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A STUDY ON FACTORS AFFECTING DECISION TO USE 4G SERVICES: A CASE STUDY

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Abstract. 4G has been developed in Vietnam for a long time with commitments to superior speed and interactions compared with 3G services from telecommunications service suppliers such as Viettel, VinaPhone, MobiFone, Gmobile. However, by now, the growth rate of 4G services in Vietnam still remains low and the services are not highly appreciated by users in comparison with some countries in the region and the world. It is therefore very necessary to identify factors affecting the decision to use 4G services. The article proposes a research model on factors affecting the decision to use 4G services of Vietnamese customers based on TAM model and previous research findings. The research model is set up to measure the factors affecting the decision to use 4G services of Vietnamese customers, so that suppliers can further develop their services to meet the demand of users and attract more customers. On the side of users, they can enjoy more conveniences that this advanced technology brings to their work, study and communication so as to raise their work performance and improve their quality of life.

Keywords: 4G services; affecting factors; decision to use 4G services; Vietnamese users

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JEL Classifications: G00, G30

1. Introduction

4G is the following generation of the wireless mobile communications network with superior features over the previous generation of 3G. 4G Technology was first introduced in early 21st century to meet the demand for a speedy broadband and multimedia services, and 4G services are considered an extension of the 3G cellular mobile information services. 4G services are a kind of mobile multimedia services which provides customers with every-time, every-where connection, global mobility and specific services on the 4G platform.

1.1 Overview of 4G services

1.1.1 The concept of 4G

4G (fourth-generation) is the name given by IEEE (Institute of Electrical and Electronics Engineers) to convey the sense of "3G and more". Different concepts of 4G have been introduced by various communications technology in the world. According to IEEE, 4G is the fourth wireless communications technology, which can transfer information at the maximum speed of up to 1-1.5 Gb/s in an optimum condition. International

Telecommunication Union (ITU) defines 4G technology as the wireless technology which can allow users to access data at the speed of 100MB/s while they are moving and 1GB/s when they settle in a fixed location. The fourth-generation mobile technology (4G) is being further developed and it now allows data transmission in 2 ways: sound and images with giant data, which used to be impossible in the past. 4G mobile phones can receive data at the speed of 100 Megabyte/s while users are moving and 1Gb/s when they stand still, users can download and upload images with very high quality. 4G technology enables users to enjoy services that they like. Users can receive these services via personal computer connected with high-speed broadband. With 4G technology and at the maximum speed, users can download a movie in only 5.6 seconds and send 100 songs in just 2.4 seconds.

1.1.2. Features of 4G network

According to International Telecommunication Union (ITU), no matter whether the 4G systems use LTE Advanced technology standardized by 3GPP or 802.11.16m technology standardized by IEEE, 4G services include the following features: providing mobile broadband solutions based on comprehensive and safe protocol for wireless modem of laptops, smartphones and other mobile devices; providing ultra-widebandInternet access, dialoguing via IP; providing games services and multi-media transmission to users. Specifically:

+ 4G services are services based on the Internet Protocol (IP) packed-switch network. Like 3G, 4G is protocol which allows sending and receiving data within packets. However, 4G is different from 3G in its operation modes. 4G is totally based on IP, which means that it uses Internet protocols even with dialogue data. Therefore, the chance that data is disordered when transmitting via different networks is really low, so 4G provides more constant experience along the real time for users.

+ 4G services can interact with current wireless standards. 4G allows data roaming with wireless local area network and can interact with digital video broadcasting systems.

+ The nominal speed is 100 Mbit/s when users are physically moving at a high speed and 1 Gbit/s when users and base transmission stations are at a fixed location. This guarantees that regardless of data volume, users can still maintain stable data transmission speed at almost all locations in almost all devices, including desktops, laptops or mobile phones. This enables them to do shopping and conduct transactions even when they are on the move.

+ 4G automatically shares and uses network resources to support users in each device. 4G network connections allow users to browse webs and broadcast HD videos on their mobile devices, which virtually turns smartphones into computers of the modern time.

+ The channel band can extend by 5 - 20 MHz and up to 40 MHz by option.

+ The maximum connection capacity is 15 bit /s/ Hz when downlink and 6.75 bit/s/Hz when uplink (which means 1 Gbit/s in downlink requires around 67 MHz broadband)

+ The normal network capacity reaches 3 bit/s/Hz/(device) in downlink and 2.25bit/s/Hz/(device) when used indoor.

+ 4G provide constant connection and global data roaming across various networks with smooth transmission. Its signals are better and more stable, which allows users to transmit data easily and constantly with considerably higher image and sound quality.

+ 4G can provide high-quality services with multi-media support to improve current applications such as mobile broadband access, video call, mobile TV as well as develop new applications such as high-definition TV (HDTV).

+ 4G services provide better privacy, information safety and security than 3G and Wifi. This helps users protect their personal information and prevent bad people from entering their devices.

1.2. Overview of 4G supply and use in Vietnam

1.2.1. Overview of 4G supply in Vietnam

Although telecommunications network suppliers had piloted 4G many times in Vietnam, they did not receive permits from Ministry of Information and Communications to provide 4G servicesuntil 2017. With these permits, 4 network suppliers are entitled to develop 4G services in Vietnam, including Viettel, Mobifone, VNPT, Gmobile. It is noteworthy that all these suppliers are granted permits to exploit services at 1800 MHz band. In theory, the higher the band is, the wider the network area and the faster the speed is; as a result, this requires more base stations, so development costs increase remarkably. There are two reasons why Ministry of Information and Communications decided to choose this band for the permits it granted to 4G service developers:

Firstly, the selection of the 1800 MHZ band has proved efficient for the development of 4G when many other countries across the world have used it. Statistics from Global Mobile Suppliers Association (GSA) illustrates that 1.800 MHZ is currently evaluated as the best band for the development and commercialization of 4G LTE technology. Of the total 521 LTE networks, as many as 246 are developed on this band, which accounts for 47% of 4G networks in the world. According to GSA, LTE networks using 1800 MHz band, often known as LTE1800, are developed in 110 out of 170 countries in the world to commercialize 4G.

Secondly, 1800 MHz band is highly compatible with various devices. 60% of telecommunication devices in the world have functions which are compatible with 1800 MHz band. Specifically, 3,889 out of 6,504 devices can support and run on this band. This is the band that many network suppliers as well as producers have selected.

