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Article

Determinants of consumer's adoption to use QR code-based virtual supermarket—The moderating effect of perception risk

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Abstract: QR code transforms the way retailers offer their shopping experiences in the current context. In response, various retailers adopted innovative approaches such as QR code-based applications to attract their consumers. A QR code-based virtual supermarket refers to a space where goods or services are traded in a virtual space using a smart app-based QR code. To fully understand the opportunities of this type of supermarket applying QR-code technology, initial research is required to assess consumers' use intention. This study has examined the antecedents of the adoption of QR code-based virtual supermarket among Vietnam consumers using the expanded Technology Acceptance Model (TAM) and explored the moderating effect of perceived risk on the relationship between attitude and consumers' intention to use QR code-based virtual supermarket. A questionnaire was used to collect data from a sample of 335 consumers in Vietnam. The findings revealed that the antecedents are effective in predicting consumers' attitudes and intentions toward QR code-based virtual supermarket adoption. The results showed the negative moderation effects of perceived risk for the effect of attitude on consumers intention. In addition, practical implications are supported for the application of new shopping technology and are likely to stimulate further research in the area of virtual supermarket shopping.

Keywords: QR code; virtual supermarket; technology acceptance model; consumers; perceived risk

1. Introduction

Information technology has developed many tools which can be used to approach the consumers last few years (Speicher, 2018). One tool among them is Quick Response codes (QR codes) which were created to track auto parts by a Toyota subsidiary in 1994 (Kim et al., 2022). In today's context, employing QR codes offers several advantages to consumers, facilitating smooth and swift online purchases by simply using their smartphones to complete the transaction (Jathar et al., 2022). Firstly, QR codes can be utilized anywhere and carry more information compared to standard barcodes (Asistores, 2022; Singha and Verma, 2019). Secondly, the technology behind QR codes is user-friendly, requiring no specialized knowledge for consumers to utilize the application, as QR code scanners are readily available on smartphones (Singha and Virma, 2019).

In prior research, scholars have examined the practical application of QR codes in advertising and packaging to forecast marketing efficacy (Trivedi et al., 2020; Wei et al., 2021). Recently, QR codes have seen increased utilization across various domains, especially with the rapid expansion of mobile commerce in Vietnam. For instance, in 2019, Vinmart, a retailer, introduced a QR code-based virtual

supermarket tailored for urban commuters (Vinmart, 2019). This innovative concept combines elements of both offline and online shopping, setting it apart from conventional virtual supermarkets accessible solely via the internet (Alfian et al., 2019; Speicher et al., 2017). It is evident that QR code technology plays a pivotal role in fostering competitive advantage within a savvy retail business model. Nonetheless, criticism has emerged regarding the limited growth of QR code-based virtual supermarkets compared to expectations (Kim and Yoon, 2014). Many retailers also express apprehensions about the risks and uncertainties associated with relying on QR codes as a potential solution to maximize profits (Kim and Lee, 2013; Yim and Lee, 2013). Meanwhile, as a new technology, retailers need to understand whether consumers are willing to use QR code technology in their shopping tasks (Othman et al., 2021). Despite being a growing need for researching the consumer's adoption of QR codes in the shopping context, there has been little empirical research to investigate the using QR code in virtual supermarkets from a consumer perspective.

To bridge this research gap, this paper aims to achieve three interconnected objectives. Firstly, it seeks to undertake a thorough review of literature concerning virtual supermarkets, exploring the factors influencing their adoption, and examining the relationship between attitude towards virtual supermarket adoption and the intention to use them. Secondly, the paper endeavors to empirically assess a structural model that integrates and explores the impacts of five antecedents on the intention to adopt virtual supermarkets. These antecedents encompass perceived ease of use, perceived usefulness, perceived enjoyment, Personal Innovativeness, and attitude. Moreover, the study investigates the moderating influence of risk perceptions on the antecedents of intention to use virtual supermarkets. The anticipated findings are poised to furnish both researchers and practitioners in the retail sector with valuable insights into the efficacy of virtual supermarkets, the level of their acceptance among consumers, and their potential as long-term alternatives to traditional supermarkets.

