International Journal of E-Services and Mobile Applications
Volume 16 • Issue 1 • January-December 2024

The Moderating Role of Gender and Driving Experience Duration on Drivers' Acceptance of Mobile Navigation Applications

Meltem Canoglu
https://orcid.org/0000-0001-7712-1650
Osmaniye Korkut Ata University, Turkey

Sefa Üstüner
https://orcid.org/0000-0003-1231-5694
Kayseri University, Turkey

Gülhan Yenilmez
https://orcid.org/0000-0002-6570-6448
Osmaniye Korkut Ata University, Turkey

ABSTRACT

Applications for mobile navigation are increasingly used in vehicles as their technology foundation improves. The purpose of this study is to evaluate the factors that affect drivers when they make use of mobile navigation programs in their cars as well as the factors that moderate the impact of driving experience duration and gender on the acceptability of making use of these applications. The study's data was collected through an online survey created using Google Forms. The study was completed by 400 individuals. The study concluded that drivers' perceptions of the utility and usability of mobile navigation applications are significantly influenced by extrinsic variables (e.g., sense of direction, perception of distraction, and propensity to use navigation applications). Another finding was that there were some linear correlations between the variables of gender and driving duration and the influence of outside forces on drivers' approval of using mobile navigation applications.

KEYWORDS

Mobile Navigation Applications, Technology Acceptance Model, Gender, Driving Experience Duration

INTRODUCTION

Navigation applications that leverage global positioning system technology, such as Google Maps and Komoot, and advanced driver assistance systems have become integral to our daily routines. These systems incorporate various technologies to enhance safety, efficiency, and driving comfort, and they are widely utilized across diverse sectors (Chengula et al., 2024; Voinea et al., 2020; Y.-Y. Wang et al., 2018). Given the prevalence of smartphones, it is no surprise that many drivers opt for free navigation apps, which are thought to improve driving efficiency and effectiveness (L. Wang & Ju, 2015). Compared to in-car navigation systems, mobile applications offer distinctive features, such as smaller screens and more frequent updates, making them particularly appealing to drivers (Min et al., 2019; Yang et al., 2021). These features, which include traffic information systems, speed limit

DOI: 10.4018/IJESMA.361580

This article published as an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/) which permits unrestricted use, distribution, and production in any medium, provided the author of the original work and original publication source are properly credited.

alerts, and voice assistance, contribute to a more comfortable and dependable driving experience (Tak & Gupta, 2021; Yang et al., 2021; Chengula et al., 2024). Research on mobile navigation applications is often situated within the technology acceptance model (TAM) framework, which helps explain variations in technology-related behaviors (Davis, 1989; Hernandez et al., 2010). Yang et al. (2021) incorporated drivers' sense of direction (SoD), proximity to the navigation program, perceived distractions, and TAM variables into their model to analyze drivers' intentions to use these applications.

The TAM has been critiqued for its limitations in explaining human behavior regarding the adoption of new technologies, which prompted the development of the unified theory of acceptance and use of technology. This theory incorporates additional moderating variables such as gender, age, and experience (Venkatesh et al., 2003; Yao et al., 2019). When reviewing the literature, it is evident that gender plays a moderating role in the relationship between external variables and the perceived usefulness (PU) and perceived ease of use (PEoU) central to the TAM. For instance, research shows that men use mobile phones more than women while driving (Ahlström, 2020; Vahdat et al., 2021).

Moreover, driving experience is critical in road traffic research (Jing et al., 2023). Musselwhite (2006) argues that inexperienced drivers struggle to detect and predict hazards and face increased driving risks. Li et al. (2015) further observed that less experienced drivers tend to be less aware of potential risks, are more prone to speeding, and are more likely to be involved in accidents than their more experienced counterparts. Similarly, Hussain and Shi (2021) found that distraction-related violations correlate significantly with motorcycle driving experience, noting that those with one to three years of experience are more likely to commit such violations than those with over 20 years of riding experience. Yuan et al. (2021) also highlighted that driver experience is linked to accident risk, revealing that the least experienced drivers exhibit the highest accident rates—approximately twice those of drivers with more than three years of experience.

Jing et al. (2023) indicated that experienced drivers might perceive certain driving behaviors, such as speeding, as less dangerous, diminishing their safety awareness. Their study found that driving experience moderates the relationship between risk preference, perception, and risky driving behaviors. In contrast, Ge et al. (2023) suggest that non-professional drivers rely more heavily on guidance and reminders from navigation applications, experiencing significantly more difficulty and a reduced sense of control than professional drivers. Due to work and time pressures, the researchers noted that professional drivers tend to check road conditions in advance, relying on the information provided and their prior knowledge of road conditions and planning their routes accordingly.

The literature review highlighted a paucity of studies that examined the moderating effects of driving experience and gender on the acceptance of mobile navigation applications (Ge et al., 2023; Jing et al., 2023). This study incorporated these two variables as moderating factors to address this gap and contribute to existing literature. The primary aim of this research is to investigate how drivers utilize mobile navigation applications in their vehicles and how these factors influence the acceptance of such applications. Additionally, the study seeks to assess the factors affecting drivers' usage of these tools and the moderating effects of the duration of driving experience and gender on the acceptance of these applications.

This research is organized into four sections. It begins with a review of relevant literature, followed by the hypotheses. The second and third sections detail the research methods and the analytical outcomes, while the fourth and final sections present the study's findings and suggestions for further research.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The TAM is a well-established framework that helps explain why users adopt information technology, focusing on how PU and PEoU shape user attitudes (AAs) and intentions (Davis, 1989; Min et al., 2019; Venkatesh & Davis, 2000). The TAM has been adapted to explore various technologies, including navigation systems. Researchers have examined factors such as personal innovativeness,

processing speed, location accuracy, and perceived mobility in the context of navigation tools (Chen & Chen, 2011; Gumasing et al., 2023; Park et al., 2012; Yang et al., 2021). Min et al. (2019) combined the TAM with diffusion of innovations theory to analyze the adoption of the Uber app. The positive correlation between AA, PU, and behavioral intention is consistently supported in the literature (Davis et al., 1989; Gumasing et al., 2023; Man et al., 2024; Park et al., 2015; Wasomi et al., 2021). As digital maps and mobile navigation applications become increasingly integral to daily life, understanding technology acceptance is essential for enhancing user engagement and the effectiveness of these tools (Taherdoost, 2018; Wasomi et al., 2021).

In today's fast-paced world, an ever-growing number of individuals rely on mobile navigation applications. To gain deeper insights into the acceptance of these applications, we propose an extended TAM that incorporates all dimensions suggested in the original model. This new approach investigates the factors influencing drivers' acceptance of mobile navigation applications, which aligns with existing TAM studies. The model introduces three additional external factors: SoD, predisposition to navigation applications (PNA), and perception of distraction (PoD). These factors relate to the navigation transmission medium, wayfinding guide, and information processing.

