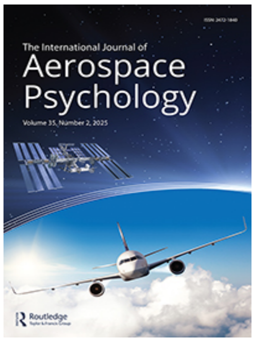

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Cars are Ready to Fly: Urban Air Mobility and Psychological Process of Sustainable Travel Mode Choices

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ABSTRACT

Objective: This study is designed to predict individuals' pro-social behavior in their choice of travel modes. Specifically, the consumer adoption process and the norm activation model are incorporated as the overarching theoretical model in consideration of the relative advantages of urban air mobility.

Background: Urban air mobility, the next generation urban transport system, is all set to fly. Urban air mobility is a notable disruptive innovation in aviation and mobility system as a sustainable means of transportation.

Method: Using a quantitative procedure, we developed the theoretical framework based on the existing theories and examined hypotheses using structural equation modeling and invariance test.

Results: The findings indicate that the adoption intention toward urban air mobility is driven by problem recognition, awareness, interest, evaluation, ascribed responsibility, and personal norms. In addition, the relative advantage of urban air mobility moderates the relationships between interest and evaluation, and between ascribed responsibility and personal norms.

Conclusion: Based on the empirical evidence, this study discusses the findings and subsequent implications for academia. We also address the opportunities for governmental organizations and industry to maximize the utilization of urban air mobility in order to make a city more convenient, cleaner, faster, greener, and safer.

Introduction

The travel volume in a metropolitan city is generally high, and various means of transportation are available for city dwellers and visitors (Afonso et al., 2021; Domènech et al., 2022). Of these, cars and buses are often the primary vehicles used to travel around the city on the ground. However, they are also notorious for disturbing citizens and lowering their quality of life due to congestion, pollution, noise, and accidents (Eissfeldt, 2020; Hensher, 2018; Lebrusán & Toutouh, 2021; Wang et al., 2019). Any cities suffer from unsustainable

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transport conditions, and some people choose to travel mainly on foot or by using bicycles and electric vehicles, which can be regarded as socially responsible behavior (Meschik, 2012; Nordlund et al., 2016). This means that people realize the problems facing society today in terms of how the current vehicles options in urban areas cause health and environmental risks (Lebrusán & Toutouh, 2021; Liu et al., 2017). This study focuses on urban air mobility (hereafter UAM) as an innovative solution to current transportation modes that are seen to have a variety of disadvantages.

UAM is a sustainable transportation mode involving several innovative concepts, including vertical take-off and landing for inter- and intra – city passenger transport services (Chancey & Politowicz, 2020; Cotton & Wing, 2018) (See Appendix). Multiple benefits of UAM have been described based on various experiments, including intelligent mobility, efficiency, environmental friendliness, and sustainability (Fu et al., 2019; Pukhova et al., 2021). UAM mitigates the problems caused by conventional modes of transportation (Al Haddad et al., 2020), and has the potential to contribute to more pleasant living environments within urban areas. In other words, technological advancements relating to UAM also offer a promising future in generating individuals' sustainable travel-mode choice. Accordingly, companies and governments have been making every necessary effort, such as increasing investments and revisiting regulations, in order to develop a UAM system optimized for their cities. For example, Korean government recently unveiled a roadmap to provide UAM services in Seoul by 2025 (The Korea Times, 2022).

Many attempts have been made to predict consumer adoption behavior toward technology-powered products and services in various sectors (Moussawi et al., 2021; Ozanne & Churchill, 1971; Radic et al., 2022; Warkentin et al., 2002). Among these endeavors, the consumer adoption process model has repeatedly been used as a foundational theoretical framework (Han et al., 2021; Rogers, 1995; Salim et al., 2014; Yu et al., 2022). The consumer adoption model involves multiple stages, which begin with problem recognition and proceed through consumer awareness, interest, and evaluation, to final adoption intention. Meanwhile, pro-social behavior has been frequently investigated based on the norm activation model, which relies on altruistic and moral beliefs (Schwartz, 1977). Many earlier studies have supported this sequential framework of problem recognition associated with the ascription of consequences, ascribed responsibility, personal norms and behavioral intentions in explaining individuals' pro-social/pro-environmental behavior (Chi et al., 2021; Kiatkawsin et al., 2020; Onwezen et al., 2013). Hence, drawing on these theoretical lenses, adoption intention with regard to UAM can be explored.

In addition, previous studies have found that one of the essential factors influencing individuals' adoption of high-tech products is the innovation characteristics of a product (Oturakci & Yuregir, 2018; Rogers, 1995; Verhoef & Langerak, 2001). Relative advantage is a key facet of innovation characteristics, and its significant role as an impelling force in acceptance behavior is evident (Fu et al., 2019; Gibbs & Kraemer, 2004). Even though there is no evidence of the effect of relative advantage at different stages of the consumer approach behavior process, earlier findings imply that the relative advantage of UAM may stimulate the process of adoption. The introduction of UAM is envisioned to offer a safer, more eco-friendly, more efficient, and more reliable alternative while addressing several problems, including congestion of transport networks in urban destinations (Al Haddad et al., 2020; Cotton & Wing, 2018; Pukhova et al., 2021). However, the role of relative advantage of UAM in consumer adoption behavior has been rarely investigated.

