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Investigating the Role of Perceived Risk, Perceived Security and Perceived Trust on Smart m-Banking Application Using SEM

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Abstract: Effective security support remains a challenge, even for mobile banking applications; this is leading to the loss of many customers due to limited protection of customer data and privacy. Cyber threats include everything from identity theft to malware threats and email and online fraud. Thus, businesses and individuals should use risk assessment methods and countermeasures to protect their m-banking apps. With this in mind, a new model using the Technology Acceptance Model (TAM) has been proposed. The model has been broken down into six main countermeasure categories, namely: perceived risk, perceived security, perceived trust, ease of use, usefulness and service quality. To test this model, structural equation modelling (SEM) was used. Our findings reveal that perceived security, perceived trust and service quality play key roles in improving the adoption of mobile banking apps. In addition, the findings indicate that perceived risk had a negative impact on both clients' trust and their attitudes toward the use of mobile banking services. The proposed model could increase the adoption of m-banking apps by enhancing their defenses against security risk issues. The model enhances the risk reduction (63.0%), data protection (75.0%), trust (32.1%), quality of service (74.0%), ease of use (44.0%) and usefulness (45.3%) ratios.

Keywords: mobile banking apps; TAM; perceived security; perceived trust; service quality; structural equation model (SEM)

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1. Introduction

With the great advancements in information and communication technologies (ICT) that have occurred in recent years, high mobility services are now a reality [1]. Furthermore, with significant investments in mobile application services from industrial sectors, academic research has investigated the usage of mobile applications in terms of their capabilities, services and benefits to users [2]. From the technological side, mobile banking applications are characterized by features such as service automation, remote access and control and the provision of services anywhere and anytime [3–5]. In addition, mobile banking services provide several benefits for both users and banks, such as access to banking services anywhere and anytime, time efficiency and greater security for bank customers [6].

Mobile banking applications have become more commonly accepted and used since the COVID-19 pandemic in Saudi Arabia [7]. During the COVID-19 pandemic, mobile

banking applications allowed customers to avoid visiting a bank branch. In addition, these applications offered ease of-use, convenience, privacy, security and a high level of interactivity [8–12]. Furthermore, bank clients can use the provided mobile banking services with no fees or cost [13]. According to a report by the BBC [14], bank clients in the UK can save up to £7bn per the year through utilizing these applications. Based on these benefits, it is clear that using mobile banking services will improve users' quality of life significantly [15–18].

Despite the benefits of the mobile banking services provided by the Saudi Investment Bank, a limited numbers of bank clients use these services [19]. In fact, the adoption rate of mobile banking among Saudi users is barely satisfactory, with 55% of bank clients utilizing mobile services [20]. This percentage is much lower than was expected. According to a statistical analysis, only 41% of clients use mobile banking applications to access their accounts, and only 19% use mobile applications to perform their financial transactions [21]. Furthermore, 33% of clients use mobile applications to transfer funds, while 66% use ATM services for such operations [22]. There are several factors that might contribute to enhancing the usage of mobile banking, including the following. (1) Convenience: Mobile banking is a convenient and flexible way for users to access their financial accounts and perform transactions. (2) Security and privacy: Ensuring that mobile banking services are secure and protect user privacy could increase usage by building trust and reducing concerns about financial information being compromised. (3) Availability of services: Offering a wide range of services and features may increase usage by providing customers with more options and flexibility. (4) User-friendliness: Making mobile banking apps and websites easy to use and navigate could increase usage by reducing barriers to their adoption and making them more appealing to users. (5) Customer support: Providing timely and helpful customer support could increase usage by helping users resolve any issues or questions they may have about a service. Overall, by addressing these issues, service providers could increase the usage of mobile banking and improve the overall user experience.

Regarding investigations of mobile banking service adoption, several studies have already been conducted [23–28] with the aim of understanding the main aspects influencing the usage mobile banking applications. It has been widely observed that the usage of mobile banking applications before COVID-19 was very different to that after the pandemic. However, studies on mobile banking application usage after the COVID-19 pandemic are still very limited [29–31]. Based on this, the purpose of this study is to explore the key drivers that influence users regarding the comprehensive adoption (or not) of mobile banking services. The study focuses on Saudi Arabia, which a country in the Middle East countries and part of the Arab world. Despite the high level of technical support and infrastructure technologies that are available to Saudi people, the mobile banking penetration rate in Saudi Arabia has remained low [32].

This research applies a conceptual model using the technological acceptance model (TAM) with two external factors, i.e., perceived trust and perceived risk, to investigate the key drivers that influence the use of mobile banking services in Saudi Arabia. This research aims to help the banking sector to better understand its clients in order to increase the usage of mobile banking services. Our research outcomes are expected to fill the research gap related to the investigation of mobile banking acceptance through examining perceived trust, perceived risk and service quality on actual use of mobile banking. Finally, our findings offer important recommendations and insights for both the banking sector and academic research about the critical factors that have encouraged users to adopt mobile banking services since the COVID-19 pandemic. This study mainly aims to answer the following question:

Which measures could contribute to the adoption of smart mobile-banking apps?

