DETERMINANTS OF CONTINUANCE INTENTION OF USER ON SMARTPHONE-BASED TRAVELLER INFORMATION SYSTEMS IN THE GREATER KLANG VALLEY

WAN SUHAILA BINTI WAN RANI

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Department of Real Estate
Faculty of Built Environment and Surveying
Universiti Teknologi Malaysia

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DEDICATION

This PhD research thesis is dedicated to all my beloved family members. Especially to my husband Mohd Fadhil Bin Abdullah, thank you for never hold me back from what I desire in life and for being there for our future together. It is also dedicated to my father Wan Rani Bin Ahmad and my mother Siti Fatimah Binti Ali, without them this thesis work would not have been completed successfully. My son Rayyees Bin Mohd Fadhil, your presence during this period remind me, Allah (SWT) in His infinite wisdom never leaves a human being alone and unable to face all of life's trials.

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ABSTRACT

In these modern-days, the use of mobile traveller information service is pivotal in the efficient and effective running of the transportation system for an urban area. The role of urban facilities managers in urban transportation planning is to develop a plan to provide drivers with real-time traveller information services to enable regional economic growth and transition. Existing research in the mobile information traveller information services area has not deeply investigated the determinants of continuance intention to use smartphone-based traveller information systems (STIS). The purpose of this study is to attempt to do so by investigating STIS users' continuance intention at the post-adoption phase. This study developed and validated an extended framework based on the expectation-confirmation model (ECM). The 280 STIS users from the Klang Valley highways and major streets participated in the study. The extended ECM results revealed that STIS users' continuance intention is determined by perceived enjoyment and perceived usefulness of continued STIS use, followed by satisfaction with STIS use. In this study, satisfaction and perceived usefulness are determined primarily by confirmation of expectation from participants' previous use, except for the perceived enjoyment. The findings of this study have implications for the transportation sectors in planning their strategies to increase users' continuance intention to use STIS services. Most of the current literature in mobile information services studies focused only on pre-adoption and have paid little attention to user's continuance intention, especially in the context of smartphone apps or electronic information in the transportation system services. This study fills the theoretical and practical gaps by focusing on the post-adoption phase and developed an extended framework based on the ECM to explain the STIS continuance intention context. In addition, the topic is timely, as mobile information services have been flourishing in the current worldwide transportation sector services.

ABSTRAK

Dalam zaman moden ini, penggunaan perkhidmatan maklumat pengembara mudah alih adalah penting dalam melaksanakan sistem pengangkutan yang efisien dan berkesan untuk kawasan bandar. Peranan pengurus kemudahan bandar dalam perancangan pengangkutan bandar adalah membangunkan rancangan untuk menyediakan pemandu dengan perkhidmatan maklumat pengembara masa nyata demi membolehkan pertumbuhan dan peralihan ekonomi serantau. Penyelidikan sedia ada dalam perkhidmatan maklumat pengembara maklumat mudah alih tidak menyiasat secara mendalam penentu niat berterusan untuk menggunakan sistem maklumat pengembara berasaskan telefon pintar (STIS). Tujuan kajian ini adalah untuk cuba melakukannya dengan menyiasat niat berterusan pengguna STIS pada fasa pasca adopsi. Kajian ini membangunkan dan mengesahkan rangka kerja lanjutan berdasarkan model pengesahan jangkaan (ECM). Sejumlah 280 pengguna STIS dari lebuh raya Lembah Klang dan jalan-jalan utama telah mengambil bahagian dalam kajian ini. Keputusan ECM yang dilanjutkan menunjukkan bahawa niat berterusan pengguna STIS ditentukan oleh tanggapan keseronokkan dan tanggapan kebergunaan penggunaan STIS yang berterusan, diikuti dengan kepuasan penggunaan STIS. Dalam kajian ini, kepuasan dan tanggapan kebergunaan ditentukan terlebih dahulu oleh pengesahan jangkaan dari penggunaan sebelumnya, kecuali untuk tanggapan keseronokkan. Penemuan kajian ini mempunyai implikasi untuk sektor pengangkutan dalam merancang strategi mereka untuk meningkatkan niat berterusan pengguna untuk menggunakan perkhidmatan STIS. Kebanyakan kajian-kajian masa kini dalam perkhidmatan maklumat mudah alih lebih memfokus kepada pra-penerimaan dan memberi sedikit perhatian kepada niat berterusan pengguna, terutama dalam konteks aplikasi telefon pintar atau maklumat elektronik dalam perkhidmatan sistem pengangkutan. Kajian ini mengisi jurang teoretikal dan praktikal dengan memberi tumpuan kepada fasa pasca adopsi dan membangunkan rangka kerja lanjutan berdasarkan ECM untuk menerangkan konteks niat berterusan STIS. Di samping itu, topik ini adalah bertepatan pada masanya kerana perkhidmatan maklumat mudah alih sedang berkembang pesat di dalam perkhidmatan sektor pengangkutan di seluruh dunia.