Studies on technology innovations related to UAM have proliferated in recent years. However, the studies pertaining to UAM, to date, have centered overwhelmingly on the technology and its implementation, such as feasibility and infrastructure (Pukhova et al., 2021; Straubinger et al., 2020). Despite several attempts to study consumer acceptance of UAM (Chancey & Politowicz, 2020; Garrow et al., 2021), these investigations have been confined to consumer adoption behavior with regard to the technological innovations of UAM. We are uncertain to what extent the introduction of UAM would compel individuals to make a sustainable travel mode choice. Therefore, the consumer adoption process and the norm activation model are incorporated as the overarching theoretical model in this study in order to predict individuals' sustainable travel-mode choices, given the relative advantage of UAM. The succeeding parts of this research are as follows: firstly, we discuss the theoretical background and empirical evidence in proposing the research model and hypotheses, followed by the research methodology and analysis of the results. Discussions of the findings are followed by the implications for theory and practice, and suggestions for future research.

Literature Review

UAM and Its Relative Advantages

The most common forms of ground transportation in urban areas are cars, buses, motorbikes, and trains (Afonso et al., 2021). People are generally striving for something better, and the importance of mobility in urban areas is increasing (Fu et al., 2019; Van Den Heuvel et al., 2020). This means that new transport solutions are necessary for people who want transportation that is cleaner, faster, greener, and safer. Such systems should be promoted to people in order to build more pleasant living environments, and the responsibility for maintaining sustainable transportation systems is not limited to the inhabitants of the city, but includes travelers within the city. Rowen (2020) asserted the importance of pro-social mobilization among festival travelers in order to achieve sustainability. With this in mind, the UAM is in the limelight as it ultimately proposes a new paradigm for transportation (Chancey & Politowicz, 2020; Garrow et al., 2021).

UAM, which is an outcome of the third aviation revolution, refers to the use of small, on-demand, fully-automated aircraft to transport people at lower altitudes in metropolitan areas (Cotton & Wing, 2018). UAM provides a new window of opportunity, not only related to enhanced mobility, but also to tackle the problems generated by existing road vehicles (Eissfeldt, 2020; Fu et al., 2019; Pukhova et al., 2021). Ko et al. (2011) estimated the road-traffic noise in urbanized areas on a basis of a noise prediction model, and found that most areas were at risk. Transportation noise adversely affects quality of life, creating serious annoyance and disturbance. Cotton and Wing (2018) described how UAM could contribute to solving traffic congestion in Dallas/Fort Worth, which suffers from major traffic issues. Afonso et al. (2021) regarded UAM as a more sustainable form of transportation since it fosters decarbonization in the dense metropolitan areas. UAM is thus seen as a more efficient travel option without road congestion, and more environmentally positive due to lower emissions. It also extends pro-social values, and the introduction of UAM would increase average ground speeds (Mudumba et al., 2021).

The advantages of UAM are slightly different, based on factors, such as its development progress and the different kinds of automobile modes in a UAM-based trip (e.g., non-autonomous versus autonomous) (Afonso et al., 2021; Eissfeldt, 2020; Mudumba et al., 2021). Nonetheless, the relative advantages of UAM compared to the current means of transportation in urban areas can be summarized as reducing crashes, easing traffic congestion, saving time, and improving air quality. In addition, mobility is vital not only to build a smart city, but also to promote smart tourism (Gretzel et al., 2015; Khan et al., 2017), and thus, UAM is positively necessary to gain a competitive edge for the city.

Consumer Adoption Process

Scholars have successfully investigated consumer adoption behavior based on a process that encompasses consumers' cognitive, affective, and behavioral responses to technology-mediated offerings (Bitner et al., 2002; Ozanne & Churchill, 1971; Rogers, 1995; Salim et al., 2014). This is the consumer adoption process model, which states that consumer adoption behavior is formulated based on a hierarchal process (i.e., problem recognition → awareness → interest → evaluation → adoption intention) (Ozanne & Churchill, 1971; Rogers, 1995).

Problem recognition leads individuals to find a solution (Schiffman & Kanuk, 2000; Steur et al., 2022). In particular, problem recognition is a kind of prerequisite to activate the consumer adoption process with regard to technological innovations (Jun et al., 2014; Kim & Hwang, 2020). This means that once people recognize the problems associated with the current modes of transportation, they agree that new transport modes are needed that lessen the adverse effects and support sustainability. Such problem recognition induces awareness of novel products and services: in this case, UAM. Once individuals establish awareness, they are eager to seek additional information about UAM, thus progressing to the stage of interest. For example, Herring et al. (2007) conducted a survey to predict consumer adoption of low and zero carbon technologies, and their results indicated that awareness related to renewable energy technology increases interest in renewables. Similarly, Kester et al. (2018) highlighted the importance of initial awareness, which would lead individuals to seek for more information about electric vehicles. When individuals learn about the mechanism behind UAM, they will have a desire to assess this new offering. Okada et al. (2019) confirmed that consumers' evaluation of electric vehicles had a salient effect on purchase intention. If the result of their evaluation is positive, individuals will subsequently display willingness to adopt UAM, which is the final stage of the consumer adoption process. Following these processes, scholars have advanced our knowledge of consumers' approach behavior (Radder, 2003).

Norm Activation Model

The norm activation theory, which was proposed by Schwartz (1977), states that problem recognition, ascription of responsibility, and personal norms are the core determinants of pro-social behavior, acting as a sequential model (De Groot & Steg, 2009; Han, 2021). Problem recognition indicates that people are normally aware of the negative outcomes that result when they do not behave pro-socially. This cognitive trigger increases ascribed responsibility for the negative fallout of not acting pro-socially (Kim & Hwang, 2020;

Schwartz, 1977). As a psychological consequence of problem recognition, ascribed responsibility has been intensively studied as an emotional state that reflects the responsibility for their behavior. Once individuals feel heavily responsible for any harmful consequences, personal norms are activated (Chi et al., 2021). A personal norm causes an individual to feel a "moral obligation to perform or refrain from specific actions" (Schwartz & Howard, 1981, p. 191). In summary, the model posits a process in which behavioral intentions are formulated from problem recognition, which in turn increases feelings of responsibility for the negative outcomes of not behaving pro-socially. This ascribed responsibility activates a personal norm and subsequently affects pro-social behavior.