2. Literature Review

2.1. Mobile Banking

Mobile banking is a type of banking service that allows customers to access their bank accounts and perform financial transactions using a mobile device, such as a smartphone or tablet [30]. Mobile banking services can be accessed through a dedicated mobile banking app or through a mobile web browser and can include a wide range of features and functions, such as account management, money transfers, bill payments and more [31]. Mobile banking has become increasingly popular in recent years due to the convenience and flexibility it offers to users [31]. With mobile banking, customers can access their accounts and perform financial transactions at any time and from any location, as long as they have an internet connection. This can be especially useful for people who are on the go or who do not have easy access to traditional banking services. Overall, mobile banking is a convenient and accessible way for customers to manage their financial affairs, and it has become an essential service for many people around the world.

However, mobile banking is still in its infancy. It is a form of application that allows customers to access financial services and conduct transactions using their mobile devices, such as smartphones or tablets. It has the potential to greatly enhance the convenience and accessibility of financial services for customers, particularly in regions where traditional banking infrastructure may be limited. In order for mobile banking to be successful, it is important for multiple stakeholders to work together to establish the necessary agreements and infrastructure [32].

For mobile banking to be successful in Saudi Arabia, it will be important for these stakeholders to come together and establish a common interest in the development and growth of the mobile banking ecosystem [33]. This may involve establishing agreements around security, interoperability and other key issues. In addition to providing a convenient and accessible means for customers to interact with banks and other financial institutions, mobile banking applications can also offer a range of services, such as financial transactions, applications and mobile payments. These services can help to further enhance the convenience and functionality of mobile banking for customers and drive its adoption and usage in Saudi Arabia and other regions [33].

Mobile banking applications have become increasingly popular in recent years, particularly after the COVID-19 pandemic, as they provide a convenient means for individuals to access financial services and conduct transactions using their mobile devices [33]. One important feature of mobile banking applications is their ability to make mobile payments using technologies like near-field communication (NFC) or contactless payment. This allows customers to make payments simply by tapping their mobile device against a payment terminal, without the need to enter a PIN or sign a receipt. Mobile payments have become particularly popular due to their convenience and speed, as well as their potential to reduce the risk of fraud and identity theft. Mobile banking applications that support mobile payments can also offer other benefits, such as the ability to track and manage finances, access to discounts and rewards and the ability to make secure, seamless transactions with other individuals or businesses [33]. There are a variety of mobile banking applications on the market that use different approaches and technologies to support mobile payments and other financial services. It is important for customers to carefully research and compare these options in order to find the solution that best meets their needs and preferences.

Therefore, in order to better understand the usage of mobile banking applications in Saudi Arabia, it may be helpful to consider a range of factors that could influence adoption, including technological, economic, social and psychological factors. By examining these factors and their interrelationships, it may be possible to develop a more comprehensive model of mobile banking adoption and usage in Saudi Arabia. This could help to inform the development of strategies to increase adoption and usage, as well as to identify potential barriers or challenges that may need to be addressed in order to drive the wider adoption and usage of mobile banking applications in the region. The conclusions of such a study can have a significant impact on the acceptance and adoption of mobile banking applications

in Saudi Arabia, as they can help to identify the key factors that influence user behavior and guide the development of strategies to increase adoption and usage.

2.2. Related Works

Despite the widespread adoption of mobile applications, some services are still underutilized. Many aspects can influence the usage of mobile applications, and various models have been developed to analyze user intention, actual behavior and acceptance of new technologies. One such model is the Unified Theory of Acceptance and Use of Technology (UTAUT) model, which was developed to explain how individuals adopt and use technology. The model identifies several key factors that influence adoption, including performance expectation, effort expectation, social influence and facilitating conditions. Another model that has been widely used to study the adoption of mobile technologies is the Technology Acceptance Model (TAM), which proposes that the perceived usefulness and perceived ease of use of a technology are key determinants of its acceptance and usage. Other models that have been used to study the adoption of mobile technologies include the Theory of Reasoned Action (TRA), the Diffusion of Innovations (DOI) model and the DeLone and McLean Information Systems Success (DL&ML) model.

In the literature, previous studies [33–38] have looked at the factors that influence user acceptance of mobile banking. For example, the authors of [39] employed the TAM model and found that perceived trust was a primary factor motivating users to adopt mobile banking services. This suggests that building trust with users may be an important factor in increasing the adoption and usage of mobile banking applications. Several researchers have mentioned that it is important for mobile banking services to consider security and trust factors when seeking to increase adoption and usage. Several studies have found that perceived trust, perceived ease of use and perceived usefulness are key factors that influence the adoption of mobile banking services [40–42]. A study conducted by Ntsiful et al. [43] investigated the adoption of m-banking in Ghana using Partial Least Square Structural Equation Modeling (PLS-SEM). They found that performance expectations and hedonic motivation were the main factors influencing m-banking application adoption. Nair et al. [44] found that personal innovativeness, perceived ease of use, perceived usefulness, trust and subjective norms have significantly influenced intention to adopt mobile banking. In the same way, Kumar et al. [45] indicated that self-efficacy and personal innovativeness have a statistically substantial impact on m-banking application adoption. Inaddition, Alnemer [46] confirmed that the adoption of digital banking in Saudi Arabia was significantly influenced by perceived usefulness, perceived ease of use and trust. Trust in banking has become a significant factor influencing the adoption of digital banking, which banks should consider by strengthening the security and privacy of their customers. According to a study by Jouda [47], consumer intention to use mobile banking services is negatively impacted by perceived risk. In Palestine, attitudes, facilitating conditions, perceived ease of use, website usability and perceived trust were found to be the key determinants of consumers' intentions to use mobile banking services.