SoD, defined as an awareness of one's location or orientation, plays a crucial role in navigation. Research indicates that a strong SoD enhances one's ability to locate themselves and reduces navigational errors (Kozlowski & Bryant, 1977). In a study by Cornell et al. (2003), college students expressed the belief that a robust SoD aids in identifying one's position using natural environmental cues. Furthermore, SoD significantly affects orientation, which is the ability to navigate toward goals (Yang et al., 2021). Research has shown that SoD influences wayfinding, as evidenced by findings that it affects reaction delays in orientation tasks. Padgitt and Hund (2012) concluded that individuals with poor SoD commit more navigational errors. Navigational tools are designed to assist users with their SoD, making navigation more manageable. Despite its importance, SoD remains an underexplored factor in the context of navigation product acceptance. This has led to its incorporation as an additional dimension in the TAM (Yang et al., 2021).

The text presents the concept of PNA, which gauges the perceived significance of navigational tools in everyday life. PNA notably influences drivers' perceptions, atitudes, and intentions regarding the use of these applications (Ponchillia et al., 2020). Despite its relevance, limited research on navigation products explores the propensity to utilize navigation applications, leaving the relationship between predisposition and usage intention somewhat ambiguous. Yang et al. (2021) found that drivers' perceptions of mobile navigation applications—particularly their PU and PEoU—are significantly shaped by their inclinations to use them. This suggests that a driver's eagerness to engage with navigation applications may be influenced by their propensity for such tools. PNA has been incorporated as a new dimension in the original TAM to understand better how PNA affects drivers' perceptions, attitudes, and usage intentions.

The third new dimension introduced is PoD, which pertains to the users' beliefs about the effects of navigation applications on their auditory and visual attention, decision-making, and overall behavior. Although the increased use of navigational tools can enhance comfort for drivers, it also raises the risk of distraction and accidents (Morris et al., 2015). Distraction occurs when drivers divert their attention from the road to other tasks, impairing their judgment and elevating the likelihood of accidents (Hedlund et al., 2006). Research indicates that navigation applications frequently lead drivers to look away from the road, diminishing their focus on critical road information (Hernandez et al., 2010). Yang et al. (2021) also assert that PoD affects drivers' PU and PEoU and their AAs and intentions toward using mobile navigation applications.

STUDY AIM AND HYPOTHESIS

In this research, we introduce a new dimension to the TAM, termed PoD, to examine the impact of distraction perception on drivers' AAs, perceptions, and intentions regarding their use of

technology. Figure 1 illustrates the revised TAM model proposed in this study. We explore how factors such as gender and the duration of driving experience moderate the effects of critical variables on drivers' adoption of mobile navigation applications. Additionally, we investigate the interrelations of these concepts within a theoretical framework. The findings of this research aim to enhance our understanding of how individuals utilize mobile navigation applications, ultimately informing the optimization of their design and the enhancement of their service quality. Our inquiry is based on the following hypotheses:

- **Hypothesis 1 (H1)**: Extrinsic effects have a statistically significant impact on PU within the context of drivers' acceptance of mobile navigation applications.
- **Hypothesis 2 (H2)**: Extrinsic effects have a statistically significant impact on PEoU within the context of drivers' acceptance of mobile navigation applications.
- **Hypothesis 3 (H3)**: PU has a statistically significant impact on AA within the context of drivers' acceptance of mobile navigation applications.
- **Hypothesis 4 (H4)**: PEoU has a statistically significant impact on AA within the scope of drivers' acceptance of mobile navigation applications.
- **Hypothesis 5 (H5)**: Drivers' AAs towards mobile navigation applications have a statistically significant impact on intention to reuse (ITR).
- **Hypothesis 6 (H6)**: Gender has a moderating role in the impact of extrinsic effects on PU and PEoU.
- **Hypothesis 7 (H7)**: Driving experience duration has a moderating role in the impact of extrinsic effects on PU and PEoU.

METHOD

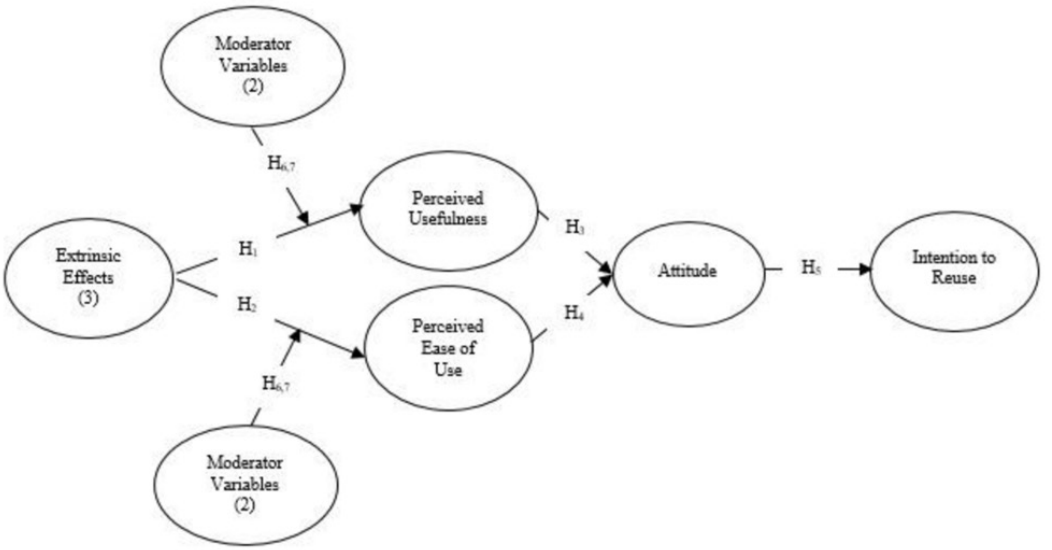
The rise in smartphone usage and technological advancements has significantly boosted the demand for free mobile navigation applications. Modern drivers now have access to abundant information made possible by advancements in positioning, geographic information, and communication technologies (Ahlström et al., 2020). To facilitate the growth of mobile navigation applications, examining the factors influencing users' willingness to download them is crucial. Consequently, our study contributes to the existing literature on this topic (Ahlström et al., 2020; Chuang, 2020; Min et al., 2019; Ponchillia et al., 2020; Shaaban, 2019; Tak & Gupta, 2021; L. Wang & Ju, 2015; Y.-Y. Wang et al., 2018; Yang et al., 2021) by proposing that variations in the adoption of mobile navigation applications may arise based on factors such as gender and driving experience duration.

Our research aims to evaluate the linear relationships between external variables (such as PNA, PoD, and SoD) and dimensions of the TAM, specifically PEoU, usefulness, and AA. Additionally, we explore the correlations among extrinsic influences, PU, and PEoU as well as the moderating effects of gender and driving experience duration. Figure 1 presents the conceptual model for our study, developed based on insights from the research conducted by Yang et al. (2021) and Hegarty et al. (2002).

