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Towards Sustainable Adoption: Investigating QR Codes Mobile Payment Continuance in Tanzania

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Abstract

The adoption of QR codes in the payment of various services has grown and deepened financial inclusion in Tanzania. Despite its initial acceptance, the sustainability of using QR codes for payment is unknown. Based on that, this study examines the continuance intention of using QR codes for payment in Tanzania by extending the Technology Continuance Theory (TCT) to assess the moderating effects of perceived risks and perceived service trust. A convenient sampling technique was employed to identify respondents. Online and paper-and-pencil techniques were used to distribute the questionnaire. Among the received responses, 271 responses were considered to be valid and reliable for data analyses. Partial List Square Structural Equation Modeling (PLS-SEM) was employed to evaluate the hypothesised relationships. Findings from this study show that perceived usefulness, confirmation, and ease of use significantly influence attitude and satisfaction. Moreover, satisfaction, attitude, perceived risk, perceived usefulness, and perceived service trust significantly influence the continuance of QR codes for mobile payments in Tanzania. The study also found that perceived risk and perceived service trust moderate the relationships between attitude and continuance usage of QR codes. The implications from this study have been provided to enable financial service providers and policymakers to enhance how QR code services and infrastructures should be implemented and enhanced for sustainability in Tanzania.

Keywords: QR Code, Mobile Payments, Financial Inclusion, Tanzania

1. Background

Recently, there has been an increase in the use of Quick Response (QR) codes globally. QR code is a two-dimensional digital image readable by a smartphone, allowing high-speed access to mobile services (Barrera et al., 2013). Initially, it was used in the Japanese automotive industry for tracking inventory (Bamoriya, 2014; Pandya & Galiyawala, 2014), and currently, it is widely used for various mobile-related transactions such as mobile payment, marketing and library (Jiang et al., 2021; Kadli, 2020; Vuksanović et al., 2020) to mention a few uses. QR codes are preferred in mobile transactions because of their high speed and security features compared to traditional bar codes (Focardi et al., 2018; Wahsheh & Luccio, 2020). The technology offers customers an easy, secure, and convenient way to settle payments (Rafferty & Fajar, 2022). Moreover, it can be scanned quickly and

does not require costly hardware; therefore, it is an economically viable payment method (Hamzah et al., 2023). As such, the QR code payment system gained popularity in China, spreading worldwide (Rafferty & Fajar, 2022). Its prominence and wider acceptance were also witnessed during the COVID-19 pandemic, especially in Asian countries and elsewhere (Hamzah, 2023; Koay & Ang, 2023).

However, the technology is not very popular in sub-Saharan Africa, including Tanzania, where mobile money transfers and payment through mobile money operators are popular (Ledi et al., 2023). In Tanzania, for instance, the mobile payment method using a QR code was introduced in 2018 when several financial firms and telecommunication companies partnered with Mastercard to offer payment services. Despite this initial stage, the QR code payment services were provided without a standardised framework. Reasonably, the Bank of Tanzania, to promote interoperability between multiple independent and potentially heterogeneous systems containing risks, developed the Tanzania Quick Response Codes (TANQR) standard to enhance security in transactions (Bank of Tanzania, 2022). Subsequently, all banks, mobile money service providers, and other payment service providers wishing to use the QR code to offer payment services were compelled to use the standard (BOT, 2022). The established standard enhanced customers' confidence and increased the acceptance of QR code payment services. The QR codes add to the already-existing mobile payment culture using smartphones. Hence, its continuance usage among customers is expected to be high. However, there is scarce literature documenting the extent of QR code acceptance and continuance usage for payment among customers in Tanzania (Ledi et al., 2023). Moreover, the intention to continue using QR codes for payments among users has not been investigated. This research gap necessitates the current study to examine factors behind the continuance usage of QR codes for mobile payments in Tanzania.

Previous studies confirm that the success of any information system depends on its continuance usage and not on its initial adoption (Bhattacharjee, 2001). Hence, understanding factors contributing to sustainable adoption is imperative for the success of QR codes in mobile payment services in Tanzania. Prior studies on sustainable adoption of mobile payment employed the Expectation- Confirmation Model (ECM), a dominant model in studying mobile payment adoption (Franque et al., 2021a; Humbani & Wiese, 2020; Ifada & Abidin, 2022; Singh, 2020; Sleiman et al., 2022; Sreelakshmi & Prathap, 2020; Zhao & Bacao, 2020). However, other studies have confirmed that ECM has lower explanatory power than the Technology Continuance Theory (TCT). Moreover, EMC heavily relies on satisfaction as the sole determinant of continuance intention (Liao et al., 2009; Rahi et al., 2021). Accordingly, the current study uses the Technology Continuance Theory (TCT) as a theoretical lens to investigate the intention to continue using QR codes in mobile payment services. Reasonably, TCT is a specialized theory on technology continuance adoption which addresses the weaknesses of the traditional theory for technology continuance adoption, ECM. Similar to other theories' limitations in studying every aspect of technology continuance intention, the current study extends TCT by integrating it with perceived service trust and security risks.

Trust is an ongoing concern for users in financial transactions. Previous studies indicate that perceived service trust and security risks play a crucial part in motivating and de-motivating users to use and continue using financial services (Al-Okaily et al., 2022; Chin et al., 2022; Liébana-Cabanillas et al., 2022; Medlin & Cazier, 2007; Shankar et al., 2023). Nevertheless, perceived service trust and security risks have received little attention in studies investigating the adoption of QR codes in mobile payment services.

Further, while previous studies on financial transactions have indicated the potentiality of perceived service trust as a moderating factor (Kaur & Arora, 2021; Riemenschneider et al., 2009; Tian et al., 2023), its moderation impact on the continuance usage of QR code has been under-researched. Therefore, the current study integrates perceived service trust and security risks as moderating variables and the direct predictors of continuance use of QR codes for mobile payments. The study's novelty is the integration of TCT with two constructs, perceived risks and perceived service trust, and modelling their direct and moderating impact on the continuance use of QR codes in mobile payments. The rest of the paper is organized: a literature review, methodology, data analysis and findings, discussions, implications and limitations, and future studies.

2. Literature Review

2.1. Cashless Payment System

The popularity and usage of cashless payment systems have increased worldwide as financial technology speeds up the payment processes (Rahman et al., 2020). As such, cashless payment systems allow service consumers to conduct financial transactions without physical cash (Rahman et al., 2020), and the trend of using cashless services enables consumers to transact anywhere and anytime (Tee & Ong, 2016). For instance, electronic payment increased tremendously during the COVID-19 pandemic due to directives on social distancing and contactless (Eren, 2024). As people were obliged to stay home, cashless payment systems were considered the best option (Tripathi & Dave, 2022). Despite the many cashless payment system such as mobile payment, credit and debit card payment, bank transfer, and online payment, the QR code payment method was highly recommended during the pandemic (Eren, 2024), as most service providers considered QR codes to simplify the payment process. Literature has pointed out the primary factors driving the use of cashless payment systems: digitization, financial inclusion, and changes in the retail business model from offline to online (Raya & Vargas, 2022). Moreover, the advantages of using cashless payment are highlighted as discouraging tax evasion and enabling central banks to monitor and control financial transactions (Raya & Vargas, 2022).

