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RESEARCH ARTICLE

Exploring Market Segmentation for Autonomous Ferries

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Abstract

This study aims to investigate the determinants that underlie psychographic segmentation in the domain of autonomous ferries (AFs) by using the theory of planned behaviour (TPB) as a guiding theoretical construct. The paper focuses on Indonesian individuals who had previously utilised conventional ferry services. TPB was applied as a catalyst to identify possible market segmentation among potential AF passengers. In this study, cluster analysis is used to differentiate passengers by their perception of using AFs. The results identified three market segments through cluster analysis based on passengers' perceptions of using AFs: Resource-Limited, Resource-Capable, and Value-Optimistic. Among these segments, the Resource-Capable and Value-Optimistic groups are most inclined toward using AFs. This research contributes to the extension of the application of TPB by assessing the potential AF market and emphasising the relevance of TPB in understanding user preferences and decision-making processes. Furthermore, several managerial considerations aimed at enhancing awareness of AFs within the segmented research are discussed.

Keywords: Theory of planned behaviour, Market segmentation, Autonomous ferry

1. Introduction

Autonomous vehicles, including autonomous ships, are rapidly advancing innovations in transportation. They offer enhanced safety, sustainability, and cost-efficiency compared to conventional vehicles [1,2]. In the maritime industry, autonomous ships have the potential to contribute to sustainability by reducing weight, energy consumption, and greenhouse gas emissions [3]. Furthermore, they offer benefits such as cost reduction, improved environmental sustainability, and operational efficiency [4].

Three Norwegian projects are pioneering autonomous ship technology: MUNIN, DNV GL ReVolt, and YARA Birkeland. MUNIN is addressing the shortage of seafarers in European shipping industries by focusing on the feasibility of autonomous ships [5]. DNV GL has developed the ReVolt, a fully battery-powered autonomous ship designed for short-sea shipping, intending to ease pressure on onshore logistics networks, reduce operational costs, and enhance maritime safety [6]. YARA, a Norwegian chemical export company, in collaboration with Kongsberg, a Norwegian maritime technology export company, has created the YARA Birkeland, the world's first fully electric autonomous container ship [7]. In January 2022, a demonstration of a fully autonomous navigation system occurred on a large car ferry in the Iyo-nada Sea, departing from Shinmoji in Kitakyushu City, Japan [8]. The trial featured a fully autonomous navigation system operating on a 222-meter ferry, demonstrating its ability for autonomous port berthing and unberthing.

The International Maritime Organization has engaged in discussions regarding the regulation of autonomous ships, aiming to establish interim

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guidelines for trials involving Maritime Autonomous Surface Ships (MASS), the category in which autonomous ferries (AFs) are included [9]. According to these guidelines, the level of autonomy in MASS can be categorised into four key degrees:

Level 1: Ships with automated processes and decision support systems. Seafarers are present on board to oversee and control shipboard functions. While some operations may be automated and are occasionally unsupervised, seafarers are always on hand to assume control if necessary.

Level 2: Remotely controlled ships with seafarers on board. The ship is operated and controlled from a different location, with seafarers on board and available to take charge of shipboard systems and operations.

Level 3: Remotely controlled ships that operate without any seafarers on board. These ships are controlled and operated from a separate location, and there are no seafarers physically present on board.

Level 4: fully autonomous ships, where the ship's operating system can make independent decisions and execute actions without human intervention.

The development of AFs represents a transformative advancement in the maritime transportation industry, offering improved safety, efficiency, and sustainability [10]. To ensure its success, ferry operators and stakeholders must understand the preferences, motivations, and attitudes of potential users [11]. Accurate evaluations of the impact of AFs on infrastructure and the environment require insights into their market penetration and customer preferences. Effective market segmentation can provide valuable insights into different customer segments, enabling tailored marketing strategies and targeted service offerings for AFs [12,13].

Psychographic segmentation, which focuses on understanding consumer behaviours, preferences, and lifestyles, has emerged as a valuable approach in market research [14,15]. By segmenting the market based on psychographic variables, such as attitudes, values, and personality traits, ferry operators can gain a deeper understanding of their customers and design strategies that resonate with specific segments [16]. In the context of AFs, psychographic segmentation can significantly contribute to a comprehensive understanding of user preferences and decision-making processes.

The most widely recognised theories for comprehending user preferences are the theory of planned behaviour (TPB) [17,18] and the theory of reasoned action (TRA) [19]. TPB is an extended theory derived from TRA, providing a conceptual framework for understanding human behaviour in specific contexts. It introduces the concept of 'perceived behavioural control' (PBC), which factors in an individual's belief in the ease or difficulty of executing a behaviour based on past experiences and anticipated obstacles. PBC elucidates the access to resources and opportunities necessary for different segments to engage in a behaviour, thus assisting in the generation of a tailored marketing strategy [20]. Therefore, TPB sheds more light on exploring potential market segments in the context of AFs.

TPB is a widely accepted theoretical framework that explains human behaviour and decision-making in various contexts [21−23]. It posits that behavioural intentions are influenced by three main factors: attitudes, subjective norms, and PBC. Attitudes represent a person's evaluation or perception of a behaviour; subjective norms reflect social influences and normative beliefs; and PBC refers to an individual's perceived ability to perform the behaviour [19].

Using the abovementioned literature statements and TPB as a guiding theoretical construct, this study aims to investigate the determinants underlying psychographic segmentation in the domain of AFs. Thus, the objectives of this study are as follows:

1. To identify distinct market segments within potential AF users based on the factors derived from TPB.
2. To provide marketing strategies and service offerings tailored to different market segments to promote the adoption and usage of AFs.

2. Literature review

2.1. Market segmentation

Market segmentation involves adjusting market offerings to meet the requirements of consumers or users [24]. It divides a diverse market into homogeneous segments based on product preferences, aiming to create manageable groups of consumers. This is achieved through tailored marketing strategies catering to the specific needs and characteristics of each group [24]. Successful market segmentation can strengthen a market position in well-defined categories. To be effective, segments should be accessible, actionable, sustainable, and measurable [25]. It is important to note that market segmentation is a management strategy that makes assumptions about groups rather than individuals [26].

Two approaches to population segmentation in market research are a priori and post hoc. A priori segmentation involves predefined divisions based

on factors like socio-demographics, while post hoc segmentation identifies similarities through data analysis [27]. For example, post hoc segmentation can categorise individuals based on environmentally friendly behaviour [28]. Both methods use data to identify a segmentation theme, including demographic, socio-economic, and psychological factors [29−31].

Moreover, Kizielewicz et al. [32] explore the impact of travel motivation on demand by categorising ferry riders based on their motivations (leisure, business, family, etc.). These subgroups have unique behavioural and socio-demographic characteristics. Varying age groups, genders, and income levels have different preferences for comfort, convenience, reliability, and flexibility. Similarly, Cheng et al. [33] analyse socio-demographic differences, including gender, age, income, and occupation, in travel behaviour between two underdeveloped cities in China.

Additionally, recent developments in sustainable transportation technologies, such as electric vehicles (EVs) and autonomous vehicles (AVs), have specific market segments that can be identified. A study by Morton et al. [34] found that by analysing preferences for EVs, they could identify five unique segments characterised by socio-economic characteristics, current vehicle ownership, and psychographic profiles. Since EVs are still relatively new on the market but show great promise as an environmentally friendly product, market segmentation is a vital tool for obtaining greater knowledge about them and directing their growth in popularity [35−38]. Private or public AVs potentially create a cleaner and safer rider safety environment, which could affect people's perception of AVs.

2.2. Psychographic segmentation in the transportation sector

In the transportation industry, understanding the profiles of different segments helps companies target specific users. Companies can customise marketing messages and services to meet their users' unique needs and preferences. Among other methods, psychographics is more effective than other segmentation methods, such as socio-demographic and spatial segmentation, in identifying user transportation groups [14,28,39].

Psychographic factors can be derived from attitude-behaviour theories like TPB, based on the attributes of its factors in shaping behavioural intentions [40]. In TPB, attitudes pertain to an individual's positive or negative evaluation, encompassing their values and interest in a specific behaviour. Conversely, subjective norm refers to the social norm valuing society's perception of a particular behaviour. Both subjective norm and PBC are psychological elements that can be associated with psychographic segmentation. Furthermore, PBC can be utilised to categorise people into segments based on their varying levels of control over their behaviour [40]. For instance, when segmenting individuals based on their likelihood to exercise, PBC could serve as one of the segmentation variables.