Upon receiving permits, Viettel became the first mobile network supplier to launch 4G services in Vietnam on 18 April 2017. Six months later, Viettel could build nearly 36,000 BTS 4G stations to fulfill its commitments of covering nearly entire area of Vietnam with 4G services. VinaPhoneand MobiFone, the other two leading mobile service suppliers, are rapidly building infrastructure to prepare for 4G. Under its ambitious plan, MobiFone will build 30,000 BTS stations to ensure 4G service quality. By October 2016, this supplier had set up 4,500 stations. Although analysts believed that Gmobile, another supplier with permits for 4G services like Viettel, VinaPhoneand MobiFone, would launch 4G services quickly to the market to gain a breakthrough, it still provides GPRS (2G) servicesby now. In the meantime, Vietnamobile believes that it will not be too late to launch 4G in two years. Although Vietnam started to apply 4G later than many other countries, including some in Africa, Vietnamobile still believes that this is still not the right time to launch 4G. To meet the urgent need for data, Viettel has recently supplemented nearly 10,000 BTS 4G stations on 21.00MHz band, increasing its number of base stations to 130,000, of which 50,000 are 4G stations. Viettel has also released 2G subscribers from 1800 MHz band to save the entire band for 4G. Upon completion, the total capacity of high-speed 4G network of Viettel will increase by 25% compared with present. For its part, VNPT is currently having over 76,000 BTS stations, of which 30,000 are 4G stations. The company is actively joining with some technology firms to experimentNB-IoT (technology developed for devices to connect with Internet of Things) on 900 MHz and 1800 MHz bands. 4G MobiFone network was introduced by MobiFone Telecom Group on 1 July 2017. After two years of operations, MobiFone had 4G network coverage area of 95% of the country. In Quarter 1, 2019 only, MobiFone built more than 4,500 4G stations. By the end of 2019, MobiFone expanded its network and increased the number of 4G stations to over 30,000, the company had 4G network coverage area of the entire country with high quality in some key markets. Thanks to continuous investments in and supplements to 4G infrastructure, network suppliers have gained considerable achievements when the quality of their 4G services has exceeded the standards set by Ministry of Information and Communications. The results of assessing the Internet connection (via 3G and 4G) in 6 provinces of Lang Son, Thai Nguyen, Quang Tri, Quang Binh, Ben Tre and Tien Giang released by Telecommunications Department in June 2018 reveal that all indicators of 4G services of 3 suppliers Viettel, VinaPhone, MobiFone exceeded the standards.

Statistics released by Telecommunications Department, Ministry of Information and Communications in the 4G LTE International Conference held by Vietnam Internet Association in coordination with International Data

Group IDG in Hanoi on 27 July 2017 shows that currently Vietnam has approximately 60 million broadband subscribers, including 48 million broadband mobile subscribers. Six months after the introduction of 4G services, only 6.3 subscribers change to 4G simcards and at the moment, only 3.5 million subscribers are using 4G services. However, compared with some other countries in the world, the growth rate of 4G versus 3G is not really high.

Statistics released by Telecommunications Department also includes the results of assessing 4G service quality of suppliers based on 5 criteria: radio network availability; service success access ratio; average service access time; data transfer cut-off ratio and data transfer rate (upload/download speed and percentage of samples with download rate higher than or equal to minimum downlink rate in core areas). The Department conducted assessments on the quality of 4G services provided by Viettel from 8 to 16 June 2017 in Hanoi. The results of the 8-day checks reveal that the radio network availability of Viettel is 100%,data transfer cut-off ratio is 0.65%, minimum download speed is 34.9 Mbit/s and upload speed is 16.88 Mbit/s. The Department ran tests on services provided by MobiFone from 19 to 26 July in Hanoi. The results show that its radio network availability is 99.98%, service success access ratio is 100%, data transfer cut-off ratio is 0.74%, average service access time is 1.69 seconds, average download and upload speeds are 36.91Mbit/s and 19.28 Mbit/s respectively. Based on the results of the Department, it can be seen that Viettel is leading in radio network availability with the rate of 100% while MobiFone just reaches 99.98%. But the upload and download speeds of 4G network of MobiFone are higher than those of Viettel when Viettel only gains the speed of 34.9 Mbit/s and 16.88 Mbit/s respectively. Also in this conference, IDG uncovered its *survey report on the satisfaction of consumers with 4G LTE in Vietnam* conducted with 13,828 participants from 1 April to 1 July 2017. The report shows that 88% of 4G users live in Hanoi and Hochiminh City, 74% are students, small traders, housewives, 51% have income range from VND 5-10 million a month, 38% are aged 20 – 30.

Regarding their satisfaction with 4G, 56% of users working as freelancers and Uber / Grab drivers are satisfied with 4G stability, 7% say they are not satisfied with 4G services. About 4G costs, 79% of users believe it is necessary to have more promotional and marketing programs for 4G. As for purposes of using 4G, 29% of users inform that they use 4G for working, including making payments, doing business, advertising, conferencing, etc. while 56% say they use 4G for entertainment including surfing social network, watching movies and TV, listening to music, playing games, etc.

The report also indicates that of the three suppliers of 4G LTE services in Vietnam, 52% of users use 4G services of Viettel, 21% use 4G services of VinaPhone and 27% use 4G service of MobiFone. Among them, MobiFone is evaluated as a supplier with distinctive 4G service quality, VinaPhone is rated as a supplier with the best customer care services according to the survey conducted by IDG.

The 2017 survey of Buzzmetric (a site specializing in researching and analyzing social networks in Vietnam) conducted with the participation of 2,100 users about 4G service shows that only 32% of recipients say they have used and felt satisfied with 4G. The survey results also indicate that before using, only 8% of the total 2,100 people say they will not choose to use 4G but after experiencing the network, the percentage of users who are not satisfied rises to 35%, i.e. around 735 people in Vietnam are not satisfied with 4G network.

According to *the report on the situation of 4G LTE in the global scale released by Open Signal (UK)*in February 2018, the 4G coverage area of Vietnam is around medium compared to the world while its 4G speed ranks only after Singapore in ASEAN. The report also illustrates that the growth rate of 4G is high in developed countries and Vietnam has medium coverage area compared to other surveyed markets.

