A Hybrid SEM and Neural Network Approach to Understand and Predict the Determinants of Consumers' Acceptance and Usage of Mobile-Commerce Application

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Abstract—Mobile commerce has become an important marketing channel with the increasing usage of internet by consumers. However, Privacy and security are still a concern in m-commerce applications. Since the previous studies have investigated the link between security and privacy and purpose to use, the factors that influence the formation of privacy and security in m-commerce are mostly unidentified. On the basis of UTAUT2, this study investigates the factors of security and privacy affecting mobile commerce acceptance. A hybrid SEM-ANN method was utilized to identify non-linear and compensatory interactions. Compensatory and Linear models are based on the idea that a deficiency in one component might also be compensated by other variables. Linear and Non-compensatory models, on the other hand, seem to overcomplicate buyer decision mechanisms. Survey criteria have been conducted to obtain 890 mobile commerce consumer's datasets utilizing an application on m-commerce. The following are the results. (1) M-commerce acceptability and use were positively influenced by five determinants (Security, performance expectancy, effort expectancy, habit, and price value). (2) Un-authorization, Error, secondary usage, collection, control, and awareness were all shown to directly and significantly negatively impact M-COMMERCE acceptance and use. (3) Three additional variables (social influence, hedonic motivation, and facilitating conditions) did not affect customers' intentions to use m-commerce applications in Jordan. In m-commerce, the integrated model expects a 45% increase in security and privacy.

Keywords—privacy, security, acceptance, mobile commerce, mobile application, neural network approach

1 Introduction

E-commerce, once a wealthy and developing industry, has expanded rapidly and is on early success, especially in the domain of m-commerce. The word m-commerce describes the capacity to do business via smartphones. It is similar to getting on the go while online. However, the wireless feature of m-commerce and the flexibility of smartphones allow for a broader variety of shopping options [1]. It is noticed that there is a rapid increase in cloud computing technology in parallel with the growth of e-commerce overall and mobile commerce specifically. Although there are many resemblances between mobile commerce and electronic commerce, there is a fundamental difference. Both are a feature for executing transactions via the internet, although most advancement is made in mobile trade via mobile networks across wired connections. By adopting a smartphone market; customers can only operate on their mobile devices from remote locations, which saves time and expenses when they are traveling to a physical site. On the other hand, mobile commerce providers can advantage by reaching a larger number of people with their services and products. M-commerce has grown to announce significant changes in a variety of industries and areas in our lives, including banking, industry, economics, and service domains, among others. As a result of this, many businesses are becoming more involved in m-commerce, which will allow them to provide a variety of low-cost business services. Several technical, financial, cultural, and political barriers to m-commerce adoption exist in advanced countries like Jordan, and these barriers must be addressed. In the field of information technology, the Technology Acceptance Model (TAM) is often used to detect such factors (IS).TAM is also well-known in the area of m-commerce adoption and technological innovation uptake[2]; [3]; [4]; [5]; [6]; [7];[8].Since the sociological, cultural, and economic aspects of mobile commerce adoption in Jordan are being researched by other experts, this research is focusing on the technical variables that influence the willingness to adopt it. In this paper, the researchers also provide and evaluate a new M-commerce technology adaptation model.

Rapid advancements in telecommunication technologies, as well as the growth of wireless technologies, provide companies with many opportunities to do business utilizing mobile commerce (m-commerce). The internet is adopted by most people all over the globe to perform online payments [9]. Furthermore, various kinds of businesses are searching for m-commerce as a latest advanced network. This would enable them to provide goods and operations to customers in a more comfortable manner due to its diversity, adaptability, and Mobile qualities [10]. The favorable legal climate helps to create electronic business applications, with governments and regulatory authorities operating together to guarantee the protection of consumer electronic commerce rules, policies, and regulations (Johar &Awalluddin, 2011). M-commerce is a wireless network e-commerce function, particularly the internet [12]. M-commerce is a subclass of electronic commerce related to online transactions carried out on smartphones [13]. Buyers will be able to conduct online purchases using smartphones and receive an unlimited number of personalized services at any time and from any place because of m-commerce [14]. Organizations, on the other side, will be able to offer personalized products and services to buyers depending on their interests,

region, and time because of the personalization aspects of m-commerce, which will assist them to achieve buyer happiness and loyalty. Any organization's progress depends on gaining such a benefit. Another organizational benefit is the ability to contact a large number of customers all around the world, despite geographical limitations. There are some problems and possible issues presented by m-commerce that must be addressed by parties engaged in implementing such business innovation in order to attain the promised advantages of this technology; key considerations include security, confidentiality, and trustworthiness [15]. Acceptance of technological advances by consumers is seen as an essential aspect of m-success, commerce's efficiency, and long-term growth [16]. According to [16], the Technology Acceptance Model (TAM) uses assessed comfort of use and perceived usefulness as essential constructs to predict whether users will accept or decline new technological advances. The TAM will be expanded in this study to involve apparent trust and apparent threats (security and privacy issues), as well as the effect of these variables on Jordanian consumers' intentions to utilize portable commerce.

Several researchers have identified components that promote customers' behavioral willingness to embrace and utilize M-Commerce apps; several of these researches have highlighted the value of loyalty, risk Security, Security, confidentiality, perceived user-friendliness, and Utility regarded as key factors having a major effect on users' conduct to adopt apps and services in m-commerce. [17]; (Wu & Wang, 2005); [18]; [14]. This study explores the security and privacy factors of mobile commerce based on the hybrid SEM-ANN methods.

2 Literature review

2.1 Studies on M-commerce acceptance and use

There are nine research papers related to M-commerce acceptance and use. [19] explored the major factors that affect the adoption of e-commerce online shopping from a technical aspect such as payment security and payment data encryption. Later, [20] investigated the adoption of e-business in enterprise resource planning, and identified the perceived security concern in general as a factor that affects the adoption within a specific organizational and environmental context. Found that security concern affects directly on the adoption of the systems.[21], [22]investigated the security concern from the general concern that affects the adoption of e-commerce without consideration of security dimensions and measurements that would contribute to understanding the specific security and privacy dimensions. [23] extended the Perceived credibility to involve (security, trust, privacy and risks) and the findings point to the factors effecting on-line shopping adoption. The investigated factors were analyzed from general aspects of Perceived credibility. The study lacks the dimensions of security, privacy and trust as well.