According to the literature, there are several problems that can impact the adoption and usage of mobile banking. Some of the key issues include:

- Security and privacy concerns: Mobile banking involves the transfer of sensitive financial information over the internet, which can raise concerns about the security and privacy of these transactions [48].
- Technological barriers: Some users may be hesitant to adopt mobile banking due to a lack of familiarity with the technology or due to issues with device compatibility or internet connectivity [49].
- Limited availability of services: Mobile banking services may not be available in all areas or may not offer all of the features and functions that users require [50].
- Cost: Mobile banking services may require users to pay fees for certain transactions, which can be a barrier to adoption for some users [51].

- Trust: Users may be hesitant to adopt mobile banking if they do not feel that their financial information is secure or if they do not trust the service provider [52].

Overall, the above issues can impact the adoption and usage of mobile banking, and it is important for service providers to address these concerns in order to increase adoption and usage.

Despite several studies on m-banking adoption, previous mobile banking adoption models have some weaknesses, like a lack of factors related to security, risk, privacy and trust. To compensate for these limitations, we have added additional factors, such as perceived security, perceived risk and perceived trust, to the TAM model in order to study the usage of mobile banking. By adding these factors to the model, it may be possible to more fully understand the adoption and usage of these technologies and to identify the key drivers of user adoption. We have added perceived risk and perceived trust factors to the TAM model in order to assess the usage behavior of mobile banking applications. This may help to provide a more comprehensive understanding of the factors that influence the adoption and usage of mobile banking applications and to identify strategies for increasing adoption and usage.

3. The Proposed Research Model and Hypotheses Development

Several researchers have employed TAM to evaluate the adoption of mobile banking applications [42–45]. TAM is a widely used framework for understanding the adoption and usage of technology, including mobile banking applications. The model proposes that the perceived usefulness and perceived ease of use of a technology are key determinants of its acceptance and usage. It has been indicated that TAM has a strong predictive power compared to other models [42–45]. Overall, TAM can be a useful tool for understanding the adoption and usage of mobile banking applications and for identifying the key factors that influence user behavior. By taking these factors into account, it may be possible to develop strategies to increase the adoption and usage of mobile banking applications and to improve the overall user experience [46–52]. The proposed model is shown in Figure 1.

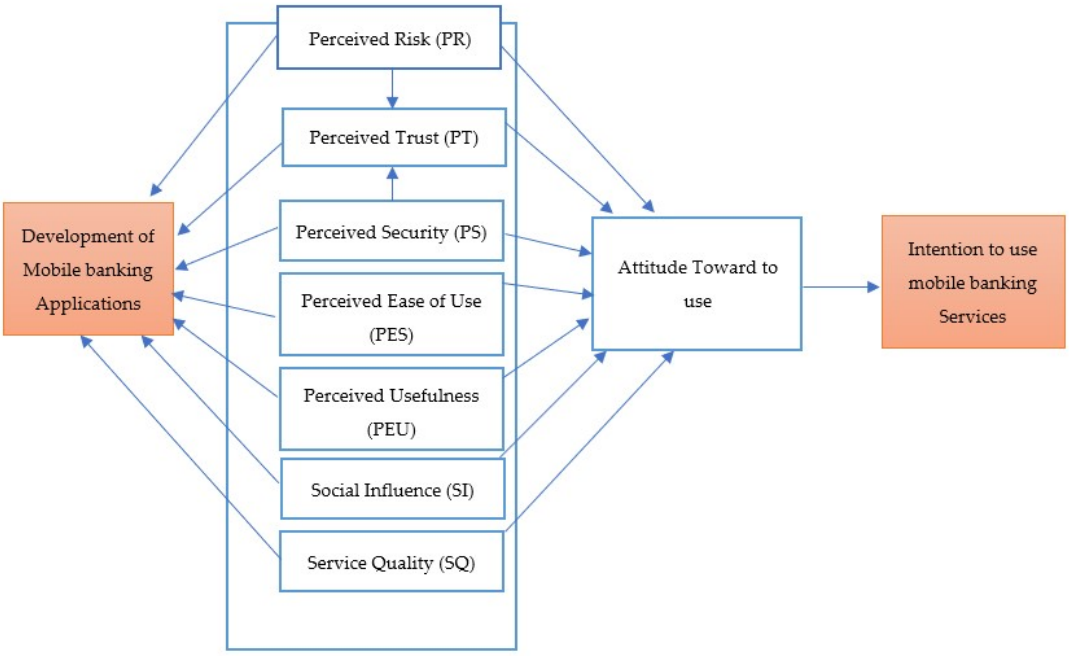

Figure 1. The Proposed Model.