OpenSignal records the 4G coverage area of Vietnam at 71.26% of its geographical area, higher than some other big countries like Italy (69.66%), France (68.31%) or Germany (65.67%). About the 4G coverage area, South Korea tops the list with 97.49%, followed by Japan with 94.7%. In comparison with other countries in Southeast Asia (ASEAN), the 4G coverage area of Vietnam rank after Thailand, Singapore, Malaysia, Brunei and Indonesia.

The average speed of Vietnam 4G network reaches 21.49 Mbps, higher than that of some Southeast Asian countries like Thailand, Malaysia, Brunei, Myanmar and Indonesia. In terms of 4G speed, Vietnam ranks only after Singapore, which has the highest 4G speed in the world with 44.31 Mbps. Another survey was conducted by IDG Vietnam and Digital Communications Association from 1 January to 20 March 2019 in different localities including 9 big cities and provinces of Hanoi, Hai Phong, Quang Ninh, Hochiminh city, Binh Duong, Vung Tau, Da Nang, Hue, Can Tho. 8 criteria were chosen for voting including: signal strength, coverage area, connection stability at peak time (Saturday, Sunday, holidays), quality-price equivalence, download speed, upload speed, speed of watching/downloading movies and frequently using social networks.

Under these 8 criteria, VinaPhone scores 90.0 points, highest among the suppliers; Viettel remains market leader in terms of coverage area and signal strength thanks to its massive 4G station system; MobiFone does not have equally large coverage area as the other two suppliers but has higher connection stability, especially in some key markets like Hanoi and Hochiminh city, MobiFone is the network with the highest 4G connection speed.

1.2.2. Overview of 4G use in Vietnam

In Vietnam at the moment, there are 3 companies developing and supplying 4G services, including Viettel, VinaPhoneand MobiFone. Vietnamobile and Gmobile are granted permits but have not yet supplied the services. Among these 3 suppliers, Viettel has the largest coverage area. The other two are providing 4G services in the oil-spilling mode, which means providing the services in cities first; in other words, they provide services upon market demand. As of May 2018, Vietnam had 76.8 million Internet users. For broadband access, there were 64.2 million users, including 51.2 million users of 3G and 13 million users of 4G. According to the report of the first half 2019 by Ministry of Information and Communications, as of June 2019, the number of mobile subscribers in Vietnam was 134.5 million, an increase of 112% year-on-year. Of these subscribers, the number of people using broadband devices (3G, 4G) was 51.128 million, the number of people using fixed phone was only 4.02 million. According to statistics of Telecommunications Department, Ministry of Information and Communications, by November 2019, Vietnam had 61.86 million subscribers (including 3G and 4G).

When launching 4G, service suppliers announced that the experimental data transfer rate could reach 200 – 250 Mbps. However, in reality, the actual speed that many users measure of 4G services is just around 20 – 30 Mbps, which is much lower than the original experimental speed. With mobile broadband, there are hundreds of data packages from these suppliers with prices ranging from several thousand to several hundred thousand Vietnam dong for 30 days of use. Some can be named such as MIMAX 70 of Viettel with 3GB data/month at the price of VND70,000, MAX of VinaPhone with 3.8GB/30 days at the price of VND70,000 or HD70 of MobiFone with 3.8GB/30 days at the price of VND70,000 among many others.

Besides, there are "combined" packages where network suppliers join hands with other service providers such as Facebook or YouTube to attract customers. These packages give more freedom of use to customers when they can consume 30 high-speed GB for 30 days at the price of around VND 300,000 provided by network companies. Another popular package is data SIM with 2BG of main data per day at the price of VND 90,000 a month. So it can be seen that 4G packages of Vietnam are quite attractive to 3G packages in terms of prices and diversity. But if compared with the average prices in the world, these packages are still high-priced and there are not yet unlimited packages for users to choose. Besides, the real value of "unlimited data" according to the advertisements of suppliers is not really reliable because upon the main data of the package runs out, although users can still stay connected, it takes almost a day to download the content they need. Even for the most basic demand such as Internet access, receiving emails, watching videos or popular applications such as Facebook, YouTube, OTT messengers, that users have to pay additional fees to get supplemented data or register new packages after just a few days of use is very common if they want to stay connected. Therefore, although 4G package prices are fairly cheap, connectivity and real speed remain big questions to users when they consider using 4G services in Vietnam.

2. Literature review and research model

Hamed (2019) pointed that a great technology and application might be designed and developed but if people do not get involve and do not use it, the project is failed, thus, user acceptance is an undeniable key of any further implementation and development of any technology and application. In other words, in order to increase the level of technology usage and user adoption, the emphasis on factors that can influence on user acceptance should be raised. Laužikas & Miliūtė (2020) emphasized role of human resource management in performance of high-tech companies. Korneć (2020) indicated that stakeholders significantly affect smart solutions. Batkovskiy et al. (2019) draw attention to role of industry 4.0 in sustainable development processes. Shukla & Harma (2018) used Technology acceptance model (TAM) and extended the knowledge of consumer behaviour in emerging field of m-commerce, and practically, it will help the m-commerce practitioners to understand need of the consumer. Huy (2010) pointed that IT has certain impact on corporate governance in companies.

Then et al. (2019) mentioned that the addition of smart service belief factors as antecedents, as well as user experience type as a moderator, are crucial to expand the generalizability of TAM to the smart media service context.

From a customer experience management perspective, this study shows how to convert ad-supported users into new paid subscribers, while keeping existing subscribers by fulfilling their smart service requirements. TAM model is considered the most widely-used model to evaluate user acceptance for new technology services in the fields of information technology and telecommunications (Kuo & Yen, 2009; Shroff et. al, 2011; Melas et.al, 2011). TAM model, which was introduced and proved by Davis in 1989, includes the following variables:

(1) External variables (exogenous variables), also known as the variables of previous tests: these variables affect Perceived Usefulness (PU) and Perceived Ease-of-Use (PEU)

(2) Perceived Usefulness: is the belief of service users that the system will help raise their work performance (Davis, 1989). Users feel certain that the use of specialized systems will raise their efficiency/productivity of a specific task. Components constituting this variable include:

+*Communication*: The importance of communication in operating an information system has been affirmed by many researchers. It is clear that without information, it is impossible to connect entities while with sufficient information, people working in different divisions in an organization can understand each other and work towards common goals.

+ *System quality*: Raising system quality will help exploit information system more effectively.