[24] examined the important aspects that may restrict or assist mobile banking service uptake by adding three new constructs: security, privacy, and trust. They confirmed that positive security influenced behavioural intention to use mobile banking

services from the general public, perceived privacy and trust. [25] examined the impact of confidence in m-commerce and how it may help m-commerce providers develop appropriate advertising approaches. The results indicated that perceived security is a sub-factor of risk construct that affecting on trust in m-commerce. As a result, this research found that all of the antecedents of m-commerce trustworthiness were important, except for perceived privacy.[26] proposed a paradigm that considers trust in m-commerce systems to be a function of the customer's privacy and security perceptions of online commerce. [27][28] proposed and verified a theoretical framework based on trust in the TAM model in the same scenario. The results show that security is seen to have the most important positive direct connection with the formation of confidence [27].[29] devoted to gaining a better understanding of consumers' intents when it comes to using mobile commerce, investigated the trust from the point of distance, communication quality, and mobility. The study was limited to a particular cross-border B2C platform. As a result, when assessing the sub-dimensions of the trust construct, the results may not be relevant to other cross-border e-marketplaces.[30] examined the private sector and proposed a new user-based collaborative filtering approach combining intensity and data protection issues and introduced factors relating to privacy in six areas such as the tendency towards privacy, internal inspection, openness, extroversion, comfort and influence of the social group. This study neglects the impact of security and trust on users' privacy acceptance of mobile personalized service.

[31] examined privacy and security constructs as affecting factors on mobile commerce service quality by extending the results from [32], who performed a meta-analytic assessment of the quality of electronic services. The study proves that privacy and security construct a contribution directly to overall perceptions of mobile service quality.[33] Proposed technological solution for trustworthy mobile trade transactions under secure mobile trade preserving privacy (SPPMC) NFC (Near Field Communication) payment framework. Both communication and information privacy is achieved using the SPPMC framework. It protects the customer's privacy by using traceable anonymous certificates (TAC). The study contributed to detailed and technical formwork to secure protocols from attacks. [34] suggested a technological solution as well, proposing a system based on certificates public-key cryptography and elliptic curve cryptography that is both effective and privacy-preserving. The protocol is safe, self-contained, and offers conditional location and identity privacy.

A meta-analysis of empirical research was performed by [25]. They concluded that all of the predicted antecedents, save perceived privacy and all behavioural consequences, had a substantial connection with m-commerce trust.[35] extended UTAUT 2 framework to include constructs from the privacy calculus. The findings of empirical research based on an expanded framework indicate that perceived privacy issues affect the perceived value and that hedonic motivation and perceived value have a considerable impact on intentional use. [36], the research gathered all related studies on M-Commerce implementation in SMEs, analyzed and synthesized the research to extract obstacles to mobile commerce adoption, and developed its framework using Interpretive Structural Modeling (ISM). In the ISM model, other related factors' privacy

and security concerns are highly influenced, and the main obstacles to m-commerce adoption in SMEs have been identified.

A series of studies on the adoption and use of m-commerce is inadequate, especially in the context of privacy and security concerns. Previous literature has dealt with privacy and security issues from a single aspect. Detailed analysis is required to address these issues. In general, no existing research considers privacy and security factors associated with m-commerce to be multidimensional from the consumer's point of view. Moreover, most of the existing studies applied TAM or UTAUT with privacy and security as a single dimension, Therefore there are limited studies that addressed privacy and security as a multi-dimension with UTAUT in the context of M-commerce in developing countries.

3 Models and theories of technology acceptance

3.1 UTAUT2

A variety of theories, including planned behavior theory (TPB), TAM, and UTAUT, are used to analyze the usage and adoption of M-COMMERCE. In contrast, the number of research using UTAUT2 to assess the acceptability and usage of M-COMMERCE is still limited. This research thus uses UTAUT2.[37] UTAUT model changed to become more consumer-centered, culminating in UTAUT2. UTAUT2 is suitable for customer acceptability and technological usage. Around UTAUT2, the structures are solely modified on the basis of age, sex, and skill. Free uses are decreased since the target audience does not have to utilize the machinery.UTAUT2 also adds three additional structures, specifically, hedonic motivation, the cost of money, and habit. Hedonic motivation and price values clarify the aim and habit of action both rationalize behavioral purposes and behavior of users. In contrast to UTAUT, UTAUT2 extensions produce significant variance improvements described in behavioral intent (56%-74%) and T utilized (40% to 52%) [37]. Nevertheless,[38] It argued, however, that value for money should be eliminated if a system is publicly accessible.

Most research utilizes TAM or TAM extensions to evaluate published studies in the area of consumer health information technologies adoption. [39] and [40]. Neither UTAUT nor TAM have been developed for the customer. Instead, we prefer to utilize a model designed for consumers, and UTAUT2 has precisely been developed for this purpose and has achieved highly excellent results. [37] A recent study utilizing a UTAUT2 modification has shown its utility in assessing the critical drivers of adopting M-commerce portals without considering the privacy and security concerns. [41].

3.2 Security

M-commerce is a successful application but has safety concerns and problems [42]. Safety protection has a function in user thinking utilizing a specific technology [42]. Security threats are described as "A situation, condition or occurrence, which may potentially result in economic hardship in the manner of data loss, revelation, data

alteration, service denial and scam, rubbish and violence."[43]. Safety risks are problems facing all kinds of companies who rely on the basis of informational systems and knowledge; this is especially true of e-commerce and m-commerce settings. As a result, safety concerns are critical and may restrict the development of these technologies. [44]Because m-commerce relies on portable computing, which has security vulnerabilities because data is transmitted through open media, the Internet as a communication medium creates extra dangers to the m-commerce ecosystem.[45]; [46]; [10];[47]. Common online security risks include problems with privacy, information reliability, and service accessibility[48]; similar issues are raised with the usage of mobile wireless technologies.

Another critical security issue is the absence of standard technology for safe fee methods in the internet world.[44] As harmful code issues affect e-commerce security, a similar is true of the spread of m-commerce. In addition, the increasing capacity of moveable portable gadgets is projected to impact malicious code risks owing to the dependence on portable technologies [45].

H 1. Security has a positive effect on the intention to use m-commerce.

3.3 Privacy factors (IPC)

According to recent research, 91% of customers believe that they have lost the freedom to make personal decisions and associated records [49], and 70% of customers are very anxious about their security concerns as compared to clients of many years before [50]. Moreover, the increasing worry about privacy has led customers to undertake significant behavioral adjustments, such as deleting social media accounts and doing less online shopping [50]. For online businesses thus need to recognize the causes and inhibitors of people's personal security to develop ways to relieve these worries.