The norm activation model has gained increasing empirical support in explaining a wide range of pro-social behaviors, including donating, recycling, saving, and volunteering (Han, 2021; Obuobi et al., 2022). Also, this theory has been used to understand consumers' acceptance behavior toward innovative technologies that are designed with enhanced sustainability (He & Zhan, 2018; Kim & Hwang, 2020). Similarly, the norm activation model has been popular in predicting the use of sustainable transportation (Liu et al., 2017; Nordlund et al., 2016; Vaske et al., 2015). These studies paid attention to the negative issues resulting from current urban transport modes and increased private car ownership, and they examined determinants of socially responsible behavior in the selection of vehicles by incorporating the norm activation model. Furthermore, in reviewing publications on sustainable transport from 2000 to 2019, Zhao et al. (2020) noted how effectively consumer adoption behavior has been explored based on the framework of norm activation.

Relationships Among Study Variables

Numerous studies provide evidence of how effectively the consumer adoption process helps to explain consumer behavior toward novel products and services (De Bruyn & Lilien, 2004; Ozanne & Churchill, 1971; Radder, 2003). For instance, Jun et al. (2014) predicted consumer behavior toward hybrid cars according to the adoption process including awareness, interest, evaluation, use and adoption. Hence, the consumer adoption process could potentially contribute to the understanding of individuals' adoption behavior for UAM.

Meschik (2012) discussed problems related to inner-city traffic and claimed the low usefulness of car travel in urban areas. Similarly, Lebrusán and Toutouh (2021) found that car restrictions promote a better urban environment and better health due to reduced levels of car emissions in Madrid. The common observation in many studies is that congestion, pollution, noise, and accidents are the major problems generated by road vehicles in today's cities (Hensher, 2018; Ko et al., 2011; Wang et al., 2019). In response, Hensher (2018) asserted that smart technology could contribute to building a collaborative and connected model for transportation in metropolitan areas. If more people are aware of the problems associated with current primary transportation modes, there is an increased likelihood of learning novel tools and new ways to alleviate those problems. Awareness creation has been studied as a predictor of interest (Jung et al., 2012). Scholz et al. (2013) investigated the effect of user- and marketer-generated contents on social network services in consumers' purchase decision processes and their results indicated that awareness does not necessarily increase purchase decisions but apparently stimulates consumer interest. This implies that awareness of UAM increases interest, and that people will readily look for more information on the subject.

This will lead individuals to build sufficient knowledge to enable them to make an evaluation (De Bruyn & Lilien, 2004; Jun et al., 2014). If their judgment is positive, they are highly likely to adopt new offerings. Likewise, interest will motivate individuals to assess the use of UAM for the means of transportation, and they are more likely to adopt UAM upon obtaining positive results from their assessment. Therefore, this research proposes the following hypotheses.

H1. Problem recognition of current means of transportation positively affects awareness of UAM.

H2. Awareness of UAM positively affects interest in it.

H3. Interest of UAM positively affects evaluation of it.

H4. Evaluation of UAM positively affects adoption intention toward it.

Scholars have repeatedly found that the consumers' pro-social/environmental behavior can be explained by applying the norm activation theory (De Groot & Steg, 2009; Han, 2021). A similar approach has been made to understand consumers' socially responsible behavior toward innovative technologies (Kim & Hwang, 2020; Nordlund et al., 2016). For example, Vaske et al. (2015) confirmed that travelers on holidays can mitigate their carbon footprint when they are aware of the consequences of their activities, which increases ascribed responsibility. Subsequently, such feelings provoke descriptive and injunctive norms, which influence individuals' intentions to engage in ecologically appropriate behavior. Nordlund et al. (2016) investigated the importance of using a hybrid, plugin, or electric vehicle for personal transport in order to counter climate change. Their study, based on the norm activation theory, showed the salient effect of personal norms in inducing individuals' intentions to go green for their transportation choices. He and Zhan (2018) extended the norm activation model to determine how to trigger moral norms to increase the use of electric vehicles. The norm activation model was also successfully adopted to examine travelers' environmentally responsible behavior in the domain of smart tourism, which is powered by innovative technologies (Kiatkawsin et al., 2020). Meanwhile, personal norms involve an intrinsic motivation (Han, 2021; Han et al., 2024) and reflect internalized values (Kim & Seock, 2019). Such motives and values influence individuals' evaluations and thus affect normative decision making for the selection of travel modes (Davari et al., 2024; Klöckner & Matthies, 2004). Likewise, personal moral obligation to engage in pro-social/pro-environmental behavior is likely to influence the evaluation of UAM. According to the norm activation model and the role of personal norms, we proposed the following hypotheses.

H5. Problem recognition of the current means of transportation positively affects ascribed responsibility.

H6. Ascribed responsibility positively affects personal norms.

H7a. Personal norms positively affect evaluation of UAM.

H7b. Personal norms positively affect adoption intention for UAM.

