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4G Adoption : A Survey of Vietnam Market

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Abstract

The aim of this study is to assess the impacts of service properties, price expectancy, social influences, and switching costs on adoption intention of 4G in Vietnam. The research model was established by the theory of diffusion of innovation, technology acceptance model, service quality, social influences and switching costs. The result from customers using telecommunication services in Vietnam shows that adoption intention of 4G is affected directly by perceived usefulness, personal innovativeness, price expectancy, social influences, prior service quality and switching costs. Whereas, switching costs have negative effect on adoption intention. Other factors such as personal innovativeness, perceived ease of use and prior service quality have an indirect effect on adoption intention of 4G.

Keywords : Adoption Intention, Switching Costs, Price Expectancy, Social Influences, TAM

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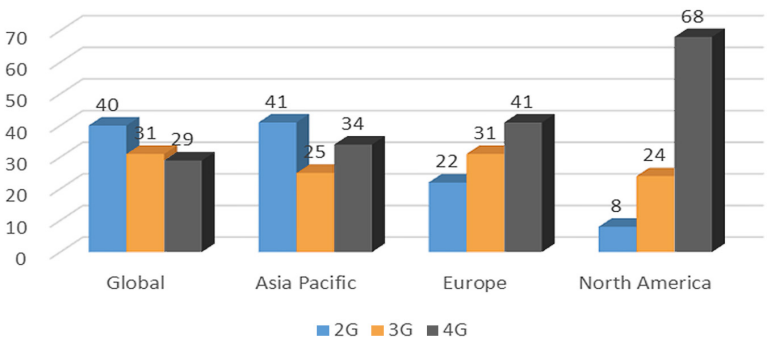
1. Introduction

In recent decades, the development and advance of mobile communications (2G, 3G and 4G) have increased the reach of the global information network. It has connected mobile devices and brought content available on different mobile platforms in such a way that the main consequence of updating one's mobile device is the change in user interface. The same content and applications are available in a variety of devices. This has made it easier for consumers to update devices, making product life cycles shorter for mobile technologies. For instance, many smartphones have applications to automatically store one's data in a cloud and recover this data when the user purchases a new device.

The increasing capabilities of mobile infrastructure have enabled new service innovation in handsets. In addition to the traditional voice calls, 2G mobile phones were capable of text messaging and voice mail. Many new services were introduced in 3G phones, such as playback of music and video over the Internet, online games, email and instant messaging, and Web browsing [Huh and Kim, 2008]. While application software may reside on the handset and third-party servers, these services depend crucially on the speed and protocols offered by the network technology.

A similar development can be seen in the transfer to 4G, whose speed is up to 10 times faster than 3G. As with previous technologies, the development of 4G technology is being driven primarily by the new services [Rouffet et al., 2005]. 4G comprised two different standards, WiMAX and long-term evolution (LTE) [Tseng and Lo, 2011], which Vietnamese mobile firms selected the LTE technology; hence, this study only focused on mobile services related to 4G LTE.

〈Figure 1〉 below described the percent of mobile connections in 2017 in the world. At the global level, in 2017, the 2G subscribers was still the highest number (40%), followed by 3G (31%) and 4G (29%). Asia Pacific also had the highest number of 2G mobile users (41%). However, in Norther America and Europe the number of 4G subscribers surpass older technology generations (68% and 41% of 4G compared to 24% and 31% of 3G, and 8% and 22% of 3G [GSM Association, 2018]. The GSM Association predicted that in 2019, 4G will become the leading mobile network technology worldwide by number of connections (more than 3 billion)-another major milestone for the mobile industry, about 10 years since the launch of early 4G commercial services.



Source : GSM Association, 2018.

〈Figure 1〉 % of Mobile Connections Excluding Cellular IoT in 2017

The 4th generation of mobile telecommunications (4G) is considered as one way to increase the adoption of internet-related services in developing countries like Vietnam. 4G technology enables the widespread use of the Internet at home, in public places, and in the workplace. Moreover, it also provides availability of internet access for customers on the road and for those who are in remote areas [Shin et al., 2011]. Prior studies show that there are many different factors affecting directly and indirectly adoption intention of telecommunication services such as perceived ease of use and perceived usefulness in the Technology Acceptance Model (TAM) [Davis, 1989; 1993], social influences [Lu et al., 2005], service quality [Shin and Kim, 2008; Kim et al., 2004], perceived price [Shin and Kim, 2008], personal innovativeness [Rogers, 1995; 2010; Lu et al., 2005] and switching costs [Huang and Hsieh, 2012; Shin and Kim, 2008].