Privacy has long been a subject in the study of corporate ethics. (e.g., [51]; [52]; [53]; [54]. Internet privacy concern (IPC) is defined as a person's concern about losing their privacy due to willingly or covertly exchanging personal information with websites [55]. Here is an explanation of IPC, which refers to an entity's sense of social fairness in the context of privacy information and adapts the traditional concept of personal information to the online world [56]. A dyadic link between a user and an online entity develops. This may be a single website or a collection of websites, which is described as an IPC. Researchers utilized similar criteria in earlier IPC research.(e.g., [57]; [58].

Though considerable studies must be done on informational privacy concerns generally and Much of the work on IPC has concentrated on the connection between security matters and consequences, with minor concentration paid on the link among privacy concerns as well as antecedents1. [59]Whereas some research has examined what factors affect an entity's data privacy concern, or IPC, others have not (e.g., [60]; [61], the primary objective of determining the significant backgrounds of IPC continues in definable because of the numerous interior exterior and situation specified factor that will impact IPC. The social in addition to legal contexts, for example, may have an impact on what a person considers to be fair or not fair. ([62];[63]; [64]. Meanwhile, an

individual's perception of such external circumstances may differ depending on personal traits [65]; [66] and previous experience [67]. In conclusion, even though prior research has looked at the links between various antecedents and privacy considerations, they have often been done in a fragmented way [68]. Consequently, to lead the existing regulations and investigate IPC antecedents, a significant stream of privacy research, a complete theoretical framework is needed [50].

Six essential aspects have been most frequently used in previous IPC conceptualizations. Compilation, secondary use, faults, illegal access, control, and consciousness are the five categories. They adjusted the descriptions of these measures to fit the present research situation. Specifically, collection refers to how worried a person is about the quantity of personally identifiable information held by websitesm [57].

The degree with which a person is worried that safeguards against purposeful and unintentional mistakes in personal data gathered by websites are insufficient is measured in errors [69]. The extent to which an individual is worried that personal information stored by websites is easily accessible to individuals who are not allowed to see or operate with the data is referred to as improper access [69]. The extent to which a person is worried that they do not have sufficient control over personal information stored by websites is referred to as control [57]. Finally, awareness refers to how worried a person is about the privacy policies of websites they are familiar with [57]:

- H 2.a unauthorized access has a negative effect on the intention to use m-commerce.
- H 2.b error has a negative effect on the intention to use m-commerce.
- H 2.c secondary use has a negative effect on the intention to use m-commerce.
- H 2.d collection has a negative effect on the intention to use m-commerce.
- H 2.e control has a negative effect on the intention to use m-commerce.
- H 2.f awareness has a negative effect on the intention to use m-commerce.

3.4 Individual factors

UTAUT2 covers effort probability, performance expectancy, societal impact, enabling circumstances, price worth, great hedonic courage, and habit. [70] examined each of these variables separately. In the health care framework, UTAUT2 is used to evaluate HIT approval[71]; [72];[73]. These variables are also considered as individual factors in the current research.Performance expectation was described by [37] as the "degree to which utilizing a technology will offer advantages to customers in completing different tasks." As a result, performance expectation relates to the many features of information systems that may benefit consumers. According to previous research, New technology is more likely to be accepted and used by people if they think it will benefit them [37], [74]. In the m-commerce context, performance expectation relates to how likely a customer believes that utilizing an m-commerce app would help them complete their business transactions. The "degree of ease associated with customers' use of technology" is described as "effort expectancy" [37]. Buyers would feel extremely at ease doing m-commerce purchases in this circumstance. In a study of

m-commerce adoption in Jordan, it was shown that effort expectation had a strong positive relationship with the intention to use m-commerce [75]. [37] explain the social impact as the “extent to which people consider it important and others feel that they should adopt the latest technology."They want to be adopted by the group and follow group standards in social situations [76]. The importance of social impact for mobile commerce has been shown in research [77]. While mobile commerce may be carried on as an individual effort, people may be encouraged to participate because their relatives and friends do. They may also want to amaze others by claiming that they purchased something using their smartphone. Buyers’ views of the support and resources available to perform the behavior are known as facilitation conditions [37]. In other terms, facilitation conditions are customers' views of environmental hurdles or access resources that make m-commerce systems easier to use. Clients' use of mobile phone applications for shopping may be facilitated or impeded depending on the expense or availability of mobile internet connections in a specific area. In e-commerce research, [78] combined habit with TAM and discovered that when customers acquired habitual behaviors with regard to a certain website, they were more likely to continue visiting that same website. [37]introduced habit to UTAUT2, suggesting that unconscious acts, as well as conscious intents, affect behavioral intention. Based on what has been discussed so far:

- H 3.a social influence has a positive effect on the intention to use M-commerce.
- H 3.b hedonic motivation has a positive effect on the intention to use M-commerce.
- H 3.c facilitating conditions have a positive effect on the intention to use M-commerce.
- H 3.d performance expectancy has a positive effect on the intention to use M-commerce.
- H 3.e effort expectancy has a positive effect on the intention to use M-commerce.
- H 3.f Habit has a positive effect on the intention to use M-commerce.
- H 3.g price value has a positive effect on the intention to use M-commerce.