Relative advantage is defined as "the degree to which an innovation is perceived as being better than the idea it supersedes" (Zolkepli & Kamarulzaman, 2015, p. 194). People often perceive the relative advantage of products and services that offer more convenience, additional economic gain, and improved social prestige (Adapa et al., 2020; Rogers, 1995; Suarez et al., 2019; Vafaei-Zadeh et al., 2022). The relative advantage of UAM is primarily driven by its innovative technology, which enables more efficient, greener, and safer mobility (Afonso et al., 2021; Eissfeldt, 2020; Pukhova et al., 2021), while making road traffic smoother and less congested (Mudumba et al., 2021).

Relative advantage, which is built by cognitive attributes, is likely influencing approach behavior toward novel technology. Fu et al. (2019) tested preference for different travel modes and found the critical determinants for accepting UAM are cost, travel time, and safety. They also noted that technology awareness is higher for products associated with environmental friendliness. Consistent with this assertion, Kim and Hwang (2020) observed that when individuals have better knowledge about the environmental contribution of novel technological products, the effect of ascribed responsibility on their moral obligation to adopt that specific product is stronger. Al Haddad et al. (2020) extended the technology acceptance model to predict individuals' adoption behavior toward using UAM. Their results indicated that when consumers have a greater perception of the benefits of UAM, such as a decrease in congestion, and improved road safety resulting from fewer road crashes, they tend to exhibit a higher intention to adopt it. The relative advantage of UAM would thus lead to a higher perceived usefulness, resulting in a positive evaluation, and consequently higher user acceptance. In a similar vein, Choe et al. (2021) found a moderating impact of product innovativeness in the link between norms and approach behavior, and they suggested improving potential users' perceptions of advanced capabilities in order to raise the likelihood of adoption behavior relating to new technology. UAM is a form of transportation that exhibits innovations compared to current modes of transportations, and it is likely that individuals with a greater level of understanding of its advantages will display more favorable assessment of UAM in the formation of their acceptance behavior. Given the above rationale, this study proposed the following hypotheses.

H8a. The relative advantage of UAM moderates the link between problem recognition and awareness.

H8b. The relative advantage of UAM moderates the link between awareness and interest.

H8c. The relative advantage of UAM moderates the link between interest and evaluation.

H8d. The relative advantage of UAM moderates the link between evaluation and adoption intention.

H8e. The relative advantage of UAM moderates the link between problem recognition and ascribed responsibility.

H8f. The relative advantage of UAM moderates the link between ascribed responsibility and personal norms.

H8g. The relative advantage of UAM moderates link between problem norms and evaluation.

H8h. The relative advantage of UAM moderates the link between personal norms and adoption intention.

Based on the foregoing discussions, Figure 1 illustrates the overarching theoretical framework of this study.

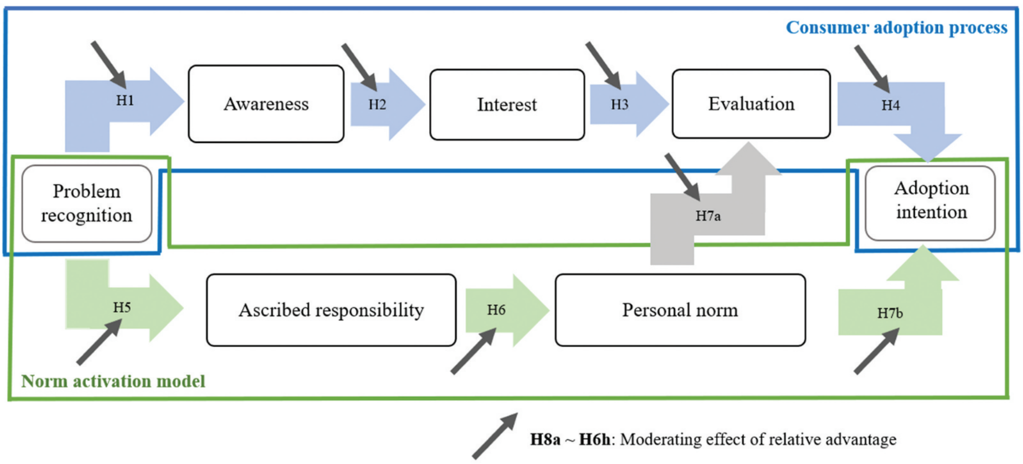

Figure 1. Proposed theoretical framework.

Methodology

Survey Design

Measurement tools to assess each study variable were adapted from valid scales in the extant literature. With regard to the constructs of the consumer adoption process and the norm activation model, in each case three to four items were adopted from Ozanne and Churchill (1971), Schwartz (1977), Radder (2003), De Groot and Steg (2009), and Han (2021). Each item was then modified to be applicable in the UAM context. As such, the measurements for problem recognition were related to the negative consequences of the current modes of transportation in urban areas, which involve noise, pollution, congestion, and accidents. In addition, five items to estimate relative advantage were borrowed from Rogers (1995), Zolkepli and Kamarulzaman (2015), and Oturakci and Yuregir (2018), and these were adjusted to reflect the pro-environmental value, positive impact on road traffic, and efficiency of UAM. Specifically, questionnaires were developed for respondents to rate their level of agreement with the statements 1) UAM vehicles would reduce air pollution, 2) UAM vehicles would ease traffic congestion in the city, and 3) UAM vehicles would help reduce the time/effort involved in getting around the city. This study used a 7-point scale ranging from "strongly disagree" to "strongly agree" in evaluating each statement related to each construct.