Although there have been many studies on service adoption intention, most of the research models were established on the Technology Acceptance Model [Davis, 1989; 1993] and the premise of new services. However, regarding the generations of telecommunications, although new services are involved, the operator may not necessarily change even as the service is upgraded. Upgrading services leads to additional costs for new suitable hardware, which creates switching costs [Shin and Kim, 2008; Kim et al., 2004]. In addition, while there are studies on the association between service quality and loyalty [Lim et al., 2006] these studies are still limited in the area of telecommunications. This is probably due to the relatively short period that we have used smartphones [Jung and Kwon, 2015]. Furthermore, studies on service quality are limited on upgrading to new technology generations. To address these gaps, our study combines the theories of service acceptance based on the Technology Acceptance Model, Innovation Diffusion Model, the theory of service quality, perceived price, social influences, personal innovativeness, and switching costs in order to establish a model on upgrading services to 4G services in Vietnam.

2. Literature Review and Research Hypotheses

2.1 Vietnam Mobile Market

The launch of digital services in world mobile telecommunications happened in the 1990's [Gruber, 2001; Gruber and Verboven, 2001], and in Vietnam, GSM services debuted in the end of 1994. Therefore, Vietnam was not notably late with its adoption of digital mobile. The pace of development in these services has also been fast [Hwang et al., 2009]. However, until the early 2000's, there was only one service provider : Vietnam Post and Telecommunications Corporation (VNPT). The competitive situation changed in 2003, when the Vietnamese government reformed the sector and opened the market to new entrants. Competitors quickly emerged, and by 2010 there are seven mobile operators among which three (Viettel, VinaPhone and MobiPhone) are dominating the market with a 90% stake of subscribers [VNPT, 2010].

In 2017, Vietnam has approximate 136 million mobile subscribers, including 68.8 million 2G and 54.2 million 3G, with 53 million Internet users [Vietnam Posts and Telecommunication Group, 2017]. These figures are also constantly increasing [MIC, 2017; Statista, 2016]. This is due to the increasing demand for internet access and use of mobile data

services. Hence, provision of the 4G network with high-speed internet connection and internet-based services is promising for the purpose of proliferating internet use in Vietnam. In October 2016, Vietnam's Ministry of Information and Communication officials awarded 4G licenses for 3 mobile operators, namely, Viettel, Mobifone, and Vinaphone. These companies were expected to launch their commercial 4G networks 6 months after launching their pilot [MIC, 2017]. By 2017, these operators have installed approximately 43,000 of 4G LTE stations nationwide, covering about 95% of the population [VNPT, 2017].

Despite the investment, the adoption of 4G has been lagging behind expectations. There were only 6.3 million 4G subscribers after 6 months of operating the new network [VNPT, 2017], which seems low considering the total number of mobile subscribers in Vietnam (130 million). Research shows that the majority, 88 percent, of these initial adopters to come from the two largest cities (Hanoi and Ho Chi Minh City). Additionally, only 50% of those adopters had used the services that take advantage of the new features of 4G. This situation highlights the need for operators to investigate the reasons for the low adoption rate when switching from 2G or 3G to 4G. For instance, users might be put off because they should change their handset for a 4G-compatible one in addition to paying for the higher subscription fees of 4G.

2.2 Mobile Service Adoption

Mobile internet brings many benefits to users such as high-speed connection [Lopez et al., 2007; Zhou and Lu, 2011]; usage of data services, website access, commercial transactions and database services [Lu et al., 2005; Kim et al., 2004; Al-Debei and Al-Lozi, 2014]. However, the mobile operators need people to subscribe and use the services in order to guarantee for their survival and development. Thus, a number of studies attempted to investigate the determinants of intention to adopt new mobile technologies [Ovcjak et al., 2015].

Previous studies found that adoption intention could be used to explain the switching behavior to another service at a higher level, and the upgrading equipment of users [Shin and Kim, 2008; Oliveira et al., 2016]. Adoption intention is a common variable in the fields of technology services such as mobile telecommunication services [Kuo and Yen, 2009; Kim et al., 2007; Lu et al., 2005] and 3G and 4G mobile generations [Chong et al., 2012; Tseng and Chiang, 2013; Jung and Kwon, 2015; Teng et al., 2009]. Adoption intention is defined as an individual's purpose to performing a given behavior and is thought of as a good indicator of actual behavior [Ajzen, 1991; Venkatesh et al., 2003].

Studies relating to adoption intention in technologies are based on the Technology Acceptance Model [TAM, Davis 1989; 1993; Taylor and Tood, 1995] which is one of the common models [King and He, 2008]. Other studies have further developed TAM and integrated many theories to it relating to services such as innovation impact [Rogers, 2010; Lu et al., 2005], service quality [Shin and Kim, 2008; Kim et al., 2004], and social influences [Venkatesh, 2000]. The findings of previous studies show that adoption intention of technology services such as 4G can be affected directly and indirectly by following elements : (1) personal innovativeness [Lee, 2013; Oliveira et al., 2016]; (2) perceived ease of use [Abdullah et al., 2016; Carlsson et al., 2005]; (3) perceived usefulness [Erkan and Evans, 2016; Tapanainen et al., 2018; Wei et al., 2009]; (4) price expectancy [Al-Debei and Al-Lozi,

2014; Venkatesh et al., 2012]; (5) prior service quality [Kuo et al., 2009; Tapanainen et al., 2018]; (6) social influences; (7) switching costs [Shi et al., 2010; Shin and Kim, 2008].