3.5 Theoretical model proposal

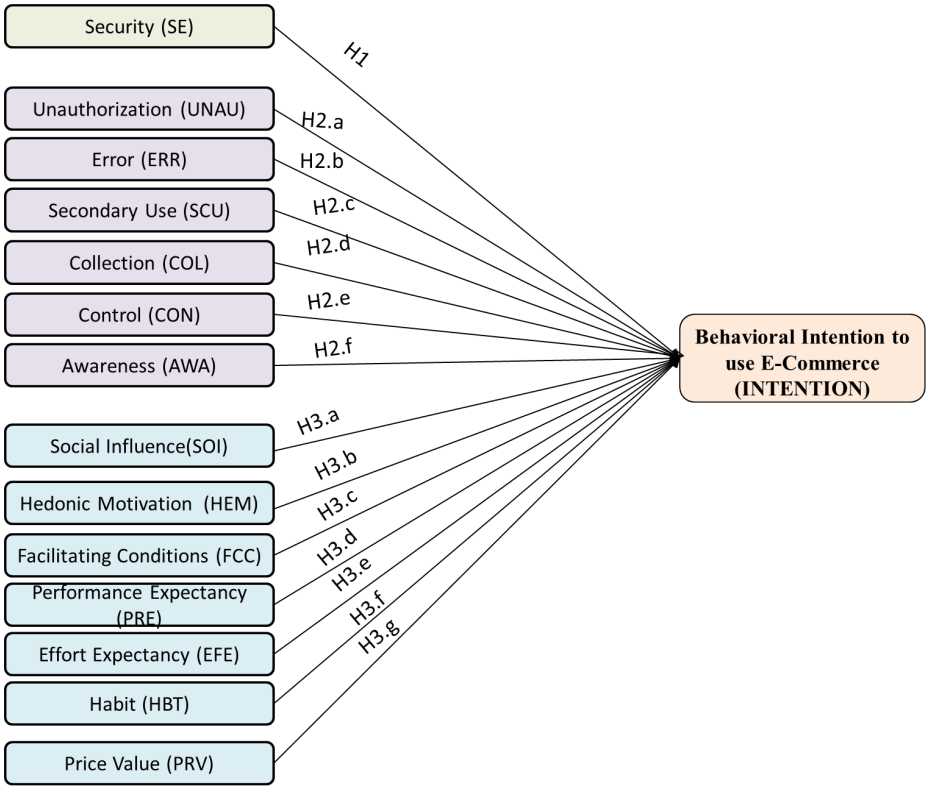

Fig. 1. Proposed framework

4 Methodology

4.1 Population and sampling

Between May 2020 and July 2021, online surveys were used to conduct the self-administered questionnaire in Jordan. Clients who shop online are the target audience. The sampling frame is using the random sampling method. A total of 931 valid responses were collected. Missing values, outliers, and normality are all handled via data cleaning and inspection procedures. Forty-three cases, including those with questions unanswered, incomplete data, and outliers, were deleted due to these procedures. Ultimately, for statistical analysis, 890 acceptable answers were kept. Table 1. below show the characteristics of the participants.

Table 1. Characteristics of participants

Characteristics		Participants	N (%)
Gender	Male	384	43.1%
	Female	506	56.9%
Age	Below 18 years old	206	23.1%
	19-30 year	489	54.9%
	31-42 year	121	13.6%
	Above 42	74	08.4%
Most Used Mobile Commerce Application	Amazon	202	22.7%
	SHEIN	194	21.8%
	Jollychic	314	35.2%
	OpenSooq	146	16.4%
	Dubizzle	11	1.2%
	Others	23	2.5%
Daily duration use of Mobile commerce	Less than 1 hour	157	17.6%
	1-2 hours	287	32.3%
	2-4 hours	379	42.6%
	4-6 hours	48	5.4%
	More than 6 hours	19	2.1%

4.2 Instrument

The experts used a five-point Likert scale questionnaire to gather data and participant answers. The answers range from (1) strongly disagree to (5) strongly agrees on a scale of one to five. The Cronbach's Alpha, which is shown in Table 2, was used to perform the pilot study dependability.

Table 2. Instrument

Variables	Items	Cronbach's Alpha
Behavioural intention to use M-commerce	4	0.738
Security	4	0.849
Confidentiality (CNF)	4	0.739
Unauthorization (UNAU)	3	0.754
Collection (COL)	4	0.901
Error (ERR)	4	0.748
Secondary Use (SCU)	4	0.791
Control (CO)	4	0.729
Awareness (AW)	4	0.864
Facilitating Conditions (FCC)	5	0.845
Performance Expectancy (PRE)	4	0.754
Effort Expectancy (EFE)	5	0.832
Habit (HBT)	4	0.754
Social influence (SOCI)	5	0.759
Hedonic Motivation (HEDO)	4	0.796
Price Value	4	0.764

4.3 Data collection

Data collection was completed from January to February of 2022. Online questionnaires were approximately distributed among the participants of the survey. The researcher used 890 questionnaires which were fully completed and considered for further analysis. The selected sample was high and achieved the expectation of structural equation modeling.

5 Structural Equation Modeling (SEM)

5.1 Stage 1 of SEM: CFA

CFA was utilized to evaluate the entire measurement model by the experts. All latent constructs and their associated indicators are included in the overall measurement model.CFA model presented in Figure 2.

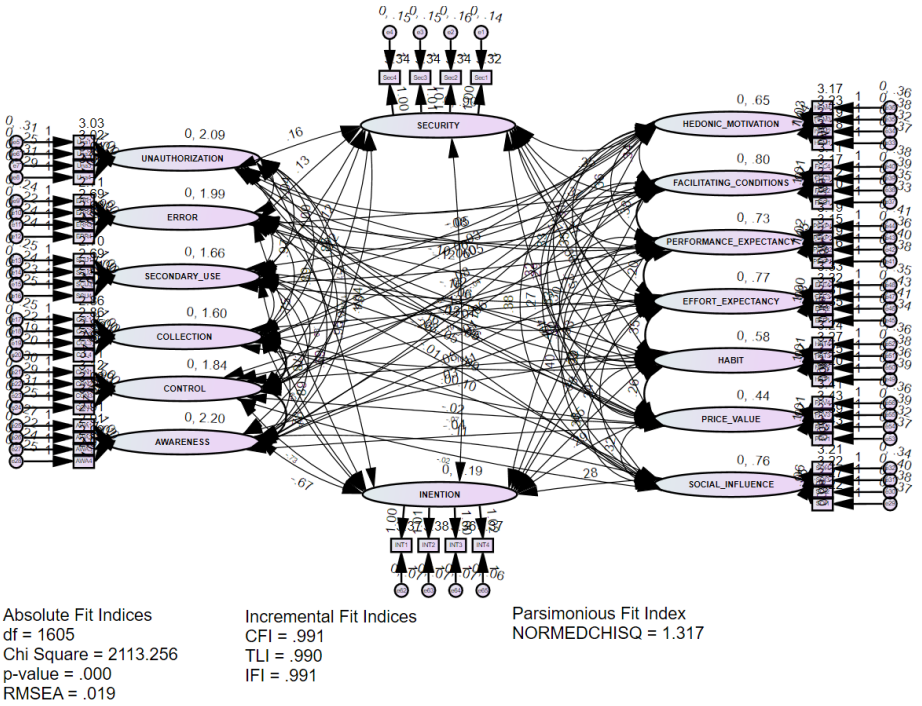

Fig. 2. CFA model

5.2 Goodness of fit indices

Table 3 include all goodness of fit tests used in the overall model, and all measurement used gave adequate fit of data. In addition Table 3 contains Convergent

& Discriminant validity and Reliability and all results achieves the recommended by [79] were AVE > ASV &MSV , AVE >0.50 , CR > 0.7.

Table 3. Goodness of fit indices

Measure	Estimate	Threshold
CMIN	2113.256	--
DF	1605.000	--
P-value	0.000	0.000
CMIN/DF	1.317	Between 1 and 3
CFI	0.991	>0.95
SRMR	0.019	<0.08
RMSEA	0.019	<0.06
PClose	1.000	>0.05

The results show that the overall measurement model for the research provides adequate fit of data (DF = 1605, p value = 0.000, CFI = 0.991, RMSEA = 0.019 and Pclose=1.000). According to results all measures are fit.