2. Literature review

2.1. QR code-based virtual supermarket

A QR code-based virtual supermarket (VS) refers to a space where goods or services are traded in a virtual space using a smart app-based QR code. It is sometimes classified as a smart virtual store in that it is a model that uses a smartphone as a means of a multi-channel strategy that combines the advantages of online and offline (Song, 2012). The environment of the QR code virtual store consists of a digital display screen where products are displayed, a QR code scanner using a smartphone app, and a mobile virtual space information system for information retrieval, ordering, and payment. Consumers can be induced to purchase products by actively exploring detailed product information through QR codes and participating in events and promotions at the point of purchase (Shim and Go, 2012). With a QR code-based virtual supermarket, consumers can replenish all of their essentials while going about their daily routines, no special trips to the supermarket required.

Continuing studies on the acceptance of virtual stores so far have revealed the model of intention to accept virtual stores in the context of online, mobile, and applications as new information technology is introduced (Ko et al., 2009; Venkatesh et al., 2012). However, since QR code stores are still in the early stages in domestic and overseas markets, thus now is an important time to diagnose the technology acceptance model to predict future growth potential.

2.2. Technology acceptance model—TAM

The utilization of technology across production, business, and daily life is gaining popularity and emerging as a significant area of research (Rauschnabel and Ro, 2016). Accompanying this trend is the crucial aspect of consumer acceptance or rejection, which determines its success or failure (tom Dieck et al., 2017).

Davis and Bagozzi (Bagozzi et al., 1992) introduced a widely recognized model, the Technology Acceptance Model (TAM), to gauge consumer attitudes and behaviors toward adopting technology. Davis (1989) previously proposed that perceived ease of use and perceived usefulness are key drivers influencing users' intentions and actual usage of technology within the TAM framework. This model has been extensively applied and adapted across various studies in diverse contexts, cultures, and research domains (Mohammadi, 2015; Venkatesh and Davis, 2000). For instance, TAM has also been used for explaining the information technology application in different contexts like knowledge sharing systems in virtual communities (Deng and Yuan, 2020), 3D virtual world (Huang et al., 2023), mobile technology adoption (Alsharida, 2021), virtual reality in education (Barrett et al., 2023) and big data tool adoption (Al-Ateeq, 2022). Additionally, TAM serves as a foundational model for more in-depth and comprehensive research in various fields (Mailizar et al., 2021; Sarmah et al., 2021; Sagnier et al., 2020).

2.3. QR code virtual supermarket and TAM model

Although there are few empirical studies related to QR code virtual stores at home and abroad, as a result of examining most studies focusing on mobile and digital technology in the context of information technology (IT), and most studies have suggested that the perceived usefulness and ease of TAM are decisive predictors of technology acceptance (Martín-García et al., 2022; Rafique et al., 2020; Munoz-Leiva et al., 2017).

Looking at the studies in the context of virtual stores, Oh et al. (2009) based on the TAM model and focused on the Internet-based online virtual store, not only usefulness and ease of use, but also playfulness due to abundant information are important in the acceptance attitude of virtual stores. Supporting this, Ko et al. (2009) suggested that the usefulness, ease, and pleasure of mobile shopping increase the purchase intention for fashion products. More recently, a study applying the TAM model focusing on the mobile app store revealed that perceived usefulness and ease of use increase the acceptance intention of the mobile app store (Bae, 2015; Kim et al., 2017).

As a result of examining the preceding studies, the technology acceptance model has been empirically verified from online to mobile contexts, but no research

has yet been conducted to verify the technology acceptance model in the context of QR code virtual stores. The perceived ease and usefulness suggested in previous studies can also act as a benefit factor that can increase acceptance in the QR code-based basis. In order to predict the acceptability of consumers in the early stage of recognition, it is necessary to consider the perceived benefits and risk factors of QR code virtual stores at the same time.

The advancement of technology and the swift pace of globalization have altered both business and the ways we gauge user behavior. Röcker (2010) suggests that the traditional "ease of use" metric in TAM might not accurately forecast user actions anymore. Ajzen and Fishbein (2000) emphasized the importance of aligning measures with the "context" and "time". Pourfakhimi et al. (2018) indicate that there might be unaccounted factors crucial for predicting behavior, necessitating updates to existing models. Therefore, the current study uses the TAM model and combines some new factors to make it suitable for the virtual supermarkets context.