Sample and Data Selection

Given the constraints of time and cost in data collection, as well as the expansive geographical area of Adana, we selected this city as our study location. This decision highlights the significant issue of traffic congestion and the substantial demand for mobile navigation applications. Additionally, Adana's diverse demographics provide an excellent context for investigating the use of mobile navigation among drivers with varying genders and experience levels. The city's high technological adoption rate further supports exploring the factors influencing the utilization of these applications.

Figure 1. Conceptual model of the research



The primary population for this research consists of 1,797,186 residents from the districts of Seyhan, Sarıçam, Çukurova, and Yüreğir in the Adana city center. Due to the unavailability of data regarding the total number of licensed drivers in Adana, we employed a convenience sampling technique for our study. In the absence of information on the average characteristics of our primary sample, we calculated the necessary sample size using a 95% confidence interval, a 5% margin of error, and a population ratio of 0.50, ultimately establishing a minimum sample size of 384 (Worcester & Downham, 1986). Given the impracticality of reaching the entire population due to time and cost limitations, we conducted an online survey using Google Forms involving 400 participants. In the initial section of the survey, we asked participants if they held a driver's license, allowing only those who answered "yes" to proceed. Data collection occurred over one month, from May 25, 2022, to June 25, 2022. After excluding nine incomplete or inaccurate responses, we were left with 391 valid questionnaires for our analysis.

Measurement Item

Initially, demographic and personal information was collected, including years of licensing, active driving experience, place of birth, and residence in Adana, to ensure the sample's relevance. The second section of the survey focused on extrinsic effects and factors related to the TAM. PNA and PoD were assessed through nine statements derived from Yang et al. (2021), while SoD consisted of 14 statements based on Hegarty et al. (2002). The TAM factors—PEoU, PU, AA, and ITR—were evaluated through 18 statements from Yang et al. (2021). The survey comprised 48 statements on a five-point Likert scale. Information about the survey items can be found in the Appendix.

Data Analysis and Results

The Cronbach's alpha was calculated to evaluate the internal reliability of the assumptions derived from the study's factors. Exploratory factor analysis determined whether each research statement aligned with the predicted factors. The validity and reliability of the research model were examined through confirmatory factor analysis. Additionally, the study's hypotheses were tested using the structural equation model (SEM). To assess the moderating effects of driving experience duration and gender, Hayes's (2013) PROCESS Model 1 was utilized. The analysis was conducted

Table 1. Reliability and validity results of the research model

	CR	AVE	PNA	PoD	SoD	PEoU	PU	AA	ITR
PNA	0.868	0.625	**(0.791)**						
PoD	0.868	0.569	0.140	**(0.754)**					
SoD	0.730	0.505	-0.208*	-0.016	**(0.710)**				
PEoU	0.839	0.569	0.090	-0.118*	0.330*	**(0.754)**			
PU	0.834	0.626	0.384*	-0.072	0.085	0.535*	**(0.791)**		
AA	0.846	0.578	0.399*	-0.055	0.177*	0.612*	0.729*	**(0.760)**	
ITR	0.873	0.697	0.367*	-0.003	0.159*	0.546*	0.627*	0.704*	**(0.835)**

Note. *P < 0.05; the values in parentheses are the square root values of the variance explained by each factor.

using AMOS (Analysis of Moment Structures) 26.0 and SPSS (Statistical Package for the Social Sciences) 25.0 software.

Sample Characteristics

Males comprised 58.3% of the participants. The majority of participants were primarily aged between 18 to 30 years (44.8%) and 31 to 40 years (39.1%), with most being undergraduates (58.1%). A significant portion of the participants was born in Adana (54%), and the same amount had lived there for an average of approximately 19 years. Additionally, participants had held a driver's license for an average of 10.5 years and had been actively driving for around eight years.

Assessment of Measurement Model

Reliability refers to the internal consistency of a questionnaire and how accurately it represents the researched subject. The Cronbach's alpha coefficient was calculated for each factor, with a reliability threshold set at 0.70 (Hair et al., 2009). The factors examined included PNA ($\alpha = 0.866$), PoD ($\alpha = 0.868$), SoD ($\alpha = 0.713$), PEoU ($\alpha = 0.825$), PU ($\alpha = 0.826$), AA ($\alpha = 0.845$), and ITR ($\alpha = 0.869$). All of these factors exceeded the threshold. Additionally, Harman's single-factor analysis was performed, showing that the variance explained by each factor was below 50%. This indicates no standard method bias (Fuller et al., 2016). Table 1 shows the realiability and validity results of the research model.

Reliability in research refers to the degree to which a research model is utilized in repeated studies, yielding consistent results. In contrast, validity pertains to the accuracy with which the scale measures the intended structural concept within any given analysis. To ensure the measurement structure is valid, the factors within the research model must demonstrate discriminant validity (Hair et al., 2009). Table 1 presents the square root of the variance explained by each factor in the model under investigation and their respective correlation coefficients. To assess the precision of the measurement model, it is essential that the computed reliability levels for the factors exceed 0.70 and the variance explained by each component surpasses 0.50 (Hair et al., 2009). Additionally, Table 1 displays the estimated composite reliability and average variance extracted values for each component, as determined through confirmatory factor analysis.

The reliability and validity study of the research model, as presented in Table 1, indicates that the composite reliability levels for each factor in the measurement model exceed 0.70 and the average variance extracted for each factor is more significant than 0.50. This suggests that there are no multi-collinearity issues among the factors. Additionally, since the square root of the variance explained by each factor is greater than the correlation coefficients between the other factors, it confirms that

Table 2. Fit index results of the confirmatory factor analysis

	Excellent Levels of Goodness of Fit Measures	Acceptable Levels of Goodness of Fit Measures	(N= 391)
Chi-Square (χ2)	Low (χ2) Value	Low (χ2) Value	850.648
Degrees of Freedom (df)	------	------	363
Significance Level (P)	>0.05	>0.05	0.000
Adjusted Chi-Square (χ2) / (df)	1-3	3-5	2.343
Goodness of Fit Index (GFI)	≥0.90	≥0.85	0.875
Adjusted Goodness of Fit Index (AGFI)	≥0.90	≥0.85	0.860
Root Mean Square Error of Approximation (RMSEA)	<0.05	<0.08	0.059
Tucker Levis Index (TLI)	≥0.95	≥0.90	0.904
Increased Fit Index (IFI)	≥0.95	≥0.90	0.921
Comparative Fit Index (CFI)	≥0.97	≥0.90	0.920

the factors possess discriminant validity. Therefore, it can be concluded that the measurement model utilized in the analyses to assess the study hypotheses is both valid and reliable.