5.3 Validity analysis

Table 4. Convergent & Discriminate validity and Reliability

	CR	AVE	MSV	MaxR (H)	SEC	UNA	ERR	SCU	COL	AWA	SOI	HEM	FCC	PEX	EFE	HBT	PRV	INT	CON
SEC	0.960	0.858	0.247	0.960	**0.926**														
UNA	0.967	0.879	0.358	0.967	0.117***	**0.938**													
ERR	0.971	0.894	0.321	0.971	0.101**	0.510***	**0.946**												
SCU	0.965	0.874	0.286	0.965	0.099**	0.535***	0.534***	**0.935**											
COL	0.968	0.883	0.246	0.968	0.185***	0.468***	0.496***	0.459***	**0.940**										
AWA	0.974	0.902	0.233	0.974	0.322***	0.483***	0.452***	0.361***	0.476***	**0.950**									
SOI	0.885	0.658	0.335	0.885	0.486***	-0.008	0.045	0.076*	0.095**	0.085*	**0.811**								
HEM	0.884	0.656	0.300	0.884	0.455***	-0.073*	-0.040	-0.026	0.098**	0.054	0.548***	**0.810**							
FCC	0.896	0.683	0.335	0.897	0.442***	-0.089*	-0.042	-0.052	0.075*	-0.005	0.579***	0.475***	**0.826**						
PEX	0.890	0.669	0.294	0.890	0.453***	-0.079*	-0.052	0.015	0.063	-0.087*	0.542***	0.530***	0.499***	**0.818**					
EFE	0.887	0.662	0.270	0.888	0.445***	-0.208***	-0.128***	-0.117**	-0.116**	0.063	0.451***	0.442***	0.452***	0.263***	**0.814**				
HBT	0.865	0.616	0.296	0.866	0.497***	-0.143***	-0.028	-0.056	0.005	0.024	0.544***	0.535***	0.474***	0.500***	0.520***	**0.785**			
PRV	0.832	0.554	0.306	0.833	0.401***	-0.085*	-0.049	-0.038	-0.021	-0.043	0.553***	0.545***	0.450***	0.525***	0.380***	0.504***	**0.744**		
INT	0.986	0.947	0.264	0.986	0.258***	-0.513***	-0.509***	-0.440***	-0.401***	-0.413***	0.300***	0.340***	0.334***	0.421***	0.399***	0.414***	0.395***	**0.973**	
CON	0.962	0.864	0.358	0.962	0.133***	0.598***	0.567***	0.509***	0.452***	0.387***	-0.018	-0.040	-0.021	-0.011	-0.160***	-0.095*	-0.073	-0.496***	**0.930**

Note: CR: Composite reliability/ AVE: Average Variance Extracted /MSV: Maximum Shared Variance/ ASV: Average Shared Variance
Significance of Correlations:† p < 0.100, * p < 0.050, ** p < 0.010, *** p < 0.001

5.4 Stage 2 of SEM: Structural model

The independent factors' substantial effects on the relying variables (safety, confidentiality, individual traits, and faith) are shown in the research model's structural framework. (intention to use M-commerce), and the paths relative to H1, H2,a,H2,b,H2,c,H2,d,H2,e,H2,f, H3.a,H3.b,H3.c,H3.d,H3.e,H3.f,H3.g examined.

Figure 3 represents the hypothesized impacts test together by standardized degeneration weight using AMOS 26.

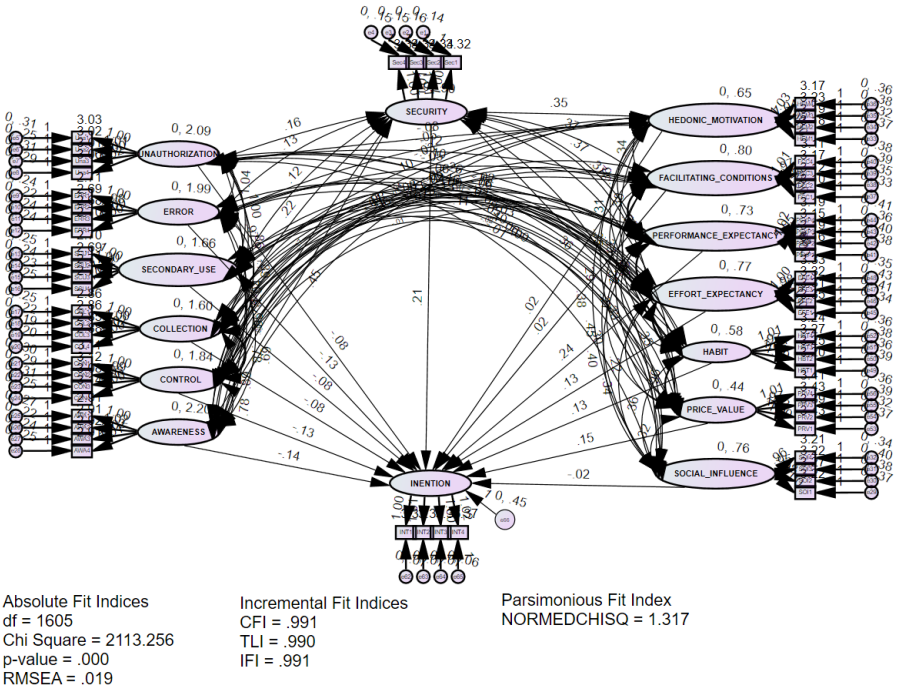

Fig. 3. Structural model

The GOF signs show that the model of structure is subsequently good for the data MIN= 2113.256 , DF 1605.000, CMIN/DF =1.317, CFI = 0.991, SRMR= 0.019 , RMSEA= 0.019 PClose = 1.000

The R2 is 0.45. Table – shows the hypnotized results. Namely, performance expectancy, effort expectancy, habit, price value, security, un-authorization, error, secondary use, control, collection, and awareness, on intention are significant due to P-value <0.05. As a result, H1d, H1e, H1f, H1g, H2, H3a, H3b, H3c, H3d, H3e, and H3f are accepted respectively. On the other hand, H1a, H1b, and H1c hypotheses are rejected due to P-values are > 0.05.

5.5 Direct effect

The path coefficients and outcomes of the predicted direct effects are shown in the table. All the hypotheses were accepted due to their p-values are greater than 0.05. In addition, As shown in Table 5. The direct consequences are shown in the table below.