2.2. QR Payment System in Tanzania

Financial service providers such as banks have recently adopted the QR-code payment option as an alternative to cash payments to allow consumers to pay for various services (Bank of Tanzania, 2022). Similarly, mobile service providers have introduced QR codes (*Scan QR code to pay service*) to enable users to conduct payments. Furthermore, the Bank of Tanzania (BoT) introduced a QR code payment system called TANQR code to initiate and accept payments from customers and merchants. Introducing the TANQR code is expected to increase the use of non-cash payments in the retail ecosystem and enable Such an initiative to strengthen financial inclusion.

Moreover, TANQR will enhance the connectivity of various financial systems and enable the Bank of Tanzania to monitor and regulate risks from using QR codes in payments. A study from the Bank of Tanzania (2022) has shown that QR code option payment is currently considered an option in Tanzania. Despite adopting a QR code payment system, the sustainability of QR codes in Tanzania has not been researched in detail.

3. Theoretical Framework and Hypotheses

The current study proposes a theoretical framework that guides the main objective and hypotheses to investigate the continuance intention to use QR codes for payment. The proposed theoretical framework comprises six (6) constructs emanating from the TCT theory: perceived ease of use, perceived usefulness, confirmation, attitude, satisfaction, and continuance intention to use QR code for making payment, and two (2) additional constructs which are perceived risks and perceived service trust. TCT was coined by Liao et al. (2009) to address the weakness of the ECM- a traditional theory used to study post-adoption behaviours. TCT integrates three theories: the Technology Acceptance Model (TAM), the Cognitive Model (COG) and ECM. TAM posits that the intention to use technology is determined by the user's attitude (Davis, 1989), which is shaped by two key variables: perceived usefulness and perceived ease of use of the technology. TAM is primarily used to investigate the acceptance of technology in different contexts. However, the theory has rarely been used to investigate technology's continuous adoption behaviour when integrated with other theories (Mustafa & Garcia, 2021; Wu & Chen, 2017). On the other hand, COG suggests that user satisfaction is the function of expectations and disconfirmation (Oliver, 1981). As such, a user cognitively evaluates prior expectations to confirm or disconfirm satisfaction.

Regarding ECM, the model postulates that continuance usage of the technology is mainly influenced by user satisfaction (Liao et al., 2009). This theoretical framework emulates the perceived risks and perceived service trust as direct predictors and moderators. Perceived risks moderate the relationships between attitude and continuance intention, and perceived service trust moderates the relationships between attitude, perceived usefulness,

satisfaction, and continuance intention. The current theoretical framework and its associated hypothetical relationships are indicated in Fig. 1. The hypothetical relationships between the constructs of the study are explained in the following paragraphs.

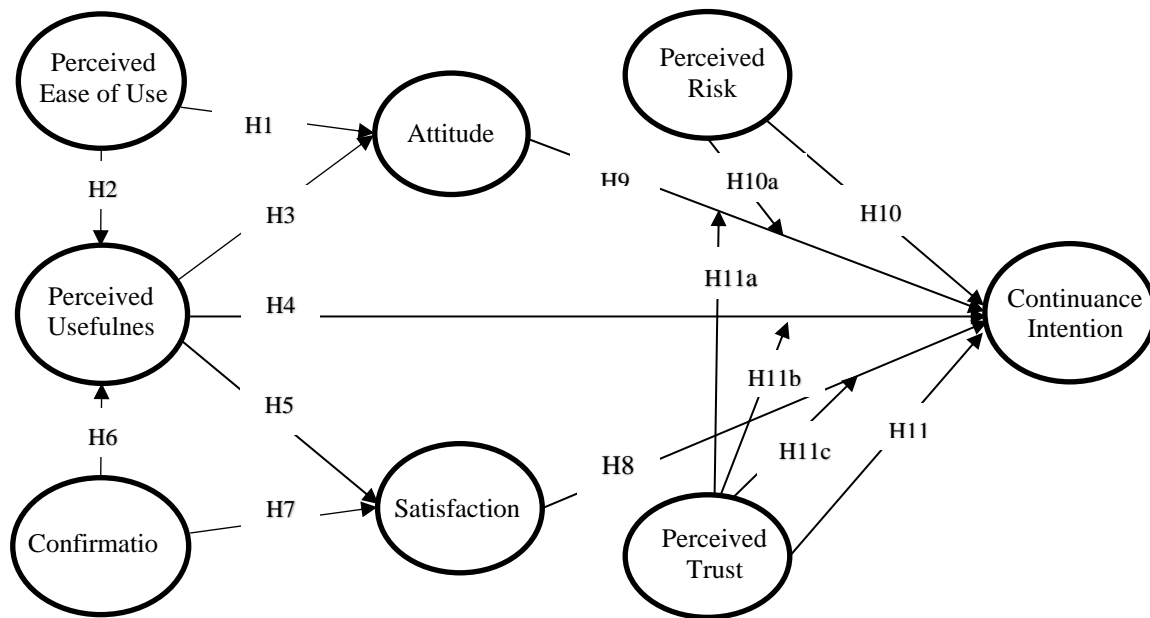


Figure 1: Theoretical Framework

Perceived ease of use is the extent to which an individual perceives that the technology or system requires less or no effort to accomplish specific functions. When users perceive the system as usable, easy to use, and requiring no effort to achieve a particular activity, such a system will be considered user-friendly in accomplishing tasks. Several empirical studies have concluded that perceived ease of use positively influences the usefulness of mobile payment (Franque et al., 2021a; Yan et al., 2021). Similarly, the QR code is considered one of the simplest payment methods; users are not required to key in a lot of information to make payments. Instead, users ought to scan, and automatically, they will be directed to payment options. Such an interface simplifies the payment process and reduces the chances of errors, making the QR code helpful among the available payment options (Yan et al., 2021). Additionally, Using a QR code in mobile payment makes it easier to achieve the payment process because it is quicker and faster than using cash and credit/debit cards (Yan et al., 2021). Therefore, based on this explanation, this study hypothesizes that:

H1: Perceived ease of use positively and significantly influences users' attitudes toward using QR codes in mobile payments.

H2: Perceived ease of use has a positive and significant influence on the usefulness of using QR codes in mobile payments.

Perceived usefulness is an individual belief in which a user perceives that using a particular system/technology will improve their job performance (Bolodeoku et al., 2022). When individuals perceive that using a specific technology/system tends to boost the outcome of a specific activity, their likelihood of continuing to use that system increases. Studies have shown that when users believe there is an increase in productivity, quick transactions, and individual effectiveness when using a specific technology or system, that technology or system is considered valuable (Bolodeoku et al., 2022). Besides, when users perceive the technology as helpful, they will be satisfied and continue using it (Sleiman et al., 2022). Additionally, when users perceive the information system as helpful, their attitude toward it becomes positive (Alhassan et al., 2020). Several past studies have shown that perceived usefulness has a positive and significant effect on attitude, satisfaction, and continued usage of mobile

payments (Alhassan et al., 2020; Sleiman et al., 2022; Yan et al., 2021). Similar to using QR codes in mobile payments, when savvy mobile users perceive that using QR codes in conducting financial transaction payments will enhance convenience and simplify the payment process, they will likely be satisfied and continue using QR codes in mobile payments. Based on the above explanation, this study postulates that:

H3: Perceived usefulness has a positive and significant influence on the attitude of using QR codes in mobile payments.

H4: Perceived usefulness positively influences the intention to continue using QR codes in mobile payments.

H5: Perceived usefulness positively and significantly influences satisfaction with using QR codes in mobile payments.