+ *Information quality*: The output quality of the information system: Reliable, Sufficient, Prompt.

+*Service quality*: have assurance, reliability and response.

(3)Perceived Ease-of-Use: is the level of ease that users expect to have when using a system, the perception of customers that using a specialized system or service does not require a lot of efforts.

(4)Attitude to use: is defined as the positive or negative feelings about taking an action (Ajzen & Fisbein, 1975). It is the attitude towards using a system that is established by the trusts of its usefulness and ease.

(5) Intention to use: is the perception of the trend of the ability to decide to use the system or service. Intention to use is closely related to the real use.

(6) Decision to use or using behavior: is the level of satisfaction and willingness to continue using or the level as well as frequency of using the service/system in reality.

TAM is a typical model to apply in the research of the use of a system because TAM is a model to measure and predict the use of an information system. Therefore, TAM model is suitable for the study of this article.

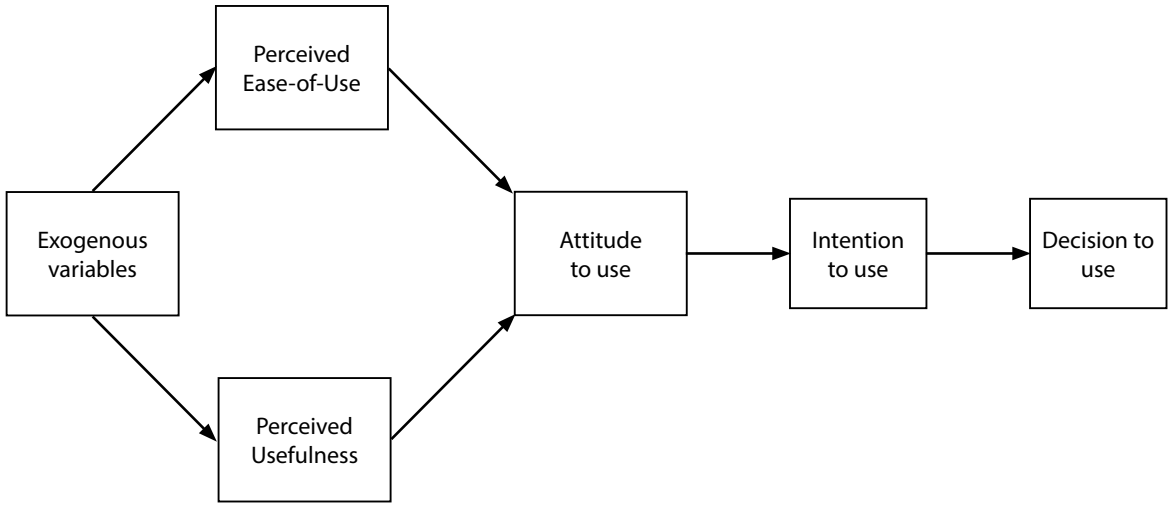

Figure 1. Technology Acceptance Model TAM

Source: Davis 1989

On the basis of TAM model by Davis (1989) and previous research findings, the authors propose some factors affecting the use of 4G services of users in Hanoi. Perceived Ease-of-Use is the belief of customers that using the service will bring them comforts (Ajzen et.al, 1985). 4G is a new service with many superior features which help to access the Internet faster than 3G and traditional ADSL services. Different research in the world has revealed that the perceived ease-of-use affects decision to use of customers via its effects on intention to use (Venkatesh et. al, 2003; Klopping & Mickinney, 2004). Therefore, the authors propose the following hypothesis:

H1*: Perceived Ease-of-Use (SD) affects decision to use (QD)*

Perceived usefulness is the perception of customers about the potential benefits that come from their decisions. This factor has been researched in many studies related to the application of new technology. It is affirmed in previous studies that the perception of usefulness has positive relations with targeting behavior (Taylor and Todd, 1995; Wang et. al, 2008; Koenig-Lewis et. al, 2010).

H2*: Perceived usefulness(HI) affects decision to use (QD)*

Information quality is the belief of customers about the promptness and usefulness of the information system (Delone & Mclean, 1992). Service quality involves meeting customer expectations and satisfying their demand when they use the service. Previous studies demonstrate that information and service quality have influences on intention to use of customers (Delone & Mclean, 1992, 2003; Kim et.al, 2011). Information quality and service quality, via effects on intention to use, affect decision to use of customers.

H3*: Information quality (TT) affects decision to use (QD)*

H4*: Service quality (DV) affects decision to use (QD)*

Social impacts are generally understood as when the behavior of a person becomes the instruction and orientation for behavior of another person. Therefore, social impacts affect decision to use of individuals (Venkatesh et.al, 2003).

H5*: Social impacts (XH) affect decision to use (QD)*

Prices are monetary representation of product values. They are the amount of money that needs to be paid for a product, service or asset. Prices affect decision to use via perceived value. Users are willing to pay reasonable prices for what they receive from service satisfaction (Polatoglu & Ekin, 2001).