The utilisation of TPB in identifying psychographic segmentation was applied to segment travel behaviour. It involved profiling travel behaviour between individuals who own cars and those who do not, leading to the development of market strategies tailored to each segment's distinct psychological characteristics [31]. Additionally, Tkaczynski [41] explored the connection between mode choice and travel behaviour using psychographic segmentation based on TPB, which includes factors such as intention, perceived risk, social norms, PBC items, and attitude items.

The segmentation process can deliver actionable behavioural insights to inform planning at the segment level through the application of theory. Hence, the application of TPB in exploring the market segmentation of AF passengers could help with the understanding of the perception of potential passengers from psychological aspects, as TPB is a widely used social psychology theory that explains how attitudes, subjective norms, and PBC influence individual intentions and subsequent behaviours [42]. TPB has been used to recognise and predict a range of behaviours, such as commuting mode choice, vehicle purchasing, and sustainable travel behaviour [28,29,39].

TPB is a useful tool for understanding the psychological determinants of behaviour in different segments, including attitudes, subjective norms, and PBC. In transportation marketing, comprehending the psychological and emotional factors that influence attitudes towards AFs is crucial for effective marketing strategies. By segmenting the target audience based on attitudes, marketers can gain insights into perceptions and decision-making processes related to public transportation. Attitude segmentation, as revealed in [43], uncovers important factors in travel behaviour decisions and provides valuable information for targeted advertising campaigns. Latent segmentation using attitudes, as shown in [44,45], helps create resonant campaigns and increases the intention to use public transportation. Attitudinal approaches have higher predictive power and provide a direct focal point for information and communication strategies [28].

Subjective norms as social norms could influence an individual's perception through the perception of their wider community, which could change an individual's behaviour toward a specific action [42]. Subjective norms put social pressure on an individual through the influence of their community; for instance, an individual may be surrounded by people concerned about environmental sustainability in transportation mode choices [28]. Community social pressure influences the individual's perception to change their behaviour to align with the wider community's beliefs [46]. In addition, classifying a potential AF passenger through social norm perception could help identify a "high intention" group, as proven by Mohamed et al. [29] in a study of potential electric vehicle adoption. Those segments concerned about other people's perceptions of AFs might be classified and identified to aid the development of a marketing strategy targeting potential AF passengers.

Internal and environmental factors, including self-efficacy, resources, social support, and behaviour difficulties, influence PBC [42]. Many potential AF passengers may lack confidence in their ability to control and overcome obstacles due to limited awareness about AFs [28]. PBC plays a role in defining a group with high control over their mobility among commuter transport segments [28]. Previous literature [47] identifies ten significant determinants of behavioural intention to drive an AV: attitude towards AVs, compatibility, complexity, sensation-seeking driving, PBC, perceived moral norm, perceived advantage, self-efficacy, subjective norm, and intention to operate an AV. These elements have also been recognised as significant in recent research on behavioural intentions to drive AVs or public acceptance of the technology [47−49].

Thus, based on the abovementioned literature, this study suggests TPB variables (i.e., Attitude, Subjective Norm, PBC) as factors for exploring market segmentation among potential AF passengers based on references listed in Table 1.

2.3. Risk perception and intention to use autonomous ferries

2.3.1. Risk perception of using autonomous ferries

While TPB is a widely used psychographic variable to explore market segmentation, perceived risk also has a significant role in determining the use of AFs. Perceived risk is defined as users' subjective perception of uncertainty or fear. It may negatively affect their decision-making strategy for adopting AFs [50−53]. Risk perception can be expressed as anxiety or unpleasant reactions resulting from expected post-behavioural emotions such as fear and tension [54,55], and this may substantially impact the adoption of AFs [56]. The results of an investigation into public perception of autonomous urban ferries in Canada revealed that potential safety issues on board autonomous vessels is the primary factor of concern [57].

Table 1. Variables for segmentation.

Variables	References
Attitude	[14,41,44,45,48]
Subjective norm	[14,29,41,48]
Perceived behavioural control	[14,41,48]

The notion of an AF devoid of a captain or crew might be a novel and unfamiliar concept to potential users, passengers, and stakeholders within the industry. Insufficient acquaintance with AFs can generate doubt and unease, potentially hindering the adoption and implementation of such vessels. According to Chikaraishi et al. [50], the primary obstacle blocking the acceptance of driverless vehicles is the unfamiliarity and apprehension associated with them. The results can be linked to the inclination towards utilising AFs as a distinct implementation of autonomous technology within the maritime sector. Therefore, it is beneficial to identify the intention of each potential AF passenger market segment to identify passenger perceived risk as a hindrance factor.

The theory of planned behaviour offers a means of predicting behaviour choices by accommodating potential passenger intentions. The primary concept in this theory is that individuals engage in specific behaviours based on intention, which is shaped by attitudes, subjective norms, and PBC [42]. The exploration of perceived risk and its impact on the intention to use AVs has been studied [58,59]. The studies found that the perception of risk influences social acceptance and intention to use AVs. Elias et al. [60] also discovered that the risk perception of road crashes and fatalistic beliefs positively affect user inclination to choose public transportation. Furthermore, Osburg et al. [61] found that exposure to positive information about AV services is negatively correlated with the likelihood of membership in the two most resistant segments, indicating a potential barrier to acceptance. Based on the abovementioned literature, this current study attempts to understand the influences on each potential market segment toward risk perception when using AFs.

2.3.2. Intention to use autonomous ferries

Intention, as defined in the TPB framework proposed by Ajzen et al. [43], encompasses an individual's conscious plan or decision to engage in a specific behaviour. This social psychology theory

aims to elucidate and forecast human behaviour by considering individuals' attitudes, subjective norms, and PBC [42]. While intention plays a significant role in determining behaviour, it is noteworthy that the translation of intention into actual behaviour is not always guaranteed due to the influence of various external factors and constraints. However, this intention-behaviour gap can potentially be reduced through the strength of intention itself [62]. Nonetheless, the TPB asserts that intention remains a dependable indicator of behaviour and a valuable tool for comprehending and foreseeing human actions.

Furthermore, Şimşekoğlu et al. [63] sought to categorise various market segments within the transportation sector to gain a comprehensive understanding of the factors influencing users' choices of travel modes. These factors encompassed transport priorities, attitudes towards different travel modes, and individuals' habits pertaining to car usage. By examining these factors, the researchers aimed to investigate the extent to which they influenced users' intentions to utilise public transportation as opposed to private vehicles. The findings of the study highlighted the significant role played by attitudes in shaping users' intentions to opt for public transportation.

Extensive research has examined the factors influencing user intention, such as the use of information technology (IT) and subsequent behaviour. Sun et al. [64] have generated models that explore user perceptions of technological attributes impacting the intention to use IT. In the context of shared AVs, the adoption intention of young people is explored through the extended TPB-TAM [65]. Furthermore, Jing et al. [66] studying mode choice intention for AVs using extended TPB aimed to better grasp travellers' motivations, offering valuable insights for governments and companies to refine travel strategies and services [58]. Additionally, the intention factor accommodated several theories, such as the Unified Theory of Acceptance and Use of Technology, to provide a comprehensive model with core determinants of intention and usage associated with new technology, along with potential moderators [56]. Through the research in the existing literature

Table 2. Questionnaire items.