Confirmation is the extent to which an individual realizes the expected benefits after using the technology or system (Tam et al., 2020). The Expectation-Conformation Model (ECM) posits that when an individual confirms the expected benefits during the usage of the technology/systems, it leads to a positive influence on the perceived usefulness and satisfaction of using such technology or system, hence building the willingness to continue using the technology (Bhattacharjee, 2001). At the pre-adoption stage, users tend to have expectations of the usefulness of the technology. After usage, they build more robust experiences on the actual usefulness, confirming or disconfirming their prior expectations (Hariguna et al., 2023). Several studies have empirically concluded that confirmation positively and significantly influences satisfaction and perceived usefulness (Hariguna et al., 2023; Tam et al., 2020; Tung, 2022). Likewise, users expect many benefits (quick response, error-free, effectiveness) when using QR codes in mobile payments. When such expected benefits are apprehended during the actual usage, the likelihood of confirmation to influence satisfaction and perceived usefulness tends to be very high. Based on the above explanations, this study postulates that:

H6: Confirmation positively and significantly influences the perceived usefulness of using QR codes in mobile payments.

H7: Confirmation positively and significantly influences the satisfaction of using QR codes in mobile payments.

Satisfaction is considered an individual feeling related to usage experience performance outcome and is acquired after users have started using the information technology (Franque et al., 2021). Satisfaction is one of the leading, most decisive factors defining the continuance of information systems use (Bhattacharjee, 2001). When users are satisfied with the information system, the likelihood of using such technology tends to be very high (Chen & Li, 2017). This means that as the expected benefits are confirmed, the level of satisfaction also goes up, influencing the continuance of using the technology. It has been empirically proved that satisfaction has a positive and significant influence on the continuance of the use of information technology (Chen & Li, 2017; Franque et al., 2021; Sleiman et al., 2022). Likewise, when users are satisfied with how QR codes simplify payments, the likelihood of continuing to use QR codes will be very high. These arguments enable the authors to hypothesize that:

H8: Satisfaction positively and significantly influences the intention to continue using QR codes in mobile payments.

Attitude is defined as an individual perception of information technology. Attitude captures dimensions such as sound, harmful, beneficial, pleasant, or unpleasant (Alhassan et al., 2020). When users of information technology have any of the attitude dimensions against the information system, the decision to keep using that information system will depend on that particular dimension (Alhassan et al., 2020). Bagozzi and Warshaw (1990) categorised attitude into three dimensions: attitude toward success, failure, and learning new technology. Once a user forms an attitude to learn how to use new technology, the attitude of success in using the technology becomes high (Kejela & Porath, 2022). Several studies have empirically confirmed that positive attitudes significantly influence mobile payment use (Alhassan et al., 2020; Handoko, 2022; Kejela & Porath, 2022). Similar to the QR code, when

individuals form a positive attitude toward using QR codes to simplify the payment process, the likelihood of continuing to use the QR codes increases. Based on this explanation, this study hypothesises that:

H9: Attitude positively and significantly influences the intention to continue using QR codes in mobile payments.

Perceived risk is an individual perception of loss that can be incurred when using information technology/systems (Mutahar et al., 2022). Yang et al. (2015) described perceived risk into five major categories: financial risk, time risk, privacy risk, psychological risk, and performance risk. Corresponding to the risks, studies have also identified fear associated with monetary loss, fear of personal data being exposed or accessible by the wrong person, fear of non-performance of the information technology as expected, fear of time loss, and fear of psychological frustration and pressure which tend to reduce the possibility of users to continue using the information technology (Hossain, 2019; Yang et al., 2015). Empirical evidence from previous studies has shown that perceived risk negatively influences the continuance of technology usage (Akhtar et al., 2023; Hossain, 2019).

Additionally, using QR codes in mobile payments has several risks, such as tempered QR codes, fake QR codes generated from malicious websites, and data privacy issues. When users perceive that using QR codes in mobile payments exposes them to potential risks, the possibility of continuing to use QR codes in mobile payments becomes very low. Correspondingly, the risk perceptions suppress users' attitudes toward using or continuing to use an information system or e-service (Sadiq et al., 2022). Therefore, based on this explanation, this study assumes that:

H10: Perceived risk negatively and significantly influences the intention to continue using QR codes in mobile payments.

H10a: Perceived risk negatively and significantly moderates the relationships between users' attitudes and the intention to continue using QR codes in mobile payments.

Trust is among the main factors for the success of any electronic business because it sets up the foundation of the relationship between two parties that are transacting (Hossain, 2019). As trust is extended to other platforms used to conduct transactions, consumers must trust the systems used for electronic transactions in electronic payments. Users need to believe that the systems are secure and safe for transactions. This means that the lower the level of trust, the lower the probability of using such technology in electronic payments (Hossain, 2019). Several prior empirical studies have examined the influence of perceived service trust and concluded that it has a positive and significant influence (Hossain, 2019; Nandru et al., 2023).

Further, trust enhances users' attitudes towards an information system or an e-service (Lavuri et al., 2022), thus boosting their likelihood to continue using the same. Also, the perception of trust moderates users' satisfaction and the usefulness of intention to use an information system or e-service (Baidoun & Salem, 2024; Venkatakrishnan et al., 2023; Zhou et al., 2018). In QR code payments, when users trust that using a QR code mechanism will not reroute payment to a wrong destination, or the QR code used is not a fake generated code, the likelihood of adopting a QR code payment channel tends to be high. Based on this explanation, this study hypothesises that:

H11: Perceived service trust positively and significantly influences the intention to continue using QR codes in mobile payments.

H11a: Perceived service trust positively and significantly moderates the relationships between users' attitudes and the intention to continue using QR codes in mobile payments.

H11b: Perceived service trust positively and significantly moderates the relationships between perceived usefulness and the intention to continue using QR codes in mobile payments.

H11c: Perceived service trust positively and significantly moderates the relationships between satisfaction and the intention to continue using QR codes in mobile payments.

4. Research Methodology

4.1. Research Instrument Development

This study adopted a quantitative technique to examine the intention of using QR codes in mobile payments. The research instrument contained three sections; the first section introduced the research area to respondents and explained anonymity issues in the study. The second section was the demographic details, which captured the characteristics of respondents, and the last section was for the measurement items to measure the constructs used in the proposed conceptual framework. Measurement items were adopted from several past empirical studies; items for continuance intention from Bhattacharjee (2001) and Koloseni and Mandari (2017); items for perceived ease of use and perceived usefulness were adopted from Davis (1989); items for confirmation were adopted from Bhattacharjee (2001), and items for measuring attitude from Davis (1989). Items for measuring satisfaction were adopted from Bhattacharjee (2001) and Kumar et al. (2018); items for perceived risk from Bauer (1960), Chen (2012), and Kumar et al. (2018), and items for perceived service trust were adopted from Koloseni and Mandari (2024). All adapted measurement items were slightly modified to suit the context of the current study. All Measurement items were measured using a 5-Likert scale (1=Strongly Disagree, to 5= Strongly Agree). A skipping question was introduced to disqualify respondents who had never used mobile to make payments through QR codes.

The developed questionnaire was pre-tested for content validity using a group of experts from mobile service companies and academicians to have a quality data collection tool. The instrument's contents were verified by seven experts, which is within two to twenty as recommended by Hadi et al. (2020). A face-to-face meeting was conducted with experts, and they were required to rate the measurement items using a relevance rating scale (1=Not Relevant, 2=Relevant but Need Revision, 3=Very Relevant). Item Content Validity Index (I-CVI) value was calculated for each measurement item to establish relevance (Elangovan & Sundaravel, 2021). Hadi et al. (2020) proposed that any item with an I-CVI value greater than 0.79 is considered relevant. As such, the content validity analysis for this study found that two (2) items had I-CVI below 0.70 and were, therefore, deleted.