2.4. Research model and hypothesis development

2.4.1. Perceived usefulness (PU)

Perceived usefulness has been defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 319). In the study, perceived usefulness refers to the extent to which the consumer believes that using the QR code virtual supermarkets improves his/her shopping. In shopping, the perceived usefulness dimension relates to the usefulness of shopping, energy or time efficiency, and ordering/delivery services, and refers to the performance expectancy benefits of using QR code virtual supermarkets. It is mentioned that most of the QR code virtual supermarkets are located in easily accessible locations and can be used by consumers when commuting, thereby reducing time and effort costs. Numerous researchers across various disciplines and cultural backgrounds have illustrated the causal relationship between perceived usefulness and consumers' attitudes and intentions (Agag and El-Masry, 2016; Gunawan et al., 2019; Suki and Suki, 2011). Thus, the following hypotheses are proposed:

Hypothesis 1: Perceived usefulness of QR code virtual supermarkets for consumers has a positive impact on attitude to adopt QR code virtual supermarkets.

Hypothesis 2: Perceived usefulness of QR code virtual supermarkets for consumers has a positive impact on intention to use QR code virtual supermarkets.

2.4.2. Perceived ease of use

Perceived ease of use is described as "the extent to which an individual perceives using a specific system to be effortless" (Aditya and Wardana, 2016; Davis, 1989, p. 320). Variations in research settings can result in diverse interpretations of the issue, thus this study postulates that perceived ease of use refers to the extent to which consumers perceive using QR code virtual supermarkets as requiring minimal effort. In the realm of IT, the association between ease of use and purchase attitude has been demonstrated in particular scenarios, such as the online purchase of airline tickets (Guritno and Siringoringo, 2013), PT Tokopedia in Jabodetabek (Gunawan et

al., 2019), mobile services (Suki and Suki, 2011), interest in online buying across Apps in Surabaya (Atika et al., 2020; Ellitan and Prayogo, 2022). Thus, the following hypothesis is proposed:

Hypothesis 3: Perceived ease of use of QR code virtual supermarkets for consumers has a positive impact on attitude to adopt QR code virtual supermarkets.

2.4.3. Perceived enjoyment

Bagozzi, Davis, and Warshaw (1992) defined perceived enjoyment as "the extent to which the activity of using the computer is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated". In the current study, perceived enjoyment has been conceptualized as the extent to which consumers believe that taking part in the activity of experiencing shopping through QR code virtual supermarkets would be enjoyable. Previous studies have confirmed the significant impact of perceived enjoyment on the attitude to new technology (Childers et al., 2001; Chinomona, 2013; Praveena and Thomas, 2014). Perceived enjoyment relates to the curiosity and visual appeal of the QR code virtual supermarket (Ko et al., 2009; Oh et al., 2009). It can be seen that the respondents are curious to see the display screen of the visually presented product of the QR code virtual supermarkets. In addition, even though the product is not presented as a real product, the product photo is very similar to the actual image and catches the eye because it is pretty. In the context of this study, it can be assumed that the perceived enjoyment of using QR code virtual supermarkets to experience shopping would positively affect customers' attitude to use QR code virtual supermarkets. Thus, the following hypothesis is proposed:

Hypothesis 4: Perceived enjoyment of QR code virtual supermarkets for consumers has a positive impact on attitude to adopt QR code virtual supermarkets.

2.4.4. Personal innovativeness of information technology (PIT)

Personal innovativeness as "the degree to which the individual is receptive to new ideas and makes innovation decisions independently of the communicated experience of others" (Midgley, 1977, p. 49). Based on this definition, numerous previous studies on technology adoption included personal innovativeness as a factor influencing the willingness of an individual to use new technologies (Okumus et al., 2018). In the meantime, Tan and Ooi (2018), found innovativeness as the most significant predictor of behavioural intentions to use a new technology. There is a strong conviction that consumer personal innovativeness will have a favorable and notable impact on their willingness to embrace new technology (San and Herrero, 2012). Zang et al. (2024) identified personal innovativeness as a significant predictor of users' intentions within an omni-channel context and mobile payment in India (Patil et al., 2020). Shopping at QR code virtual supermarkets is a new technological experience for Vietnamese consumers. Therefore, consumers' perceptions of QR code virtual supermarkets shopping are significantly shaped by personal innovativeness. Individuals with higher levels of personal innovativeness are more likely to shop at virtual supermarkets. Thus, the following hypotheses are proposed:

Hypothesis 5: Personal Innovativeness of Information Technology has a positive impact on attitude to adopt QR code virtual supermarkets.

Hypothesis 6: Personal Innovativeness of Information Technology has a positive impact on intention to use QR code virtual supermarkets.

