic the behavior. Furthermore, high green consumer values can boost concerns and social norms for the sustainable behaviour [7] [11].

In young people's transportation decisions, cost, time, convenience are often key criteria. Emperically, Gen Z has willingness to sacrify these points for environmental concerns correlatedly [7]. It means the younger with higher income will have greener behaviours. Studies on electric vehicle or public transport usage show the service cost and reliability are significant components in the decisions of young consumers [2] [12]. In the circular economy, options for electric vehicles are influenced by the personal income, age group, travelling distance [13]. Of which, the short distance explains shorter time and higher reliability in transport.

Regarding the use of transportation services, perceived risk (e.g., apprehension about new technology or the inconvenience) along with supporting digital infrastructure significantly influences the adoption of green mobility [14]. The distinguishing features of Gen Z are skeptical and practical, linking to safety problems [10]. Their risky perception is egoistic value in personal decision-making to anticipated benefits [7]. Research on willingness to use green transport services shows environmental concerns drive the adoption, but the perceived risk reduces the intention; furthermore, technological infrastructure can trigger this issue due to Gen Z characteristic of tech-dependence [8] [10].

Gen Z are digital natives, understood as a generation that has early access to technologies and therefore forms habits of using these from young ages. This compatibility may improve their intention to use daily transportation services [15]. This habit is truly pinned to Gen Z [10]. Moreover, the eco-friendly behaviours formed by social norms attribute Gen Z habit [10]. Much evidence suggests the new technology enhances the transport quality [2]. Thanks to advanced technologies, more electric vehicles are integrated with digital transport platforms [16]. It necessiates the easy access to the transport service, which boosts the quality, then increases the adoption and satisfaction. As the way for acquiring information, the technology quality stimulates Gen Z decisions [10].

Studies on Gen Z show they are well self-imaged and iconoclastic [10]. The promotion on green brands increases the customer intention and decision in transport service usages [16]. In addition to the business competitive advantage of a particular travel option, the green brand reflects its unique and creativity [16]. With Gen Z, therefore, using these brands helps them achieve the personal icon. In the context of recent consumer trends, the value of corporate environmental responsibility through green branding is an effective communication lever for Gen Z [17] [18].

Much research is conducted in the relationship between the green transport and Gen Z population, but not to mention those are students [6] [7] [12]. Students are future workforce and crucially influence the consumption intention and social behaviour. They are frequently oriented by the education that strongly impacts Gen Z beliefs, cognition and habits [10]. They also confront contradictions by religious beliefs and patterns [10]. In Vietnam, studies often aim to Gen Z students, green consumption behaviours and a few big cities, but not to the green transport or geographical locals. Additionally, the method FAHP is little used with student decisions in transport. All above are gaps.

3. METHODOLOGY

Fuzzy Analytic Hierarchy Process (FAHP) is a widely used mathematical method in multi-decision making. In comparison with purposes and contexts, this method is divided into 02 phases: (i) determine relative weights; (ii) identify ranks [19]. The latter is often considerably computed after the first phase. In general, it is better to apply the fuzzy numbers to the model of AHP that there are uncertainties in decision-making, which cannot be explained with the normal one with such certain values as ‘yes’ or ‘no’ [19]. Then, when it comes to FAHP, it is more commonplace to use because of its high complexity in the evaluation [19].

There are a lot of FAHP applications in what alternatives are better to choose or select in order to solve the problems, namely selecting the best supplier, machine tool, material production [19], technology solution [20], academic applicant [21], transport choice [22] [23] [24].

Steps to apply FAHP and conduct the study are as follows:

3.1. Step 1: Build up a set of criteria based on the literature review

Based on the literature ground, 10 criteria to select green transport services are extracted for questionnaires. These are also coded: (i) Environmental perception (ENV); (ii) Social impacts on environmental standards (SOC); (iii) Service expenditures (COS); (iv) Travelling time (TIM); (v) Reliability (REL); (vi) Inconvenience risk (RIS); (vii) Digital infrastructure (INF); (viii) Habit (HAB); (ix) Service quality (QUA); (x) Green brand (BRA).

3.2. Step 2: Survey the evaluation of priorities on criteria by the Likert points

The questionnaire is linked to standardized points of the importance scale, usually Likert-5 or Likert-9, while the latter is more considerably detailed [25]. Normally, AHP-based questionnaire uses pairwise matrice but it fails to the consistency if used lots of criteria as a result. For example, it finds difficult for evaluators’ cognition to rate 45 pairwise matrice from above 10 criteria. To solve the matter, just independently rate each criterion prior to converting pairwise comparisons [26]. Moreover, questionnaire takers reduce time wasting to consider alternatives. Hence, the survey is crafted by Likert-9. Because the green transport describes various forms of movements, the study covers only such electric vehicle services by digital platforms as passenger taxis and motorbikes.