Furthermore, a group of language experts were consulted to provide recommendations regarding grammar and correct wording of measurement items; their suggestions were incorporated accordingly. Moreover, the improved research instrument was pre-tested by 20 people from expected respondents to make sure the instrument was clearly understood, as recommended by Ruel et al. (2015). The findings of the pre-testing were further incorporated to improve the instrument. The improved questionnaire was further translated into Swahili to enable respondents who are not conversant in the English language to respond to the questionnaire. A back-translation technique was employed by asking linguistic experts to translate the English Version into a Swahili Version (Bulmer & Warwick, 1993). Additionally, an independent linguist expert, unaware of the English Version, was requested to translate the Swahili Version back to an English Version; the two English versions were further compared and found to be similar with minor issues. This assured the researchers that the Swahili Version of the instrument was correct and could be used for data collection from Swahili conversant respondents.

4.2. Sample Size and Sampling

The population of this study was customers conducting payments through QR codes in Tanzania; since the population size is unknown, a formula for calculating sample size for an unknown population size was adopted with a 5% marginal error, producing a sample size of 385 (Israel, 1992). Online and paper-and-pencil techniques were employed to collect the data. The online questionnaire with a filter question targeting only customers using QR code payment was sent via WhatsApp, and respondents were requested to fill out and share the link with others. The paper-and-pencil questionnaires were distributed using a Convenience sampling technique. Convenience sampling was used because the targeted samples, who can pay using QR codes, were easily found in specific locations, such as restaurants, supermarkets, convenience stores, and shopping malls (Edgar & Manz,

2017). Similarly, the research assistants visited restaurants, supermarkets, convenience stores, and shopping malls and requested shoppers to fill in the questionnaire.

4.3. Sample Characteristics

The total number of respondents who returned questionnaires was three hundred and seven (307). However, thirty-six (36) responses were dropped due to the non-completion of many parts of the questions. Therefore, the final sample size for the subsequent analysis was two hundred and seventy-one (271). The findings indicate that most respondents were dominantly male (63.6%). Regarding income levels, the majority falls in the above one million (1,000,000 TZS/\$400 per month) income level band. Further, most respondents use QR codes to pay for goods and services once (1) to twenty (20) times per month. The detailed sample characteristics of the respondents are reported in Table 1.

Table 1: Sample Characteristics of the Respondents

Category	Variable	Frequency	Percentage (%)
Gender	Male	172	63.5
	Female	99	36.5
Age	18-24	35	12.9
	25-34	102	37.6
	35-44	100	36.9
	45 and Above	34	12.5
Income Level	100,000-300,000	33	12.2
	300,001-500,000	22	8.1
	500,001-1,000,000	60	22.1
	Above 1,000,000	156	57.6
QR Usage Frequency /Months	1-20 times	213	78.6
	21-40 times	31	11.4
	Above 40 times	27	10

4.4. Assessment of the Quality of the Measurement Model

The proposed model was assessed for reliability and validity. The study used the standard threshold values to ascertain the reliability and validity of the proposed research model. The results of the reliability analysis indicate that all constructs of the study are reliable. Mainly, Cronbach's alpha and composite reliability values are above the recommended threshold of equal or greater than 0.7 (Hair et al., 2021), as reported in Table 2. Both convergent and discriminant were used to assess the validity of the measurement model. Convergent validity was evaluated using the Average Variance Extracted (AVE) values. The study found that the AVE values for all constructs were well above the threshold of equal or greater than 0.5, signifying that each construct explains 50% of its item's variance (Guenther et al., 2023); hence, convergent validity was achieved. Heterotrait-Monotrait (HTMT) ratio was used for the discriminant validity because its performance surpasses the Fornell – Lacker criterion and cross-loadings approach (Voorhees et al., 2016). The results of the HTMT ratio are below 0.90, suggesting discriminant validity had been achieved (Henseler et al., 2015). The results of discriminant validity are reported in Table 3.

Table 2: Reliability and Convergent Validity Assessment Results

Constructs	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	AVE
ATT	0.952	0.953	0.969	0.913
CI	0.904	0.905	0.954	0.913
CON	0.885	0.895	0.929	0.815
PEOU	0.935	0.941	0.954	0.838
PR	0.871	0.993	0.917	0.788
PU	0.910	0.916	0.936	0.786
SAT	0.966	0.967	0.978	0.937

STR	0.882	0.909	0.928	0.812
				0.913

Notes:

ATT = Attitude	CI = Continuance Intention	CON = confirmation	STR = Perceived service trust
PR = Perceived Risk	PU = Perceived Usefulness	SAT = satisfaction	PEOU = Perceived Ease of Use

Table 3: Discriminant Validity Results: HTMT

Constructs	HTMT Criterion								AVE
	ATT	CI	CON	P	PR	PU	SAT	STR	
ATT									0.913
CI	0.871								0.815
CON	0.834	0.888							0.838
PEOU	0.761	0.832	0.780						0.788
PR	0.197	0.247	0.173	0.917					0.786
PU	0.832	0.884	0.843	0.707	0.185				0.937
SAT	0.886	0.857	0.838	0.719	0.129	0.833			0.812
STR	0.863	0.723	0.789	0.729	0.195	0.862	0.844		0.913

4.5. Structural Model Analysis

The quality of the structural model was evaluated using the variance inflation factor (VIF), the coefficient of determination (R^2) for the in-sample model prediction, predictive relevance (Q^2) for the out-of-sample prediction, effect size (f^2), and path analysis. The study found that the VIFs were within the acceptable thresholds of less or equal to five (≤ 5) (Guenther et al., 2023). Hence, the data had no multicollinearity issues. Figure 2 indicates the models' in-sample prediction capability. The study found that the model explained 92% ($R^2 = 0.92$) of the variance in the continuance intention, which was explained by attitude, perceived usefulness, perceived service trust, satisfaction, and perceived risks. The analysis indicates that 68.4% ($R^2 = 0.684$) of the variance in attitude was explained by perceived usefulness and perceived ease of use, 61.7% ($R^2 = 0.617$) of perceived usefulness was explained by confirmation and perceived ease of use and 76.8% ($R^2 = 0.768$) of Satisfaction was explained by perceived usefulness and confirmation. The higher the R^2 implies that the model's in-sample predictive capability is substantial for $R^2 = 92\%$, 68.4%, and 76.8% and moderate for $R^2 = 61.7\%$ (Chin, 1998) as reported in Table 4. The analysis of the out-of-sample prediction capability indicates that the Q^2 values are positive, suggesting that the model had good predictive capability (Chin, 1998). The study applied the Cross-Validated Predictive Ability Test (CVPAT), an improved version of Q^2 which estimates the model's prediction error to determine the average loss value to confirm the model's predictive capability. The PLS-SEM's average loss values were compared to the average loss value of prediction using indicator averages (IA) as a naïve benchmark, and the average loss values of a linear model (LM) as conservative benchmark (Sharma et al. 2023) to determine the model prediction capability. The results indicate that the PLS-SEM average loss values are significantly below zero, indicating that the study's model's prediction capabilities were good concerning the indicator average benchmark. However, our model had insufficient predictive power compared to the linear model (LM) benchmark. The results of the CVPAT are indicated in Table 5.