Dimension	Items	Attributes	References
Attitude	**AT1**	I like the idea of using an Autonomous Ferry (AF)	[14,41,44,45,48]
	AT2	Using an AF would be a wise idea	
	AT3	I think using an AF is a good idea	
	AT4	I think taking an autonomous ferry could minimize the risk of being exposed to Covid-19	
	AT5	I am excited about the possibilities offered by AF	
Subjective Norm	**SN1**	If people around me use AFs, I will also use AFs	[14,29,41,48]
	SN2	I would comply with the demands of people who are important to me to use an AF	
	SN3	Media or/and articles influenced me to use AF	
	SN4	The media gave me a good feeling about using an AF	
Perceived Behavioural Control	**BC1**	Whether or not I use an AF is completely up to me	[14,41,48]
	BC2	I have enough opportunity to use an AF when travelling	
	BC3	I have enough money to use an AF when travelling	
	BC4	I will have the required knowledge to use AF when travelling	
Perceived Risk	**PR1**	I am worried about certain risks for me and my family when using AFs	[41,68,76,77]
	PR2	I am afraid of suffering financial and time losses when using Afs	
	PR3	I am worried that the system will cause me trouble when using Afs	
	PR4	I worry about whether AFs will really perform as well as a common ferry ship	
	PR5	I worry that taking an autonomous ferry will make me exposed to Covid-19	
	PR6	Overall, using AF is risky	
Intention	**IA1**	I would consider using AFs when they are available in the market	[58,64,67]
	IA2	I expect that I would use AFs in the future	
	IA3	I would recommend AFs to my family and peers	
	IA4	I would encourage others to use AFs	
	IA5	I have positive things to say about AFs	
	IA6	I plan to use AFs in the future	

on intention toward behaviour, valuable insights into AF market segments can be expounded.

3. Methodology

3.1. Survey design and sampling

This study applies quantitative analysis. A three-part questionnaire was used to collect survey data. The questionnaire covered the study's goal, provided information on AFs (including a video demonstration), collected socio-demographic information, and explored respondents' perceptions of AFs, psychographic variables, risk evaluation, and intention to use.

The survey instrument used in this study was developed by drawing from multiple sources in the existing literature (see Table 2). Initially composed in English, it was then translated into Indonesian and underwent a rigorous proofreading process by an expert in transportation and shipping. Back-translation was employed to ensure the questionnaire's quality, comparing the differences between the original and back-translated versions. The questions were structured on a 5-point Likert scale.

The questionnaire used in this study did not have correct or incorrect choices; instead, respondents were asked to indicate their primary preference. To enhance the questionnaire's validity, a pilot survey was conducted, and the questionnaire was evaluated by an Indonesian academic specialist and a ferry terminal officer.

The Indonesian version of the questionnaire was distributed randomly through social media platforms and colleagues using a Google online survey template. As an incentive for completing the questionnaire, respondents received electronic vouchers promptly delivered to their e-wallet apps.

Table 3 displays the demographic data of respondents. Out of 550 distributed questionnaires, 401 questionnaire replies were received. After performing data cleaning to filter out missing values, incomplete answers, and outliers, a total of 351 valid responses were retained. Among the respondents, 63.2 % were women. Most participants were aged between 17 and 25, technologically aware, and open to trying new technologies. In terms of education, 61.8 % held a bachelor's degree, 39.3 % were employed, and 29.9 % were students. The monthly income of the majority (44.7 %) was less than or equal to 2 million IDR ($139).

Table 3. Demographical data statistics.

Attributes	Total Sample ($N = 351$)	Frequency	Percentage
Gender			
Male		129	36.8 %
Female		222	63.2 %
Age			
Less than 17		6	1.7 %
17-25		210	57.3 %
26-40		108	30.8 %
41-55		27	7.7 %
Over 55		9	2.6 %
Education			
Senior High-School		108	30.8 %
Bachelor		217	61.8 %
Master		25	7.1 %
Doctor		1	0.3 %
Occupation			
Student		104	29.6 %
Civil Servant/Police/Army		18	5.1 %
Employee		138	39.3 %
Entrepreneur		31	8.8 %
Housewife		17	4.8 %
Other		43	12.3 %
Income (IDR Million month)			
≤2		157	44.7 %
2 to <4		87	24.8 %
4 to <6		48	13.7 %
6 to <8		19	5.4 %
8 to <10		9	2.6 %
≥10		31	8.8 %

3.2. Research methods

The research utilised a questionnaire survey, incorporating 19 variables based on previous studies [14,29,41,44,45,48,56,68] to ensure question validity. Factor analysis was then applied to condense the large set of variables into a smaller number of factors or dimensions [69]. Factor analysis is a statistical technique that extracts shared variance from variables, generating a unified score as a representative measure [70]. It helps identify meaningful factors based on similarity among the original variables. In a similar vein, a prior study by Lu [71] employed factor analysis to extract information on variables related to international distribution centres into underlying factors.

Principal Component Analysis was employed to extract important information from the data and create new orthogonal variables called principal components. Principal Component Analysis helps reveal patterns of similarity between variables and observations [70]. The resulting factors underwent reliability testing to assess the adequacy of each factor in capturing perceptions towards AFs.

Two-step cluster analysis was used to identify potential adopter characteristics by grouping customers with similar traits and behaviours based on variables such as purchasing patterns, demographics, and product usage [41,72]. Therefore, the current study adopted a two-step approach to

leverage the strengths of hierarchical and non-hierarchical clustering methods [69,73,74]. In the first step, a hierarchical algorithm called Ward's method was used to determine the number of clusters [71]. Ward's method, employed within hierarchical cluster analysis, serves as a criterion that seeks to minimise within-cluster variance. Subsequently, K-means clustering was conducted to identify the segment of the potential AFs market based on their initial mean scores [75]. Thus, the application of the K-means algorithm aims to group potential AF passengers who share similar characteristics into the same cluster, while segregating those with dissimilar characteristics into separate clusters. To examine the significance between the formed cluster groups on several factors, one-way analysis of variance (ANOVA) was employed. The post hoc Scheffé test was then conducted to distinguish between each cluster group.

4. Result

4.1. Perception of autonomous ferries

The study examined public perceptions of AF usage by analysing 13 attributes derived from questionnaire responses. The mean values of the psychographic attributes ranged from 3.42 to 4.13 on a 5-point Likert scale, as shown in Table 4. Among the dimensions of PBC, BC4 had the highest mean score, followed by BC1. In terms of attitude, the attributes of excitement (AT5) and the concept of utilising AFs (AT1) ranked third and fourth, respectively. Media influence (SN4), falling under the subjective norm dimension, attained the fifth position in the mean overall analysis score.

The participants showed concerns regarding the use of AFs in terms of risk perception, as indicated by the data in Table 5. The comprehensive risk statement associated with AF utilisation received the lowest mean score, indicating high levels of apprehension. This was followed by concerns about potential financial and temporal losses (PR2) and system malfunction (PR3). The lower mean scores indicate higher levels of concern, which is also supported by prior research that analysed the role played by perceived risk and its impact on the intention [58,59]. Interestingly, the study found that the level of concern regarding COVID-19 exposure, as measured by PR5, was relatively low.

Table 6 presents the respondents' intention to use AFs, with IAF2 receiving the highest mean score of 4.14 compared to other factors. This suggests an anticipation of utilising AFs in the future, as indicated by the response "plan to use AFs in the future" with a mean score of 4.08 on a 5-point Likert scale. Additionally, participants expressed a willingness to recommend AFs to their relatives and acquaintances (IAF3), although they exhibited a lower inclination to actively promote its usage (IAF4).

4.2. Factor analysis

A total of 13 psychographic AF perception attributes were extracted to form underlying dimensions using principal component analysis with the varimax rotation method. The analysis accounted for the Kaiser–Meyer–Olkin value 0.894 as above the ideal value suggested [73]. Further, Barlett's test of sphericity was significant ($x^2 = 2428.082$, $P < 0.001$), which indicates that correlations exist between some of the responses. The eigenvalue greater than

Table 4. Psychographic variable mean score from respondents.

Index	Attributes of perception on the autonomous ferry	Mean	S.D.[b]
BC4	I will have the knowledge to use AF when travelling	4.13[a]	0.798
BC1	Whether or not I use an AF is completely up to me	4.12	0.882
AT5	I am excited about the possibilities offered by AF	3.98	0.789
AT1	I like the idea of using an Autonomous Ferry (AF)	3.97	0.769
SN4	The media gave me a good feeling about using an AF	3.87	0.826
AT3	I think using an AF is a good idea	3.83	0.765
AT2	using an AF would be a wise idea	3.81	0.812
SN1	If people around me use AFs, I will also use AFs	3.77	0.901
SN3	Media or/and articles influenced me to use AF	3.77	0.986
BC2	I have enough opportunity to use an AF when travelling	3.75	0.814
SN2	I would comply with the demands of people who are important to me to use an AF	3.62	0.945
BC3	I have enough money to use an AF when travelling	3.61	0.894
AT4	I think taking an autonomous ferry could minimise the risk of being exposed to Covid-19	3.42	0.944

[a] Likert-scale (1 = strongly disagree to 5 = strongly agree).
[b] S.D. = standard deviation.