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LIST OF ABBREVIATIONS

STIS	-	Smartphone-based Traveller Information Systems
TIS	-	Traveller Information Systems
ITS	-	Intelligent Transportation Systems
FM	-	Facilities Manager
UFM	-	Urban Facilities Management
TDM	-	Travel Demand Management
UTM	-	Universiti Teknologi Malaysia
VIF	-	Variance Inflator Factor
AVE	-	Average Variance Extracted
CR	-	Composite Reliability
PLS-SEM	-	Partial Least Squares – Structural Equation Model

LIST OF SYMBOLS

R^2	-	Coefficient of Determination
f^2	-	Effect Size to R^2
Q^2	-	Stone-Geisser Q^2 Predictive Relevance

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Nowadays, information and communication technologies (ICT) not only change the common ways of urban city lifestyle but also force cities to change their urbanisation foresight. The growing demand for the creation of smart cities, force the urban stakeholders to respond to challenges to digital services transformation. Some of the challenges are to promoting usage of the Internet of Things (IoT), mobile services and ubiquitous computing. To date, the stakeholders in the urban planning process response to the smart city transformation have tended to focus on the big data and urban informatics knowledge. The emergent field of facilities management principles that focuses on urban precinct is likely to place urban facilities management (UFM) as one of the key actors in delivering this smart city objectively. The worldwide body of transportation sector recently issued a digital technology in travel demand management to reduce congestion impact and daily travel stress. One of the major focus is to promote the use of smartphone-based traveller information systems (STIS) also known as smartphone transportation apps, such as Waze and Google Maps. The STIS could help the transportation sector to update drivers on roadway condition by means of digital traffic information. Highlighting the benefit of real-time traffic information, more informed drivers result in better traffic flow and less gridlock on the roadway. Evidence exists suggesting that influences in travel choices and behaviours affect traffic flow (U.S. Department of Transportation, 2018), this means less gridlock and congestion impacts. However, STIS could be unproductive to response to urban mobility challenges as users may have their continuance intention beliefs formed after their initial acceptance. This study investigates the factors that motivate STIS user's intention to continue to use this mobile traveller information service in urban major roads context.

1.2 The Background of the Study

Today, the worldwide urban transportation sector is aware of the importance of reliable and effective traveller information services to reduce urban mobility issues and as a way forward to create smart mobility. The concept of smart mobility comes from today's scenario in all developed and developing countries around the world that are going through the process of urbanization. In fact, urbanization causes the growth of population, lifestyle changes, and increasing household incomes which led to a rise of private motor vehicle usage which indirectly contributed to the massive traffic congestion in major cities. Due from that, smart mobility is a newer notion to improve the quality and performance of the travel demand management in the urban area, which by now it much depends on advanced traveller information systems. It is primarily generated real-time traffic data and provides mobile traveller information services through a big data platform and internet of thing (IoT). Current literature (e.g. Aleta et. al, 2017; Pronello and Camusso, 2017; Fang and Wed, 2018) reveals varying views related to advancement in traveller information systems (TIS). Generally, it is to be helpful in establishing a sustainable network on mobility information that continues to dominate the urban movement scenario today.