2.3 Hypotheses Development and Research Model

2.3.1 Personal Innovativeness (PI)

Innovativeness is a desire and readiness to accept new technology [Kuo and Yen, 2009; Lu et al., 2005]. Personal innovativeness considers this at an individual level, referring to making decisions in an innovative way [Midgley and Dowling, 1978] such as implementing and applying new ideas, new concepts and new products prior to others [Rogers, 1995; Rogers and Shoemaker, 1971]. People who accept to use services earlier find it easy to understand, perceive and evaluate the benefits of these services quickly [Moore, 2002]. This means that personal innovativeness affects perceived usefulness and perceived ease of use by customers [Mun et al., 2006; Kuo and Yen, 2009; Lu et al., 2005; Lee, 2013; Oliveira et al., 2016]. Thus, this study proposes the following hypotheses :

H1a : Personal innovativeness positively affects perceived ease of use

H1b : Personal innovativeness positively affects perceived usefulness

2.3.2 Perceived Ease of Use (PEOU)

Perceived ease of use is defined as the degree to which a person feels comfortable to use a certain product or service [Venkatesh et al., 2003] without much physical or mental effort [Davis, 1989]. Perceived ease of use allows users to save effort in using the services. As a results, services which are perceived easy to manage, have higher chances to be selected by customers [Venkatesh, 2000; Mun et al., 2006; Jin, 2014; Ha and Stoel, 2009]. The relation of positive effect between perceived ease of use and adoption intention is assessed in many studies [Davis et al., 1989; Venkatesh, 2000; Lee, 2013; Lu et al., 2005, Mun et al., 2006; Abdullah et al., 2016]. Thus, we hypothesize :

H2a : Perceived ease of use positively affects perceived usefulness

H2b : Perceived ease of use positively affects adoption intention

2.3.3 Perceived Usefulness (PU)

Perceived usefulness is defined as a degree to which a person trusts the result from external effects of using a new technology product to enhance his or her benefits in working [Venkatesh, 2000; Venkatesh et al., 2003]. Examples for such benefits would be saving time and improving the working efficiency and quality [Davis, 1993; Venkatesh et al., 2000]. Perceived usefulness is considered as direct estimated factor of behavioral intention that is common in studies relating to consumer behavior [Davis, 1989; Erkan and Evans, 2016; Lee, 2013] and technology-related products or services [Kuo and Yen, 2009; Fortes and Rita, 2016; Lu et al., 2005; Oliveira et al., 2016]. Hence, we propose that :

H3 : Perceived usefulness positively affects adoption intention

2.3.4 Price Expectancy (PE)

Price expectancy is the individual's perception of cost on using or experiencing the

service [Venkatesh et al., 2012; Kim et al., 2007]. Costs and cost structure not only have a vital effect on the customer's use of technology services, but are also a trade-off between their money and perceived benefits of products [Monroe and Krishnan, 1985; Ahtola, 1984]. For using mobile services, customers have to pay a monthly fee, hence, they are likely to feel guilty when spending their money illogically if this fee is unreasonable [Al-Debei and Al-Lozi, 2014], conversely, customers will perceive costs as positive if the perceived benefits using the technology outweigh the costs spent [Venkatesh et al., 2012; Oliveira et al., 2016]. Hence, price expectancy is considered as an indicator adoption intention of technological products [Al-Debei and Al-Lozi, 2014; Kim et al., 2007; Grewal et al., 1998; Venkatesh et al., 2012; Oliveira et al., 2016]. Therefore, we have formulated the following hypotheses :

H4 : Price expectancy positively affects adoption intention

2.3.5 Prior Service Quality (PSQ)

Prior service quality is the customer's perception of the degree of capability of the product or service in fulfilling its function [Venkatesh and Davis, 2000]. Service quality is usually evaluated through many different aspects as in a multi-dimensional scales [Parasuraman et al., 1985; Kuo et al., 2009; Jung and Kwon, 2015] or in a one-dimensional scale in technology services [Delone and McLean, 1992; 2003; Shin and Kim, 2008]. For telecommunication, quality services can be accessed by transmission quality, cost structure, value-added service, customer support and billing system [Kim et al., 2004]. In this study, service quality is measured in a one-dimensional scale integrated items from telecommunication service quality measurement of Kim et al. [2004]. If customers evaluate the current services positively, they can be willing to accept the new services. Prior studies [e.g. Lee and Lin, 2005; Kuo et al., 2009] also found the positive link between service quality and intention to adopt. Therefore, this research proposes the following hypotheses :