Model Fit

In scientific research, confirmatory factor analysis is employed to develop measurement scales, assess the validity of the research, and verify the accuracy of a predefined structure (Tabachnick & Fidell, 2013). This study utilized confirmatory factor analysis to evaluate the accuracy and validity of a model adapted from the frameworks previously established by Yang et al. (2021) and Hegarty et al. (2002). The fit indices derived from the confirmatory factor analysis and their acceptable thresholds are presented in Table 2.

The chi-square (χ^2) value, determined to be 850.648 with 363 degrees of freedom, indicated statistical significance based on the fit indices presented in Table 2. Given that the chi-square value was statistically significant, we can conclude that the proposed model is inappropriate for the data analyzed. To assess the adequacy of the suggested model, we examined the degree-of-freedom-to-adjusted chi-square (χ^2) value, along with other goodness-of-fit indices detailed in Table 2 and the standardized residual covariance matrix values. The confirmatory factor analysis results demonstrated that the proposed research model aligns well with the data.

Test of Hypotheses

The assumptions of the study model and the reciprocal linear interactions among the various structures were analyzed using the SEM. The moderating effects of gender and the duration of driving experience were evaluated using the PROCESS Model 1. Since the duration of driving experience—one of the research's moderating variables—was measured through an open-ended question, drivers were categorized into two groups: inexperienced and experienced—this classification aimed to enhance the clarity and interpretation of the analysis results. In a similar study, Yao et al. (2019) established a threshold of three years to differentiate between inexperienced and experienced drivers. Accordingly, in this study, those actively driving for three years or less were classified as "inexperienced," while drivers with more than three years of experience were deemed "experienced."

Table 3 presents the results of the t-tests for independence and hypotheses testing alongside the estimated parameters, standardized regression coefficients, standard errors, squared correlation coefficient, and t-statistics used to assess whether the coefficients significantly differ from zero.

Table 3. Hypotheses results

Hypotheses	Hypothesis Diagram			SRC	SE	T-value	R^2	Hypothesis Results
Structural Equation Model Results								
H_1	PNA	PU		0.497*	0.053	8.062	0.318	Accepted
	PoD	PU		-0.116*	0.046	-2.179		Accepted
	SoD	PU		0.239*	0.068	4.091		Accepted
H_2	PNA	PEoU		0.216*	0.050	4.022	0.212	Accepted
	PoD	PEoU		-0.145*	0.050	-2.695		Accepted
	SoD	PEoU		0.380*	0.080	5.595		Accepted
H_3	PU	AA		0.702*	0.058	10.088	0.705	Accepted
H_4	PEoU	AA		0.334*	0.040	6.481		Accepted
H_5	AA	ITR		0.830*	0.074	12.613	0.689	Accepted
Hayes Process Macro Model 1 Results								
H_6	PNA	Gender	PU	-0.106	0.082	-1.2935		Rejected
	PoD	Gender	PU	-0.232*	0.084	-2.7556		Accepted
	SoD	Gender	PU	-0.158	0.170	-0.9295		Rejected
	PNA	Gender	PEoU	-0.105	0.080	-1.3072		Rejected
	PoD	Gender	PEoU	-0.152*	0.079	-1.9315		Accepted
	SoD	Gender	PEoU	-0.231*	0.117	-1.9774		Accepted
H_7	PNA	DT	PU	-0.233*	0.086	-2.7257		Accepted
	PoD	DT	PU	-0.021	0.085	-0.2536		Rejected
	SoD	DT	PU	-0.380*	0.130	-2.9240		Accepted
	PNA	DT	PEoU	-0.169*	0.085	-1.9874		Accepted
	PoD	DT	PEoU	-0.137	0.078	-1.7506		Rejected
	SoD	DT	PEoU	-0.172	0.117	-1.4720		Rejected

Note. *P < 0.05; DED: driving experience duration; Hyp.: hypothesis.

As demonstrated in Table 3, there exists a statistically significant relationship between a user's propensity for navigation applications, their PoD, and their SoD. This evidence supports the acceptance of hypotheses H_1 and H_2. Additionally, PU and PEoU positively and significantly influence AA, leading to the acceptance of hypotheses H_3 and H_4. Lastly, it was found that AA has a statistically significant and positive effect on ITR, affirming hypothesis H_5.

Notably, the SEM analysis indicates that 31.8% of the variation in the PU factor and 21.2% in the PEoU factor can be attributed to external variables. Moreover, PU and PEoU collectively account for 70.5% of the variance in AA. Ultimately, the shift in drivers' ITR mobile navigation applications can be traced back to their perceptions of these tools.

In Table 3, the moderating role of the gender variable—one of the variables examined in this study—was analyzed using the PROCESS Model 1 to assess its impact on PU. The findings suggest that gender acts as a moderator, as seen in Figure 2, in the relationship between PoD ($\beta = -0.232$; Confidence Interval (CI) [-0.398 to -0.066]) and PU. However, it appears that gender does not serve as a moderator in the effects of PNA ($\beta = -0.106$; CI [-0.268 to 0.055]) and SoD ($\beta = -0.158$; CI [-0.494 to 0.177]) on PU.

When investigating the moderating role of gender regarding the impact of extrinsic factors on PEoU, it was found that gender influences the effect of PoD (β = -0.152; CI [-0.307 to -0.002]) and SoD (β = -0.231; CI [-0.461 to -0.013]) on PEoU. Conversely, gender does not moderate the relationship between PNA (β = -0.105; CI [-0.263 to 0.053]) and PEoU. Consequently, H6 was partially accepted, as it was determined that the gender variable has a moderating role in some relationships concerning extrinsic effects, PU, and PEoU.

When examining the moderating role of driving experience duration—another moderating variable in this study's hypotheses—on the effect of external influences on PU, it is evident that driving experience duration does serve as a moderator, as seen in Figure 3. Specifically, it influences the relationship between PNA (β; -0.236; CI [-0.407 to -0.065]) and SoD (β; -0.380; CI [-0.637 to -0.124]) with PU. In contrast, the duration of the driving experience does not moderate PoD's effect (β; -0.021; CI [-0.189 to 0.146]) on PU.

When considering the moderating role of driving experience duration concerning PEoU, it again plays a moderating role concerning PNA (β; -0.169; CI [-0.336 to -0.018]). However, it does not moderate the effects of PoD (β; -0.137; CI [-0.292 to 0.017]) or SoD (β; -0.172; CI [-0.402 to 0.057]) on PEoU.

As a result, H7 was partially accepted, as driving experience duration was found to be a moderator in some relationships.