3.1. Perceived Risk

Perceived risk (PR) is the degree to which a potential user views a mobile banking application as being dangerous [48]. PR is one of the primary inhibitors to the use or

acceptance of new technology. When deciding whether to adopt a given technology or not, users compare the level of perceived danger with the convenience that that technology delivers. PR can significantly affect users regarding their decision to adopt or not. Previous studies on mobile banking have noted that the effect of perceived risk is negative [49–52]. Prior studies [53–55] claimed that there should be a connection between perceived risk and perceived trust, as user trust can be increased if the perceived risk levels are as low as possible. Accordingly, in our proposed model, perceived risk has an influence on both perceived trust and attitude toward the use of mobile banking services. Based on that, we propose the following hypotheses:

H1. *Perceived risk has a negative effect on perceived trust.*

H2. *Perceived risk has a negative effect on attitudes regarding the use of mobile banking services.*

3.2. Perceived Trust

User trust is a crucial factor for the success of any new technology [56]. For mobile banking, trust is a primary determinant of usage and adoption. In fact, clients must trust the services provided by their bank via a mobile banking application based on the absence of risk regarding their transactions as well as the benefits that are delivered to them. Trust has an influence on client loyalty [57], and untrusted mobile banking applications will lead to lower consumer loyalty and trust. Based on this, in our study, a trust factor has been added to the TAM model to measure the influence of perceived trust on attitude toward the use of mobile banking services. Thus:

H3. *Perceived trust has a positive or negative effect on attitude toward the use of mobile banking services.*

3.3. Perceived Security

Perceived security (PS) is defined as the degree to which a user feels that a mobile banking application is secure against any risks [58]. The application of security techniques to guarantee the security of user services, transactions, privacy and data is considered the top priority for the success of mobile banking services among clients. Accordingly, the absence of security techniques will reduce trust and discourage users from adopting mobile banking applications. For the above reasons, the banking sector always seeks to provide a large budget for the development of security mechanisms for their clients, such as multi-factor authentication, transaction encryption and others. Therefore, in this study, we assumed that by providing a high level of security, the trust of users would increase, and thus, users' attitudes toward mobile banking services would become more positive. Based on this, we propose that:

H4. *Perceived security has a positive effect on perceived trust.*

H5. *Perceived security has a positive effect on attitude toward the use of mobile banking services.*

3.4. Perceived Usefulness

Within the context of this study, perceived usefulness can be defined as the level to which utilizing a mobile banking application will provide benefits for clients in performing financial transactions [59]. Prior studies [60–63] have mentioned that perceived usefulness is one of the strongest predictors in the TAM model and has a positive effect on intention to use technology. Studies in e-banking [64,65] have confirmed that perceived usefulness has positive relationship with user intention to adopt e-banking systems. Accordingly, in our study, perceived usefulness will play an important role in encouraging bank clients to adopt and use mobile banking applications if they expect to receive benefits from using this new technology. Thus,

H6. *Perceived usefulness has a positive effect on attitude toward using mobile banking services.*

3.5. Perceived Ease of Use

Perceived ease of use is the second predictor of the TAM model. Within the context of this study, perceived ease of use can be defined as the level of ease related to the use of a mobile banking application. Based on this, when bank clients perceive that a mobile banking application is user-friendly, it will increase the chances of adopting that application. In addition, when clients find that interactions with a mobile banking application are simple, understandable and clear, this will improve their intention to use that application. Prior studies [66–68] have mentioned that perceived ease of use is the strongest predictor in the TAM model and has positive effect on intention to use technology. Studies on e-banking [69,70] have confirmed that perceived ease of use has positive relationship with intention to use e-banking systems. Accordingly, in our study, perceived ease of use will play an important role in encouraging bank clients to adopt and use mobile banking applications. Thus,

H7. *Perceived ease of use has a positive effect on attitude toward the use of mobile banking services.*

3.6. Social Influence

Within the context of this study, social influence can be defined as the level of effect that other people, such as family and friends, has on intention to adopt a new technology like mobile banking [71]. Social influence is one of the most important factors in the UTAUT model, and it has been added to the TAM model in our study. Some of studies on e-banking [72,73] have found that there is no significant relationship between social influence and intention to use. Thus, this work investigates the impact of social influence on intention to use within the context of mobile banking. Based on this, we propose that:

H8. *Social influence has a positive effect on attitude toward the use of mobile banking services.*