We developed a survey composed of three sections. The first part of the survey included the study objective and introduced the key terminologies used in the study. UAM was described in words and with a video clip (the first 1 min 43 sec of a video clip on YouTube https://www.youtube.com/watch?v=mBy0qPGrktI), which illustrates the concept. The second section consisted of a series of questions to assess each study variable. In order to alleviate common method bias, procedural technics were employed (Podsakoff et al., 2003). For instance, we placed questions to evaluate independent and dependent constructs in different parts of the survey. The last section of the survey was arranged to identify the demographic profiles of survey participants, including age, gender, and educational level. The questionnaires were initially developed in English, then was translated into Chinese. Next, the questionnaires were pilot tested by an advisory group consisting of academicians and students in the tourism field. The questionnaires were also reviewed by individuals whose native language is Chinese. Throughout these processes, the survey questions were fine-tuned to improve the precision and clarity of the content.

Data Collection

The data collection of this study was managed with assistance from Qualtrics in April 2022. The company located potential survey participants through an e-mail invitation, and we provided filter questions to ensure that the data collection was restricted to the respondents who had both a basic knowledge of UAM and experience in spending holidays in a metropolitan city. A total of 400 questionnaire responses were initially collected. We identified 20 multivariate outliers using Mahalanobis distance. As a result, 380 responses were retained for data analysis. Scholars recommended greater than or equal to 200 samples when using confirmatory factor analysis and structural equation modeling analysis (e.g., Hair et al., 2006), and our sample size was sufficient to validate the generalizability of the results.

Analytical Technique

This research employed a two-step approach, following the guidelines of Anderson and Gerbing (1988). For the first step, the measurement model was evaluated by using confirmatory factor analysis, and then we conducted structural equation modeling analysis to assess the research framework and test the research hypotheses. In addition, a metric invariance test was performed to examine the moderating effect of relative advantage in the relationships among study variables. We used SPSS 25.0 and AMOS 23.0 statistical tools for all the analyses.

Results

Characteristics of Respondents

The respondents spent an average of 14.9 min completing the survey. The survey participants were 25.3% ($n = 96$) males and 74.7% ($n = 284$) females. Their average age was 33.9

years, and over half of them were between 33 years and 36 years of age. Among the respondents, 49.2% indicated their annual household income was US$ 100,000 or higher, 14.2% reported it being between US$ 55000 and US$ 69999, and 12.6% in each case indicated between US$ 70000 and US$ 84999, and between US$ 85000 and US$ 99999. Their level of educational attainment was relatively high, as 64.2% had finished graduate school, and 33.9% had graduated from a four-year university course.

Measurement Model

A confirmatory factor analysis using the maximum likelihood estimation method was performed to examine the quality of measurement model. The analysis produced an appropriate fit to the current study data: $\chi^2 = 253.508$, df = 168, $p < .001$, $\chi^2/df = 1.509$, IFI = .985, CFI = .985, TLI = .981, RMSEA = .037 (Byrne, 2001). The standardized factor loadings of each item were equal or greater than .722 and significant at $p < .001$. The confirmatory factor analysis results are shown in Table 1.

Table 1. Results of confirmatory factor analysis: items and loadings.

Construct and scale item	Standardized loading[a]
Problem recognition	
Current modes of transportation in the city (e.g. cars and buses) cause air pollution.	.768
Current modes of transportation in the city (e.g. cars and buses) lead to congestion and long delays.	.836
Current modes of transportation in the city (e.g. cars and buses) make a noise	.843
Awareness	
I believe that UAM vehicles need more awareness in in the travel and tourism industry.	.789
I am aware that UAM vehicles will be a means of transportation in the future.	.846
I am aware that the needs for UAM vehicles are increasing.	.814
Interest	
I am interested in UAM vehicles as a means of transportation.	.763
I became interested in UAM vehicles and its usability.	.788
Using UAM vehicles can be an interesting means of transportation.	.793
Evaluation	
For me, using UAM vehicles would be beneficial.	.818
For me, using UAM vehicles would be wise.	.783
For me, using UAM vehicles would be satisfactory.	.813
Ascribed responsibility	
I believe that we are partly responsible for environmental problems potentially caused by the current modes of transportation in that city.	.722
I feel that we are jointly responsible for the road congestion potentially caused by the current modes of transportation in that city.	.745
I believe that we are partly responsible for the traffic noise caused by current modes of transportation in that city.	.834
Personal norms	
I feel an obligation to choose an environmentally friendly way, such as UAM vehicles when traveling in the city.	.787
I feel that it is important to travel in reducing the harm to the host city and wider environment.	.771
I feel it is important that travelers behave in a sustainable way when traveling in the city.	.767
Adoption intentions	
I am willing to adopt UAM vehicles in the future.	.767
I intend to use UAM vehicles in the future.	.781
I am willing to use UAM vehicles as a means of transportation in the future.	.839
Goodness-of-fit statistics: $\chi^2 = 253.508$, df = 168, $p < .001$, $\chi 2/df = 1.509$, IFI = .985, CFI = .985, TLI = .981, RMSEA = 0.037	

Notes 1. [a]All factors loadings are significant at $p < .001$
2. NFI = normed fit index, IFI = incremental fit index, CFI = comparative fit index, TLI = Tucker-Lewis index, and RMSEA = root mean square error of approximation

Table 2. Results of measurement model: correlations, AVE, CR, mean, and SD.