Table 2.Satistical description of the dataset.

Characteristic	Number of students	Percentage
1. Total	49	100.00
2. Gender		
Male	18	36.73
Female	31	63.27
3. Category		
Freshmen	7	14.29
Sophomore	18	36.73
Junior	12	24.49
Senior	12	24.49
4. Living		
House leasing	14	28.57
Family home	35	71.43
5. Usage frequency		
Everyday	3	6.12
Every week	1	2.04
Sometimes	17	35.69
Rare	15	30.61
Never	13	26.53

Purposive sampling is chosen with specific student types (freshman, sophomore, junior, senior). Also, with the convenience, 49 participants currently study at Vietnam Maritime University. This number of participants would reduce subjective norms by each individual.

Table 2 indicates most of them are female, accounting for nearly 60 percent. The number of categorised students are relatively equal because of the sampling method. Students mainly stay at home with their family, not leasing outside at all. Noticeably, the frequency ‘everyday’ or ‘every week’ for green transport service usage is just 4 of 49 participants. First, it is problematic that Gen Z students intend not to use electric vehicle services in Haiphong. Second, while 13 repondents have no experience of using the service and evaluate friend-based opinions, the rest confirms the practical test but not to use frequently. Therefore, what drives them to choose the green transport service will critise the study importance.

3.3. Step 3: Create a pairwise matrix

After receiving rating points, it is necessary to create pairwise matrice with triangular fuzzy numbers in Table 1. However, it will violate base conditions of fuzzy numbers, $fij = (lij, mij, uij)$, where $lij \leq mij \leq uij$ if it is converted directly, making porportions.

If ratings for 2 criteria are ri, rj, respectively, where $i = 1,2,3,\ldots,k$; $j = 1,2,3,\ldots,k$, the conversion to a pairwise

Table 3.Summary of consistency values.

Matrix	CI	CR	Matrix	CI	CR
1	1.97e-16	1.32e-16	26	0.0025	0.0017
2	0.0027	0.0018	27	0.0016	0.0011
3	0.0100	0.0067	28	0.0092	0.0061
4	0.0129	0.0087	29	0.0016	0.0011
5	0.0062	0.0041	30	0.0100	0.0067
6	0.0016	0.0011	31	-1.97e-16	-1.32e-16
7	0.0092	0.0061	32	1.97e-16	1.32e-16
8	0.0029	0.0019	33	0.0049	0.0033
9	0.0000	0.0000	34	3.95e-16	2.65e-16
10	3.95e-16	2.65e-16	35	0.0027	0.0018
11	0.0142	0.0095	36	0.0127	0.0085
12	-1.97e-16	-1.32e-16	37	0.0000	0.0000
13	0.0016	0.0011	38	0.0000	0.0000
14	0.0033	0.0022	39	0.0029	0.0019
15	0.0049	0.0033	40	0.0016	0.0011
16	0.0016	0.0011	41	0.0129	0.0087
17	0.0000	0.0000	42	0.0058	0.0039
18	0.0103	0.0069	43	0.0033	0.0022
19	0.0033	0.0022	44	0.0000	0.0000
20	0.0058	0.0039	45	0.0033	0.0022
21	0.0127	0.0085	46	0.0062	0.0041
22	0.0000	0.0000	47	0.0103	0.0069
23	0.0000	0.0000	48	0.0000	0.0000
24	0.0000	0.0000	49	0.0142	0.0095
25	-3.95e-16	-2.65e-16			

comparison value, *rij*, needs to be formulated as follows:

$$b = r_i - r_j \quad (1)$$

$$r_{ij} = b + 1, \text{where } b > 0 \quad (2)$$

$$r_{ij} = 1, \text{where } b = 0 \quad (3)$$

$$r_{ij} = 1/(1-b), \text{where } b < 0 \quad (4)$$

After the conversion, values form a fuzzy pairwise comparison matrix *A* where a square of *i* rows and *j* columns is presented:

$$A = \begin{bmatrix} (1,1,1) & \cdots & f_{ij} \\ \vdots & \ddots & \vdots \\ 1/f_{ij} & \cdots & (1,1,1) \end{bmatrix} \quad (5)$$

3.4. Step 4: Check matrix consistency

The FAHP model is fitted when consistency rate (CR) < 0.1 and consistency index (CI) ~ 0.0. By applying the FuzzyAHP package in R software, results for each matrix are shown.