2.4.5. Attitude and intention to adopt virtual supermarket

Rokeach (1968) defines attitude as interconnected predispositions to act concerning an object or situation, while Ajzen (1991) proposes that attitudes represent the inclination to respond favorably or unfavorably towards people, objects, institutions, or events. This concept has been employed to assess its impact on behavioral intentions in various leading theories of IS/IT adoption, such as TRA (Ajzen and Fishbein, 2000) and TAM (Davis, 1989). These frameworks suggest that a person's intention is shaped by their attitude towards system usage (Acock and Fuller, 1984; Dwivedi et al., 2019; Fischer, 2017). Several researchers, including Acock and Scott (1980) and Redillas et al. (2023), have affirmed the notable connection between attitude and behavioral intention. In this study, it is reasonable to consider that Perceived ease of use, Perceived usefulness, and Perceived enjoyment had a positive influence on customers' attitudes towards the QR code virtual supermarkets, consequently resulting in a more favorable intention to use the QR code virtual supermarkets. Thus, the following hypothesis is proposed:

Hypothesis 7: The attitude to adopt QR code virtual supermarkets has a positive impact on intention to use QR code virtual supermarkets.

2.4.6. Moderating effects of perceived risk

Perceived risk was clarified as "an observation on hesitation that made by users and also an unpleasant aftermaths of business deal done by a wholesaler" (Gupta and Kim, 2010, p. 19). Risk is a crucial consideration when implementing cutting-edge virtual supermarket technology. Perceived risk acts as an obstacle in building loyalty, exerting a detrimental moderating influence on the satisfaction-loyalty connection (Huy Tuu et al., 2011). Furthermore, Thakur and Srivastava (2014) suggested a detrimental correlation between perceived risk and the behavioral intention to adopt new technology.

The use of the perceived risk construct has become widespread in recent decades (Bruwer and Cohen, 2019; Pathak et al., 2017;). Focusing on the online context, the importance of risk perceptions is evident when conducting an e-purchase. perceived risk as a moderator of the key relational mediators of satisfaction and trust, (Paulssen et al., 2014), and Perceived risk plays a significant role in moderating the relationship between satisfaction and continuance intention, as well as between confirmation and satisfaction, but it doesn't have a significant effect on the relationship between perceived usefulness and satisfaction, nor between perceived usefulness and continuance intention (Jangir et al., 2022). In addition to the risks related to intangibility and time delays, customers must share personal and financial information with providers who may not always be well-known (De Ruyter et al., 2001). In situations where consumers perceive a high genuine risk with a purchase, their preference for moderately incongruent products vanishes, and they opt for the congruent option instead. Conversely, when there's no perceived risk, the positive impact of moderate incongruity becomes evident. This shift in preference appears to be driven by consumers' tendency to adhere to the norm under conditions of high risk (Campbell and Goodstein, 2001). Hence, perceived risk holds significant

importance, particularly during the initial phases of customers adopting QR code virtual supermarkets purchasing. Similarly, this study explores how perceived risk influences the relationship between consumer attitude and the intention to engage in QR code virtual supermarkets shopping. Thus, the following hypothesis is proposed:

Hypothesis 8: Perceived risk moderates the relationship between the attitude and intention to adopt QR code virtual supermarkets, such that the relationship is stronger for consumers who perceive the perceived risk as low and vice versa.

The above hypotheses result in a theoretical model as proposed in **Figure 1**.

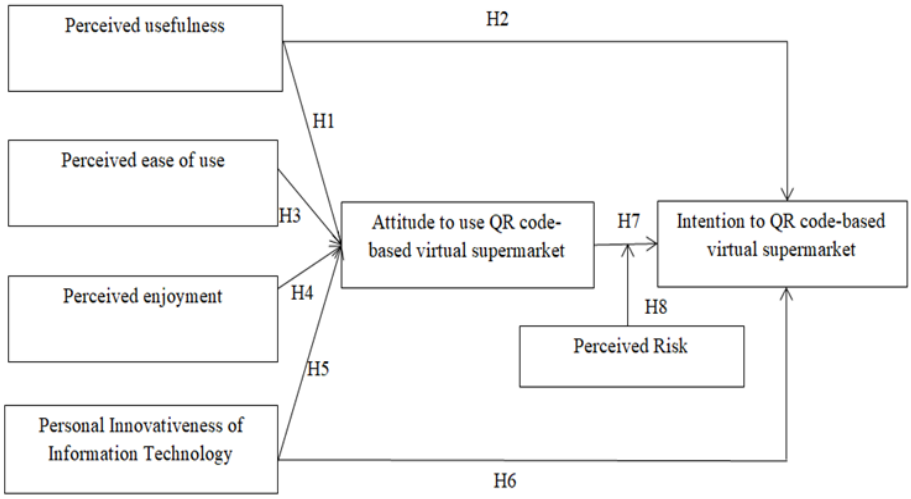

Figure 1. Research model.