H5a : Prior service quality positively affects price expectancy

H5b : Prior service quality positively affects adoption intention

2.3.6 Social Influences (SI)

Social influences is the pressure from the surrounding social network towards performing or not performing a certain behavior [Lu et al., 2005], reflecting the impact of environmental factors such as feedback from other users [Venkatesh et al., 2003]. It is expressed through individual relationships with people who are important (friends, family) and their beliefs regarding whether one should use a new product or service [Venkatesh et al., 2012]. Social influences play a role in one's personal assessment and estimation in using a product or service [Lu et al., 2005]. Hence, social influences can motivate the customer to accept services [Venkatesh et al., 2003; Carlsson et al., 2006; Lu et al., 2005; Oliveira et al., 2016, Al-Debei and Al-Lozi, 2014]. Consequently, it is proposed that :

H6 : Social influences positively affect adoption intention with 4G

2.3.7 Switching Costs (SC)

Switching costs are perceived potential

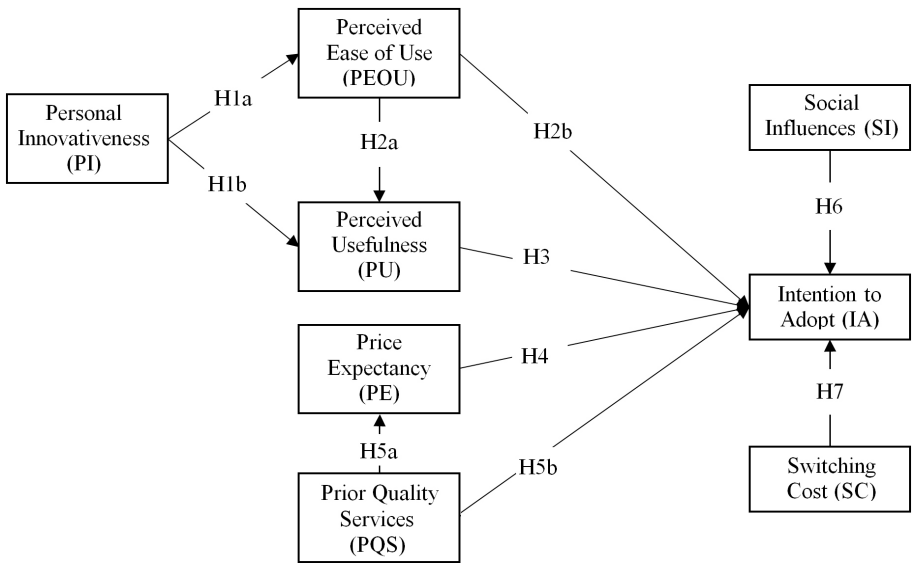
losses of customers [Shin and Kim, 2008] and the expenses that arise "one-time" relating to the changing process from one product to another product or from one provider to another provider [Burnham et al., 2003; Kim et al., 2004]. Switching costs are not only related to financial costs, but also barriers such as effort and time when they lack the necessary information and have to search for it [Samuelson and Zeckhauser, 1988; Shugan, 1980; Dick and Basu, 1994], transaction costs and cognitive efforts [Fornell, 1992, Shi et al., 2010; Kim et al., 2003]. While switching costs is the indicator of customer loyalty towards current service [Caruana, 2002; Kim et al., 2004; Liu et al., 2011; Aydin et al., 2005], it also is considered as a barrier in making decisions on service-related customer switching intention [Fornell, 1992; Shi et al., 2010; Shin and Kim, 2008]. Hence, this research hypothesis is made :

H7 : Switching costs negatively affect adoption intention with 4G

3. Methodology

3.1 Research Scales Development

We referenced items used in prior studies and adjusted them to be suitable for our research objectives. Firstly, all questions were translated from English to Vietnamese through opposite translation process in order to ensure the accuracy of original meanings. Next, a pre-evaluation with a sample of 15 customers was done in order to evaluate the suitability of this set of questionnaires. The observational items of personal innovativeness were referenced from the theory of Rogers [1995] and Lu et al. [2005]; perceived ease of use was referenced from Venkatesh [2000, 2003] and Davis [1993]; perceived usefulness was referenced from Davis [1989] and Kim et al. [2007]; price expectancy was referenced from Shin and Kim [2008] and Oliveira et al., [2016]; social influences was referenced from Venkatesh [2000] and Lu et al. [2005]; switching costs were referenced from Shin and Kim [2008] and Huang and Hsieh [2012], and



〈Figure 2〉 Research Model

adoption intention of service was referenced from Davis [1993], Venkatesh [2000] and Oliveira et al. [2016]. The "service quality" was based on the study of Kim et al. [2004] and Lim [2006]. We conducted a qualitative study using the expert interview method [Chu and Hwang, 2008] in order to narrow the scales from multidirectional scales to unidirectional ones. All questionnaires were adjusted to a trial survey to 56 customers in order to assess the reliability through testing by Cronbach's Alpha and Corrected Item-Total Correction. The scale used in this research for observational items was 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5). Finally, we collected a total of 36 items for all factors of the model (see appendix).