3.7. Service Quality

Achieving excellent quality of mobile banking services is the first step toward the success of a mobile banking application. According to previous studies [74–77], the higher the service quality, the higher the perceived value, and thus, the better the user attitude toward the technology. If the service quality factor is used to measure the quality of an application or product services and related benefits, the value of a mobile banking application is seen to be higher. Based on this, when a bank client perceives that a mobile banking application has high quality services, this will increase the chances of adopting that application. Prior studies [78–80] have mentioned that service quality is one of the strongest predictors in the Delone and Mclean model and has a positive effect on actual use. Studies on e-banking [81–84] have confirmed that service quality has a positive relationship with intention to use e-banking systems. Accordingly, in our study, service quality will play an important role in encouraging bank clients to adopt and use mobile banking applications if they expect high quality services when using such applications. Thus:

H9. *Service quality has a positive effect on attitude toward the use of mobile banking services.*

3.8. Attitude toward Use

According to the TAM model, attitude toward use is defined as the subjective probability that a user will adopt a mobile banking application. Attitude toward use is one of the most important predictors in the TAM model and in other technology acceptance models, like UTAUT, TRA and others. Studies on e-banking [85–88] have confirmed that attitude toward use has a positive relationship with intention to use e-banking systems. Accordingly, in our study, attitude toward use will play an important role in predicting the adoption by clients of mobile banking applications. Based on this, we propose that:

H10. *Attitude toward use has a positive effect on the use of mobile banking services.*

4. Methodology

In our study, a quantitative research approach was used. It was important to carefully plan and execute this methodology in order to ensure the validity and reliability of the results. This involved preparing the measurements of the model, devising a data collection method and examining the characteristics of the data and the methods used to collect and analyze that data. Figure 2 presents the research methodology applied in our study.

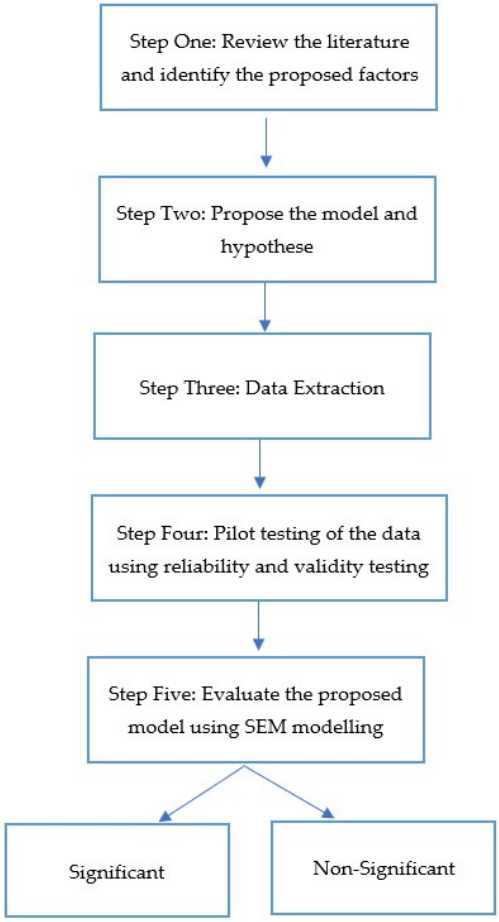

Figure 2. The steps of the research methodology.

In order to ensure the validity and reliability of the results, pilot testing for all items was applied, as shown in Table 1. Based on the findings, all items have a high level of internal consistency and reliability, which is important for ensuring the validity and reliability of the results.

Table 1. Pilot Test.

No.	Factors	Code	Pilot Test	Final Test
1	Perceived Security	PS	0.708	0.856
2	Perceived Trust	PT	0.777	0.820
3	Perceived Risk	PR	0.801	0.890
4	Service Quality	SQ	0.711	0.881
5	Perceived Usefulness	PEU	0.782	0.889
6	Perceived Ease of	PES	0.716	0.865
7	Social Influence	SI	0.786	0.864
8	Attitude towards to Use	ATU	0.792	0.927
9	Intention to Use	INU	0.809	0.824

Measurements within the Model

The measurement items in the proposed model were chosen based on previous research that has used similar conceptual frameworks to study the adoption of the aforementioned technologies. This helped us to ensure that the items were relevant and appropriate within the context of our study and that they could measure the variables of interest in a valid and reliable manner. The items related to TAM regarding perceived usefulness and ease of use were adopted from Gupta and Dhingra [89], who have been active in mobile banking application studies. Items intended to examine attitudes and intention to use were also adopted from Gupta and Dhingra [89]. The items related to perceived security, perceived trust and perceived risk were adopted from Lew et al. [90]. Finally, service quality and social influence were assessed using three items as proposed by Migliore et al. [91].

5. Results and Analysis

5.1. Reliability Analysis

To assess the reliability of measurement items in our proposed model, coefficient alphas, composite reliabilities and average variances (AVE) were used, as these could help us to assess the quality of the measurement of each factor in the model. Firstly, we assessed the internal consistency using Cronbach's alpha. Cronbach's alpha is a measure of the internal consistency or reliability of each item. It is calculated by dividing the sum of the variance of the items in the proposed model by the total variance and is typically expressed as a coefficient between 0 and 1. A coefficient of 0.7 or higher is generally considered to indicate a good level of internal consistency or reliability. As shown in Table 2, the Cronbach's alpha values were higher than 0.7, which indicated a good level of internal consistency and reliability for all variables.