Table 5. Respondents' risk perception on autonomous ferries.

Index	Attribute	Mean[a]	S.D.[b]
PR6	Overall, using AF is risky	3.74	0.686
PR2	I am afraid of suffering financial and time losses when using AFs	3.78	0.667
PR3	I am worried that the function and the system cause me trouble when using AFs	3.78	0.694
PR1	I am worried about the risks that may affect me and my family when using AFs	3.79	0.698
PR4	I worry about whether AFs will really perform as well as common ferry ship	3.79	0.703
PR5	I worry taking autonomous ferry will make me exposed to Covid-19	3.87	0.753

[a] Likert-scale (1 = Strongly agree to 5 = strongly disagree).
[b] S.D. = standard deviation.

Table 6. Respondent's intention to use autonomous ferries.

Index	Attribute	Mean	S.D.[b]
IAF2	I expect that I would use AFs in the future	4.14[a]	0.773
IAF6	I plan to use AFs in the future	4.08	0.800
IAF3	I would recommend AFs to my family and peers	3.91	0.842
IAF1	I would consider using AFs when they are available in the market	3.91	0.847
IAF5	I have positive things to say about AFs	3.82	0.826
IAF4	I would encourage others to use AFs	3.82	0.856

[a] Likert-scale (1 = strongly disagree to 5 = strongly agree).
[b] S.D. = standard deviation.

one was applied to determine the number of factors [77]. The results showed that the 13 perceptual attributes in AFs were grouped into three factors with the highest percentage of total variance on factor 1, indicating that factor 1 could explain the datasets up to 33.95 % of the total variances (58.14 %).

Table 7 provides the extracted interpretation of the formed factors, sorted by factor loading values. Factors with loading values below 0.5 were not included for interpretation based on the conservative criterion [73]. The three psychographic factors identified are as follows:

1. Factor 1: Attitude - This factor represents opinions and ideas about using AFs. It has the highest total variance (33.9 %) and includes items related to assessing the idea of using AFs in the future.
2. Factor 2: Subjective norm - This factor accounts for 17.39 % of the total variance and includes items related to social norms, relationships with significant individuals, and media exposure. Social influence has the highest loading within this factor.
3. Factor 3: PBC - This factor accounts for 6.81 % of the total variance and includes items related to individual self-reliance and knowledge-seeking. It reflects self-efficacy in using AFs.

These three psychographic factors, along with the dimensions of risk perception and intention to use AFs, were evaluated for reliability using Cronbach's α value (Table 8). All dimensions met the standard of having a Cronbach's α value of 0.7 or higher, indicating high internal consistency and good reliability [73]. These psychographic dimensions will be used to cluster the criteria of potential AF passengers.

4.3. Cluster interpretation

Hierarchical cluster analysis, utilising Ward's method and square Euclidean distance, was employed to link respondents based on factor score similarity. By comparing the variance between clusters and the variance within clusters, the number of clusters was determined.

The potential number of clusters is determined by assessing the agglomeration coefficients and dendrogram and exercising practical judgement [73]. Initially, a stopping rule is employed to identify significant changes in agglomeration coefficients, indicating the merging of very dissimilar clusters and suggesting a point to halt further merging. Conversely, the merging of two similar clusters results in minor increases in the coefficients. Table 9 shows a notable increase in the percentage change in agglomeration coefficients when transitioning from 3 to 2 (42.91 %) and from 2 to 1 (48.24 %). Consequently, it is reasonable to consider two to three clusters as potential solutions.

Next, the dendrogram, illustrated in Fig. 1, is a visual representation in the form of a tree graph that

Table 7. Psychographic factor analysis.

Index	Attributes of perception on the autonomous ferry	Factor		
		1	2	3
AT2	Using an AF would be a wise idea	0.849	0.226	0.222
AT3	I think using an AF is a good idea	0.823	0.203	0.277
AT1	I like the idea of using an Autonomous Ferry (AF)	0.751	0.206	0.300
AT5	I am excited about the possibilities offered by AF	0.634	0.226	0.416
AT4	I think taking an autonomous ferry could minimise the risk of being exposed to Covid-19	0.589	0.390	−0.040
SN1	If people around me use AFs, I will also use AFs	0.134	0.827	0.237
SN2	I would comply with the demands of people who are important to me to use an AF	0.204	0.786	0.132
SN3	Media or/and articles influenced me to use AF	0.280	0.757	0.143
SN4	The media gave me a good feeling about using an AF	0.390	0.685	0.272
BC1	Whether or not I use an AF is completely up to me	0.070	0.048	0.830
BC4	I will have the knowledge to use AF when travelling	0.382	0.193	0.667
BC2	I have enough opportunity to use an AF when travelling	0.166	0.364	0.644
BC3	I have enough money to use an AF when travelling	0.301	0.174	0.577
Eigenvalues		6.154	1.329	1.110
Percentage variance		33.949	17.389	6.810

Table 8. Reliability result.

Dimension	Total items	Cronbach Alpha
Attitude	5	0.875
Subjective Norm	4	0.853
Perceived Behavioural Control	4	0.749
Perceived Risk	6	0.861
Intention to Use AF	6	0.897

Table 9. Agglomerative schedule.

Stage	Coefficients	Differences	Proportionate Increase to the Next Stage	Number of Clusters after Combining
341	204.571	21.509	10.51 %	10
342	226.080	22.356	9.89 %	9
343	248.436	28.279	11.38 %	8
344	276.715	29.483	10.65 %	7
345	306.198	36.477	11.91 %	6
346	342.675	61.229	17.87 %	5
347	403.904	91.744	22.71 %	4
348	495.648	212.678	42.91 %	3
349	708.326	341.674	48.24 %	2
350	1050.000	–	–	1

presents the distances at which clusters come together. The dashed line on the dendrogram corresponds to the suggested three-cluster solution based on changes in agglomeration coefficients. The datasets associated with these three clusters exhibit a relatively balanced distribution of samples. Consequently, we conclude that the final cluster solution consists of these three clusters.

To gain a better understanding of the characteristics of each segment, further classification and interpretation were conducted using the K-means method with standardised mean scores from each variable. The respondents were distributed across the segments as follows: Segment 1 included 121 respondents, Segment 2 included 150 respondents, and Segment 3 included 80 respondents.

In Table 10, an ANOVA analysis was performed on three dimensions across three segments of respondents, with the number of participants in each segment mentioned in parentheses. The F-value measures the variation between the segment means relative to the variation within the segments. A higher F-value indicates a more significant difference between the segment means. The significance level (***), which is less than 0.001, indicates that the differences between the segment means for each dimension are statistically significant.

The mean scores for each segment from non-hierarchical cluster analysis reveal that in Segment 1, PBC has the highest score among the dimensions, while attitude has the lowest mean score. Similarly, Segment 2 also values PBC the most, but it has a positive mean score compared to Segment 1, and the subjective norm is the dimension with the lowest score. Conversely, in Segment 3, attitude has the highest mean score among the dimensions, while PBC has the lowest mean score in this segment.

Identifying the highest and lowest score dimensions helps describe each segment. For instance, Segment 1 emphasises PBC yet slightly follows the subjective norm and account attitude at the least. In addition, this segment exhibits a negative score in all variables. Therefore, Segment 1 being labelled as “Resource-Limited” refers to individuals in this group having constraints when it comes to accessing the necessary resources relating to AFs, including knowledge, finances, and opportunities. The influence of society and media is not the primary consideration when evaluating the use of AFs. Instead, their assessments of the value of the behaviour have a comparatively smaller impact on their decision to utilise AFs.