3. Methodology

3.1. Measures

The proposed model adopted previously validated scales from the literature to measure the different variables. First, five items for Perceived Usefulness (PU) were adapted from Agarwal and Prasad (1998) and Venkatesh and David (2000); five items for Perceived Ease of Use (PEOU) were adapted from David (1989) and seven items for Perceived Innovativeness of Information Technology (PIT) were adapted base on Agarwal and Prasad (1998). Second, five items adapted from Lindell and Prater (2000) were employed to measure Perceived Risk (PR). Third, four items based on the work of Ghani et al. (1991) were used to measure Perceived Enjoyment (PE). Fourth, attitude (ATT) was measured using a five-item scale adapted from Wilson et al. (2000). Finally, five items adopted from previous research on new technology adoption were used to measure intention (INT) (e.g., Ajzen and Fishbein (2000); Venkatesh and David (2000), and Farrid and Gisip (2021)). All the scales were measured on a Likert-type scale ranging from strongly disagree = 1 to strongly agree = 7.

3.2. Sampling

The study uses convenient sampling technique of Vietnamese consumers aged 18 years and over. Those who were familiar with QR code-based virtual supermarket or had prior experience with them were selected for the study. The questionnaire was

disseminated via wall posts on social media platforms such as Facebook, Zalo, and Google+. The data were collected at three big cities, including Ha Noi, Da Nang, and Ho Chi Minh city. As previously mentioned, two mandatory screening questions were posed before participants could access the questionnaire. Approximately 367 individuals opened the questionnaire, and of these, 32 were disqualified based on the screening questions. Consequently, 335 respondents remained eligible for further analysis. Bartlett et al. (2010) emphasized that for SEM research, a sample size of at least 10 observations per indicator (independent variable) is recommended. With 335 cases collected, the current sample size is deemed adequate for subsequent analyses using structural equation modeling. The characteristics of the respondents are presented in **Table 1**.

Table 1. Demographic characteristics of the sample.

Variable	Description	Frequency	Percent
Gender	Male	106	31.6%
	Female	229	68.4%
Age	18–25	143	42.7%
	26–33	105	31.3%
	34–41	69	14.8%
	42–49	15	4.4%
	50–57	3	0.8%
Employment	Student	45	13.4%
	Part-time	37	11.0%
	Full-time	86	25.7%
	Homemaker	22	6.6%
	Self-employed	63	18.8%
	Serving for government	37	11.0%
	Serving for private	30	9.1%
	Others	15	4.4%
Virtual supermarket shopping during the last six month	1–2 purchases	79	23.6%
	2–4 purchases	102	30.4%
	>5 purchases	154	46.0%
Amounts spent virtual supermarket (last six month)	0–1,000,000 VND	37	11.0%
	1,000,000–3,000,000 VND	117	35.0%
	3,000,000–5,000,000 VND	67	20.0%
	5,000,000–8,000,000 VND	79	23.6%
	>8,000,000 VND	35	10.4%

3.3. Data analysis

To validate the measures and examine the proposed hypotheses, the two-step approach outlined by Anderson and Gerbing (1988) was adopted, and the analysis was conducted using the AMOS 24.0 program. Initially, confirmatory factor analysis (CFA) was carried out to assess the reliability and validity of the measures. Second, a structural model was assessed to test the direct and indirect relationships between the variables of the study.

4. Results

4.1. Evaluation and refinement of measurement scales

To ensure the reliability of the measurement variables in this study, items that hindered the single dimensionality of each research concept were removed using

Cronbach's alpha and item-to-total correlation analysis for each measurement variable. Consequently, 36 items were identified for exclusion based on the calculation of item-to-total correlations, using the recommended cutoff of 0.50. To enhance the Cronbach's alpha and item-to-total correlations, one item from each of the seven factors was eliminated. The coefficient alphas arrange between 0.860 and 0.913 across the seven factors.

Table 2. Results of exploratory factor analysis (EFA).