Table 4: Coefficient of Determination Results (R^2)

Constructs	R^2	R^2_{adjusted}
ATT	0.684	0.682
CI	0.920	0.918
PU	0.617	0.614
SAT	0.768	0.766

Table 5: Cross-Validated Predictive Ability Test (CVPAT) Results

Indicator Average (IA) Benchmark

Endogenous Construct	PLS loss	IA loss	Average loss difference	t-value	p-value
ATT	0.668	1.582	-0.914	7.711	0.000
CI	0.358	1.616	-1.259	14.005	0.000
PU	0.727	1.405	-0.678	7.717	0.000
SAT	0.458	1.444	-0.986	9.747	0.000
Overall	0.583	1.494	-0.911	11.314	0.000

Linear Model (LM) Benchmark

Endogenous Construct	PLS loss	LM loss	Average loss difference	t-value	p-value
ATT	0.668	0.271	0.397	7.520	0.000
CI	0.358	0.253	0.104	4.528	0.000
PU	0.727	0.555	0.173	3.861	0.000
SAT	0.458	0.258	0.199	3.929	0.000
Overall	0.583	0.359	0.224	7.177	0.000

The results of the structural model analysis are presented in Tables 6 and 7 and in Fig. 2 and 3. Table 6 and Fig. 2 show the structure model analysis results before introducing the moderating constructs. The study found that eleven (11) direct hypothesized relationships were supported.

Table 6: Hypotheses Testing Results – Direct Effects

Hypotheses	Path	Coefficients	t-values	p-values	Remarks	f ²
H1	PEOU → ATT	0.365	5.697	0.000	Supported	0.234
H2	PEOU → PU	0.251	3.502	0.000	Supported	0.082
H3	PU → ATT	0.537	8.670	0.000	Supported	0.507
H4	PU → CI	0.102	3.215	0.001	Supported	0.041
H5	PU → SAT	0.326	5.065	0.000	Supported	0.189
H6	CON → PU	0.588	9.201	0.000	Supported	0.449
H7	CON → SAT	0.601	8.536	0.000	Supported	0.645
H8	SAT → CI	0.386	9.129	0.000	Supported	0.440
H9	ATT → CI	0.135	3.010	0.003	Supported	0.034
H10	PR → CI	-0.085	5.375	0.000	Supported	0.087
H11	STR → CI	0.386	9.594	0.000	Supported	0.362

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.00$.

Moreover, Table 7 and Fig 3 show the moderation results. The findings of the moderation effects indicate that perceived risk has a negative and significant impact on the relationship between attitude and continuance intention; thus, H10a was supported. Perceived service trust has positive and significant moderating effects on the relationships between attitude and continuance intention; consequently, H11a was supported. However, the moderation relationships between perceived usefulness and continuance intention, H11b, and satisfaction and continuance intention, H11c, with perceived service trust as moderators were not supported.

Table 7: Hypotheses Testing Results Moderation Effects

Hypotheses	Paths	Coefficients	t-values	p-values	Remarks	f ²
H10a	PR x ATT → CI	-0.066	2.483	0.013	Supported	0.026
H11a	STR x ATT → CI	0.241	3.182	0.001	Supported	0.088

H11b	STR x PU	CI	0.031	1.248	0.212	Not Supported	0.005
H11c	STR x SAT	CI	-0.251	3.657	0.000	Not Supported	0.132

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

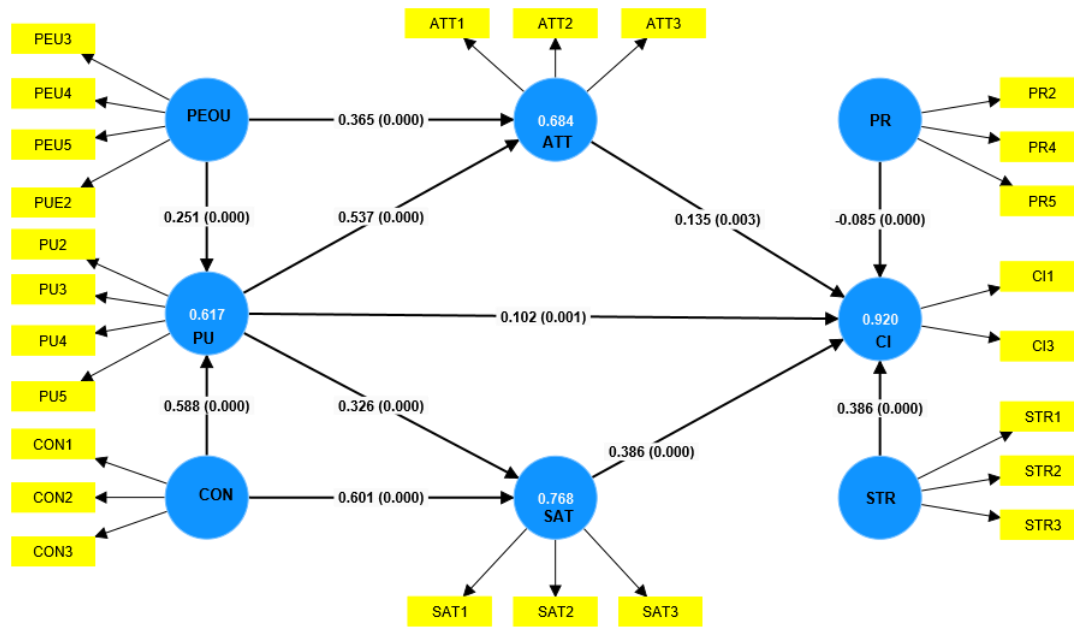


Figure 2: Structural Model Results for the Direct Effects

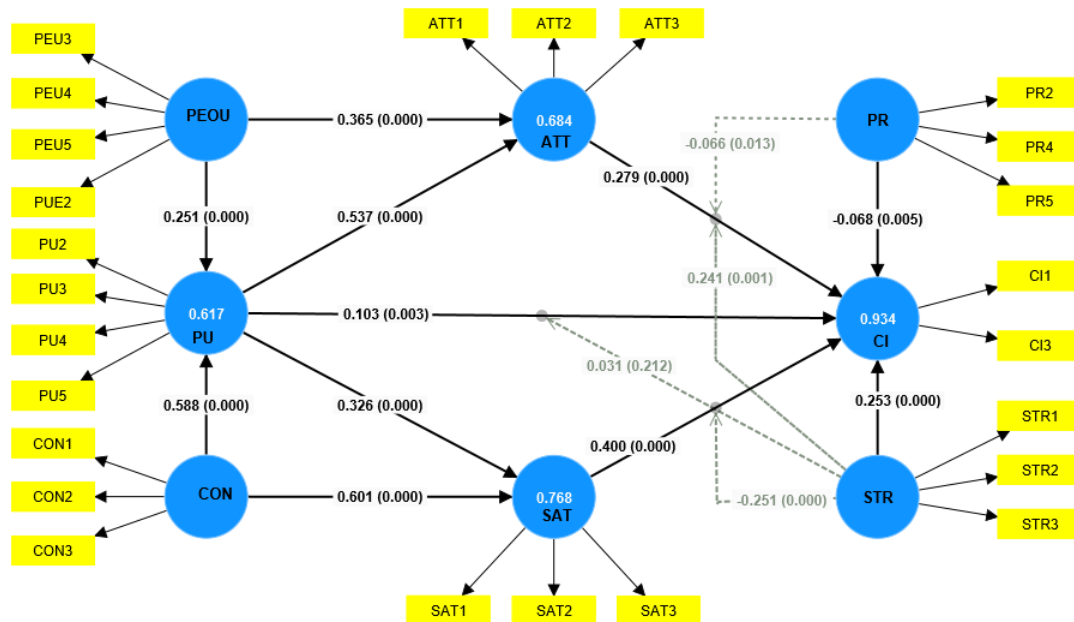


Figure 3: Structural Model Results for the Moderation Effects

The moderating analysis shows that perceived risk moderates the relationship between attitude and continuance intention (see Fig.4). Furthermore, Fig. 5 and 6 depict that perceived service trust moderates the relationship between attitude and continuance intention as well as satisfaction and continuance intention, respectively.