3.5. Step 5: Rank criteria

With fitted matrice, defuzzified weights *Wi*, where *i = 1,2,3,…,k*, are calculated in R software. These values are extracted to find normalized ones and rankings by the following formula.

$$sW_i = \frac{W_i}{W_1 + W_2 + \cdots + W_k} \quad (6)$$

4. RESULTS

With the support of the R software, 49 fitted matrice are confirmed due to CR < 0.1 and CI ~ 0.0 in Table 3. Some values are negative because of machine precision, which does not matter.

It is noted that 49 fitted matrice lead to 49 defuzzified weights for each criterion. Let average, Table 4 shows average outputs. Based on these values, normalized weights are made by Equation 6. Small differences among final ones indicate Gen Z students in Haiphong take relatively similar consideration in 10 mentioned criteria.

However, ranks in Table 4 still explain what points they have prioritised to select such green transport services as electric taxis and motorbikes. The most important factor is the travelling time (TIM). It reflects the effect of their personality where they just do everything in one click [10]. Although they have the

Table 4.Criteria ranks.

Criteria	Average	Normalized	Ranking
ENV	1.129	0.1050	4
SOC	0.939	0.0873	9
COS	0.989	0.0919	8
TIM	1.306	0.1214	1
REL	1.157	0.1075	3
RIS	1.102	0.1024	5
INF	1.080	0.1004	6
HAB	1.077	0.1001	7
QUA	1.169	0.1087	2
BRA	0.811	0.0754	10

willingness to sacrifice for the green transport, rushing time pushes their limited decisions. Compared to traffic jams, Haiphong is less crowded than such big cities as Hanoi or Ho Chi Minh. Nevertheless, green transport services still do not create much difference in the travelling time as opposed to individual moving ways.

Other much prioritised factors that Gen Z students take care of are the quality (QUA) and reliability (REL) prior to the environmental perception (ENV). Both are likely interrelated with the first one – if transport services fit their demand of the time, they aware the increasing quality and reliability. In addition, most transport services these day are based on digital platforms and they can enhance the quality. The technological infrastructure ranks sixth, but Gen Z students just concern whether if they could do one click in the platform, which means the order completion needs to be easily fulfiled by one transaction.

Meanwhile, it is surprising that the cost, social norms, and green branding are less interactive. The green branding boosts intentions to green transport usage but not effective to Gen Z students in this study [16]. Its lowest rank implies they do not feel iconic when using the service. Besides, Gen Z population sounds financial and sociological decisions [10]. However, the cost and social norms that may suit with their decisions are not weighed by Gen Z students in Haiphong. Therefore, their green transport selection mainly comes from the self-awareness of the service time and quality.

Besides, despite based-friend ratings, non-users using green transport services confirm the same priorities as the time, quality, reliability and environment. They also claim having at least one individual electric vehicle already. These priorities of the individual transport means are more weighed, so non-adopters are willing to use green services if individual ones are unavailable.

From the above result, some recommendations are given to make attractive green transport services with Gen Z students. For businesses, the improvement should be focused on the digital platform. In addition to real-time tracking, AI-based route optimization and time forecasting should be invested. Using AI for the routing can reduce travelling time for each trip while it helps Gen Z students make quick decisions before ordering if it estimates pickup and travelling time to their destination as well, which increases the service quality and reliability. On the other hand, the platform should display carbon savings per trip or award ‘plant a tree’ per certain kilometers, which promotes their environmental perception. For the government, autonomous vehicles run by alternative energy need to be supported for the future of the green transport service. Also, the priority access for green transport vehicles is considered in congested areas.

5. CONCLUSION

The research result shows that the criteria set of the time, quality, and reliability is priority in Gen Z students’ perspectives in Haiphong. Their most perceived one is the travelling time. Although they have practical experience with such green transport services as electric taxis and motorbikes, they do not intent to use frequently because the difference of the travelling time between the service and individual mobility is relatively close. Other practical factors that they take consideration are the quality and reliability. They believe these factors if the service fits the time demand. Meanwhile, it is surprising that other cores as the cost, social norm, green brand are not effective. In conclusion, their green transport selection mainly comes from the self-awareness of the service time and quality.

The research contributes empirical materials to Gen Z’s green consumption behavior in the local context as theoretical meanings. Also, some recommendations are related to AI-based platforms and future autonomous vehicles.

However, it still exists some limitations. First, this paper just focuses on the scope of Haiphong that does not cover the whole students’ selection in the Vietnam or Gen Z more or less. Second, the fuzzy model confirms less subjective awareness, though it is based on the evaluation perspectives.

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