Table 2. Factor Analysis and Factor Loadings.

Factors	Items	Factor Loadings	Composite Reliability	Cronbach's Alpha	AVE	R Square
ATU	ATU1	0.862	0.895	0.824	0.741	0.649
	ATU2	0.919				
	ATU3	0.798				
SI	SI1	0.898	0.912	0.856	0.775	0.000
	SI2	0.880				
	SI3	0.862				
INU	INU1	0.890	0.922	0.874	0.798	0.487
	INU 2	0.887				
	INU 3	0.903				
PR	PR1	0.901	0.926	0.881	0.808	0.000
	PR2	0.898				
	PR3	0.896				
PES	PES1	0.846	0.876	0.890	0.702	0.000
	PES2	0.868				
	PES3	0.799				
PU	PU1	0.865	0.885	0.804	0.720	0.000
	PU2	0.905				
	PU3	0.770				
PS	PS1	0.857	0.862	0.865	0.675	0.731
	PS2	0.792				
	PS3	0.816				
SQ	SQ1	0.939	0.953	0.927	0.872	0.762
	SQ2	0.938				
	SQ3	0.924				
PT	PT1	0.871	0.917	0.864	0.786	0.621
	PT2	0.917				
	PT3	0.871				

5.2. Construct Validity

Construct validity is the second step to ensure that a measurement tool has good construct validity [92]. It can be used to ensure the accuracy and meaningfulness of the results of a study. Table 3 shows the components that must be included in the measurement structure, as well as their corresponding loadings. These components and loadings can help to demonstrate the construct validity of the measurement tool, as they show how well the tool is able to capture the concept or construct of interest. By carefully examining these components and loadings, it is possible to ensure that the measurement tool is measuring the variables of interest in a valid and reliable manner [93]. According to these findings, all variables were shown to be valid and reliable.

Table 3. Loadings and cross-loadings of items.

Factors	Items	ATU	SI	INU	PR	PES	PU	PS	SQ	PT
ATU	ATU1	0.862	0.539	0.599	0.617	0.522	0.630	0.716	0.657	0.670
	ATU 2	0.919	0.565	0.614	0.603	0.538	0.599	0.694	0.687	0.707
	ATU 3	0.798	0.544	0.477	0.507	0.372	0.366	0.549	0.586	0.572
SI	SI1	0.584	0.898	0.579	0.496	0.476	0.465	0.502	0.504	0.556
	SI2	0.613	0.880	0.557	0.516	0.426	0.429	0.535	0.570	0.539
	SI3	0.461	0.862	0.518	0.439	0.341	0.328	0.371	0.462	0.425
INU	INU1	0.592	0.537	0.890	0.657	0.566	0.624	0.584	0.528	0.576
	INU 2	0.541	0.517	0.887	0.558	0.509	0.533	0.528	0.554	0.527
	INU 3	0.628	0.625	0.903	0.680	0.530	0.548	0.607	0.599	0.605
PR	PR1	0.631	0.532	0.668	0.901	0.532	0.625	0.764	0.650	0.609
	PR2	0.568	0.503	0.620	0.898	0.538	0.577	0.706	0.667	0.588
	PR3	0.612	0.452	0.623	0.896	0.518	0.573	0.665	0.587	0.582
PES	PES1	0.401	0.362	0.510	0.436	0.846	0.467	0.436	0.408	0.414
	PES 2	0.511	0.446	0.539	0.530	0.868	0.632	0.617	0.517	0.512
	PES 3	0.484	0.381	0.453	0.503	0.799	0.434	0.495	0.423	0.484
PU	PU1	0.517	0.319	0.510	0.544	0.521	0.865	0.658	0.478	0.528
	PU2	0.595	0.485	0.611	0.580	0.577	0.905	0.669	0.505	0.506
	PU3	0.483	0.397	0.495	0.559	0.474	0.770	0.563	0.390	0.405
PS	PS1	0.815	0.574	0.628	0.704	0.511	0.555	0.857	0.824	0.808
	PS2	0.508	0.417	0.482	0.609	0.492	0.668	0.792	0.464	0.449
	PS3	0.489	0.300	0.440	0.632	0.550	0.650	0.816	0.529	0.494
SQ	SQ1	0.695	0.588	0.605	0.633	0.484	0.494	0.703	0.939	0.787
	SQ 2	0.729	0.557	0.580	0.702	0.566	0.523	0.768	0.938	0.793
	SQ 3	0.675	0.497	0.576	0.645	0.467	0.503	0.679	0.924	0.798
PT	PT1	0.643	0.550	0.545	0.555	0.374	0.426	0.594	0.735	0.871
	PT2	0.695	0.470	0.611	0.564	0.527	0.503	0.643	0.792	0.917
	PT3	0.679	0.535	0.543	0.638	0.596	0.580	0.734	0.729	0.871

5.3. Validity of Convergent

In the third step of data analysis, discriminant validity was assessed to examine the correlations between the elements within the constructs being measured. According to Hair [93], the correlations between these elements should be less than the average variance extracted (AVE) square root shared by items that represent a single concept. This can help to demonstrate that the measurement tool is able to accurately distinguish between different concepts or constructs and is not measuring unrelated variables. In our study, the values were greater than 0.50 and significance was at $p = 0.001$, which supports the discriminant validity for all items, as shown in Table 4.