H6*: Service prices (GC) affect decision to use (QD)*

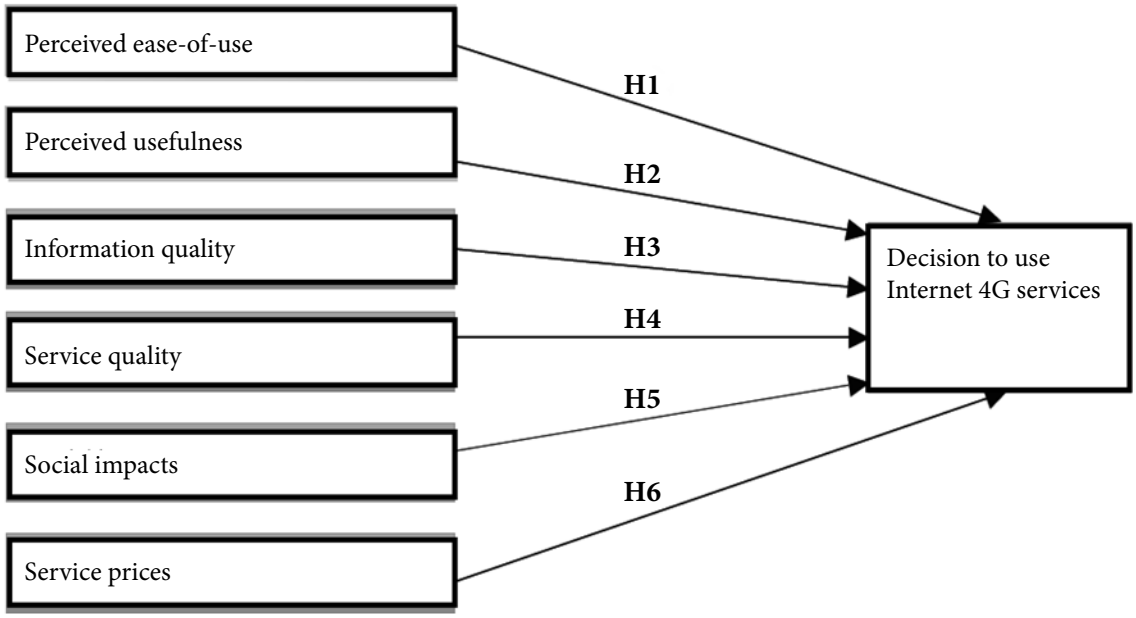

Figure 2. Proposed research model

Source: Authors

Table 1. Measurements of proposed research model

Code	Variables in the research model	References
SD	**Perceived Ease-of-Use(SD)**	
SD1	Users perceive that they can use 4G service fluently	Davis (1993)
SD2	Users perceive that they can operate and communicate with 4G service easily	Davis (1983); Đào Trung Kiên (2015)
SD3	Users can use 4G service without anyone instructing them	
SD4	Users can use 4G services although they have never used them before	
SD5	Users can use 4G services very easily	
HI	**Perceived usefulness(HI)**	
HI1	Using 4G services helps to accelerate Internet access rate	Davis (1993); Taylor & Todd (1995),Venkatesh (2000), Klopping &Mekinnay (2004), ĐàoTrung Kiên (2015)
HI2	4G services raise the Internet use effectiveness of users and can be used everytime, every where	
HI3	Contents provided via 4G services are useful to users	
HI4	Generally 4G services provide good values to users	
TT	**Information quality(TT)**	
TT1	Information about 4G services from service suppliers is accurate	Delone & McLean (1992), Đào Trung Kiên (2015)
TT2	Information about 4G services from service suppliers meet the demand	
TT3	Information system about 4G services is fast and prompt	
TT4	Users can easily consult on and refer to information about 4G services invarious ways at anytime (24/7 call centres, websites, etc.)	
DV	**Service quality(DV)**	
DV1	Service suppliers always supply 4G services rapidly	Delone & McLean (1992), Đào Trung Kiên (2015)
DV2	Service suppliers realize their commitments to quality of the 4G services they supply	
DV3	4G services are complete core services	
DV4	4G services meet the expectations and desires of users	
XH	**Social impacts(XH)**	
XH1	Users think they should use 4G services like their friends and relatives	Taylor & Todd (1995), Venkatesh (2000), Đào Trung Kiên (2015)
XH2	That their relatives (family and friends) use 4G services affects their decision to use	
XH3	Users think that using 4G services helps them keep up with people around	
XH4	Users think that not using 4G services makes them lagged behind	

GC	**4G Service prices(GC)**	
GC1	Users think that the current fees of 4G services are reasonable	Polatoglu & Ekin (2001)
GC2	Package fees and volumes of 4G services are compatible	
GC3	Users think that the prices of 4G services when not registering packages of suppliers are reasonable	
GC4	Promotional and discount programs of network suppliers help users use 4G services more	
QD	**Decision to use(QD)**	
QD1	Generally, the 4G services of suppliers make me feel satisfied	Venkatesh et al (2003)
QD2	Using 4G services is my right decision	
QD3	I feel interested when using 4G services for my activities	
QD4	I will continue to use 4G services in the coming time	

Source: authors

4. Research method and results

4.1. Overview of research methods

Questionnaires: the research was conducted via a questionnaire with 5-point Likert scale. Convenience sampling was chosen to survey people using 4G services in Hanoi, Hochiminh city and Da Nang city.
The authors use quantitative research method, specifically:

- Research was conducted via citation review to select measurement scales and adjust scales to this particular research.

- Data was collected by questionnaires, coded and processed by SPSS software to lay the foundation for the use of descriptive analysis, Cronbach's Alpha test, Exploratory Factor Analysis (EFA), multiple regression analysis.

The minimum sample size for EFA analysis is n=5m, where m is the number of questions in the research. As for multipleregression analysis, the minimum sample size is n = 50 + 8m, where m is the number of independent factors (Tabachnicho Fidell, 1996). In our research model, there are 6 variables with 29 questions (observation variables), so the minimum sample size must be 145 questionnaires. However, to raise the reliability and remove unsuitable results, the researchers decided to use convenience sampling method with sample size of 250 questionnaires. 250 questionnaires were delivered to customers of 4G services using direct mailing via telephones and email based on the customer lists of Viettel; Mobile andVinaPhone.

In the following stage, questionnaires were collected, information was filtered. Of the 231 collected questionnaires, 214 were valid. For limited conditions, the researchers only employed 200 valid questionnaires to process via SPSS 20.0 software. The main indicators of the sample used for analysis are presented in Table 2.

Table 2. Research sample descriptions

Indicators	Number	Percentage	Indicators	Number	Percentage
Regions			***4G service suppliers***		
Hanoi	76	38%	VinaPhone	69	34.5%
Da Nang	53	26.5%	Viettel	94	47%
Hochiminh	71	35.5%	MobiFone	37	18.5%
Gender			***Qualification***		
Male	87	43.5%	Under college	27	13.5%
			College	61	30.5%
Female	113	56.5%	University	73	36.5%
			Post-graduation	39	19.5%

Age groups			*Income (VND)*		
Under 18 years old	32	16%	Under 1 million/month	25	12.5%
18 – 22 years old	45	22.5%	1 – 5 million/month	37	18.5%
23 – 30 years old	74	37%	5 – 7million/month	37	18.5%
31 – 45years old	28	14%	7 – 10million/month	48	24%
Over45 years old	21	10.5%	Over 10million/month	53	26.5%

Source: authors

4.2. Research findings

4.2.1. Testing measurement reliability by Cronbach's Alpha

Evaluating measurement scales is evaluating the suitability of the factors which are used in the measurement scales via Cronbach' Alpha coefficients. The purpose of this step is to see what variables are suitable and what are not suitable before conducting EFA analysis, so that unsuitable variables can be removed. In this step, Cronbach' Alpha should be > 0.6 (Nguyễn Đình Thọ, 2014), Corrected Item – Total Correlation< 0.3 (Nguyễn Đình Thọ, 2014).