3.2 Sample Characteristics

The sample data was collected from those who were using mobile services of the telecommunication three biggest Vietnamese operators in Hanoi, Vietnam. The respondent characteristics were described in 〈Table 1〉. Even though we succeeded to collect 342 answers, there was missing data since the demographics questions were not compulsory. Respondents were mainly young (under 30 year old) (68.71%) with the university level (70.76%). A high proportion of participants (74.27%) had the mobile with 4G support.

3.3 Data Analysis

We used Confirmatory Factor Analysis (CFA) in order to test the validity of research factors with the data sample. The model does fit well with data if Chi-square/df 〈 3, CFI, TLI, IFI 〉 0.9, RMSEA 〈 0.08 [Hair et al., 2010; Kline, 2015, Hooper et al., 2008]. The factor loading

〈Table 1〉 Respondent Characteristics

Characteristics		Number(%)
Age	〈 = 30	235(68.71%)
	〉 30	88(25.73%)
	Missing	19(5.56%)
	Total	**342(100%)**
Gender	Men	133(38.89%)
	Women	205(59.94%)
	Missing	4(1.17%)
	Total	**342(100%)**
Education level	High School	10(2.92%)
	University	242(70.76 %)
	Currently studying	87(25.44%)
	Missing	3(0.88%)
	Total	**342(100%)**
The device has 4G support	Yes	254(74.27%)
	No	52(15.20%)
	Unknown	35(10.23%)
	Missing	1(0.29%)
	Total	**342(100%)**

in every factor should be higher than 0.5 to achieve convergent validity [Hair et al., 2010]. In testing reliability, Composite Reliability (CR) and Cronbach's Alpha should be 〉 0.7 and Average Variance Extracted should be 〉 50% [Hair et al., 2010]. In order to assess the discriminant validity among research factors, the correlation coefficient with a 95% confidence interval were tested by the bootstrap method [Anderson and Gerbing, 1988; Torkzadeh et al., 2003]. To test the hypotheses, we used the Structural Equation Model (SEM) with the statistical significance at 5%. We also used impact factors, which are direct, indirect, and systematic to assess the total effect of factors to adoption intention.

4. Results

4.1 Reliability, Validity, and Fit of the Model

We used CFA analysis to assess the fit of

〈Table 2〉 Result of Reliability and Validity

Constructs (No of Items)	Factor loadings Range	AVE (%)	Composite Reliability	Cronbach's Alpha
PI(4)	0.703~0.806	57.10%	0.841	0.825
PEOU(5)	0.684~0.829	60.18%	0.883	0.874
PU(4)	0.759~0.822	64.34%	0.878	0.877
PE(4)	0.694~0.863	61.67%	0.865	0.861
PQS(4)	0.606~0.830	52.73%	0.815	0.809
SI(4)	0.701~0.907	60.01%	0.856	0.863
SC(3)	0.536~0.922	64.85%	0.840	0.823
IA(3)	0.777~0.817	63.07%	0.872	0.871

the research model and the reliability of factors. Based on assessing the content value and factor loading, we eliminated some items, and the result shows that the model fits well with the data (Chi-square = 2.274 〈 3, CFI = 0.914; TLI = 0.901; IFI = 0.914, all are greater than 0.9, RMSEA = 0.061 〈 0.08). Cronbach's Alpha and Composite Reliability for each factor are greater than 0.7 and the Average Variance Extracted are greater than 50%, which shows that factors are reliable 〈Table 2〉.

In addition, the analysis of correlation coefficients using the bootstrap method showed that the largest correlation between the PEU and PU variables (0.796) with the 95% confidence interval (0.698÷0.866) confirmed that the factors in the model are discriminated.