Table 4. Discriminant validity.

No.	Factors	1	2	3	4	5	6	7	8	9	10
1	ATU	1.000									
2	INU	0.659	1.000								
3	SQ	0.750	0.628	1.000							
4	PES	0.561	0.599	0.542	1.000						
5	PR	0.672	0.710	0.707	0.589	1.000					
6	PS	0.764	0.643	0.768	0.626	0.794	1.000				
7	PT	0.758	0.639	0.848	0.566	0.661	0.742	1.000			
8	PU	0.628	0.636	0.543	0.619	0.659	0.745	0.569	1.000		
9	SI	0.636	0.629	0.586	0.477	0.553	0.543	0.583	0.470	1.000	

5.4. Analysis of the Structural Model

To test the proposed model, structural equation modelling (SEM) was used to analyze the proposed hypotheses in the model. Table 5 presents the results of the path coefficient and the *t*-values.

Table 5. Validation of the research model.

No.	Hypotheses Links	Path Coefficient	Mean	S.D	S.E	*t*-Values
1	PR → PT	−0.063	0.071	0.091	0.091	−0.694
2	PR → ATU	−0.193	0.171	0.117	0.117	−1.650
3	PT → ATU	0.321	0.330	0.107	0.107	2.999
4	PS → PT	0.075	0.080	0.127	0.127	0.592
5	PS → ATU	0.077	0.098	0.117	0.117	0.658
6	PEU → ATU	0.044	0.051	0.101	0.101	0.432
7	PES → ATU	0.453	0.443	0.109	0.109	4.162
8	SI → ATU	0.072	0.097	0.160	0.160	0.451
9	SQ → ATU	0.074	0.060	0.113	0.113	0.659
10	ATU → INU	0.182	0.176	0.139	0.139	1.309

6. Discussion

This work aimed to develop a conceptual model that integrated the TAM model constructs with five external factors, namely, perceived risk, perceived trust, perceived security, service quality and social influence, to investigate the key drivers that influence user intention to comprehensively adopt mobile banking services in Saudi Arabia. This research aims to help the banking sector to better understand its clients, with the aim of increasing the usage of the mobile banking services provided to customers. Our research outcomes are expected to fill the research gap related to the limited investigation of mobile banking acceptance through examining perceived trust, perceived risk and service quality on actual use of mobile banking technology. Finally, our findings offer important recommendations and insights for both the banking sector and academic research about the critical factors that have encouraged users to adopt mobile banking services since the COVID-19 pandemic.

The findings of the present study reveal that perceived risk has a negative impact on both trust and attitude toward the use of mobile banking services. This result can be attributed to some applications being risky and susceptible to attack or financial fraud by hackers. This result will negatively affect user trust regarding mobile banking and is in accordance with previous studies [94]. In addition, this study proved that there is a link between perceived risk and user trust. When bank clients are deciding whether to use technology or not, they compare the level of perceived danger with the convenience benefits they would receive. Prior studies [92–94] have claimed that there is a connection between perceived risk and perceived trust, as user trust can increase if the perceived risk levels are as low as possible.

In addition, our results found that perceived trust has a positive impact on clients' attitudes toward the use mobile banking services. This result can be attributed to the fact that client trust of the services provided by banks via mobile banking applications can increase due to the low risk regarding transactions, as well as the benefits that such services offer. In addition, this study proved that there is a link between perceived trust and client loyalty, particularly when mobile banking services are highly trusted. Our findings are in accordance with those of previous studies in the context of e-banking [92–94], which found that user trust is a crucial factor for the success of an e-banking system.

The findings of the present study reveal that perceived security has a positive impact on both trust and attitude toward the use mobile banking services. This can be attributed to the implementation of security defense techniques to guarantee the security of services and transactions. Privacy and data protection are considered top priorities among mobile banking services clients. Furthermore, this study proved that there is a link between perceived security and user trust. Therefore, the banking sector must seek to provide a large budget to invest in the development of security mechanisms for their clients, such as multi-factor authentication, transaction encryption and others. Our findings are in accordance with those of previous studies [92–94], which found that by providing high security procedures, the trust of users will increase, and thus, users' attitudes toward e-banking services will improve.