Segment 2 has the highest positive score of PBC. Thus, this segment is labelled “Resource-Capable”,

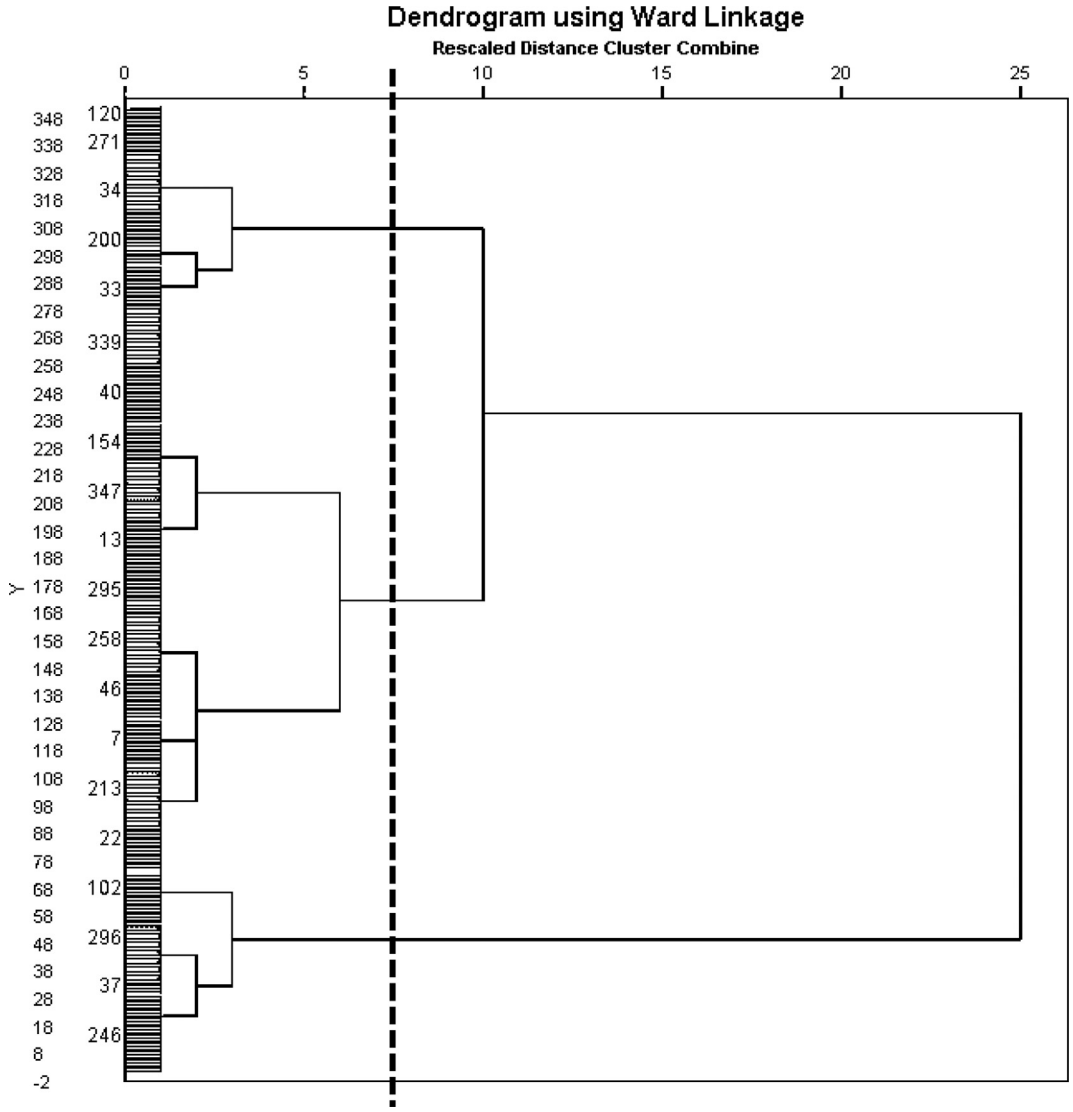

Fig. 1. Hierarchical cluster analysis result.

referring to the ability of individuals in this category to effectively use their financial resources, knowledge, and available opportunities for utilising AFs. They hold a positive outlook on AFs as a promising mode of transportation in the future. Additionally, external factors such as media influence and the opinions of others had a limited impact on their decision to use AFs.

Moreover, attitude is the highest score for Segment 3, emphasising its role in this segment. Segment 3 is labelled as "Value-Optimistic". This label indicates their positive belief in the benefits of using AFs and their expectation of it being their preferred mode of transportation. Additionally, their decisions to use AFs are influenced to a limited extent by factors such as their financial resources,

Table 10. ANOVA of psychographic variables among the three segments.

Dimensions	Segments			*F* Value	*F* Prob	Scheffé Test
	1 (n = 121)	2 (n = 150)	3 (n = 80)			
Attitude	−0.95	0.11	1.24	353.865	0.000***	(1,2) (2,3) (1,3)
Perceived Behavioural Control	−0.82	0.42	1.17	210.775	0.000***	(1,2) (2,3) (1,3)
Subjective Norm	−0.85	0.06	1.18	229.726	0.000***	(1,2) (2,3) (1,3)

*** Significance level <0.001.

knowledge, and available opportunities, as well as external factors like media influence and the opinions of others.

Hence, these three groups are named Segment 1 (Resource-Limited), Segment 2 (Resource-Capable), and Segment 3 (Value-Optimistic).

The Scheffé test was used to determine which segments differ significantly. The (1,2), (2,3), and (1,3) indicate the pairs of segments that are significantly different. Overall, the results suggest that there are significant differences in the scores obtained from the different segments in each dimension, with Value-Optimistic generally scoring higher than the other two segments.

Table 11 presents the ANOVA results and Scheffé test for the differences in risk perception and intention to use AFs among the three AF segmentation groups. The findings indicate that intention to use AFs varies significantly across all segment groups ($p < 0.001$). Additionally, the Scheffé test reveals significant differences in perceived risk among the segment groups, except for the comparison between the Resource-Limited and Resource-Capable segments. The Resource-Limited segment places more emphasis on perceived risk rather than intention to use AFs. Conversely, the Resource-Capable and Value-Optimistic segments show a stronger intention to use AFs, with the Value-Optimistic segment having the highest overall mean score.

Additionally, cross-table is used to analyse demographic attributes within segmented groups, providing deeper insight into individual members within each segment. In the Values-Optimistic group with the highest intentions, the cross-table results show that this group consists mostly of women between the ages of 17 and 25, all of whom have college degrees. Most group members are employed and earn less than IDR 2 million. This distinctive demographic composition is also reflected in all segments. For detailed demographic characteristics of each segment, see Table 12.

5. Discussion and conclusion

Three market segmentations were identified using cluster analysis to distinguish passengers through their perception of using AFs. Those segments are namely Resource-Limited, Resource-Capable, and Value-Optimistic. Resource-Limited and Resource-Capable are the two segments that account for self-efficacy in terms of resource availability when using AFs. However, the Resource-Limited segment tends to have limited resources regarding AF utilisation. Moreover, the subjective norm factor exhibits a negative mean score. This means that other people's opinions did not affect the member group in this segment.

This research revealed that groups of people can be classified according to their perception of AFs and behavioural control. Resource-Capable segments consist of psychological factors which self-assess the capacity for future AF use. Hence, targeting this group's use of AFs should consider the aspect of ease-of-use technology, particularly in the utilisation of AFs as public transportation. People can be engaged to shift their transportation choices through personalised information, which aims to reduce ignorance about alternative sustainable transportation, such as AFs [78].

The public's interest in AFs created a group segment that considers AFs as a promising future means of transportation. The Value-Optimistic segment group identified in this study could be an example of several people having the same interest in the value of AFs. Members in this segment tend to seek the benefits of AFs over conventional ferries and judge whether AFs positively affect their lives. Targeting this market segment through information or a simulation can likely aid their recognition, leading people in this segment to shift to using AFs as an alternative mode of transportation. When provided with information, users spend time considering a product or service's advantages and disadvantages. Spending more on providing information and knowledge to raise awareness of AFs

Table 11. ANOVA of perceived risk and intention to use AF among three segments.

Dimensions	Segments			*F* Value	*F* Prob	Scheffé Test
	Resource-Limited	Resource-Capable	Value-Optimistic			
Perceived risk[1]	3.62[a] (0.43)[b]	3.76 (0.43)	4.11 (0.53)	27.488	0.000***	(1,3) (2,3)
Intention[2]	3.38 (0.56)	3.94 (0.53)	4.71 (0.46)	210.775	0.000***	(1,2) (2,3) (1,3)

*** Significance level <0.001.
[1] On the 5 Likert-Scale (1 = Strongly agree to 5 = strongly disagree).
[2] On the 5 Likert-Scale (1 = Strongly disagree to 5 = strongly agree).
[a] Mean score.
[b] Standard deviation.