4.2 The Result from SEM Analysis

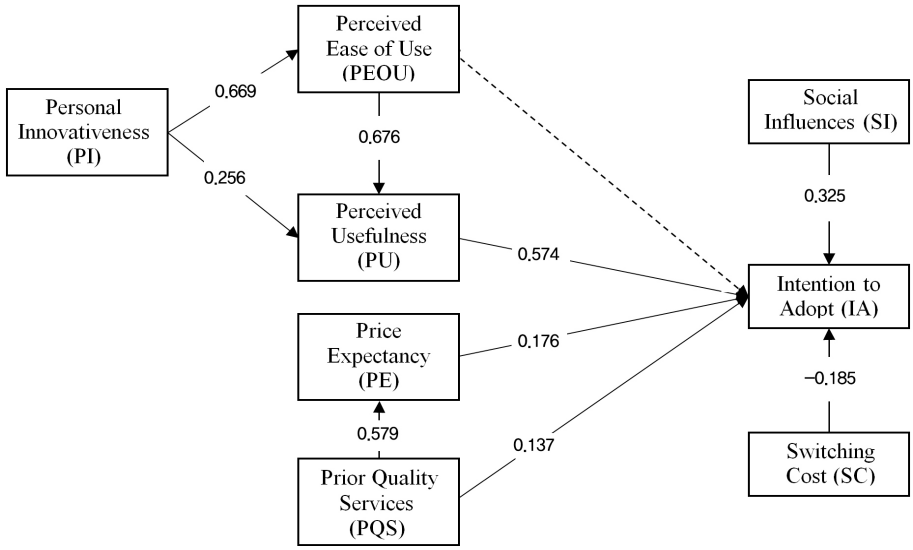
4.2.1 Path Analysis

The results from the SEM analysis show that the model fits with the data (Chi-square/df = 2.278 〈 3; CFI = 0.911, TLI = 0.901, IFI = 0.912, RMSEA = 0.061).

The research supports hypotheses H1a, H1b, H2a, H3, H4, H5a, H5b, H6, H7 and rejects hypotheses H2b (〈Table 3〉 and 〈Figure 3〉).

〈Table 3〉 Result of Hypotheses Test

Hypotheses	Relationship			Std. Beta	Critical ratio	p-value	Supported or not
H1a	PI	⟶	PEOU	0.669	10.395	〈 0.001	Yes
H1b	PI	⟶	PU	0.256	4.211	〈 0.001	Yes
H2a	PEOU	⟶	PU	0.676	9.728	〈 0.001	Yes
H2b	PEOU	⟶	IA	-0.026	-0.226	**0.821**	**No**
H3	PU	⟶	IA	0.574	5.274	〈 0.001	Yes
H4	PE	⟶	IA	0.176	3.272	0.001	Yes
H5a	PQS	⟶	PE	0.579	7.751	〈 0.001	Yes
H5b	PQS	⟶	IA	0.137	2.381	0.016	Yes
H6	SI	⟶	IA	0.325	6.718	〈 0.001	Yes
H7	SC	⟶	IA	-0.185	-4.457	〈 0.001	Yes



〈Figure 3〉 Result of Structural Equation Model (Standard Coefficients and Significant Values)

〈Table 4〉 Test Results of Model 1 (without PU) and Model 2 (with PU)

Relationships	Model 1			Model 2		
	Std. Beta	C.R.	p-value	Std. Beta	C.R.	p-value
PI ⟶ PEOU	0.684	10.648	〈 0.001	0.672	10.553	〈 0.001
PI ⟶ PU	-	-	-	0.247	4.133	〈 0.001
PEOU ⟶ PU	-	-	-	0.686	9.870	〈 0.001
PSQ ⟶ PE	0.597	7.986	〈 0.001	0.598	7.983	〈 0.001
PU ⟶ IA	-	-	-	0.668	5.730	〈 0.001
PE ⟶ IA	0.198	3.354	〈 0.001	0.188	3.381	〈 0.001
PSQ ⟶ IA	0.211	3.346	〈 0.001	0.155	2.648	0.008
SC ⟶ IA	-0.175	-3.929	〈 0.001	-0.175	-4.169	〈 0.001
SI ⟶ IA	0.344	6.682	〈 0.001	0.297	6.206	〈 0.001
PEOU ⟶ IA	0.448	8.356	〈 0.001	-0.097	-0.917	0.359
Model fit index	Chi-square/df = 2.259; CFI = 0.916; TLI = 0.905; IFI = 0.916; RMSEA = 0.061			Chi-square/df = 2.232; CFI = 0.911; TLI = 0.902; IFI = 0.912; RMSEA = 0.060		

4.2.2 Perceived Usefulness as a Mediator

The mediating role of perceived usefulness in the relationship between perceived ease of use and behavioral intention was confirmed in this study. We ran two different models. Model 1 estimated the relationship between perceived ease of use and intention to adopt without the present of perceived usefulness and the result show that perceived ease of use had the positive effect on intention to adopt ($\beta = 0.448 > 0$; p-value < 0.01). While in Model 2, with the present of perceived usefulness, the relationship between perceived ease of use and intention to adopt did not have a significant meaning (p-value = $0.359 > 0.05$). These results suggested that perceived usefulness mediated the association between perceived ease of use and behavioral intention.