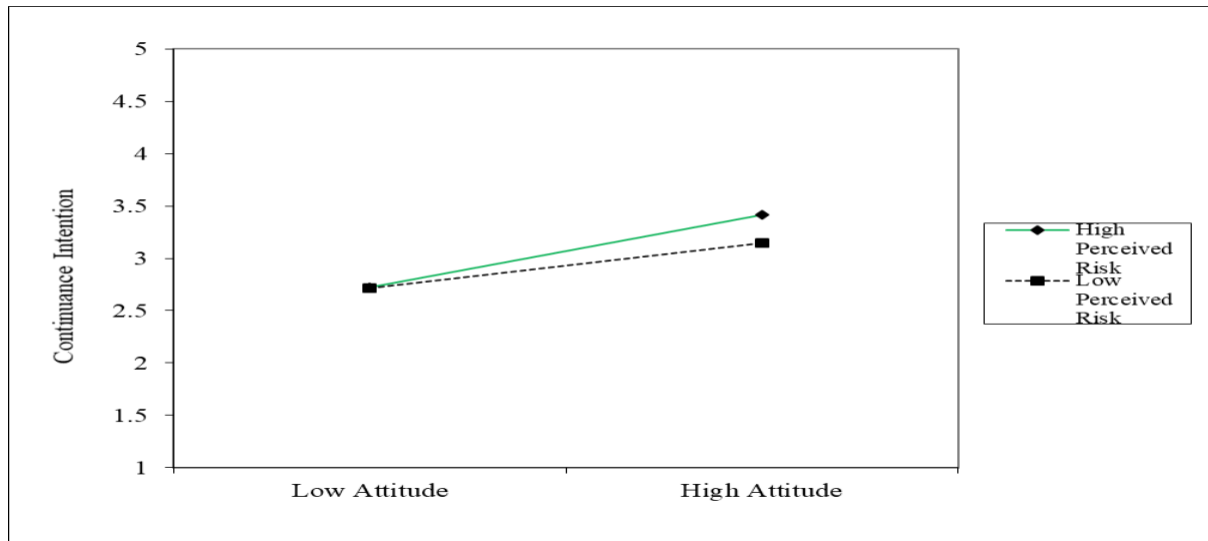


Figure 4: Moderation effects for Perceive Risks and Attitude on Continuance Intention

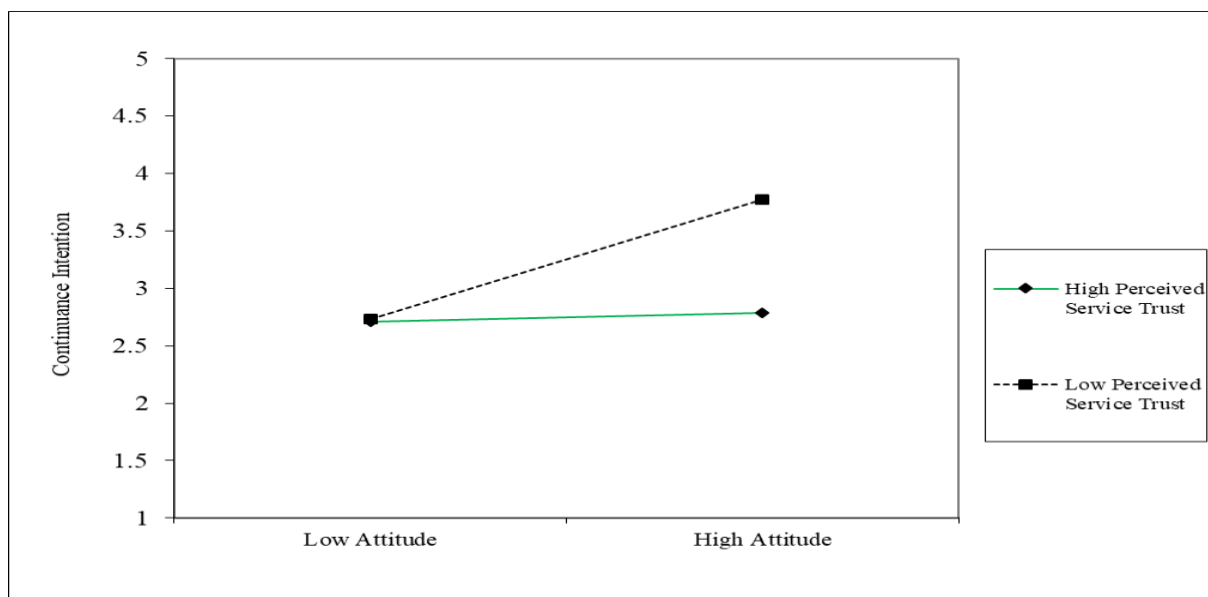


Figure 5: Moderation effects for Perceived service trust and Attitude on Continuance Intention

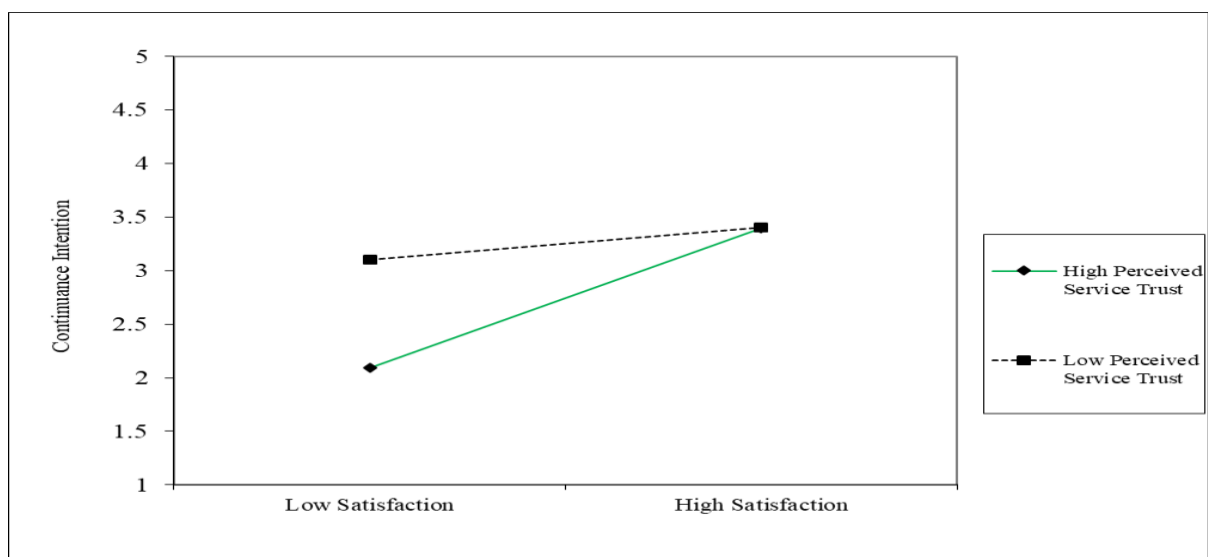


Figure 6: Moderation Effects for Perceived Service Trust and Satisfaction on Continuance Intention