	Component					
	1	**2**	**3**	**4**	**5**	**6**
PI5	0.807					
PI7	0.803					
PI1	0.743					
PI3	0.731					
PI6	0.706					
PI2	0.657					
PI4	0.571					
PU3		0.903				
PU4		0.858				
PU2		0.834				
PU1		0.830				
PU5		0.786				
IN3			0.903			
IN2			0.816			
IN1			0.813			
IN4			0.770			
IN5			0.582			
PEU5				0.868		
PEU3				0.850		
PEU1				0.779		
PEU4				0.759		
PEU2				0.705		
PE4					0.895	
PE2					0.858	
PE5					0.821	
PE3					0.813	
AT3						0.794
AT4						0.715
AT1						0.715
AT5						0.571
AT2						0.562

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser normalization.
a. Rotation converged in 6 iterations.

The findings from **Table 2** indicate that the initial set of 35 observed variables was effectively maintained and organized into 6 distinct clusters. Each observed variable demonstrated satisfactory factor loadings, all exceeding 0.5 (Hair et al., 2010). The factor loadings spanned from 0.562 to 0.903, confirming that all variables were deemed acceptable. Consequently, these observed variables can be categorized into the 6 identified clusters.

4.2. Measurement model assessment

Confirmatory Factor Analysis (CFA) was employed for each research concept, utilizing refined items identified through internal consistency analysis. The objective was to assess the factorial structure of the complete scale and validate the reliability and validity of the corresponding measurement model, focusing on convergent and discriminant validity to ensure the unidimensionality of the multiple-item structures (Bollen, 1989). Residual difference analysis was conducted for further scale refinement. Specifically, items with residuals exceeding ± 2.58 were flagged for deletion to enhance the single dimensionality of each study concept (Kline, 1998). The outcomes revealed that 2 items of Personal Innovativeness of Information Technology (PIT) were eliminated to improve model fit.

As depicted in **Table 3**, the findings reveal that the items comprising each construct exhibit substantial loading values (0.50 or higher). Furthermore, each constituent concept demonstrates an AVE (Average Variance Extracted) level surpassing the threshold of 0.50, indicating their reliability as measurement tools. Additionally, to validate each constituent concept, it is imperative to assess whether the individual factors exhibit distinct differences from one another, as well as their correlations with external variables. The fit indices of the measurement model are as follows: $\chi 2/df = 2.332$, GFI = 0.821, TLI = 0.901, CFI = 0.910, IFI = 0.911, RMSEA = 0.063 (Hair et al., 2010).

Table 3. CFA results of the measurement model.

Constructs	Number of items		Cronbach's alpha	CR	AVE	Parameter estimate	*t*-value
	Before analysis	After analysis					
PU	5	5	0.913	0.843	0.681	0.767–0.875	17.139–21.436
PEU	5	5	0.886	0.780	0.609	0.759–0.796	14.718–15.387
PE	4	4	0.896	0.826	0.550	0.813–0.904	16.829–20.722
PIT	7	5	0.841	0.718	0.584	0.673–0.796	10.692–11.946
ATT	5	5	0.893	0.729	0.689	0.758–0.825	16.337–17.103
INT	5	5	0.893	0.835	0.632	0.715–0.871	14.493–19.120
PR	5	5	0.875	0.790	0.586	0.730–0.794	13.874–14.952

$\chi 2/df = 2.332$, GFI = 0.821, TLI = 0.901, CFI = 0.910, IFI = 0.911, RMSEA = 0.063.

Assessing discriminant validity involves calculating the correlation between concepts along with their respective confidence intervals, following Jőreskog's (1988) method. If the confidence interval encompasses 1.0, it suggests that there are no significant differences between the two concepts (Anderson and Gerbing, 1988). The findings indicate that the correlations between each concept, along with their

standard errors and confidence intervals, do not exceed 1.0. Additionally, the AVE (Average Variance Extracted) of each variable surpasses the squared correlation between the variables. Comparing AVE with squared correlations (*R*-squared values) helps to demonstrate discriminant validity by ensuring that each construct explains more variance in its indicators than it shares with any other construct. This ensures that the constructs are distinct and not highly correlated due to measurement overlap or shared variance.

4.3. Structural model analysis

Structural Equation Modeling (SEM) was utilized to test the proposed research model (see **Figure 2**).