〈Table 5〉 The Results of the Direct, Indirect and Total Effects of the Factors on the Adoption Intention

Factors	Impact	PI	PEOU	PU	PSQ	PE	SI	SC
PEOU	Direct	0.669	-	-	-	-	-	-
	Indirect	-	-	-	-	-	-	-
	Total	0.669	-	-	-	-	-	-
PU	Direct	0.256	0.676	-	-	-	-	-
	Indirect	0.452	-	-	-	-	-	-
	Total	0.708	0.676	-	-	-	-	-
PE	Direct	-	-	-	0.579	-	-	-
	Indirect	-	-	-	-	-	-	-
	Total	-	-	-	0.579	-	-	-
IA	Direct	-	-	0.574	0.137	0.176	0.325	-0.185
	Indirect	0.406	0.388	-	0.102	-	-	-
	Total	0.406	0.388	0.574	0.239	0.176	0.325	-0.185

4.2.3 Path Analysis

The results from the analysis of direct, indirect, and systematic effects show that all factors affect the adoption intention of 4G. Perceived usefulness has the most positive effect ($\lambda = 0.574$), followed by personal innovativeness ($\lambda = 0.406$), perceived ease of use ($\lambda = 0.388$), social influences ($\lambda = 0.325$), prior service quality ($\lambda = 0.239$), expectancy price ($\lambda = 0.176$) and switching costs with the negative effect ($\lambda = -0.185$) (see 〈Table 5〉).

5. Discussion and Limitations

All seven factors in this research affect adoption intention from 2G or 3G to 4G either directly or indirectly. In particular, perceived usefulness had the strongest effect on adoption intention ($\lambda = 0.574$), which was consistent with prior studies [Davis, 1989; Kuo and Yen, 2009; Mun et al., 2006; Venkatesh et al., 2003; Lee, 2013; Wu et al., 2016]. For perceived ease of use, surprisingly it did not have direct effect on intention to adopt (Hypotheses H2b was rejected). This is not consistently with the findings of many previous studies such as Venkatesh et al., 2003; Kuo and Yen 2009. One explanation could be that present mobile technologies are, in general, relatively easy to use [Chong et al., 2012]. In addition, the subjects in the sample could be interested in applications in which the role of perceived ease of use is ambiguous. These can be intimately familiar applications such as basic phone calls, surfing the internet, and chatting programs. Despite that, perceived ease of use still played an important role (only after perceived usefulness and personal innovation) because of its indirect impact via perceived usefulness ($\lambda = 0.388$).

Furthermore, we note the significant role of personal innovativeness to perceived ease of use ($\lambda = 0.669$) and indirect effect to adoption intention ($\lambda = 0.406$) regarding the 4G upgrade customers in Vietnam. This result is consistent with the theory of diffusion of innovation [Rogers, 1995; 2010], indicating that the pioneer innovation factor seems to be significant to service perception and increases service adoption in the launch period of new services. This finding is also consistent with other studies [Kuo and Yen, 2009; Lu et al., 2005; Oliveira et al., 2016], noting that personal innovativeness has a positive effect on perceived usefulness and perceived

ease of use of technology services. This finding also implies that mobile providers can increase customers' awareness through advertisement campaigns focusing on the outstanding values of 4G compared with 3G.

Our study also shows that social influences impact strongly to the customers' intention to upgrade the services ($\lambda = 0.325$). This result is consistent with prior studies on technology services [Venkatesh et al., 2003; Carlsson et al., 2006; Lu et al., 2005; Oliveira et al., 2016]. It reveals the significance of a persons' social surroundings and reference groups to his/her service selection decision in the initial adoption [Rogers, 2010]. This suggests that operators should use different communication channels including reference groups to have influence on service upgrading decisions of customers in the new service trail period.

The significant negative effect of switching costs to customer adoption intention ($\lambda = -0.185$) is consistent with prior studies showing that switching costs have a positive effect on customer loyalty [Caruana, 2002; Kim et al., 2004; Liu et al., 2011; Aydin et al., 2005] or being a barrier in decision making relating to adoption intention [Shi et al., 2010; Shin and Kim, 2008]. In our research, the customers are of low or middle income; therefore spending money on changing devices is likely to be a challenge to them. This implies that mobile suppliers should focus more attention to minimize conversion costs to their customers. We recommend that mobile operators (i) provide terminal equipment compatible with 4G services with pay-as-you-go system in order to reduce the initial costs; and (ii) collaborate with other corporations to provide terminal equipment for installment programs.

Previous studies [Teng et al., 2009; Kuo et al., 2009] found the positive link between service quality and intention to adopt different mobile generations. In this study, service quality ($\beta = 0.527$, $p < 0.001$) also showed the great effects ($\lambda = 0.239$) on intention to adopt 4G. This is reasonable because services that are of poor quality (e.g. slow speed of connection or unstable internet access) would be unlikely to be adopted by many users. In this research, we investigated service adoption as upgrading from low-level services to high-level ones within the repertoire of one supplier. Hence, service quality is the foundation for customers to evaluate and expect better services. This also implies that suppliers should emphasize about the service quality to increase the customers' expectation. After that, they can promote their customers' intention to upgrade to their 4G services more easily.