Table 3. Reliability of measurement scales in the research model

No.	Variables	Cronbach's Alpha	Corrected Item – Total Correlation	Cronbach's Alpha if Item Deleted
SD	**Perceived Ease-of-Use(SD)**	**0.867**		
SD1	Users perceive that they can use 4G service fluently		0.709	0.834
SD2	Users perceive that they can operate and communicate with 4G service easily		0.673	0.843
SD3	Users can use 4G service without anyone instructing them		0.696	0.838
SD4	Users can use 4G services although they have never used them before		0.699	0.837
SD5	Users can use 4G services very easily		0.676	0.843
HI	**Perceived usefulness(HI)**	**0.669**		
HI1	Using 4G services helps to accelerate Internet access rate		0.540	0.543
HI2	4G services raise the Internet use effectiveness of users and can be used every time, every where		0.436	0.611
HI3	Contents provided via 4G services are useful to users.		0.408	0.629
HI4	Generally 4G services provide good values to users		0.420	0.623
TT	**Information quality(TT)**	**0.586**		
TT1	Information about 4G services from service suppliers is accurate.		0.442	0.456
TT2	Information about 4G services from service suppliers meet the demand.		0.413	0.479
TT3	Information system about 4G services is fast and prompt.		0.433	0.463
TT4	Users can easily consult on and refer to information about 4G services in various ways at any time (24/7 call centres, websites, etc.)		**0.207**	**0.644**
DV	**Service quality(DV)**	**0.621**		
DV1	Service suppliers always supply 4G services rapidly		0.460	0.504
DV2	Service suppliers realize their commitments to quality of the 4G services they supply.		0.409	0.545
DV3	4G services are complete core services		0.381	0.565
DV4	4G services meet the expectations and desires of users.		0.352	0.584
XH	**Social impacts(XH)**	**0.713**		
XH1	Users think they should use 4G services like their friends and relatives.		0.445	0.682

XH2	That their relatives (family and friends) use 4G services affects their decision to use.		0.516	0.642
XH3	Users think that using 4G services helps them keep up with people around.		0.596	0.587
XH4	Users think that not using 4G services makes them lagged behind.		0.448	0.681
GC	**4G Service prices4G (GC)**	**0.663**		
GC1	Users think that the current fees of 4G services are reasonable		0.374	0.640
GC2	Package fees and volumes of 4G services are compatible		0.468	0.581
GC3	Users think that the prices of 4G services when not registering packages of suppliers are reasonable		0.521	0.541
GC4	Promotional and discount programs of network suppliers help users use 4G services more		0.418	0.615
QD	**Decision to use(QD)**	**0.752**		
QD1	Generally, the 4G services of suppliers make me feel satisfied		0.572	0.681
QD2	Using 4G services is my right decision		0.548	0.695
QD3	I feel interested when using 4G services for my activities		0.549	0.695
QD4	I will continue to use 4G services in the coming time		0.525	0.707

Source: data analysis via SPSS

Table 3 presents the data analysis results when testing the reliability of measurement scales via Cronbach's Alpha for variables SD, HI, TT, DV, XH, HV, QD. As can be seen from the table, SD has very high *Cronbach's Alpha*of 0.867; XH and QD have *Cronbach's Alpha*of 0.713 and 0.752respectively; HI, DV and GC have *Cronbach's Alpha*of 0.669; 0.621; 0.663 respectively – all are higher than 0.6. TT has *Cronbach's Alpha* of 0.586 and *Cronbach's Alpha if Item Deleted* of TT4 is 0.644, so TT4 is removed from the observation variables. Other variables have*Corrected Item – Total Correlation* higher than 0.3. So only TT4 is deleted in EFA analysis.

4.2.2. EFA analysis results

Factor analysis is used to summarize data and shorten the collection of observation variables into the main factors used in the following analysis and tests. Factor loading is the criterion to ensure the practical significance of EFA: Factor loading > 0.3 is considered as the minimum level; Factor loading> 0.4 is considered as important; Factor loading> 0.5 is considered as having practical significance (Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E. & Tatham, R,L, 2006). The conditions for exploratory factor analysis is: (1) (Factor loading) > 0.5; (2) KMO (Kaiser-Meyer-Olkin) coefficient ranges in [0.5; 1]; (3)Bartlett test has significant (Sig.) < 0.05; (4) (Percentage of variance) > 50% (Hair et al. 2006).

24 observation variables of 6 independent variables (after TT4 deleted) were inserted for EFA analysis with the results as follows:

Table 4. Analysis results of KMO and Bartlett's Test

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.777
Bartlett's Test of Sphericity	Approx. Chi-Square	1353.978
	df	276
	Sig.	.000

Source: data analysis via SPSS

Data analysis results in Table 4 reveal that *KMO = 0.777 > 0,5*and*Sig. = 0.000*have significance, variables in the model are correlated. 24 variables were inserted for factor rotation of Varimax method. Data analysis results are presented in Table 5.

Table 5. Results of Rotated Component Matrix[a]

Observation variables	Factor loading					
	1	2	3	4	5	6
SD1	.850					
SD4	.791					
SD5	.782					
SD3	.781					
SD2	.738					
XH3		.795				
XH4		.733				
XH2		.696				
XH1		.640				
GC4			.707			
GC2			.655			
GC3			.654			
GC1			.582			
HI1				.787		
HI2				.740		
HI4				.623		
HI3				.550		
DV1					.745	
DV2					.653	
DV3					.627	
DV4					.606	
TT3						.783
TT2						.693
TT1						.648
Total Variance Explained (%)	**57.464**					
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.						
a. Rotation Converged in 6 iterations.						

Source: data analysis via SPSS

Data analysis results in Table 5 show that all variables in the groups have factors loading > 0.5, thereby reaching reliability. Factors loading of observation variables are 0.5; Total Variance Explained divided into 6 groups with 24 variables could explain 58.184% of the variations of the model. As such, after EFA analysis, 24 observation variables and 6 independent variables are extracted.