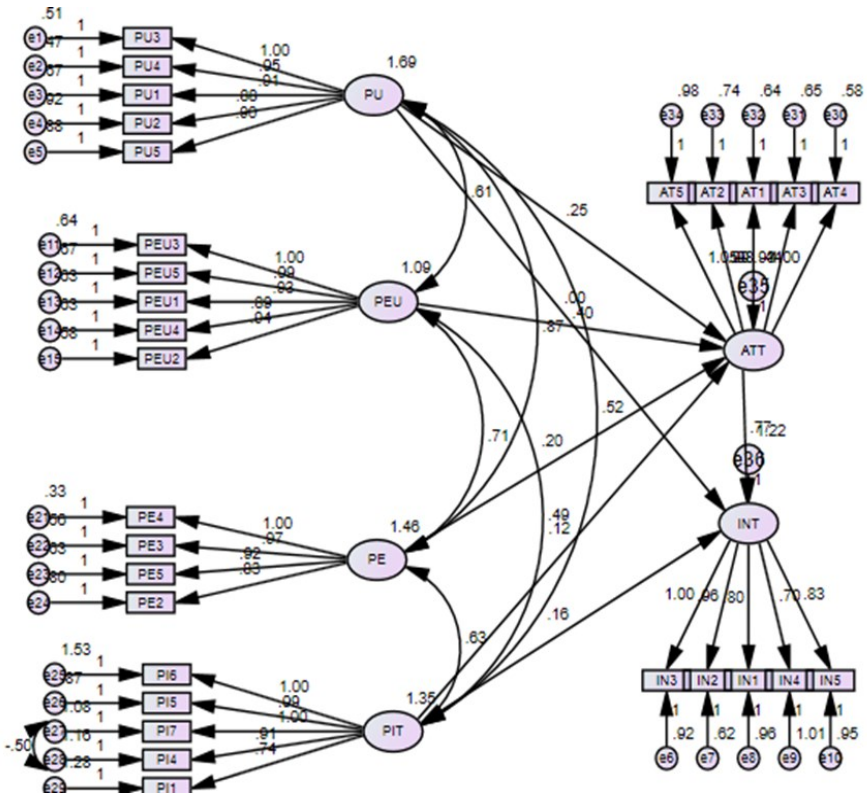

Figure 2. SEM results of the research model.

The outcomes revealed that the TLI, CFI, and IFI scores (0.897, 0.908, and 0.909, respectively) met the criteria, indicating a favorable fit between the structural model and the data. The RMSEA and GFI values were 0.068 and 0.825, respectively, indicating a fit close to the desired level. The relative Chi-square/df ratio (2.616) fell within the recommended range. The R-squared value for ATT is 0.637, indicating that 63.7% of the variation in ATT can be explained by the independent variables. Similarly, the R-squared value for INT is 0.570, meaning that 57.0% of the variation in INT can be attributed to the independent variables. These fit indices were deemed satisfactory, suggesting that the structural model adequately represents the data, considering the sample size, and could potentially be employed to elucidate the hypotheses in this study. Thus, all fit indices fell within the appropriate range, indicating a good model fit (Hair et al., 2010). Additionally, a structural equation

model analysis was conducted to evaluate the hypotheses of this research, with the results presented in **Table 4**.

Table 4. Path analysis results.

Hypothesis	Path	Estimate	C.R.	*p*	Result
H1	PU → ATT	0.295	5.507	***	Supported
H2	PU → INT	0.000	−0.005	0.996	Not Supported
H3	PEU → ATT	0.379	6.521	***	Supported
H4	PE → ATT	0.214	3.581	***	Supported
H5	PIT → ATT	0.122	2.430	0.015**	Supported
H6	PIT → INT	0.125	2.133	0.033**	Supported
H7	ATT → INT	0.585	7.533	***	Supported

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ level of significance; C.R. (Criteria Ratio).

Once the model fit reached satisfactory levels, a null hypothesis (H0) was employed to test whether any relationship remained or was estimated to be zero. As anticipated, the results indicate that all hypothesized relationships, with the exception of those involving Perceived Usefulness (PU), Perceived Ease of Use (PEU), Perceived Enjoyment (PE), and Personal Innovativeness of Information Technology (PIT) to Attitude to Use QR code-based virtual supermarkets, were positively significant. Moreover, Attitude to Use VSs exhibited a significant relationship with Intention to Use VS ($\beta = 0.585$, $p < 0.01$), supporting hypothesis H7. Contrary to the proposed hypothesis, it was found that hypothesis H2 ($\beta = 0.000$, $p = 0.996$) was not statistically significant, indicating that Perceived Usefulness did not influence Intention to Use VS. This suggests that all hypotheses (except H2) were supported. Additionally, the results highlight strong direct influences from Perceived Usefulness and Perceived Ease of Use on Attitude to Use QR code-based virtual supermarkets, subsequently influencing Intention to Use QR code-based virtual supermarkets.