Moreover, based on studies of Kim et al., [2004], Shin and Kim [2008], and Delone and McLean [2003], we adjusted the prior service quality scale from a multi-dimensional to a one-dimensional one. As shown in the analysis section, the reliability and validity of the adjusted scale is valid, which indicates the possibility of using service quality in telecommunication as a one-dimensional scale. The results of this study also show the suitability of using theories such as TAM to predict the acceptability of technology in developing countries, for example Vietnam. As telecommunications services are upgraded to 5G [GSM Asosciation 2018], a technology offering yet faster connection speeds, it may be expected that customer behavior exhibits similar characteristics in Vietnam as was found in this study. Whether this will be the case remains to be seen.

In conclusion, our study have certain theoretical and practical contributions. For theory, we establish and assess the fit of the model that explains the adoption intention of 4G services in Vietnam market. This model is based on the integration of the technology acceptance model, the theory of service quality and switching costs. In terms of practice, this study highlights the recommendations of reducing initial costs, focusing on awareness-building with the customers, and the effectiveness of 4G services compared with 3G. Although the study achieved the research aim, our study also has certain limitations. First, the data sample selected within one city might not generalize to the whole of Vietnam. Second, this research only focuses on examining service properties or service-supplied systems to adoption intention, and does not consider the personal preferences of customers. Hence, we suggest that future research can widen the research scope and add personal preferences in order to assess their effects to adoption intention.

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〈Appendix〉

Code	Questionnaires	References
I	***Personal Innovativeness***	
INN1	Would you like to use new technology-related service if you know them?	Rogers [1995], Lu et al. [2005]
INN2	Do you regularly use new technology-related service?	
INN3	Are you interested in using technology-related service?	
INN4	Are you willing to use and experience new technology-related service?	
II	***Perceived Ease of Use***	
PEU1	Do you think that it will be easy to use 4G services?	Venkatesh [2000; 2003], Davis [1993]
PEU2	Do you think that it will be not difficult to be used to 4G services?	
PEU3	Do you think that it does not require much effort to work with 4G services?	
PEU4	Do you think that 4G services will support your work more effectively?	
PEU5	Do you think that 4G services will support your work more effectively?	
III	***Perceived Usefulness***	
PU1	Will 4G services make Internet access better?	Davis [1989], Kim et al. [2007]
PU2	Will 4G services enhance the efficiency of Internet access?	
PU3	Will 4G services help to save time in work and life?	
PU4	Will 4G services help to improve the work implementation and the quality of life?	
PU5	In general, do you think that 4G services are useful for work and life?	
IV	***Price Expectancy***	
PRI1	Do you think that the price of 4G services is reasonable?	Shin and Kim [2008], Oliveira et al. [2016]
PRI2	Do you think that the monthly charge for 4G services is reasonable?	
PRI3	Do you think that any arising cost is reasonable?	
PRI4	Do you think that 4G services will bring good values with budget spent?	
V	***Prior Service Quality*** *(With current mobile service, how do you think?)*	
QUA1	Is the quality of Internet connection stable?	Kim et al. [2004], Lim [2006]
QUA2	Does the supplier offer many affordable Internet packages?	
QUA3	Is customer care system professional?	
QUA4	Is there a variety of additional values?	
QUA5	Is it logical and reasonable in calculating service fees of the supplier?	
VI	***Social Influences***	
SCI1	Will you use 4G services if other peoples surrounding you use?	Lu et al. [2005]
SCI2	Will you use 4G services if the person who affects you using?	
SCI3	Will you use 4G services if your relatives and friends advise to use?	
SCI4	Will you use 4G services if the person who affects you advise to use?	
SCI5	Do you think it will be out of date if not using 4G services while people surrounding you using already?	
VII	***Switching Costs***	
SWI1	Do you think that you cannot manage and understand all related costs clearly if changing to 4G services?	Huang and Hsieh [2012], Shin and Kim [2008]
SWI2	Do you think it will take time and effort to seek for information and evaluate services comprehensively?	
SWI3	Do you think the changing process is complex with 4G (change sim card, upgrade software…)?	
SWI4	Do you think the changing process takes time (change sim card, upgrade software, wait…)?	
VIII	***Adoption Intention***	
INT1	Do you intend to adopt 4G services?	Davis [1993], Venkatesh [2000], Oliveira et al. [2016]
INT2	Do you intend to upgrade your mobile devices to use 4G if necessary?	
INT3	Are you willing to share experience to your friends and relatives about 4G services if they are good?	
INT4	Do you think that using 4G services should be encouraged?	

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