	Mean (SD)	AVE	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Problem recognition	5.632 (.911)	.654	**.850**[a]	.746[b]	.719	.717	.599	.635	.694
(2) Awareness	5.713 (.891)	.642	.557[c]	**.843**	.828	.825	.665	.736	.789
(3) Interest	5.805 (.918)	.580	.517	.686	**.806**	.858	.609	.739	.821
(4) Evaluation	5.799 (.902)	.687	.514	.681	.736	**.839**	.637	.726	.803
(5) Ascribed responsibility	5.325 (.973)	.587	.359	.442	.371	.406	**.766**	.726	.562
(6) Personal norms	5.674 (.933)	.559	.403	.542	.546	.527	.527	**.792**	.714
(7) Adoption intention	5.856 (.900)	.620	.482	.623	.674	.645	.316	.510	**.830**

Notes 1. SD = Standard Deviation, AVE = Average Variance Extracted
2. [a]composite reliabilities are along the diagonal, [b]Correlations are above the diagonal, [c]Squared correlations are below the diagonal

We computed the average variance extracted (AVE) values in order to investigate the convergent validity. The AVE values of each study variable were all greater than the threshold of .50 (Fornell & Larcker, 1981). Also, the composite reliability (CR) values for all the constructs were higher than the standard .70 (Hair et al., 2006). Hence, internal consistency was established. In addition, we compared the squares of the correlations between the constructs with the AVE values. The results indicated that the AVE value for each construct was overall greater than the square of the correlation between each pair of variables. For some exceptions, a χ^2 difference test between constrained and unconstrained models was conducted by combining two variables into one, and discriminant validity was evident (Bagozzi & Yi, 1988). For example, the difference of χ^2 was more than 3.941 (df = 1) for awareness and interest ($\Delta\chi^2$ (1) = 23.419), and for interest and evaluation ($\Delta\chi^2$ (1) = 19.508). Table 2 shows the results of the measurement model evaluation.

Structural Equation Model

This study conducted structural equation modeling analysis to assess the relationships among study variables. The goodness-of-fit statistics, $\chi^2 = 369.687$, df = 181, $\chi^2/df = 2.042$, $p < .001$, IFI = .967, CFI = .967, TLI = .962, and RMSEA = .052, confirmed an acceptable level. With regard to the hypotheses related to consumer adoption process, Hypothesis 1, Hypothesis 2, Hypothesis 3, and Hypothesis 4 were all statistically supported. The effect of problem recognition on ascribed responsibility ($\beta = .834$, $t = 12.025$, $p < .001$) was significant, and therefore Hypothesis 5 was supported. The results also determined a significant link between ascribed responsibility and personal norms, confirming Hypothesis 6. Personal norms affected evaluation ($\beta = .120$, $t = 2.723$, $p < .01$), but did not influence adoption intention. Hence, Hypothesis 7a was retained, whereas Hypothesis 7b was rejected. Finally, the R^2 for adoption intention was .921, indicating a high explanatory power for our overarching theoretical model. The summary of analyses is displayed in Table 3.

Metric Invariance Test

In order to identify the moderating effect of relative advantage, we divided the group depending on how respondents perceived the level of relative advantage of UAM. Using the mean value of relative advantage, we classified the survey participants into a low level of relative advantage group ($N = 171$) versus a high level of relative advantage

Table 3. Results of structural model evaluation.

	Independent variable		Dependent variable	β	*t*-value	Status
H1	Problem recognition	➔	Awareness	.916	14.359**	Supported
H2	Awareness	➔	Interest	.956	15.737**	Supported
H3	Interest	➔	Evaluation	.926	14.597**	Supported
H4	Evaluation	➔	Adoption intention	.969	12.798**	Supported
H5	Problem recognition	➔	Ascribed responsibility	.834	12.025**	Supported
H6	Ascribed responsibility	➔	Personal norms	.937	13.158**	Supported
H6a	Personal norms	➔	Evaluation	.120	2.723*	Supported
H6b	Personal norms	➔	Adoption intention	−.012	−.202	Not supported

Goodness-of-fit statistics: χ^2 = 369.687, df = 181, χ^2/df = 2.042, p < .001, IFI = .967, CFI = .967, TLI = .962, and RMSEA = .052

Note. **p < .001, *p < .01.

group (N = 209). Previous studies considered that each group includes over 100 cases or more is tolerable for the group comparison (Steenkamp & Baumgartner, 1998; Yoo, 2002), and thus our sample size was not insufficient. The structural invariance of the baseline model was compared with a nested model. The goodness-of-fit statistics of the freely estimated model were χ^2 = 579.582, df = 362, χ^2/df = 1.601, p < .001, IFI = .942, CFI = .941, TLI = .932, and RMSEA = .040. The goodness-of-fit statistics of the equally constrained model were χ^2 = 600.024, df = 370, χ^2/df = 1.622, p < .001, IFI = .942, CFI = .941, TLI = .932, and RMSEA = .041. Thus, the results supported the significant difference ($\Delta\chi^2$ = 20.442, Δdf = 8) between the chi-square values of these two models. This study then tested the moderating effect of relative advantage in each relationship among study variables (See Table 4). A moderating role of relative advantage was found

Table 4. Results of the invariance test.

Path			Low relative advantage group (n = 171)		High relative advantage group (n = 209)		Baseline model (Freely estimated)	Nested model (Equally constrained)
			β	t-values	β	t-values		
H8a	Problem recognition	➔ Awareness	.910	9.216**	.735	6.778**	χ^2 (362) = 579.582[a]	χ^2 (363) = 579.587
H8b	Awareness	➔ Interest	.938	9.470**	.906	8.338**	χ^2 (362) = 579.582[b]	χ^2 (363) = 580.411
H8c	Interest	➔ Evaluation	.976	9.559**	.881	7.325**	χ^2 (362) = 579.582[c]	χ^2 (363) = 583.919
H8d	Evaluation	➔ Adoption intention	.939	7.536**	.950	6.709**	χ^2 (362) = 579.582[d]	χ^2 (363) = 579.583
H8e	Problem recognition	➔ Ascribed responsibility	.783	8.077**	.568	5.032**	χ^2 (362) = 579.582[e]	χ^2 (363) = 580.161
H8f	Ascribed responsibility	➔ Personal norms	.946	8.695**	.761	5.776**	χ^2 (362) = 579.582[f]	χ^2 (363) = 584.699
H8g	Personal norms	➔ Evaluation	.104	1.647	.186	2.257*	χ^2 (362) = 579.582[g]	χ^2 (363) = 579.974