4.4. Moderating effects

A moderating effect is identified when the interaction between two hidden variables is influenced by a third variable, thus altering the relationship (Hair et al., 2013; Memon et al., 2019). In this study, perceived risk was employed as a moderator. The analysis results are shown in **Table 5**.

Table 5. Moderating effects.

			Estimate	S.E.	C.R.	*P*
ZINTENTION	←	INTERPRISK	−0.120	0.030	−3.259	0.030
ZINTENTION	←	ZPRISK	0.174	0.049	3.568	***
ZINTENTION	←	ZATTITUDE	0.503	0.049	10.344	***

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ level of significance.
ZINTENTION, ZATTITUDE, and ZPRISK are the names of the standardized variables created from INTENTION, ATTITUDE, and PRISK, respectively.

As shown in **Table 5**, both perceived risk and attitude significantly influence the intention to use QR code-based virtual supermarkets. It also indicated that the

interaction between perceived risk and attitude was significant ($p = 0.030 < 0.05$) in explaining the variance in Intention, thereby supporting H8. This suggests that varying levels of perceived risk could significantly moderate the relationship between attitude and intention to use QR code-based virtual supermarkets during the consumption process. Furthermore, the regression coefficient is −0.12, indicating a negative correlation. This suggests that as perceived risk increases, it diminishes the impact of attitude on intention to use QR code-based virtual supermarkets.

5. Conclusion and discussion

5.1. Summary findings

Majority of existing studies have explored the significant impact of innovativeness on behavioural intention (Cheng and Huang, 2013; Tan and Sie, 2015; Thakur and Srivastava, 2014; Yang, 2012). However, not many studies have analysed the impact of personal innovativeness on attitude. This indicates that the simplicity of using the technology and the level of satisfaction with the virtual supermarket shopping encounter are crucial factors in predicting the prospective shopper's intent. In particular, this study argues that consumers will opt for QR code virtual supermarket purchases only if they perceive the experience as enjoyable and find the technology easy to navigate. This assertion is backed by findings from Ramayah et al. (2003) as well as Shaikh et al. (2020). The perceived usefulness did not emerge as a significant determinant of the intention to shop at QR code virtual supermarkets. This study suggests that this unexpected outcome may be influenced by factors such as the nature of shopping preferences. QR code virtual supermarkets purchases are believed to be less common in Vietnam consumers, while shoppers still prefer traditional supermarkets for purchasing items. Consumers' attitude toward this type of shopping determines their expectations, which further determines their behavioral intentions (Alshare and Lane, 2011; Rahman et al., 2019; Šumak et al., 2010). Especially, the relationship between consumers' attitudes and behavioral intentions is largely influenced by the perceived risk. The moderating role of perceived risk is supported by the study of Johnson (2022).

5.2. Research significances

5.2.1. Theoretical implications

This study adds to the current body of literature in several ways. Initially, previous research in the retail sector has predominantly focused on investigating virtual reality stores and their impacts. However, few studies have been found on QR code-based virtual supermarkets and consumers' responses to this type of shopping. Therefore, this study contributes to the literature by analyzing the adoption of consumers of QR code-based virtual supermarkets in the retail industry. And second, the primary theoretical advancement of this study involves broadening the application scope of TAM theory within retail research. Specifically, it explores three key factors of TAM theory (perceived ease of use, perceived usefulness, and attitude) as they relate to retailing and the additional factors, include perceived enjoyment and personal innovativeness of information technology, in TAM theory

has been recognized as playing a role in enhancing consumers' attitudes to use QR code-based virtual supermarket applications in shopping.

5.2.2. Practical implications

The findings of this research carry practical implications for both marketers and retailers. Since perceived ease of use has been identified as the major driving force in QR code-based virtual supermarket adoption, promotional messages emphasizing the convenience and simplicity of using QR code virtual supermarkets can assist potential shoppers in making informed decisions about their purchases. Secondly, it is especially important for the retailers to carefully develop the QR code-based virtual supermarket content and make it as immersive as possible. Thirdly, the significance of consumers' perceptions risk enhances consumers' using QR code-based virtual supermarkets; therefore, managers should provide a series of support measures to minimize the perceived risk of users as much as possible.

5.3. Limitations and future research

Although there are many theoretical and practical contributions, some limitations exist in this study that can provide directions for future research. First, when collecting data, one of the limitations of this study is that it only contains data from Vietnam, which may not be generalized to the other cultural context and different research situations may produce different results. Second, the study did not consider demographic variables as moderating variables. Future research suggests examining differences in acceptable behavior for QR code-based virtual supermarket applications among these demographic variables.

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