Table 12. Cross-table of demographic characteristics distribution between segments.

Demographic Characteristics		Segments			Total
		Resource-Limited	Resource-Capable	Value-Optimistic	
Gender	Male	40	57	32	129
	Female	81	93	48	222
Total		121	150	80	351
Age	<17	4	1	1	6
	17−25	68	91	42	201
	26−40	40	39	29	108
	41−55	7	15	5	27
	Over 55	2	4	3	9
Total		121	150	80	351
Education Background	Senior High-School	42	42	24	108
	Bachelor	71	96	50	217
	Master	7	12	6	25
	Doctor	1	0	0	1
Total		121	150	80	**351**
Occupation	Student	35	47	22	104
	Civil Servant/Police/Army	6	8	4	18
	Employee	56	52	30	138
	Entrepreneur	11	13	7	31
	Housewife	4	8	5	17
	Other	9	22	12	43
Total		121	150	80	351
Income (IDR Million/ month)	<2	54	70	33	157
	2 to <4	34	35	18	87
	4 to <6	12	22	14	48
	6 to <8	4	11	4	19
	8 to <10	2	4	3	9
	≥10	15	8	8	31
Total		121	150	80	351

would engage potential passengers' perspectives on AFs, which influences the adoption of AFs.

Moreover, the results of ANOVA (Table 11) revealed how the Resource-Limited segment has concerns about risk perception. A study by Rundmo et al. [79] noted that risk plays a crucial role in determining people's choices regarding transportation modes. It defines the safety concerns of this segment group when choosing AFs as a future transportation mode. In contrast, the other two segments showed an interest in using AFs that outweighed their risk perception. Therefore, the Resource-Capable and Value-Optimistic segment groups are the most likely users of AFs.

This research offers a marketing strategy and organisational resources to comprehend and evaluate the characteristics of segment groups. This will assist stakeholders and ferry companies in effectively targeting potential AF passengers and raising awareness of the benefits of AFs. Consequently, it is imperative to differentiate between segmented groups in the promotional strategy to initially heighten their awareness of the value of AFs when targeting potential AF passengers [80].

Furthermore, the characteristics of the segmented groups should be considered when formulating such a promotional strategy to engage people's awareness of AFs. For instance, PBC is the dominant factor in the Resource-Capable segment, which accounts for self-control toward a behaviour. PBC considers the knowledge and resources required to self-assess the capability to use AFs. In this study, self-efficacy to the knowledge, cost, and opportunity to use AFs are the key factors that form characteristics in the Resource-Capable segment's group. Tian et al. [81] also found that people are concerned about vehicle availability and access time when considering shared AVs. In addition, the lack of observation and trials can also lead to disengagement stages in the market penetration of AFs [81].

Therefore, organisational resources such as public relations and marketing teams should focus on educational campaigns and demonstration events to emphasise practical knowledge and promote the convenience of using AFs, which is important in aligning their preference for self-directed choices. Additionally, offering incentives can further motivate this group [84].

In contrast, the Value-Optimistic group requires a unique approach that places a significant emphasis on attitudes and is subsequently influenced by subjective norms. Given that the majority of this

group's members possess a high level of education, it is imperative to tailor promotional strategies effectively. This can be achieved by concentrating on educational campaigns that underscore the advantages of reduced travel time, minimised environmental impact, and enhanced safety through advanced technology [82].

Additionally, leveraging social media, digital marketing, and influencer collaborations as a form of community engagement can be instrumental in conveying the positive impact of using AVs and increasing awareness. Online social media holds immense potential as a primary channel for raising awareness and serving as a public education platform for disseminating accurate and trustworthy information about autonomous vehicle-related technology to the public, particularly younger audiences [83]. Moreover, social networks, including family members, close friends, and peer groups can play a persuasive role in encouraging the potential adoption of AF solutions [84].

Theoretically, this research has contributed to enriching knowledge about the assessment of AVs, especially in the ferry market. This research expands the implementation of TPB as a psychological theory that was applied as the catalyst to identify potential market segmentation in AFs. The current study uses TPB as the factor that underlies psychographic segmentation. This study also contributes to the AV field in terms of consumer perspective; usually, AV studies are concerned with technology development.

Lastly, this research has some limitations regarding geographical and demographic perspectives. Indonesia was chosen for this study's sample as it is surrounded by many islands, and the ferry is a required mode of public transportation. Furthermore, the participants primarily consist of the younger demographic with modest incomes, making them more inclined to adopt new technologies at an affordable cost. Thus, future research could be applied to other countries and targeted to broaden respondents' characteristics to enrich the literature on AF studies.

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References

[1] Rolls-Royce. Autonomous ships: The next step. In: AAWA position paper. London: Rolls Royce Plc; 2016.

[2] Laurinen M. Remote and autonomous ships: The next steps. AAWA: Advanced autonomous waterborne applications. London: Rolls Royce Plc; 2016. Retrieved from, http://www.rollsroyce.com/~/media/Files/R/Rolls-Royce/documents/customers/marine/ship-intel/aawawhitepaper-210616.pdf.

[3] Allal AA, Mansouri K, Youssfi M, Qbadou M. Toward energy saving and environmental protection by implementation of autonomous ship, 2018. In: 19th IEEE Mediterranean Electrotechnical Conference (MELECON). Marrakech, Morocco: IEEE; 2018. https://doi.org/10.1109/MELCON.2018.8379089.

[4] Levander O. Autonomous ships on the high seas. IEEE Spectr 2017;54:26–31. https://doi.org/10.1109/MSPEC.2017.7833502.

[5] MUNIN. The Autonomous Ship | MUNIN n.d. http://www.unmanned-ship.org/munin/about/the-autonomus-ship/ (accessed December 13, 2019).

[6] Tvete HA. Unmanned Vessels – The DNV GL "REVOLT" Project – DNV GL. 2015. https://iumi.com/images/Berlin2015/3Pressies/1609_HansAntonTvete.pdf. [Accessed 21 January 2024].

[7] Schuler M. Yara Debuts Yara Birkeland, the World's First Autonomous and Emission-Free Containership. 2021. https://gcaptain.com/yara-birkeland-worlds-first-autonomous-zero-emission-ship/. [Accessed 21 January 2024].

[8] The Nippon Foundation, Mitsubishi Heavy Industries Ltd, Shin Nihonkai Ferry Co., Ltd. MEGURI 2040 Fully Autonomous Ship Program Successful Demonstration Test of World's First Fully Autonomous Ship Navigation Systems on Coastal Ferry in Northern Kyushu – Successful fully autonomous navigation of large, high-speed ferry expected to improve safety. 2022. https://www.mhi.com/news/220117.html. [Accessed 7 September 2023].

[9] IMO. Autonomous shipping. London: IMO; 2019. http://www.imo.org/en/MediaCentre/HotTopics/Pages/Autonomous-shipping.aspx. [Accessed 13 December 2019].

[10] Burmeister H-C, Bruhn WC, Rødseth ØJ, Porathe T. Can unmanned ships improve navigational safety?. In: Proceedings of the Transport Research Arena, TRA 2014; April 2014; Paris. Paris: Institut Francais des Sciences et Technologies des Transports; 2014. p. 14–7.

[11] Behrens C, Pels E. Intermodal competition in the London-Paris passenger market: High-Speed Rail and air transport. J Urban Econ 2012;71:278–88. https://doi.org/10.1016/j.jue.2011.12.005.

[12] Xiao J, Goulias KG. How public interest and concerns about autonomous vehicles change over time: A study of repeated cross-sectional travel survey data of the Puget Sound Region in the Northwest United States. Transport Res C Emerg Technol 2021:133. https://doi.org/10.1016/J.TRC.2021.103446.

[13] Hult GTM, Hurley RF, Knight GA. Innovativeness: Its antecedents and impact on business performance. Ind Market Manag 2004;33:429–38.

[14] Haustein S, Thorhauge M, Cherchi E. Commuters' attitudes and norms related to travel time and punctuality: A psychographic segmentation to reduce congestion. Travel Behav Soc 2018;12:41–50. https://doi.org/10.1016/j.tbs.2018.04.001.