Table 5. Coefficients and direct effects hypothesized

Hypotheses		Estimate	S.E.	C.R.	P-value	Hypothesis result
H1	SECURITY→INENTION	0.181	0.036	5.752	***	√
H2a	UNAUTHORIZATION→INENTION	-0.105	0.024	-3.291	0.001	√
H2b	ERROR→INENTION	-0.164	0.024	-5.377	***	√
H2c	SECONDARY_USE→INENTION	-0.099	0.025	-3.385	***	√
H2d	COLLECTION→INENTION	-0.093	0.025	-3.2	0.001	√
H2e	CONTROL→INENTION	-0.164	0.025	-5.251	***	√
H2f	AWARENESS→INENTION	-0.192	0.022	-6.436	***	√
H3a	SOCIAL_INFLUENCE→INENTION	-0.013	0.046	-0.356	0.722	x
H3b	HEDONIC_MOTIVATION→INENTION	0.012	0.046	0.357	0.721	x
H3c	FACILITATING_CONDITIONS→INENTION	0.014	0.039	0.426	0.67	x
H3d	PERFORMANCE_EXPECTANCY→INENTION	0.184	0.044	5.3	***	√
H3e	EFFORT_EXPECTANCY→INENTION	0.103	0.04	3.175	0.001	√
H3f	HABIT→INENTION	0.09	0.05	2.585	0.01	√
H3g	PRICE_VALUE→INENTION	0.093	0.056	2.728	0.006	√

5.6 SEM-ANN two-stage approach

The SEM-ANN two-stage approach has been applied in anticipating the critical factors that precede confidence in electronic commerce because the SEM approach only detects linear relationships by relying on compensatory models. Nevertheless, it can exaggerate complex human decision-making processes because it follows linear equations and performs the theoretical testing of models. Linearity while SEM and ANN can be integrated to test linear and non-linear relationships, relying on the compensatory model, allowing to address complex processes in human decision-making [80].

Where the ANN approach deals with the linear and non-linear relationships because it depends on the black box process of the algorithm, which is the basis for the prediction. Therefore, both the advantages of SEM and ANN can be taken advantage of, and the shortcomings of the two approaches have been used. As a primary entry point to initiate neuronal analysis using the ANN approach [81].

An artificial neural network (ANN) is a parallel distributed processor composed of processing units with a neural propensity to store and utilize experiential information. These basic components are called nodes or neurons, and they function similarly to neurons in the human body. ANN stores and retrieves information in the communication weights of neurons via learning processes[82].

6 Method

6.1 Relative importance and total contribution

This study used a multilayer perceptron (MLP) using the Feed forward-Back Propagation (FFBP) technique. It consists of three levels, with the inward signals being fed forward but the erroneous signals being represented in the reverse directions. Three layers are as follows,

- Input layer
- Output layer
- Hidden layer

Every layer comprises Neuron that is linked to the synapses in the previous levels. The wave is carried further through the unknown coating from input to output. Every Single neuron determines its output on the basis of an input vector. X The weights that link the hidden neuron-j to the output neuron-k are shown by Vkj, whereas the input component-i to the hidden neuron-j is indicated by Wji.[83].Further particularly, intended for the j-the mysterious neuron,

$$net_j^h = \sum_{i=1}^{N} Wjix_i \; and \; Y_i = f\,(net_j^h) \tag{1}$$

For the k-th output neuron,

$$net_k^0 = \sum_{j=1}^{J+1} V_{kj} y_j \; and \; o_k = f\,(net_k^0) \tag{2}$$

A typical x-function (Eq. (1)) Is used with a parameter to process the color gamut for a function that ranges from 0 to 1 which is a monotonic and differentiable increment. The weight adjustment formula will be used for the output layer weights V using (Eq. (2)) in where the hidden layer weights will be extracted using (Eq. (3))Where dpk denotes the desired output from neuron-k while opk denotes the true output of neuron-k of the input type ([84] ; [83]In addition, weights are reduced in this way to reduce the square of the sum of the SSE (Eq. (6))across training modes for some of the pre-defined tolerance levels.

$$f\,(net) = \frac{1}{1+e^{-\lambda net}} \tag{3}$$

$$V_{kj}(t+1) = v_{kj}(t) + c\lambda(d_k - o_k)o_k(1-o_k)y_i(t) \tag{4}$$

$$W_{ji}(t+1) = W_{ji}(t) + c\lambda^2 y_j(1-y_j)x_i\,(t)\left(\sum_{k=1}^{k}(d_k - o_k)o_k(1-o_k)V_{kj}\right) \tag{5}$$

$$SSE = \frac{1}{2P}\sum_{p=1}^{p}\sum_{k=1}^{k}(d_{pk} - o_{pk})^2 \tag{6}$$

Consequently, ANN can detect linear and non-linear associations among variables, which gives more accurate results and summarizes, in the end, the contribution of each variable in the model accurately, overcoming the weaknesses in MRA, SEM, or logistical analysis, however, ANN analysis is not suitable for testing hypotheses

because it depends on the black box. To analyze the neural network, therefore, SEM was integrated with ANN by hypothesis testing with AMOS, after which ANN was used. The sigmoid functions were employed to activate the hidden and output layers, and the neural network method was computed by SPSS using a ten-fold ANN analysis to avoid the possible issue of over-fitting, with 10% of the data used for testing and the remaining data used for training procedures, Through many rounds of the learning process, errors can be reduced and prediction accuracy improved, as well as 90% allocated to training operations and the rest of the samples were used for testing, to avoid over processing, the probe was used ten times as much (Table 5). The root means square of the error RMSE was used to compute the predictive accuracy of the ANN model [85].

Thus, as (Table 6) shows, the RMSE values for training and testing are 0.446 and 0.489, and we can notice small differences between the training and testing values for the study variables, which indicates high predictability and excellent fit to the data and this is what is observed from the amount of weights associated with hidden neurons. While the sensitivity analysis evaluates each predictor's impact on mobile commerce trust, the relative natural significance was determined as a percentage based on the percentage of each added neuron's relative value divided by the highest relative importance (Table 7). The results show that the EFE the most important predictor of the adoption of mobile commerce while HBT is less important in terms of the total contribution of the input neurons according to (Table 8). On the other hand, hidden neurons of H (1:2)are the most contributing cells, followed by H (1:3), H(1:5), and H(1:4). H (1:7), H (1:1), H (1:6) respectively. Finally, the goodness-of-fit index (Eq. (7)) was calculated that is comparable to the R2 in SEM.

$$R^2 = 1 - \frac{RMSE}{S_y^2} \tag{7}$$

Where S_y^2 is the variance preferred outcome in accordance with the estimated value of SSE, and the outcome indicates,93.78 % of adoption of mobile commerce is predicted by the ANN model.