4.6. Importance-Performance Map Analysis Results (IPMA)

The IPMA is a graphical tool used to inform management about which constructs of the study are most important and which have the lowest performance. In doing so, managers should strategise to improve constructs' performance. The IPMA results indicate that satisfaction and perceived usefulness are the most critical constructs if the service providers, retailing, managers, and merchants want to keep customers using the QR codes for payments (see Table 8 and Fig. 7). A unit increase in satisfaction from 69.163 to 70.163 will increase the performance by 0.381 (total effects). Also, a unit increase in perceived usefulness from 66.247 to 67.247 will improve the performance by 0.379 (total effects).

Table 8: IPMA Results

	Importance	Performance
ATT	0.238	72.827
SAT	0.381	69.163
PR	-0.059	47.625
PU	0.379	66.247
STR	0.255	69.133

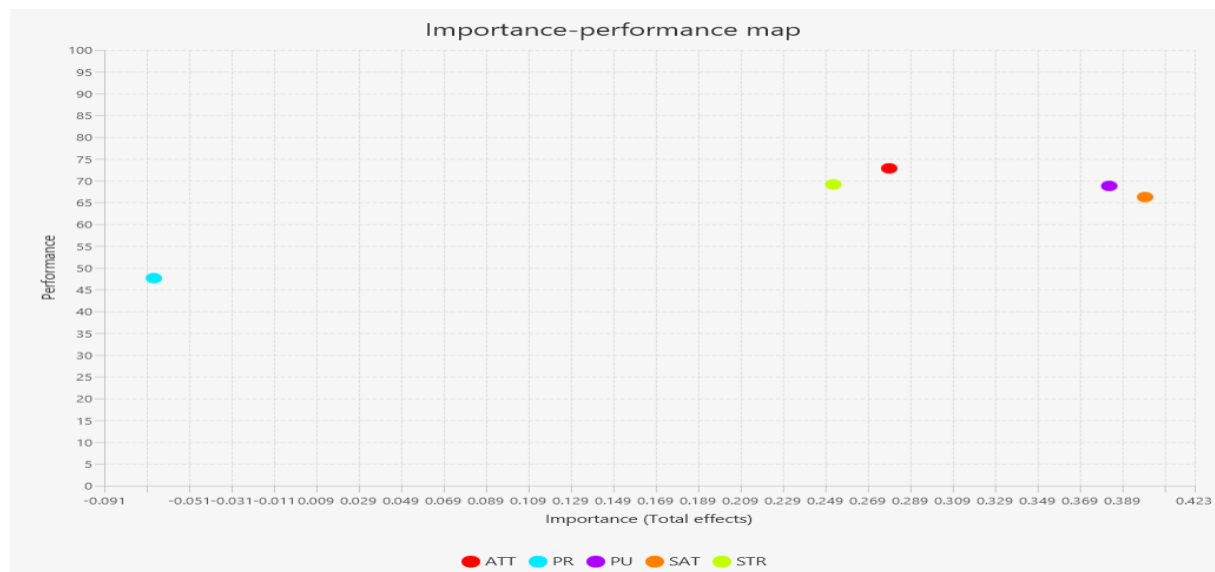


Figure 7: Graphical Representation of the IPMA Results

5. Discussion

The focus of the study was to investigate factors influencing the continuance of the intention to use QR codes for mobile payments in Tanzania. The study examined the inter-relationships between eight (8) constructs: perceived usefulness, perceived ease of use, confirmation, satisfaction, attitude, perceived risks, perceived service trust, and continuance intention to use the QR codes. Also, the study examined the moderation impact of perceived service trust and perceived risks. The study found that perceived ease of use positively and significantly impacted attitude and perceived usefulness; hence, *H1* and *H2* were supported. This finding implies that the simplicity of the QR codes during payment of services and goods cultivates a positive attitude towards using them; similarly, as the QR codes become easy to use, their utility to consumers also increases. These findings complement previous studies, which found the same relationship pattern in tap-and-go payment, mobile learning, and chatbot reuse (Bailey et al., 2020; Habibi et al., 2023; Silva et al., 2023). As perceived usefulness is critical in technology adoption, acceptance, and post-adoption, the findings of this study confirmed its importance; that is, perceived usefulness was found to positively and significantly impact users' attitude, *H3*, continuance intention, *H4*, and satisfaction,

H5, respectively. This finding implies that the benefits accrued from using a QR code for payments drove users' attitudes and intentions to continue using the QR code for payments and satisfaction. The impact of perceived usefulness on users' attitudes supports a previous study conducted by Safari et al. (2022), and continuance intention corroborates previous studies (Safari et al., 2022; Silva et al., 2023), while its impact on satisfaction is congruent to other prior studies (Jangir et al., 2023; Zhong & Moon, 2022).

Moreover, the study found that confirmation positively and significantly influences perceived usefulness, *H6*, and satisfaction, *H7*. The results suggest that once users have confirmed their expectations of using QR codes for payments, their perception of the usefulness of technology and their levels of satisfaction increase. Previous studies support this finding in the context of mobile payment services (Franque et al., 2021; Park et al., 2017; Sreelakshmi & Prathap, 2020). Regarding the relationship between satisfaction and the intention to continue using QR codes for payments, *H8*, the study found that when users' levels of satisfaction increase, the urge to continue using QR codes for payment also increases. The findings imply that as satisfaction with using QR codes increases, users' intention to continue using the technology accelerates. The positive and significant relationship between satisfaction and continuance intention is cemented by previous findings (Inan et al., 2023; Zhong & Moon, 2022). In yet another finding, the study also found that attitude, *H9*, and perceived service trust in the QR code payment services, *H11*, positively and significantly impact the continuance of QR code payment usage. A QR code-enabled payment system is a relatively new way of settling payments. Therefore, users' trust and a positive attitude are essential to motivate them to keep using it. The fundamental role of attitude and perceived service trust in continuance usage is also confirmed in the literature (Poromatikul et al., 2020; Raman & Aashish, 2021). Nevertheless, the current study confirmed that the presence of risks could thwart the intention to continue using QR codes for payments, *H10*. Risks, such as financial and data loss, are common in mobile payments. Addressing these risks would increase users' confidence and strengthen their intention to continue using QR codes to settle payments. The findings support previous studies on mobile payment services (Poromatikul et al., 2020; Raman & Aashish, 2021; Sinha et al., 2024).

Regarding the moderation relationship of perceived risks on the relationship between attitude and the intention to continue using QR codes for payments, *H10a*, the study found that, indeed, the perception of risks significantly suppresses the impact of attitude on the continuance usage of QR codes. However, the effect size of perceived risks is small. The findings suggest that the likelihood of users' attitudes towards the technology diminishes as long as the perception of risks in using QR codes is significant. This result corroborates previous findings in mobile payments, indicating that perceived risk reduces users' attitudes toward product recommendations (Cabeza-Ramírez et al., 2022). On the other hand, the study observed that perceived service trust significantly moderates the relationship between attitude and continuance intention, *H11a*, to use the QR code-enabled payments system to settle payments; thus, perceived service trust accelerates the user's attitude to continue using the QR codes for mobile payments. This finding coincides with (Lavuri et al., 2022), who found that trust strengthens the relationship between attitude and online shopping. Also, the moderation effects of *H11a* caused a minimal increase in effect size (f^2) from 0.026 to 0.088.