Chi-square difference test:
[a] $\Delta\chi^2$ (1) = .005, p > .05 (H8a: Not supported)
[b] $\Delta\chi^2$ (1) = .828, p > .05 (H8b: Not supported)
[c] $\Delta\chi^2$ (1) = 4.336, p < .05 (H8c: Supported)
[d] $\Delta\chi^2$ (1) = .001, p > .05 (H8d: Not supported)
[e] $\Delta\chi^2$ (1) = .578, p > .05 (H8e: Not supported)
[f] $\Delta\chi^2$ (1) = 5.117, p < .05 (H8f: Supported)
[g] $\Delta\chi^2$ (1) = .392, p > .05 (H8g: Not supported)

Goodness-of-fit statistics for the baseline model: χ^2 = 579.582, df = 362, χ^2/df = 1.601, p < .001, IFI = .942, CFI = .941, TLI = .932, and RMSEA = .040

Goodness-of-fit statistics for the constrained model: χ^2 = 600.024, df = 370, χ^2/df = 1.622, p < .001, IFI = .942, CFI = .941, TLI = .932, and RMSEA = .041

Note. **p < .001, *p < .05.

in the path between interest and evaluation, and between ascribed responsibility and personal norms, confirming Hypothesis 8c and Hypothesis 8f. As shown in Figure 2, the effect of interest on evaluation was more prominent for the group with low relative advantage ($\beta = .910$, $p < .001$) than the group with high relative advantage ($\beta = .735$, $p < .001$). Similarly, the impact of ascribed responsibility on personal norms was greater for the low relative advantage group ($\beta = .946$, $p < .001$) than the high relative advantage group ($\beta = .761$, $p < .001$). However, the moderating effect of relative advantage was not statistically supported for the rest of the links, resulting in the rejection of H8a, H8b, H8d, H8e, and H8g.

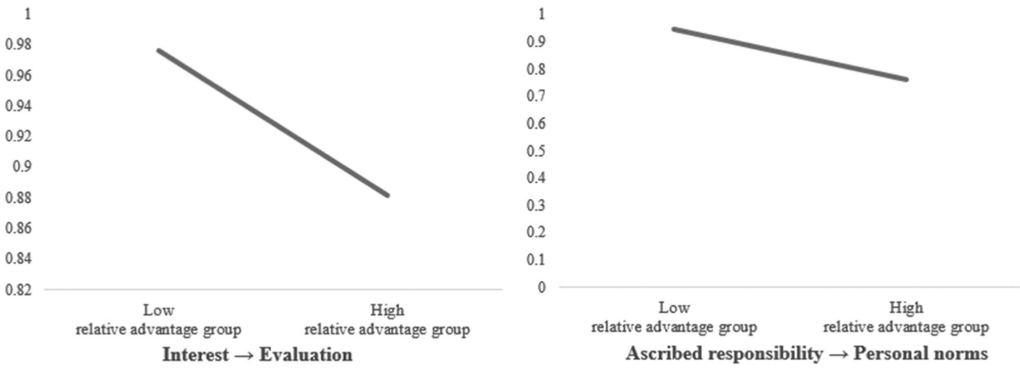

Figure 2. Identified moderating role of relative advantage.

Discussion and Implications

Discussion

This study drew on the consumer adoption process and the norm activation model to synthesize a framework to predict individuals' sustainable transport mode choice. With regard to the sequential framework of the consumer adoption process, the findings indicate that problem recognition of the current transportation methods increased awareness of UAM as a possible transport solution. Subsequently, awareness promoted an interest, which induced people to find more information in order to evaluate UAM. A positive evaluation resulted in stronger intention to adopt UAM. These findings support the consumer adoption process, and they align well with earlier studies (De Bruyn & Lilien, 2004; Jun et al., 2014; Radder, 2003) which explained individuals' adoption behavior based on sequential process of development.

In addition, we found that when people recognize the problems caused by current means of transportation, they are likely to show ascribed responsibility. This is consistent with previous findings (e.g., Vaske et al., 2015). Individuals who believe that they are partly responsible for such problems, exhibit a moral obligation to use eco-friendly city transportation. The results of this study also indicated that personal norms affected evaluations of UAM use. However, contrary to expectations, personal norms did not influence adoption intention. Numerous studies have determined that pro-social/pro-environmental behavioral intentions are constructed via by personal norms (De Groot & Steg, 2009; Han, 2021). Despite that, our findings do not support the role of personal norms forming the approach behavior toward UAM. Even though people potentially regarded UAM as an innovative vehicle, UAM is not yet available commercially. The insignificant effect of personal norms on adoption intention perhaps accounts for the current status of UAM, which is seen as an alternative option for city transportation but one that cannot be used at the present time.

The findings also unpacked the role of relative advantage in the formation of individuals' responsible behavior in selecting their modes of city transportation. The effect of interest on evaluation was stronger for the group with a low level of relative advantage of UAM. This result differs from earlier studies (Al Haddad et al., 2020; Fu et al., 2019), which indicated that relative advantage strengthens the formation of adoption intentions toward novel offerings. According to the consumer adoption process, people who are initially interested in UAM begin to look for more information. Hence, people who perceive a low relative advantage of UAM are likely to be interested in obtaining more information which would lead them to the stage of evaluation. Similarly, the relative advantage of UAM moderated the path from ascribed responsibility to personal norms as its effect was intensified for those who perceived a low level of relative advantage. It is expected that individuals who perceive a high level of relative advantage of UAM acutely aware of its current status, which is not available. It probably explains why the effect of ascribed responsibility on personal norms is relative weak for these group of people.