DISCUSSION

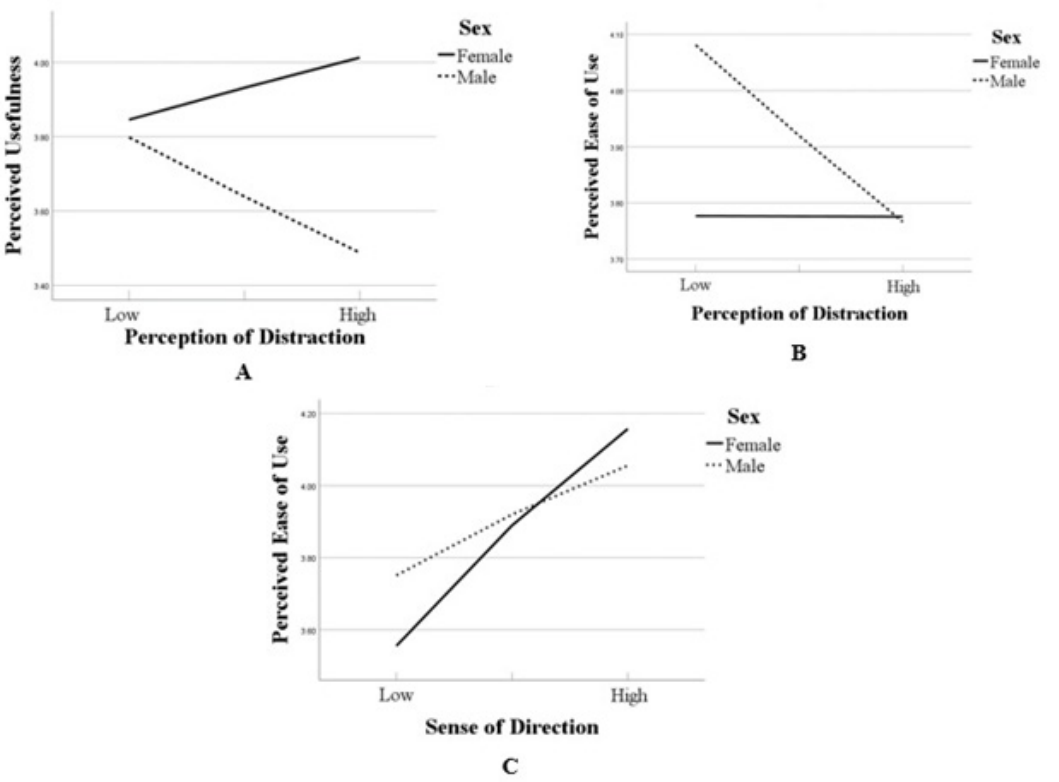
All linear correlations between the four factors in the original TAM were confirmed, aligning with research on in-car mobile tools and navigation applications (Chuang, 2020; Min et al., 2019; Rahman et al., 2017; Vahdat et al., 2021; Yang et al., 2021). The study found that extrinsic factors significantly influence TAM's PU and PEoU. Specifically, PNA and a strong SoD positively and significantly affect mobile navigation applications' PU and PEoU. Conversely, PoD has a notably negative impact. The predisposition factor towards navigation applications demonstrated the most substantial effect among the extrinsic variables. This could be attributed to drivers' reliance on these mobile navigation tools. Moreover, the research indicated that drivers' perceptions of mobile navigation applications—precisely their PU and PEoU—can be significantly hindered by concerns regarding the distractions they may cause. Consistent with prior studies, it was noted that in-car distractive warning systems primarily diminish PEoU (Rahman et al., 2017; Roberts et al., 2012; Yang et al., 2021). Therefore, it can be concluded that PoD may adversely affect drivers' performance and safety, potentially making them hesitant to use mobile navigation applications. This study contributes to the literature by underscoring the importance of extrinsic factors within the TAM concerning mobile navigation applications. It highlights the significant influence of PNA and SoD on PU and PEoU while emphasizing the detrimental effects of distraction perceptions on drivers' acceptance and performance. This reinforces the necessity of minimizing distractions in in-car technologies to enhance driving safety.

Theoretical and Practical Implications

The SEM indicates that mobile navigation applications' PU and PEoU significantly influence users' AAs. It suggests that viewing an application as beneficial holds greater importance than simply perceiving it as user-friendly when fostering a positive AA. This aligns with the findings of Doub et al. (2015) and Vahdat et al. (2021), which highlighted that when a mobile application is deemed valuable, its usage tends to increase. As customers recognize the benefits of using such applications, they will likely develop a favorable AA toward mobile app usage, enhancing their intention to utilize it.

The extrinsic factors outlined in the conceptual model of the research demonstrate a statistically significant impact on PU and PEoU within the TAM. The findings indicate that a PNA and an innate SoD positively and significantly influence mobile navigation applications' PU and PEoU. Conversely,

Figure 2. The moderating role of gender



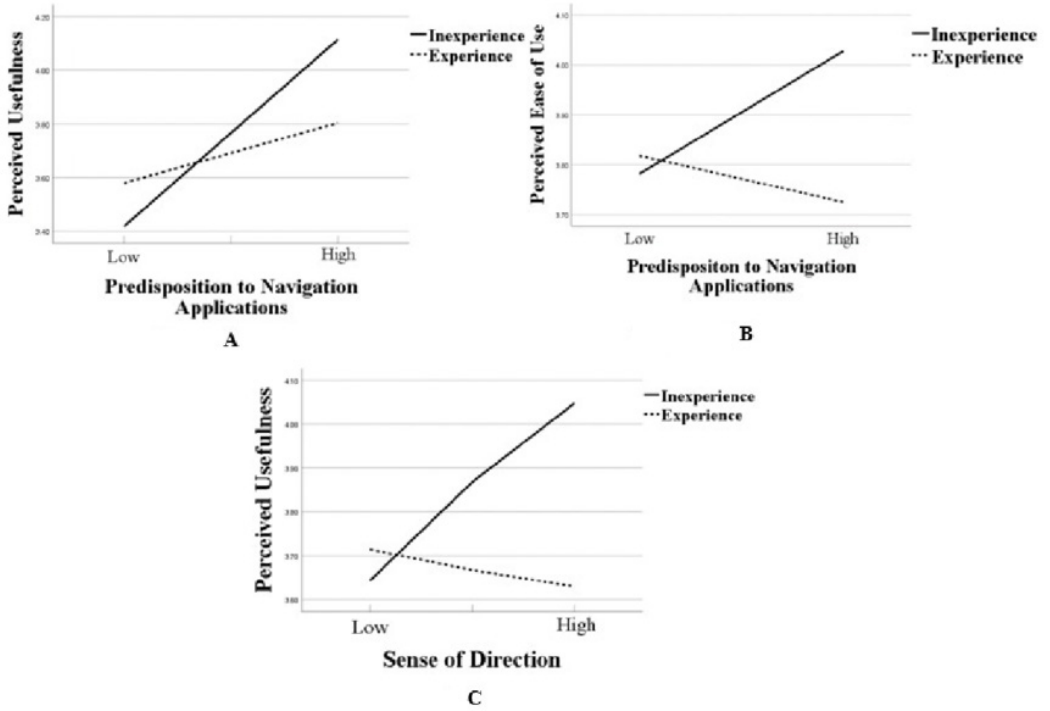
PoD has a negative significant effect. Among the extrinsic factors, PNA emerged as the most influential. This may be attributed to a driver's dependency or addiction to mobile navigation apps. Additionally, it was concluded that PoD stemming from navigation applications could considerably dampen drivers' views on PU and PEoU.