On the contrary, the study's results indicated that perceived service trust does not moderate the relationship between perceived usefulness and continuance intention to use QR codes for payment, *H11b*. The reason could be as perceptions of the usefulness of the QR codes for payments become more significant, trust also becomes minimally insignificant. However, this finding is congruent with (Le et al., 2024), who found that the moderating impact of perceived service trust on the relationship between perceived usefulness and intention to use self-payment services was insignificant. The current study found that the moderating effect of perceived service trust between satisfaction and continuance intention to use QR codes for payments, *H11c*, was negative and significant, contrary to the expectations. Previous studies have pointed out that excessive trust may lead to complacency and passivity in the face of inadequate outcomes (Gargiulo & Ertug, 2006), thus diminishing user satisfaction. As such, the current finding suggests that excessive trust in using QR codes to make payments significantly weakens the relationship between user satisfaction and intention to continue using QR codes for payment.

6. Implications

6.1. Theoretical Implications

The primary contribution of this study is the inclusion of perceived risks and perceived service trust constructs in the TCT to investigate the continuance usage intention of QR codes for mobile payment services. The obtained R^2 (i.e., $R^2 = 0.93.4$) is reasonably strong compared to previous studies (Aisyah et al., 2023; Hamzah, 2023; Ifada & Abidin, 2022; Iskandar et al., 2023; Koay & Ang, 2023; Tu et al., 2022; Türker et al., 2022) investigated the initial adoption and post-adoption behaviours of QR codes. Also, the inclusion of these two constructs in the TCT forms a novel post-adoption model that provides a nuanced understanding of the factors motivating the continuance of QR code usage for settling payments among customers.

Nevertheless, a few studies investigating the initial adoption of QR code payments have concentrated on the direct effects (Mughtar et al., 2024; Rosli & Ibrahim, 2020). Our study contributes to an understanding of the moderation effects of the perceived risks and perceived service trust in the context of QR code continuance usage in mobile payments, a phenomenon little understudied. To our knowledge, this study is the first to apply the TCT to study the continuance usage of QR codes in mobile payments, at least in sub-Saharan Africa. Therefore, the study further validates and adds valuable knowledge on the applicability of this theory in studying post-adoption behaviour in the African context.

6.2. Practical implications

Practically, this research provides important insights for service providers, merchants, retailing, and managers in general about customers' driving factors for using QR codes for electronic payments. For instance, perceived service trust and satisfaction are critical for continuance intention to use QR codes to settle payments. Trust has been well-documented as a vital factor in financial service provision, internet shopping, and e-commerce (Alshehri et al., 2012; Kim et al., 2005). As such, service providers such as banks, mobile money service providers, and other FinTech service providers should ensure that trust in their services is established and maintained to keep the customers using the services. To build confidence, service providers should ensure the security of financial transactions and all-around customer support to resolve customers' complaints and offer assistance in using the services whenever needed.

Further, as pointed out in previous studies, quality of service plays an integral part in building trust (Alkrajji & Ameen, 2022; Qalati et al., 2021). Thus, the quality of services through QR code technology should be consistent and reliable to cultivate customers' trust in the services. As for satisfaction, perceived usefulness and attitude, service providers such as retailing managers and merchants should encourage customers to use the services by rationally informing them of its perceived benefits, such as fast, convenient, reliable, and secure to accomplish the non-cash transactions using QR code technology. Since customers are often attracted to the perceived usefulness of the technology, and when they have confirmed its utility, they become satisfied (Bhattacharjee, 2001), strategic dissemination of information on the usefulness of the technology will massively boost customers' intention towards continuing use of the QR code technology for payments.

Moreover, service providers should not only pay attention to the motivators for the continuance intention of using QR codes for payments but also work on the impediments, particularly reduction of the risks of losing money and privacy intrusion when using the QR code technology for payments. For instance, service providers could enhance the security of QR codes by integrating with blockchain (Purnomo et al., 2016). By doing so while improving privacy concerns, the fear of losing money will be reduced. To further facilitate the continued usage of the QR code, service providers could also ensure that transactions cover the financial risks. Knowing that the financial transactions are covered, the confidence to continue using the service will increase.

The IPMA results indicate that satisfaction is the most critical factor driving customers' intention to continue using QR codes for payments, followed by perceived usefulness. Accordingly, service providers, retailing managers, and merchants should deliberate efforts to improve the technology to ensure that customers are satisfied in all aspects when using the technology. Moreover, there is a need to inform potential customers of the benefits the technology could bring. As such, marketing strategies should keep informing and demonstrating to customers the usefulness of the technology to attract more customers to use the QR technology for payments and, at the same time, retain those currently using it.

6.3. Limitations and Future Studies

Although the study's findings provide insights into multiple dimensions of adopting the QR code for mobile payments, there are a few limitations worth noting; the limitations pave the way for future studies. Firstly, while limiting the data collection process to Tanzania to control data variability, this study did not consider other factors, such as cross-cultural differences across online communities. Previous studies confirmed notable variations in ICT adoption across countries and cultures (Khan et al., 2022). Future studies may consider cross-cultural factors such as national culture to understand better the continuance intention to use QR codes for payments. Secondly, the study focused on the continuance of the adoption of QR codes for mobile payments. Future studies should focus on examining the continuance of QR code usage in different fields, such as marketing, education, and healthcare records, which can provide new insight into QR code post-adoption aspects, leading to the most effective implementation of QR code technology in various fields. Thirdly, while the current study investigated the moderation role of perceived risks and perceived service trust, to gain more valuable insights, future studies may investigate the mediation role of the same on the continuance usage of QR codes for payment services.

7. Conclusion

This study investigated users' intention to continue using QR codes for mobile payments. It employed a novel approach by integrating TCT with perceived risk and perceived service trust constructs. The proposed model yielded substantial explanatory power and predictive capability to validate the extended TCT. Overall, the study's findings proved that the proposed model is relevant and appropriate for cultivating users' intention to continue using QR codes for mobile payment since all hypothesized direct relationships turned significant. However, the study's findings stressed that satisfaction and perceived usefulness are critical factors in enhancing users' intention to use QR codes for mobile payments; a unit increase yielded substantial performance on the intention to continue using the QR codes for payment compared to other factors (i.e., attitude, perceived service trust, and perceived risks). Hence, an investment in increasing users' satisfaction and awareness of the perceived usefulness of paying using QR codes will hugely motivate current users to continue using and encourage new users to use QR codes to make payments.

Furthermore, the findings cemented the significance of perceived service trust in strengthening (i.e., moderating) users' attitudes towards the continuance intention of QR codes for mobile payments. Thus, service providers should strengthen users' trust in the QR code payment services to keep them using it. Moreover, the perception of risks is a concern that needs immediate attention since it hinders users from continuing to use the payment services and suppresses their attitude towards using QR codes for mobile payments. The study's findings offer insightful practical and theoretical implications worth addressing by service providers, merchants, retailing, and managers to ensure the sustainable adoption of QR codes for payment.

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