Theoretical Implications

Individuals' pro-social behavior deserves more attention in the modern world across different sectors. This study aimed to advance our knowledge of how to stimulate individuals' sustainable travel mode choice behavior in using UAM, which in turn contributes to a healthier society. The existing studies pertaining to UAM do not provide evidence of how UAM encourages people to adopt socially responsible behaviors for their transport mode choices in urban areas. With this respect, this research successfully filled these voids and enriches the scant body of knowledge. Furthermore, the aviation and transportation sectors have traditionally been male-dominated to some extent, and previous studies showed that males tend to adopt the UAM than females (Garrow et al., 2021; Tran et al., 2013). Our findings based on sample, which is composed of more female than male travelers would add values to the current literature.

The integration of the consumer adoption process and the norm activation model is based on our observation that the adoption intention for UAM is the result of a mixture of attractive technology and sustainable concerns. The consumer adoption model neglects the role of individuals' moral obligations in explaining approach behavior toward pro-environmental innovations, whereas the norm activation model underestimates the building mechanism of cognition-emotion-behavior responses toward novel offerings. As we built a conceptual model that incorporates the consumer adoption model and the norm activation model, our study shows a process how individuals' adoption behavior toward a sustainable and innovative product is formulated. Consequently, our findings advance the understanding of consumer behavior by laying the groundwork on how innovation adoption behavior and sustainable behavior are related. More importantly, this study discovered the significance of individuals' moral obligation to enact specific behaviors in this context.

Relative advantage, which is the core concept of innovation characteristics, has been generally regarded as a promotor of new products and services that are powered by high technologies (Al Haddad et al., 2020; Fu et al., 2019; Rogers, 1995). Even though relative advantages of UAM is debatable to some extent since it is still under development, this study took the extra step and investigated the moderating effect of relative advantage in the different formation process of adoption behavior, which fills the voids left by previous studies. The results indicate that relative advantage does not necessarily play a positive role at every stage of the consumer adoption process, which is a novel finding.

Practical Implications

There are unsolved issues such in this field, as the technical hurdles and legal issues associated with the commercialization of UAM. However, UAM could become an ordinary kind of transportation in metropolitan cities worldwide in the near future (Eissfeldt, 2020). Furthermore, the domestic travel demand during the pandemic has given industry practitioners the confidence to develop the potential of travel at close range (Arbulú et al., 2021; Wong et al., 2021). In order to accelerate individuals' adoption of UAM, this study has emphasized the importance of problem recognition related to current transport systems. Once people recognize problems such as air pollution, congestion, and noise, they are more likely to have a high level of awareness of alternative transportation modes and a high level of ascribed responsibility. Therefore, efforts should be made to increase problem recognition relating to the challenges posed to the living environment in urban areas by current transportation methods. Statistics on the negative consequences of primary ground transportation, such as carbon dioxide emissions and car crashes, should be shared with the general public on a regular basis. Providing information, as well as comparative information, on adverse effect of a different type of vehicle including a new mode will also be helpful.

For a successful market penetration by UAM, individuals' moral obligations should be increased. People should be provided with information about how their travel behaviors within metropolitan cities affect the various problems, so that they can carefully choose their transportation mode. In addition, the critical roles of central and local governments are constantly highlighted in order to increase personal norms (Ge et al., 2020). It is recommended to develop policies, such as clean transportation policies, to encourage residents to behave sustainably with regard to their transportation choices. Influencer endorsements on such policies would be also helpful to drive social norms, which increase personal norms. Alternatively, running a series of online and offline campaigns can be considered to involve more audience including citizens and visitors to the city. Organizations such as destination marketing organizations are thus encouraged to coordinate with the government to produce pro-social/sustainable characteristics and promote socially responsible behavior for travelers within their cities. Based on its relative advantages, UAM has the potential to substitute for current transportation methods in a city. UAM should be promoted as a form of sustainable city transportation.

Limitations and Future Research

According to KPMG's UAM readiness index, China has a high level of infrastructure and consumer acceptance (KPMG, 2021). The results of this study are based on data collected in China only, and might not be easily generalized due to the different degrees of readiness between countries. With respect to previous findings about the role of individuals' technology readiness (Chang & Chen, 2021), individuals' acceptance behavior toward UAM needs further examination depending on technology readiness. Also, our data display an uneven distribution, particularly in the high disproportion between male and female respondents. Studies in future are suggested to have a balanced distribution when gathering data. Earlier studies also showed that demographic factors potentially affect the adoption process (Fu et al., 2019; Jung et al., 2012; Maltese & Zamparini, 2022). For example, Tran et al. (2013) described that the early adopters of electric cars are males in their twenties and early thirties, and with high educational and income levels. Future studies are suggested to consider these demographic factors when examining customer adoption behavior related to UAM.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

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Appendix

Figure A1. Urban air mobility. Sources: Retrieved from https://supercarblondie.com/xpeng-x2-flying-car-world-first-public-flight-dubai/ (the first image); https://magneticsmag.com/honeywell-and-denso-collaborate-on-electric-propulsion-systems-for-urban-air-mobility/ (the second image); https://www.verdict.co.uk/urban-air-mobility-uam/?cf-view (the third image); https://www.aerospace-technology.com/projects/aeromobil-4-0-flying-car/ (the fourth image).