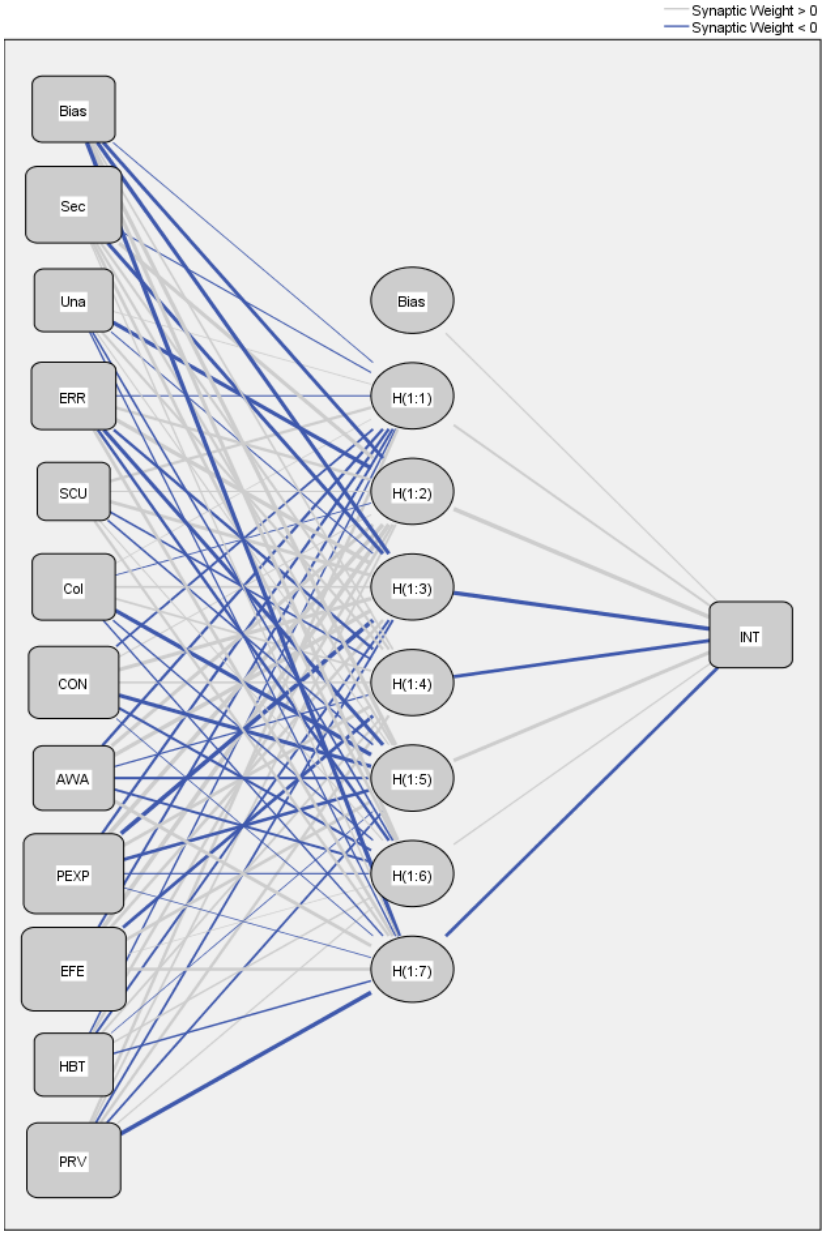

Fig. 4. The ANN model

Table 6. The RMSE for training and testing processes in a ten-fold ANN

Neural Network	Input neurons: SEC,UNA,ERR, SCU, COL, CON, AWA, PEXP, EFE, HBT, PRV Output nodes: INT						Total
	Training			Testing			
	N	***SSE***	***RMSE***	***N***	***SSE***	***RMSE***	
1	796	171.495	0.464	94	23.845	0.504	890
2	791	163.009	0.454	99	24.322	0.496	890
3	785	141.190	0.424	105	26.151	0.499	890
4	800	146.663	0.428	90	21.923	0.494	890
5	797	144.126	0.425	93	19.486	0.458	890
6	805	172.533	0.463	85	23.063	0.521	890
7	801	150.063	0.433	89	18.368	0.454	890
8	799	159.714	0.447	91	23.151	0.504	890
9	795	177.695	0.473	95	25.176	0.515	890
10	801	162.169	0.450	89	18.028	0.450	890
Mean		158.865	0.4461		22.351	0.4895	
SD		12.848	0.017766		2.840	0.0258	

Table 7. Sensitivity analysis

Neural Network	Relative importance										
	SEC	***UNA***	***ERR***	***SCU***	***COL***	***CON***	***AWA***	***PEXP***	***EFE***	***HBT***	***PRV***
1	0.134	0.071	0.74	0.79	0.32	0.71	0.91	0.112	0.076	0.132	0.128
2	0.126	0.069	0.093	0.074	0.060	0.064	0.080	0.117	0.105	0.115	0.099
3	0.136	0.070	0.097	0.073	0.055	0.072	0.079	0.112	0.081	0.118	0.107
4	0.142	0.056	0.093	0.104	0.072	0.058	0.091	0.085	0.079	0.113	0.106
5	0.143	0.066	0.080	0.099	0.066	0.082	0.075	0.112	0.099	0.088	0.091
6	0.143	0.057	0.091	0.085	0.047	0.059	0.087	0.126	0.096	0.117	0.101
7	0.136	0.063	0.086	0.094	0.083	0.074	0.060	0.105	0.100	0.085	0.115
8	0.143	0.048	0.088	0.081	0.056	0.085	0.094	0.107	0.094	0.111	0.093
9	0.138	0.066	0.083	0.077	0.050	0.077	0.086	0.127	0.091	0.098	0.109
10	0.123	0.061	0.069	0.105	0.080	0.069	0.080	0.110	0.106	0.099	0.098
Mean relative importance	0.1364	0.0627	0.152	0.1582	0.0889	0.135	0.1642	0.1113	0.0927	0.1076	0.1047
Normalized importance (%)	80%	40.4%	53.7%	26.8%	50.6%	67.0%	45.8%	89.6%	100%	40.8%	75.2%

Notes: SEC=Security; UNA=Unauthenticated; ERR= Error; SCU= Secondary Use; COL= Collection; CON=Control; AWA= Awareness; PEXP= Performance Expectancy; EFE=Effort Expectancy; HBT=Habit; PRV=Price Value