Previous studies have consistently shown that in-car distractive warning systems weaken PEoU (Rahman et al., 2017; Roberts et al., 2012; Yang et al., 2021). Thus, it can be inferred that PoD may adversely affect drivers' performance and safety, potentially leading to reluctance to use mobile navigation apps. This research substantially contributes to the existing literature by deepening our understanding of how extrinsic factors influence mobile navigation applications' PU and PEoU.

According to Hayes (2013), in the PROCESS Model 1, gender moderates how distraction affects PU in this study. As concerns about the distracting nature of in-car mobile navigation applications increase, males tend to view these applications as less effective and more challenging to use than females. Despite PoD, female drivers find mobile navigation applications more useful and user-friendly than their male counterparts. Additionally, the study revealed that gender influences the relationship between SoD and PEoU. Specifically, as drivers' SoD improves, women tend to find mobile navigation applications more accessible than men. These findings align with several studies on technology acceptance discussed in the literature. For instance, Riquelme and Rios (2010) determined that women view mobile banking applications as more practical and valuable than men. Similarly, Ladhari and Leclerc (2013) discovered that women generally have more favorable perceptions than men regarding online travel agency websites' ease of use and content.

The results concerning driving experience duration, another regulatory variable of the study, revealed that driving experience plays a moderating role in the relationship between PNA and

Figure 3. The moderating role of driving experience duration



perceptions of their PU and PEoU. Specifically, it was found that as PNA increases, inexperienced drivers perceive it as more useful, as seen in Figure 3, and easier to use compared to their experienced counterparts. Conversely, for experienced drivers, PNA did not notably influence their PU or PEoU. This suggests that new drivers are more inclined to rely on mobile navigation applications than experienced drivers. One possible explanation for this trend is that inexperienced drivers may not be accustomed to the various driving conditions, making them more dependent on navigation tools for direction. Additionally, the study highlighted that driving experience duration moderates the impact of a driver's SoD on PU. Inexperienced drivers with a strong SoD may find mobile navigation applications particularly beneficial compared to experienced drivers. However, SoD does not seem to significantly influence the perceptions of experienced drivers regarding the benefits of using a mobile navigation application during their driving experiences. These findings imply that mobile navigation applications are particularly crucial for inexperienced drivers. This aligns with the conclusions drawn by Yao et al. (2019), which indicate that inexperienced drivers utilize navigation applications more frequently while driving than their experienced peers.

Marketers should emphasize the perceived benefits of mobile navigation apps, particularly for novice drivers who depend heavily on these tools. Strategies highlighting these apps' advantages are likely to enhance user engagement, especially among male drivers who view distraction as a significant concern. Furthermore, recognizing gender differences in perception can facilitate the creation of targeted advertisements that resonate more effectively with female users, who often find these apps more beneficial and user-friendly. This study makes a valuable contribution by illuminating how gender and driving experience influence technology acceptance. It establishes a foundation for future research on technology adoption in varied contexts by clarifying user AAs toward mobile navigation apps. These insights can aid in designing improved tools and interventions tailored to the specific needs of diverse driver groups.

Limitations and Future Research

This study explored drivers' perceptions and tendencies toward mobile navigation applications, highlighting the impact of factors such as SoD, PoD, and PNA on their acceptance. The findings revealed that acceptance varied by gender and driving experience. However, the use of convenience sampling limits the generalizability of the results. Despite this limitation, the study offers valuable insights for developers and market stakeholders, underscoring the importance of user preferences in creating more effective and user-friendly applications.

Future research should address these limitations by employing random sampling and considering additional personal characteristics, such as age, socioeconomic status, regional differences, and cultural factors. Previous studies indicate that personal elements like passion and engagement significantly influence technology acceptance (Burton-Jones & Hubona, 2006; Park et al., 2015). Furthermore, incorporating qualitative methods, such as interviews or focus groups, alongside quantitative approaches could provide deeper insight into drivers' perceptions and experiences with mobile navigation applications. This mixed-method approach would enrich the quantitative findings and offer a more nuanced understanding of user behavior.

COMPETING INTERESTS STATEMENT

The authors of this publication declare there are no competing interests.

FUNDING STATEMENT

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. The authors of the article covered funding for this research.

PROCESSING DATES

11, 2024

This manuscript was initially received for consideration for the journal on 09/20/2024, revisions were received for the manuscript following the double-anonymized peer review on 10/25/2024, the manuscript was formally accepted on 10/25/2024, and the manuscript was finalized for publication on 11/04/2024

CORRESPONDING AUTHOR

Correspondence should be addressed to Meltem CANOGLU; meltemcanoglu@osmaniye.edu .tr, Tel: +90 328 8271000 /3234

REFERENCES

Ahlström, C., Wachtmeister, J., Nyman, M., Nordenström, A., & Kircher, K. (2020). Using smartphone logging to gain insight about phone use in traffic. *Cognition Technology and Work*, *22*(1), 181–191. DOI: 10.1007/s10111-019-00547-6

Burton-Jones, A., & Hubona, G. (2006). The mediation of external variables in the technology acceptance model. *Information & Management*, *43*(6), 706–717. DOI: 10.1016/j.im.2006.03.007

Chen, C., & Chen, P. (2011). Applying the tam to travelers' usage intentions of GPS devices. *Expert Systems with Applications*, *38*(5), 6217–6221. DOI: 10.1016/j.eswa.2010.11.047

Chengula, T. J., Mwakalonge, J., Comert, G., Sulle, M., Siuhi, S., & Osei, E. (2024). Enhancing advanced driver assistance systems through explainable artificial intelligence for driver anomaly detection. *Machine Learning with Applications*, *17*, 100580. Advance online publication. DOI: 10.1016/j.mlwa.2024.100580

Chuang, C.-M. (2020). A current travel model: Smart tour on mobile guide application services. *Current Issues in Tourism*, *23*(18), 2333–2352. DOI: 10.1080/13683500.2019.1631266

Cornell, E. H., Sorenson, A., & Mio, T. (2003). Human sense of direction and wayfinding. *Annals of the Association of American Geographers*, *93*(2), 399–425. DOI: 10.1111/1467-8306.9302009

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *Management Information Systems Quarterly*, *13*(3), 319–339. DOI: 10.2307/249008

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science*, *35*(8), 982–1003. DOI: 10.1287/mnsc.35.8.982

Doub, A. E., Levin, A., Heath, C. E., & LeVangie, K. (2015). Mobile app-etite: Consumer attitudes towards and use of mobile technology in the context of eating behaviour. *Journal of Direct, Data and Digital Marketing Practice*, *17*(2), 114–129. DOI: 10.1057/dddmp.2015.44