[15] dos Reis RA, Grant-Muller S, Lovelace R, Hodgson F. Different people, different incentives? Examining the public acceptance of smartphone-based persuasive strategies for sustainable travel using psychographic segmentation. Int J Sustain Transp 2022;16:1–21. https://doi.org/10.1080/15568318.2020.1836693.

[16] Sarli A, Tat HH. The role of psychographic for distinguishing main categories of consumers based on lifestyle, personality and value variables. Int J Eco Res 2011:2229–6158.

[17] Ajzen Icek, Ajzen I. From intentions to actions: A theory of planned behavior. Action Control 1985:11–39.

[18] Ajzen I. The theory of planned behavior. Organ Behav Hum Decis Process 1991;50:179–211. https://doi.org/10.1016/0749-5978(91)90020-T.

[19] Fishbein M, Ajzen I. Predicting and understanding consumer behavior: Attitude-behavior correspondence. In: Ajzen I, Fishbein M, editors. Understanding Attitudes and Predicting

Social Behavior. Englewood Cliffs, NJ: Prentice Hall; 1975. p. 148−72.
[20] Schuster L, Kubacki K, Rundle-Thiele S. A theoretical approach to segmenting children's walking behaviour. Young Consum 2015;16:159−71. https://doi.org/10.1108/YC-07-2014-00461.
[21] Donald IJ, Cooper SR, Conchie SM. An extended theory of planned behaviour model of the psychological factors affecting commuters' transport mode use. J Environ Psychol 2014;40:39−48. https://doi.org/10.1016/j.jenvp.2014.03.003.
[22] Yuen KF, Chua G, Wang X, Ma F, Li KX. Understanding public acceptance of autonomous vehicles using the theory of planned behaviour. Int J Environ Res Publ Health 2020;17:1−19. https://doi.org/10.3390/ijerph17124419.
[23] Jain T, Rose G, Johnson M. "Don't you want the dream?": Psycho-social determinants of car share adoption. Transport Res F Traffic Psychol Behav 2021;78:226−45. https://doi.org/10.1016/j.trf.2021.02.008.
[24] Smith WR. Product Differentiation and Market Segmentation as Alternative Marketing Strategies. J Market 1956;21:3−8. https://doi.org/10.1177/002224295602100102.
[25] Kotler P, Armstrong GM. Principles of marketing. 14th ed. Hoboken, New Jersey, U.S.: Prentice Hall; 2011.
[26] Bass FM, Tigert DJ, Lonsdale RT. Market Segmentation: Group versus Individual Behavior. J Market Res 1968;5:264. https://doi.org/10.2307/3150342.
[27] Wedel M, Kamakura WA. Market segmentation: Conceptual and methodological foundations. New York, NY: Springer Science & Business Media; 2000.
[28] Haustein S, Hunecke M. Identifying target groups for environmentally sustainable transport: Assessment of different segmentation approaches. Curr Opin Environ Sustain 2013;5:197−204. https://doi.org/10.1016/j.cosust.2013.04.009.
[29] Mohamed M, Higgins C, Ferguson M, Kanaroglou P. Identifying and characterizing potential electric vehicle adopters in Canada: A two-stage modelling approach. Transport Pol 2016;52:100−12. https://doi.org/10.1016/j.tranpol.2016.07.006.
[30] Mahmoud MM, Hine J, Kashyap A. Segmentation analysis of users' preferences towards bus service quality. Strategies 2012;9:15.
[31] Anable J. "Complacent Car Addicts"; or "Aspiring Environmentalists"? Identifying travel behaviour segments using attitude theory. Transport Pol 2005;12:65−78. https://doi.org/10.1016/j.tranpol.2004.11.004.
[32] Kizielewicz J, Haahti A, Luković T, Gračan D. The segmentation of the demand for ferry travel − a case study of Stena Line. Economic Research-Ekonomska Istrazivanja 2017;30:1003−20. https://doi.org/10.1080/1331677X.2017.1314789.
[33] Cheng G, Zhao S, Li J. The effects of latent attitudinal variables and sociodemographic differences on travel behavior in two small, underdeveloped cities in China. Sustainability 2019;11. https://doi.org/10.3390/su11051306.
[34] Morton C, Anable J, Nelson JD. Consumer structure in the emerging market for electric vehicles: Identifying market segments using cluster analysis. Int J Sustain Transp 2017;11:443−59. https://doi.org/10.1080/15568318.2016.1266533.
[35] Abotalebi E, Mahmoud M, Ferguson M, Kanaroglou PS. Utilizing stated preference in electric vehicle research; evidence from the literature. In: Proceedings of the 50th Annual Canadian Transport Research Forum Conference, Montreal; 2015. p. 1−19.
[36] Anable J, Skippon S, Schuitema G, Kinnear N. Who will adopt electric vehicles?: A segmentation approach of UK consumers. European Council for an Energy Efficient Economy; 2011.
[37] Hidrue MK, Parsons GR, Kempton W, Gardner MP. Willingness to pay for electric vehicles and their attributes. Resour Energy Econ 2011;33:686−705. https://doi.org/10.1016/j.reseneeco.2011.02.002.
[38] Plötz P, Schneider U, Globisch J, Dütschke E. Who will buy electric vehicles? Identifying early adopters in Germany. Transport Res Part A Policy Pract 2014;67:96−109. https://doi.org/10.1016/j.tra.2014.06.006.
[39] Hunecke M, Haustein S, Böhler S, Grischkat S. Attitude-based target groups to reduce the ecological impact of daily mobility behavior. Environ Behav 2010;42:3−43. https://doi.org/10.1177/0013916508319587.
[40] Brand C, Schwanen T, Anable J. 'Online Omnivores' or 'Willing but struggling'? Identifying online grocery shopping behavior segments using attitude theory. J Retailing Consum Serv 2020;57:102195. https://doi.org/10.1016/j.jretconser.2020.102195.
[41] Tkaczynski A. Segmentation Using Two-Step Cluster Analysis. In: Dietrich T, Rundle-Thiele S, Kubacki K, editors. Segmentation in social marketing. Singapore: Springer Singapore; 2017. p. 109−25. https://doi.org/10.1007/978-981-10-1835-0_8.
[42] Ajzen I. The theory of planned behavior. Organ Behav Hum Decis Process 1991;50:438−59. https://doi.org/10.4135/9781446249215.n22.
[43] Ajzen I, Fishbein M, Heilbroner RL. Understanding attitudes and predicting social behavior, vol. 278. Englewood Cliffs, NJ: Prentice-hall; 1980.
[44] Beirão G, Cabral JS. Market segmentation analysis using attitudes toward transportation exploring the differences between men and women. Transport Res Rec 2008:56−64. https://doi.org/10.3141/2067-07.
[45] Fu X, Juan Z. Transit commuting market investigation using the latent segmentation approach. Travel Behav Soc 2015;2:102−8. https://doi.org/10.1016/j.tbs.2014.11.001.
[46] Sally D. Changing Times for Social Marketing Segmentation. In: Timo D, Rundle-Thiele S, Kubacki K, editors. Segmentation in Social Marketing: Process, Methods and Application. Singapore: Springer; 2016. p. 41−60. https://doi.org/10.1007/978-981-10-1835-0_8.
[47] Gkartzonikas C. A Stated Preference Study for Assessing Public Acceptance Towards Autonomous Vehicles. West Lafayette, Indiana: Purdue University Graduate School of Civil Engineering Department, Ph.D. Thesis; 2020.
[48] Losada-Rojas LL, Gkritza K. Individual and location-based characteristics associated with Autonomous Vehicle adoption in the Chicago metropolitan area: Implications for public health. J Transport Health 2021;22:101232. https://doi.org/10.1016/j.jth.2021.101232.
[49] Yuen KF, Cai L, Qi G, Wang X. Factors influencing autonomous vehicle adoption: an application of the technology acceptance model and innovation diffusion theory. Technol Anal Strateg Manag 2020;33:505−19. https://doi.org/10.1080/09537325.2020.1826423.
[50] Chikaraishi M, Khan D, Yasuda B, Fujiwara A. Risk perception and social acceptability of autonomous vehicles: A case study in Hiroshima, Japan. Transp Policy 2020. https://doi.org/10.1016/j.tranpol.2020.05.014.
[51] Liu P, Yang R, Xu Z. Public Acceptance of Fully Automated Driving: Effects of Social Trust and Risk/Benefit Perceptions. Risk Anal 2019;39:326−41. https://doi.org/10.1111/risa.13143.
[52] Patel RK, Etminani-Ghasrodashti R, Kermanshachi S, Rosenberger JM, Foss A. Exploring willingness to use shared autonomous vehicles. Int J Transport Sci Technol 2022. https://doi.org/10.1016/j.ijtst.2022.06.008.
[53] Hulse LM, Xie H, Galea ER. Perceptions of autonomous vehicles: Relationships with road users, risk, gender and age. Saf Sci 2018;102:1−13. https://doi.org/10.1016/j.ssci.2017.10.001.
[54] Dholakia UM. A motivational process model of product involvement and consumer risk perception. Eur J Market 2001;35:1340−62. https://doi.org/10.1108/EUM0000000006479.
[55] Hirunyawipada T, Paswan AK. Consumer innovativeness and perceived risk: implications for high technology product adoption. J Consum Market 2006;23:182−98. https://doi.org/10.1108/07363760610674310.
[56] Wang S, Fan J, Zhao D, Yang S, Fu Y. Predicting consumers' intention to adopt hybrid electric vehicles: using an extended version of the theory of planned behavior model. Transportation 2016;43:123−43. https://doi.org/10.1007/s11116-014-9567-9.
[57] Goerlandt F. Maritime Autonomous Surface Ships from a risk governance perspective: Interpretation and implications.