This study also found that perceived ease of use and perceived usefulness have a positive impact on attitude toward mobile banking services. This means that emphasizing the simplicity of mobile banking applications is an important aspect for the success of mobile banking technology. In addition, this study proved that perceived ease of use without a strong sense of usefulness may be insufficient to encourage clients to use mobile banking services in Saudi Arabia. This result can be attributed to the fact that when a bank client finds his/her interactions with a mobile banking application to be simple, understandable and clear, his/her attitude toward that application will improve. Our findings are in accordance with those of prior studies [66–68], which noted that perceived ease of use is the strongest predictor in the TAM model and has positive effect on attitude toward such technology. Studies on e-banking [92–94] have confirmed that perceived ease of use has a positive relationship with intention to use e-banking system.

Based on the findings of this study, service quality has a substantial favorable and direct influence on attitude toward the use of mobile banking services. This means that focusing on the development of mobile banking applications with high quality of service is a critical aspect to the success of mobile banking technologies. In addition, this study proved that mobile banking applications without high quality features and services may be insufficient to encourage clients to use such services in Saudi Arabia. Based on this, when bank clients perceive that a mobile banking application offers high quality services, they will be more likely to adopt that application. Our findings are in accordance with those of prior studies [92–94] that mentioned that service quality is one of the strongest predictors in the Delone and Mclean model and has a positive effect on the actual use of such technology. Studies on e-banking [92–94] have confirmed that service quality has a positive relationship with intention to use e-banking systems. Accordingly, in our study, service quality was found to play an important role in encouraging bank clients to adopt and use mobile banking applications. Furthermore, the findings revealed that social influence has a positive impact on clients' attitudes toward mobile banking services. In this regard, our findings are not in accordance with those of previous studies [92–94], which found that there was no significant relationship between social influence and intention to use. Finally, our findings indicated that attitude toward use has a positive impact on intention to use mobile banking services; this is in accordance with studies on e-banking [92–94] that observed that attitude toward use has positive relationship with users' intention to use e-banking systems. Accordingly, in our study, attitude toward use played an important role in predicting the likelihood that bank clients would adopt and use mobile banking applications.

Research and Practical Contributions and Implications

This research has both theoretical and practical implications. First, by providing a conceptual model that considers the significant drivers of mobile banking adoption among clients in Saudi universities, this research makes an important contribution to the existing body of knowledge on mobile banking adoption. This contribution is important because it helps to identify the key factors that influence the adoption of mobile banking among university clients in Saudi Arabia. By understanding these factors, it may be possible to develop strategies to increase the adoption and usage of mobile banking technologies in this context and to improve the overall user experience. Second, future research could explore the specific mechanisms through which different factors influence mobile banking adoption or could examine the impact of these factors in other contexts or countries. Our research can provide a starting point for this work by identifying the key factors that are relevant to mobile banking adoption in Saudi Arabia and by offering insights into how these factors may interact and influence user behavior. Third, the findings of our study are important to policymakers and practitioners who are seeking to understand the factors that influence mobile banking adoption and usage in Saudi Arabia. These findings can inform the development of strategies and initiatives to promote the adoption and usage of mobile banking in this context, and to improve the overall user experience. Finally, our findings highlight the importance of perceived risk and perceived trust in mobile banking adoption and suggest that banks need to focus on improving the security and privacy of their mobile banking applications in order to increase adoption and usage. By understanding the specific concerns and priorities of their customers, banks can develop targeted strategies to address these issues and improve the overall user experience.

7. Conclusions

Since the COVID-19 pandemic, mobile banking applications have been become a fundamental tool for customers to perform their transactions. Banks have also noted the shift of their clients in terms of the use of mobile banking services via mobile devices in recent years. Therefore, this research aimed to investigate the perceptions of users toward mobile banking services in Saudi Arabia by using the technological acceptance model (TAM) with added external factors, i.e., perceived security, perceived trust, perceived risk and service quality. The model proposed in this study aimed to measure the acceptance levels of users toward the mobile banking services offered by The Saudi Investment Bank. Structural equation modelling (SEM) was used to analyze the proposed hypotheses. The findings revealed that perceived security, perceived trust and service quality play key roles in improving the adoption of mobile banking services in Saudi Arabia. In addition, the findings indicated that perceived risk has negative impact on both client trust and their attitudes toward the use of mobile banking services. Furthermore, the findings revealed that social influence has a positive impact on clients' attitudes toward mobile banking services. Accordingly, the present research findings offer a better understanding of factors that could increase the adoption of mobile banking technology by customers in order to help both the banking sector and academia in applying new strategies to increase the level of utilization of mobile banking services in Saudi Arabia.

Although this research provides useful recommendations, some limitations should be mentioned. First, the model proposed in this study could be improved by adding other factors related to system quality, content quality, ICT and technological factors with the aiming of offering more robust research solutions in order to address mobile banking adoption issues. Second, the factors that influence mobile banking adoption in Saudi Arabia may be different from those in other countries, due to cultural differences, economic conditions, technological infrastructure and other factors. Therefore, it will be interesting to see if the findings of the present study are replicated in other countries and to examine the extent to which they are applicable or generalizable to different contexts. Finally, this study was focused only on customer perception. Thus, future work could investigate the

perceptions of bank managers and could take into account their opinions in terms of the adoption of mobile banking applications.

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