Fuller, C. M., Simmering, M. J., Atinc, G., Atinc, Y., & Babin, B. J. (2016). Common methods variance detection in business research. *Journal of Business Research*, *69*(8), 3192–3198. DOI: 10.1016/j.jbusres.2015.12.008

Ge, Y., Qi, H., & Qu, W. (2023). The factors impacting the use of navigation systems: A study based on the technology acceptance model. *Transportation Research Part F: Traffic Psychology and Behaviour*, *93*, 106–117. DOI: 10.1016/j.trf.2023.01.005

Gumasing, M. J., Alonzo, R. F., Nazareno, J. M., & Guinto, K. L. (2023). Antecedents of cloud gaming acceptance among gen Z: Achieving sustainability in the digital gaming industry. *Sustainability (Basel)*, *15*(12), 9189. Advance online publication. DOI: 10.3390/su15129189

Hair, J. F., Black, J. W., Babin, B. J., & Anderson, R. E. (2009). *Multivariate data analysis*. Pearson.

Hayes, A. F. (2013). *Introduction to mediation, moderation and conditional process analysis*. The Guilford Press.

Hedlund, J., Simpson, H. M., & Mayhew, D. R. (2006). Summary of proceedings and recommendations. In *International conference on distracted driving* (pp. 2–5). Traffic Injury Research Foundation.

Hegarty, M., Richardson, A. E., Montello, D. R., Lovelace, K., & Subbiah, I. (2002). Development of a self-report measure of environmental spatial ability. *Intelligence*, *30*(5), 425–447. DOI: 10.1016/S0160-2896(02)00116-2

Hernandez, B., Jimenez, J., & Martin, M. J. (2010). Customer behavior in electronic commerce: The moderating effect of e-purchasing experience. *Journal of Business Research*, *9–10*(9-10), 946–971. DOI: 10.1016/j.jbusres.2009.01.019

Hussain, M., & Shi, J. (2021). Effects of proper driving training and driving license on aberrant driving behaviors of Pakistani drivers—A proportional odds approach. *Journal of Transportation Safety & Security*, *13*(6), 661–679. DOI: 10.1080/19439962.2019.1665601

Jing, L., Shan, W., & Zhang, Y. (2023). Risk preference, risk perception as predictors of risky driving behaviors: The moderating effects of gender, age, and driving experience. *Journal of Transportation Safety & Security*, *15*(5), 467–492. DOI: 10.1080/19439962.2022.2086953

Kozlowski, L. T., & Bryant, K. J. (1977). Sense of direction, spatial orientation, and cognitive maps. *Journal of Experimental Psychology. Human Perception and Performance*, *3*(4), 590–598. DOI: 10.1037/0096-1523.3.4.590

Ladhari, R., & Leclerc, A. (2013). Building loyalty with online financial services customers: Is there a gender difference? *Journal of Retailing and Consumer Services*, *20*(6), 560–569. DOI: 10.1016/j.jretconser.2013.07.005

Li, X., Yan, X., & Wong, S. (2015). Effects of fog, driver experience and gender on driving behavior on S-curved road segments. *Accident; Analysis and Prevention*, *77*, 91–104. DOI: 10.1016/j.aap.2015.01.022 PMID: 25700127

Man, S. S., Fang, Y., Chan, A. H., & Han, J. (2024). VR technology acceptance for English learning amongst secondary school students: Role of classroom climate and language learning anxiety. *Education and Information Technologies*. Advance online publication. DOI: 10.1007/s10639-024-12969-5

Min, S., So, K. K., & Jeong, M. (2019). Consumer adoption of the Uber mobile application: Insights from diffusion of innovation theory and technology acceptance model. *Journal of Travel & Tourism Marketing*, *36*(7), 770–783. DOI: 10.1080/10548408.2018.1507866

Morris, A., Reed, S., Welsh, R., Brown, L., & Birrell, S. (2015). Distraction effects of navigation and green-driving systems–results from field operational tests (FOTs) in the UK. *European Transport Research Review*, *7*(3), 1–9. DOI: 10.1007/s12544-015-0175-3

Musselwhite, C. (2006). Attitudes towards vehicle driving behaviour: Categorising and contextualising risk. *Accident; Analysis and Prevention*, *38*(2), 324–334. DOI: 10.1016/j.aap.2005.10.003 PMID: 16289334

Padgitt, A. J., & Hund, A. M. (2012). How good are these directions? Determining direction quality and wayfinding efficiency. *Journal of Environmental Psychology*, *32*(2), 164–172. DOI: 10.1016/j.jenvp.2012.01.007

Park, E., Kim, H., & Ohm, J. Y. (2015). Understanding driver adoption of car navigation systems using the extended technology acceptance model. *Behaviour & Information Technology*, *34*(7), 741–751. DOI: 10.1080/0144929X.2014.963672

Park, E., Kim, K. J., Jin, D., & Pobil, A. P. (2012). Towards a successful mobile map service: An empirical examination of technology acceptance model. In *International conference on networked digital technologies* (pp. 420–428). Springer. DOI: 10.1007/978-3-642-30507-8_36

Ponchillia, P. E., Jo, S.-J., Casey, K., & Harding, S. (2020). Developing an indoor navigation application: Identifying the needs and preferences of users who are visually impaired. *Journal of Visual Impairment & Blindness*, *114*(5), 344–355. DOI: 10.1177/0145482X20953279

Rahman, M. M., Lesch, M. F., Horrey, W. J., & Strawderman, L. (2017). Assessing the utility of TAM, TPB, and UTAUT for advanced driver assistance systems. *Accident; Analysis and Prevention*, *108*, 361–373. DOI: 10.1016/j.aap.2017.09.011 PMID: 28957759

Riquelme, H. E., & Rios, R. E. (2010). The moderating effect of gender in the adoption of mobile banking. *International Journal of Bank Marketing*, *28*(5), 328–341. DOI: 10.1108/02652321011064872

Roberts, S. C., Ghazizadeh, M., & Lee, J. D. (2012). Warn me now or inform me later: Drivers' acceptance of real-time and post-drive distraction mitigation systems. *International Journal of Human-Computer Studies*, *70*(12), 967–979. DOI: 10.1016/j.ijhcs.2012.08.002

Shaaban, K. (2019). Drivers' perceptions of smartphone applications for real-time route planning and distracted driving prevention. *Journal of Advanced Transportation*, *2019*, 1–10. DOI: 10.1155/2019/2867247

Tabachnick, B., & Fidell, L. S. (2013). *Using multivariate statistics*. Pearson Education Limited.