Table 8. Average weights of the input and hidden neurons in the ten-fold ANN

Predictor		Predicted								Total Contribution
		Hidden Layer 1							*Output Layer*	
		H(1:1)	*H(1:2)*	*H(1:3)*	*H(1:4)*	*H(1:5)*	*H(1:6)*	*H(1:7)*	*INT*	
Input Layer	(Bias)	-.038	-.888	-1.057	.311	1.075	.932	-1.366		
	Sec	-.126	1.000	-.927	.487	.519	.676	.190		1.819
	UNA	.031	-1.079	-.118	.498	.118	-.313	-.168		-1.031
	ERR	-.104	.589	1.212	-.560	-1.029	-.613	.728		0.223
	SCU	.534	.084	.864	-.315	-.268	.102	.523		1.524
	Col	.015	-.038	.317	.324	-1.225	-.242	-.221		-1.07
	CON	-.372	.082	.980	.267	-1.029	-.511	-.034		-0.617
	AWA	-.536	.915	1.079	-.141	-.488	-.441	.861		1.249
	PEXP	-.531	1.411	-1.738	.730	-.739	-.143	-.022		-1.032
	EFE	-.450	1.652	.651	-.799	.713	.008	.658		2.433
	HBT	-.258	.572	-.422	.345	-.030	.249	-.267		0.189
	PRV	.630	.348	-.375	.548	-.356	.139	-1.503		-0.569
Hidden Layer 1	(Bias)								.133	
	H(1:1)								.389	
	H(1:2)								1.638	
	H(1:3)								-1.354	
	H(1:4)								-.876	
	H(1:5)								.918	
	H(1:6)								.139	
	H(1:7)								-.785	

7 Discussion

7.1 Direct effects

Security factor. In the overall acceptance and usage of M-commerce, Privacy is positively linked. Hypothesis H1 is provided, advocated for, and supported in this research. The growing security inclination among customers is shown in the positive connection between M-commerce acceptability and use and privacy. So, to secure the consumers' data adequately, it should be maintained the confidentiality of the data according to the security policy. Moreover, other researches, there explained the similar results, [86][87]. Besides, [88]demonstrated that security had a good and direct impact on the implementation of E-commerce [89]. According to [90], security had a significant and positive influence on M-commerce acceptance. [91] Thus, privacy is counted as a high major element in the implementation of E-commerce.

Perceived security, according to [92], has a significant effect on the user's desire to concentrate on online features and get the required services. Furthermore, the results revealed that privacy has a considerable positive impact on E-commerce implementation and usage in a variety of ways.

IPC factors. Collection, subsequent use, un-authorization, knowledge, control, and error are all aspects of privacy. Overall, privacy issues are adversely linked with M-commerce acceptability and use. The findings indicated a negative connection between M-commerce acceptability and use, and IPC highlighted a trend in customer privacy concerns. Thus, H2.a, H2.b, H2.c, H2.d, H2.eandH2.fare supported. Consumers' poor adoption and use of the M-commerce method were attributed to increased privacy concerns.[93] It also discovered that when safety concerns seem high, opt-in EHR is low, providing significant empirical data showing the direct connection between security issues and behavioral intentions. Moreover, [93] found that confidentiality had a negative impact on intentional use. The results indicated that there was a significant and positive connection between privacy and behavioral intention (Angst &Agarwal, 2009). Furthermore, as privacy issues grow more prominent, M-commerce will decline.

Individual factors. Using the current research pattern in a digital commerce area with the M-commerce acceptance and usage of consumers had a good result. The pattern had 45% variation on the side of behavioral intention in the proposed model of the study.H3.d,H3.e,H3.f and H3.g are supported. [70]and [95]observed that individual factors have a good and direct influence on the intentional use of M-commerce text.

Our study presented and tested a model by following a two-theory model while using the SEM-ANN approach, thus arriving at an innovative model for adoption in mobile commerce with this approach it has been discovered that UTAUT2 (Performance Expectancy; Effort Expectancy; Habit; Price Value), IPC model(Unauthenticated; Error; Secondary Use; Collection; Control; Awareness) and security have a non-linear relationship with intention to use mobile commerce, this discovery is interesting and agrees with the scientists who have researched this topic. With the help of ANN, non-linear relationships between the variables were discovered while the results also indicate that the UTAUT2, IPC model and security to influence the adoption of mobile commerce also has a non-linear relationship, providing insight to scientists into the future and demonstrating that consumers' perceptions of UTAUT2, IPC model and security interact with the adoption of mobile commerce; a critical method that cannot be performed and clarified only by linear relationships. Thus, when consumers realize that mobile commerce is new trend technology due to COVID-19 spreading, they will be excited to experiment with advanced techniques and as a result will be least hesitant to use it.

8 Limitations

The research is centered on a single digital commerce structure, and the findings were shown to be generalizable to a variety of populations from whom samples were taken. That is why there isn't a direct representation of behavior.

Along with this, territorial partition in Jordan might also impact the understanding of Mobile commerce, Given that certain people from different parts of the world behave differently. Other is the use of a general survey into the collection of data. A survey is useful for collecting statistical data, but it is not sufficient for detailed research and

exploring particular issues. Moreover, current research has a small sample size that restricts the other respondent's opinions regarding the selected research problem.

Finally, various categories of consumers use mobile commerce. Consumers that are used for the conduction of the research study as digital commerce customers must replicate them, To learn how these results may be generalized.

9 Future research directions

The researcher is only focused upon the mobile commerce users that are only a few empirical studies. Future researchers may conclude this study by concentrating on higher sample sizes, discussions, and opinions that will give a visible and transparent picture regarding customer's requirements. In addition, further study is needed to focus on a specific set of people involved in m-commerce, such as managers and stakeholders. The future researcher may also tackle the study in another angle by conducting pre-execution research to focus upon M-commerce influencing the stakeholders and managers.

10 Conclusion

The present research analyzed the privacy, security, and individual elements which impact M-commerce acceptance and usage. The present study successfully achieves the research objective of investigating the elements which impact M-commerce acceptance and usage in Jordan and the development of the proposed model. The current research extended UTAUT2 to attain its objectives, considering that UTAUT2 known as it has been validating by reliable significant analysis. The results that are achieved by using the UTAUT2 may be helpful as numerical findings and thus as a basis and justification for decision-makers in their decisions. The outcome can also be contributive towards the M-commerce application developers' knowledge of enhancing existing M-commerce application based on the application’s weaknesses highlighted by the study. The finding also presented data collected from consumers in Jordan through the research models. Researchers must examine these concepts to determine the advantages and disadvantages of m-commerce adoption and use in these businesses. Furthermore, the result adds to digital commerce, particularly in terms of the acceptability and use of saved data records in business companies. It is also proposed that user adaption characteristics such as security, privacy, individual aspects, and re-use of these results, which are recognized and used in M-commerce, aid in creating UTAU`T2.

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