4.2.3. Pearson test results

Based on the results of Cronbach's Alpha test and EFA with TT4 deleted, representative factors are:

SD = Mean (SD1, SD2, SD3, SD4, SD5);

HI = Mean (HI1, HI2, HI3, HI4, HI5);

DV = Mean (DV1, DV2, DV3, DV4);

TT = Mean (TT1, TT2, TT3);

XH = Mean (XH1, XH2, XH3, XH4);

GC=Mean (GC1, GC2, GC3, GC4);

QD = Mean (QD1, QD2, QD3, QD4)

To test the linear relations between dependent and independent variables, it is necessary to run Pearson correlation test.

Table 6. Results of Pearson Correlation tests

		QD	SD	HI	TT	DV	XH	GC
QD	Pearson Correlations	1	.432**	.309**	.314**	.127**	.288**	.422**
	Sig. (2-tailed)	----	.000	.000	.000	**.073**	.000	.000
	N	200	200	200	200	200	200	200

Source: data analysis via SPSS

As can be seen in the data analysis results in Table 6, *Sig.* of observation variables SD, HI, TT, XH, GC< 0.05, which means these independent variables are correlated to dependent variable QD. DV has *Sig.* at 0.073, higher than 0.05, which means DV does not have significant correlation with QD, therefore DV should be deleted from the model.

4.2.4. Multiple regression model results

Table 7. Model Summary

Model Summary[b]

Model	R	R^2	Adjusted R^2	Standard error of the estimate	Durbin-Watson coefficient
1	.574[a]	.330	**.313**	.41297	**1.961**

a. Predictors: (Constant), GC, XH, HI, TT, SD

b. Dependent Variable: QD. Decision to use

Source: data analysis via SPSS

*Adjusted R Square*reflects the level of influence of independent variables on dependent variables. In this case, 5 independent variables result in 31.3% of changes of dependent variables, the remaining changes come from exogenous *variables and random errors. Durbin-Watson*is 1.961, within the range of 1 – 3, so according to the rule of thumb, there is no *first*-order autocorrelation.

• F Test:

Table 8. Analysis results of ANOVA[a]

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	16.281	5	3.256	19.093	**.000[b]**
	Residual	33.086	194	.171		
	Total	49.367	199			

a. Dependent Variable: QD. Decision to use

b. Predictors: (Constant); GC, XH, HI, TT, SD

Source: data analysis via SPSS

This step is used to test hypotheses of the suitability of the regression model to determine if it can be extended and applied for the whole via Sig. value (Sig. < 0.05) in ANOVA[a].

Sig .of F test is 0.000 < 0.05. As such, this regression model has significance and the established linear regression model can be extended and applied for the whole.

Table 9. Results of Correlation Coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.496	.346		1.433	.153		
	SD	.200	.049	.265	4.056	.000	.809	1.235
	HI	.143	.065	.138	2.209	.028	.882	1.134
	TT	.134	.070	.122	1.917	.057	.858	1.165
	XH	.153	.062	.152	2.472	.014	.911	1.098
	GC	.205	.064	.215	3.224	.001	.778	1.285

a. Dependent Variable: QD

Source: data analysis via SPSS

T test was conducted for each independent variable to see if these variables are significant via *Sig*. of each variable in the Coefficients Table. If Sig. is smaller than or equal to 0.05, the independent variable is significant; vice versa if Sig. is larger than 0.05, that variable is deleted. Therefore, according to the analysis results in Table 8, TT has Sig. = 0.57 >0.05, so TT was deleted from the model, SD, HI, XH, GC have Sig. <0.05, so they are significant. Therefore, hypotheses H1, H2, H5, H6 are accepted with reliability of 95%.

Multi linearity is tested via the values of Variance Inflation Factor (VIF). If VIF is higher than 10, multi linearity exists. With research projects which combine research model and Likert-scale questionnaires, VIF < 2 means there is no multi linearity between independent variables. Data analysis results in Table 8 shows that the VIF of SD, HI, XG, GC< 2, which means that there is no multi linearity between these dependent variables.

Among all regression coefficients, independent variable with the highest Beta coefficient has the biggest influences on the changes of dependent variables. So SD has the biggest influences on the changes of the dependent variable QD. The specific levels of influences of factors on QD are shown in the following equation:

$$\mathbf{QD = 0.265*SD + 0.138*HI + 0.152*XH + 0.215*GC}$$

So SD, HI, XH, GC have positive effects on QD. When an independent variable increases by 1 unit while other independent variables in the model stay the same, dependent variable QD increases by 0.265; 0.138; 0.152; 0.215 units respectively.

4.2.5. Normal distribution and linear relation test results

a. Normal distribution residual testing

Testing hypotheses of normal distribution of residuals: Based on the regression standardized residual diagram with Mean value nearly 0 and standardized deviation nearly 1, or standardized residual diagram Normal P-Plot with quantiles in residual distribution formed in a diagonal, it is possible to prove that normal distribution of residual hypothesis is not rejected.

Residuals may not follow normal distribution for different reasons: using the wrong model, variance is not constant, the number of residuals is not big enough for analysis, etc. So it is necessary to conduct different testing methods. The simplest testing method is to build regression standardized residual diagram as follows (Figure 1):

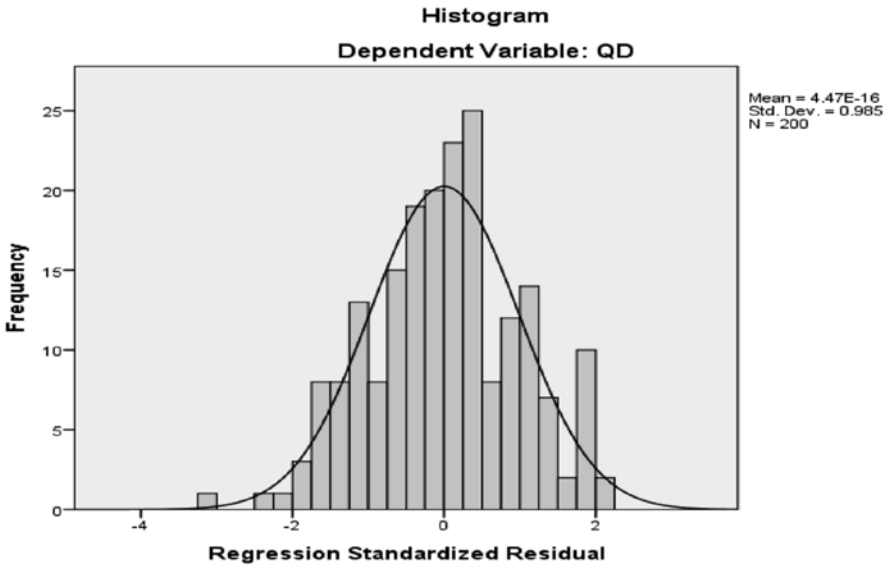

Figure 1. Regression standardized residual diagram

Source: data analysis via SPSS

The diagram illustrates that the normal distribution bell curve overlays the frequency line. This curve has symmetrical form with the line of normal distribution. Mean is nearly 0, standard deviation is 0.970 – nearly 1, which shows that normal distribution residual is nearly normal. Therefore it can be concluded that normal distribution residual hypothesis is not rejected (see Figure 2).