Saf Sci 2020;128:104758. https://doi.org/10.1016/j.ssci.2020.104758.
[58] Choi JK, Ji YG. Investigating the Importance of Trust on Adopting an Autonomous Vehicle. Int J Hum Comput Interact 2015;31:692–702. https://doi.org/10.1080/10447318.2015.1070549.
[59] Nishihori Y, Kimura K, Taniguchi A, Morikawa T. What Affects Social Acceptance and Use Intention for Autonomous Vehicles –Benefits, Risk Perception, or Experience? -Meta-Analysis in Japan-. Int J Intell Transport Sys Res 2020;18:22–34. https://doi.org/10.1007/s13177-018-0170-x.
[60] Elias W, Shiftan Y. The influence of individual's risk perception and attitudes on travel behavior. Transport Res Part A Policy Pract 2012;46:1241–51. https://doi.org/10.1016/j.tra.2012.05.013.
[61] Osburg V-S, Yoganathan V, Kunz WH, Tarba S. Can (A)I Give You a Ride? Development and Validation of the CRUISE Framework for Autonomous Vehicle Services. J Serv Res 2022;25:630–48. https://doi.org/10.1177/10946705221118233.
[62] Conner M, Norman P. Understanding the intention-behavior gap: The role of intention strength. Front Psychol 2022;13. https://doi.org/10.3389/fpsyg.2022.923464.
[63] Şimşekoğlu Ö, Nordfjærn T, Rundmo T. The role of attitudes, transport priorities, and car use habit for travel mode use and intentions to use public transportation in an urban Norwegian public. Transport Pol 2015;42:113–20. https://doi.org/10.1016/j.tranpol.2015.05.019.
[64] Sun Y, Bhattacherjee A, Ma Q. Extending technology usage to work settings: The role of perceived work compatibility in ERP implementation. Inf Manag 2009;46:351–6. https://doi.org/10.1016/j.im.2009.06.003.
[65] Liao Y, Guo H, Liu X. A Study of Young People's Intention to Use Shared Autonomous Vehicles: A Quantitative Analysis Model Based on the Extended TPB-TAM. Sustainability 2023;15:11825. https://doi.org/10.3390/su151511825.
[66] Jing P, Huang H, Ran B, Zhan F, Shi Y. Exploring the factors affecting mode choice intention of autonomous vehicle based on an extended theory of planned behavior-A case study in China. Sustainability 2019;11:1–20. https://doi.org/10.3390/su11041155.
[67] Venkatesh V, Morris MG, Davis GB, Davis FD. User Acceptance of Information Technology: Toward a Unified View. MIS Q 2003;27:425–78.
[68] Goerlandt F, Pulsifer K. An exploratory investigation of public perceptions towards autonomous urban ferries. Saf Sci 2022;145:105496. https://doi.org/10.1016/j.ssci.2021.105496.
[69] Shang KC, Lu CS, Li S. A taxonomy of green supply chain management capability among electronics-related manufacturing firms in Taiwan. J Environ Manag 2010;91:1218–26. https://doi.org/10.1016/j.jenvman.2010.01.016.
[70] Stewart DW. The Application and Misapplication of Factor Analysis in Marketing Research. J Market Res 1981;18:51. https://doi.org/10.2307/3151313.
[71] Lu CS. Market segment evaluation and international distribution centers. Transp Res E Logist Transp Rev 2003;39:49–60. https://doi.org/10.1016/S1366-5545(02)00022-4.
[72] Guo Y, Peeta S, Mannering F. Rail-truck multimodal freight collaboration: a statistical analysis of freight-shipper perspectives. Transport Plann Technol 2016;39:484–506.
[73] Hair JF, Black WC, Babin BJ, Anderson RE. Multivariate data analysis. Harlow, England: Pearson; 2014.
[74] Ketchen DJ, Shook CL. The Application of Cluster Analysis in Strategic Management Research: An Analysis and Critique. Strat Manag J 1996;17:441–58.
[75] Li Z, Wang W, Yang C, Ragland DR. Bicycle commuting market analysis using attitudinal market segmentation approach. Transport Res Part A Policy Pract 2013;47:56–68. https://doi.org/10.1016/j.tra.2012.10.017.
[76] Wang S, Wang J, Lin S, Li J. Public perceptions and acceptance of nuclear energy in China: The role of public knowledge, perceived benefit, perceived risk and public engagement. Energy Pol 2019;126:352–60. https://doi.org/10.1016/j.enpol.2018.11.040.
[77] Cliff N. The Eigenvalues-Greater-Than-One Rule and the Reliability of Components. Psychol Bull 1988;103:276–9. https://doi.org/10.1037/0033-2909.103.2.276.
[78] Abrahamse W. Encouraging sustainable transport choices. Encouraging pro-environmental behaviour. Elsevier; 2019. p. 97–109. https://doi.org/10.1016/b978-0-12-811359-2.00007-x.
[79] Rundmo T, Nordfjærn T, Iversen HH, Oltedal S, Jørgensen SH. The role of risk perception and other risk-related judgements in transportation mode use. Saf Sci 2011;49:226–35. https://doi.org/10.1016/j.ssci.2010.08.003.
[80] Hilgarter K, Granig P. Public perception of autonomous vehicles: A qualitative study based on interviews after riding an autonomous shuttle. Transport Res F Traffic Psychol Behav 2020;72:226–43. https://doi.org/10.1016/j.trf.2020.05.012.
[81] Wang X, Wong YD, Li KX, Yuen KF. This is not me! Technology-identity concerns in consumers' acceptance of autonomous vehicle technology. Transport Res F Traffic Psychol Behav 2020;74:345–60. https://doi.org/10.1016/j.trf.2020.06.005.
[82] Patel RK, Etminani-Ghasrodashti R, Kermanshachi S, Rosenberger JM, Pamidimukkala A, Foss A. Identifying individuals' perceptions, attitudes, preferences, and concerns of shared autonomous vehicles: During- and post-implementation evidence. Transp Res Interdiscip Perspect 2023;18:100785. https://doi.org/10.1016/j.trip.2023.100785.
[83] Ding Y, Korolov R, (Al) Wallace W, Wang X, (Cara). How are sentiments on autonomous vehicles influenced? An analysis using Twitter feeds. Transport Res C Emerg Technol 2021:131. https://doi.org/10.1016/j.trc.2021.103356.
[84] Jaiswal D, Deshmukh AK, Thaichon P. Who will adopt electric vehicles? Segmenting and exemplifying potential buyer heterogeneity and forthcoming research. J Retailing Consum Serv 2022;67. https://doi.org/10.1016/j.jretconser.2022.102969.