Taherdoost, H. (2018). A review of technology acceptance and adoption models and theories. *Procedia Manufacturing*, *22*, 960–967. DOI: 10.1016/j.promfg.2018.03.137

Tak, P., & Gupta, M. (2021). Examining travel mobile app attributes and its impact on consumer engagement: An application of S-O-R framework. *Journal of Internet Commerce*, *20*(3), 293–318. DOI: 10.1080/15332861.2021.1891517

Vahdat, A., Alizadeh, A., Quach, S., & Hamelin, N. (2021). Would you like to shop via mobile app technology? The technology acceptance model, social factors and purchase intention. *Australasian Marketing Journal*, *29*(2), 187–197. DOI: 10.1016/j.ausmj.2020.01.002

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, *46*(2), 186–204. DOI: 10.1287/mnsc.46.2.186.11926

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *Management Information Systems Quarterly*, *27*(3), 425–478. DOI: 10.2307/30036540

Voinea, G. D., Postelnicu, C., Duguleana, M., Mogan, G.-L., & Socianu, R. (2020). Driving performance and technology acceptance evaluation in real traffic of a smartphone-based driver assistance system. *International Journal of Environmental Research and Public Health*, *17*(19), 7098. Advance online publication. DOI: 10.3390/ijerph17197098 PMID: 32998252

Wang, L., & Ju, D. Y. (2015). Concurrent use of an in-vehicle navigation system and a smartphone navigation application. *Social Behavior and Personality*, *43*(10), 1629–1640. DOI: 10.2224/sbp.2015.43.10.1629

Wang, Y.-Y., Lin, H.-H., Wang, Y.-S., Shih, Y.-W., & Wang, S.-T. (2018). What drives users' intentions to purchase a GPS navigation app: The moderating role of perceived availability of free substitutes. *Internet Research*, *28*(1), 251–274. DOI: 10.1108/IntR-11-2016-0348

Wasomi, C. B., Waithaka, E. H., Gachari, M. K., & Kuria, D. N. (2021). Location based services acceptance and adoption evaluation: An investigation on mobile phone users' response to awareness and utilization of LBS technology in Nairobi, Kenya. *Journal of Computer and Communications*, *9*(10), 60–96. DOI: 10.4236/jcc.2021.910005

Worcester, R. M., & Downham, J. (1986). *Consumer market research handbook*. McGraw-Hill.

Yang, L., Bian, Y., Zhao, X., Liu, X., & Yao, X. (2021). Drivers' acceptance of mobile navigation applications: An extended technology acceptance model considering drivers' sense of direction, navigation application affinity and distraction perception. *International Journal of Human-Computer Studies*, *145*, 1–11. DOI: 10.1016/j.ijhcs.2020.102507

Yao, X., Wu, Y., Liu, H., Zhao, X., Bian, Y., & Qu, W. (2019). Analysis of psychological influences on navigation use while driving based on extended theory of planned behavior. *Transportation Research Record: Journal of the Transportation Research Board*, *2673*(9), 480–490. DOI: 10.1177/0361198119845666

Yuan, Q., Scott-Parker, B., Zhang, T., Viedo-Trespalacios, O., & Xu, X. (2021). Comparisons in crash rate and risky behaviors between novice drivers and experienced drivers in China. In *6th international conference on transportation information and safety (ICTIS)*, (pp. 1448–1457). Wuhan: Institute of Electrical and Electronics Engineers. DOI: 10.1109/ICTIS54573.2021.9798596

APPENDIX

Table 4. Measurement items

Constructs		References
PNA		(Yang et al., 2021)
PNA1	I would miss mobile navigation applications when driving without them.	
PNA2	I would feel nervous and confused when driving without a mobile navigation application.	
PNA3	It is difficult for me to reduce the usage frequency of a mobile navigation application.	
PoD		
PoD1	Using a mobile navigation application while driving affects my ability to observe the traffic around me.	
PoD2	Using a mobile navigation application while driving affects my ability to observe traffic signs.	
PoD3	Using a mobile navigation application while driving affects my ability to receive external sound information.	
PoD4	Using a mobile navigation application while driving slows down my reaction time.	
PoD5	Using a mobile navigation application while driving affects my ability to control the vehicle.	
SoD		
SoD1	I am very good at giving directions.	(Hegarty et al., 2002)
SoD2	I have a poor memory for where I left things.	
SoD3	I am very good at judging distances.	
SoD4	My SoD is very good.	
SoD5	I tend to think of my environment in terms of cardinal directions (N, S, E, W).	
SoD6	I very easily get lost in a new city.	
SoD7	I enjoy reading maps.	
SoD8	I have trouble understanding directions.	
SoD9	I am very good at reading maps.	
SoD10	I don't remember routes very well while riding as a passenger in a car.	
SoD11	I don't enjoy giving directions.	
SoD12	It's not important to me to know where I am.	
SoD13	I usually let someone else do the navigational planning for long trips.	
SoD14	I can usually remember a new route after I have traveled it only once.	
SoD15	I don't have a very good “mental map” of my environment.	
PEoU		

continued on following page

Table 4. Continued

Constructs		References
PEoU1	Learning to operate a mobile navigation application is easy for me.	(Yang et al., 2021)
PEoU2	It is easy to use a mobile navigation application.	
PEoU3	Information provided by a mobile navigation application is very clear and understandable.	
PEoU4	I don't spend a lot of time learning how to use a mobile navigation application.	
PU		
PU1	Using a mobile navigation application can save me time.	
PU2	Using a mobile navigation application can help me save time.	
PU3	Using a mobile navigation application makes my driving safer.	
PU4	Using a mobile navigation application makes it easier for me to drive.	
PU5	Overall, it is useful for me to use a mobile navigation application.	
AA		
AA1	Using a mobile navigation application while driving is beneficial to me.	
AA2	Using a mobile navigation application makes my trip more efficient.	
AA3	A mobile navigation application can reduce the time spent going the wrong way.	
AA4	Using a mobile navigation application makes me drive faster and more steadily.	
AA5	The pre-warning function of a mobile navigation application makes me feel more comfortable.	
AA6	Mobile navigation applications give me a sense of security instead of nervousness.	
ITR		
ITR1	I am willing to use a mobile navigation application in the future.	
ITR2	I will continue to use a mobile navigation application in the future.	
ITR3	I will increase the use of a mobile navigation application in the future.	

Meltem CANOGLU currently serves as a Assoc. Prof. Dr. at Osmaniye Korkut Ata University, Osmaniye, Turkey. Her main research areas are consumer behavior and marketing.

Sefa USTUNER currently serves as a lecturer at Kayseri University, Kayseri, Turkey. He's studying for a PhD in marketing at Osmaniye Korkut Ata University. His main research areas are consumer behavior and marketing research

Gülhan Yenilmez currently serves as an research assistant at Osmaniye Korkut Ata University, Osmaniye, Turkey. She's studying for a PhD in marketing at Osmaniye Korkut Ata University. Her main research areas are experiential retailing, consumer behavior and marketing research.