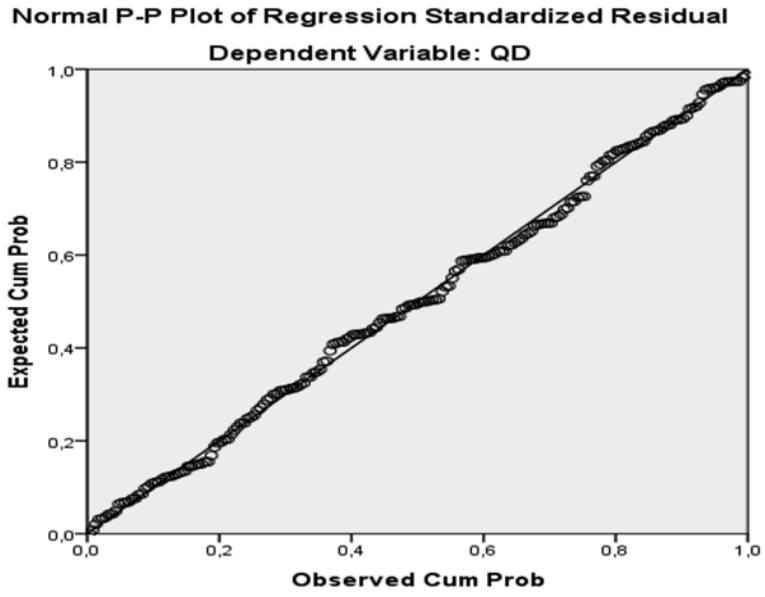

Figure 2. Normal P-P Plot diagram

Source: data analysis via SPSS

With P-P Plot, quantiles in distribution residual focuses on the diagonal, so hypothesis of regression standardized residual is not rejected.

b. Linear relation hypothesis testing

Scatter Plot diagram for standardized residual and standardized predicted values enables us to see if current data violate linear relation hypothesis. Values of Standardized Residual are presented on horizontal axis while Standardized Predicted Valuesare shown in vertical axis (see Figure 3).

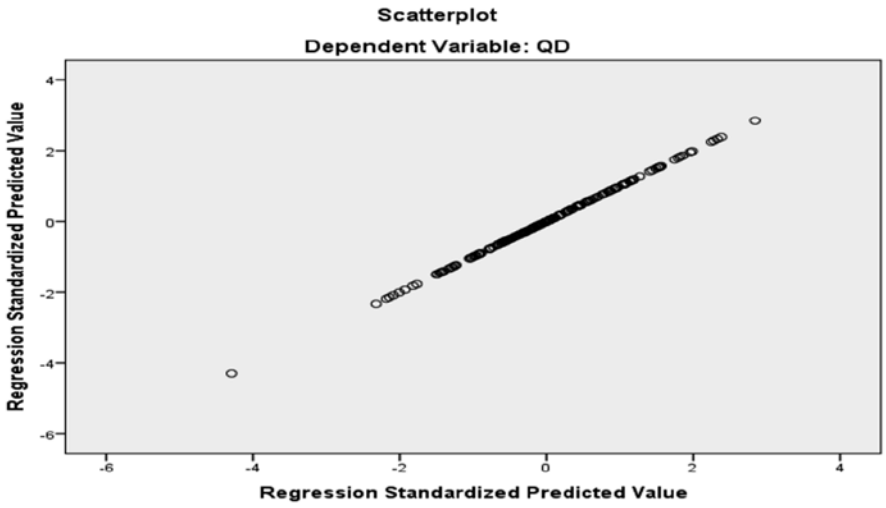

Figure 3. Scatter Plot diagram for linear relation hypothesis testing

Source: data analysis via SPSS

If the diagrams show the distribution of residuals in the forms of Parabolic, Cubic, etc. rather than the line, data violate linear relation hypothesis. If the linear relation hypothesis is satisfied, residuals must scatter randomly in an area around abscissa line at 0. Particularly with the current data, standardized residuals focus around abscissaline at 0, so the linear relation hypothesis is not violated.

Conclusion

The research has fulfilled the initially-set objectives:

(1) Generalizing theoretical grounds of factors affecting intentions and behavior of using 4G services.

(2) Identifying factors affecting decision to use 4G services of users in Hanoi, including 4 factors: Perceived Ease-of-Use, Perceived Usefulness, Social Impacts and Service prices.

(3) Evaluating the importance levels of each factor affecting decision to use 4G services of users in Vietnam.

(4) Identifying the inter-influences between factors affecting decision to use 4G services of users in Vietnam.

(5) Suggesting solutions to develop 4G service markets and proposals to service suppliers to further develop 4G service market in Vietnam.

The research findings affirm that Perceived Ease-of-Use (SD), Social Impacts (XH), Perceived Usefulness (HI) and Service prices (GC) affect decision to use 4G services but their influences are of different levels. Particularly, Perceived Ease-of-Use (SD) has the strongest influence on decision to use 4G of users in Hanoi. That the two factors - Perceived Ease-of-Use (SD) and Perceived Usefulness (HI) - affect decision to use completely go in line with TAM model (Davis, 1989; Davis, 1993) Taylor & Todd (1995), Klopping and Makinney (2004) and previous studies. Social impacts (XH) is a factor with quite strong influences on decision to use. This consolidates hypothesis of Venkatesh et.al (2003) and goes in line with the research by Đào Trung Kiên (2015) about acceptance trend of Internet 3G. Quality prices (GC) is a new factor which is affirmed by this research to have influences on decision to use 4G services of Vietnamese users.

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