Revolutionary in today's traveller information systems channel are profoundly influencing the way travellers interact with the transportation system and their behaviours. As such, much of the smart mobility literature highlighted the need for smartphone-based traveller information systems (STIS) use on the success of traveller information services revolution. U.S Transportation Department (2018) state that the worldwide urban transportation sector committed expanded the gamification opportunities on traffic apps in order to provide real-time driver routing with smartphone transportation apps. Within high technology traveller information channel, the smartphone transportation apps like Waze and Google Maps are proven to have the most direct impact on flow efficiency on roadways capacity, especially for urban arterial roads and highways. It is the latest traveller information services revolution to overcome the drawbacks of conventional traveller information services which exhibits limitations in travel demand management especially in handling traffic congestion problems. In taking the current smart city innovation state and

smart mobility as one of the components in it, the smartphone transportation apps satisfying the needs of the urban travellers (Lopez-Carreiro and Monzon, 2018). However, some studies purport that the high technology channel cannot improve road transport performance if it not used entirely in the system. Some researchers suggest that continuous effort to increase travellers' continuance intention towards smartphone transportation apps is necessary and the transportation sector struggling to better understand why travellers accept or reject their use.

Current literature (e.g. Raveau et. al, 2016b; Soriguera et. al, 2016; Ferreiraa et. al, 2018) reveals the smartphone transportation apps continuance intention is important as it has led towards future city liveabilities such as cleaner environment, safer driving, travel time reliability and modern technologies application. During daily travel, smartphone applications could mitigate a number of cognitive difficulties in a complex situation and give travellers more perceived control and satisfaction over their travel experiences. Somewhat, user's continuance intention often posits the relationship of psychological, cognitive, emotional, and social mechanisms in their intention and must be fulfilled accordingly (U.S. Department of Transportation, 2018). Bhattacherjee (2001a) also state that the continuance intention to use information systems (IS) or information technology (IT) influenced by means of components of cognitive and affective beliefs. Perhaps with a better understanding of users' cognitive and affective beliefs do not just influence their continuance intentions but also help the people to better cope with daily travel stress. In addition, what makes the city of liveable is not a skyscraper or a vast infrastructure development, but how the surrounding city reacts to the people and provide a positive trait for the wellbeing of life.

Recently, the worldwide transportation sectors have a process to ensure effective retention of smartphone transportation apps users, and they found that users continuance intention root causes not well addressed (e.g. U.S. Department of Transportation, 2018; Raveau et. al, 2016b). Evidence exists suggesting that the current trends of smartphone transportation apps implementation should be adhered to meet the user's demand for actual and perceived control. Most of the current information systems (IS) literature has agreed that develop the IS services strategy

based on psychological mechanisms solve the end-user usage behaviours issues and keep the services to grow in nature, instead of solving new technology technical issues. Yet, the context of the urban lifestyle has changed. The proliferation of information and communication technology (ICT) has allowed smartphone apps users to use their mobile information services through personal devices to perform daily activities (Robert D. Moore, 2006). Moreover, smartphone applications have also had improved transportation sector ability to retain best practices in the hi-tech travel information channel as well as to fulfil important requirements of users' trust in current traveller information services. It has reduced the worldwide transportation sectors struggling by open up barriers in transportation systems interaction and influences travellers' behaviours on travel choice. Most important, smartphone applications help to reduce the cognitive impacts on travel behaviours and choice since travellers are always connected with real-time information at fingertips convenience and allowing drivers more control over their journey.

As a whole, continuance intention of smartphone-based traveller information systems (STIS) is based on today's individual decision to either continue or discontinue the use in daily commute getting more attention from academician and practitioner in this area. Hence, there is a need to improve the relationship between the post-adoption of smartphone-based traveller information systems (STIS) with the user's psychological motivations. Evidence also exists stating that satisfaction and enjoyment in smartphone applications affect their user's continuance intention (Hsu and Lin, 2015), however, most traveller information systems (TIS) validation studies only concerned with initial acceptance beliefs. As well as in the transportation sector, there is a lack of specific research on user's social-psychological mechanism in smartphone transportation app continuances (U.S. Department of Transportation, 2018). Moreover, the current traveller information systems (TIS) services studies have tended to highlight the importance of service tangible aspects rather than intangible aspects such as psychology motivation, it is likely to multiply the current issues of urban mobility. Despite all this fact, the question is what are the determinants factors underlying travellers' motivation to continue using smartphone-based traveller information systems (STIS) continues to be a problem.

1.3 Problem Statement

Inefficient of information dissemination to the drivers in an urban transportation system may affect travel decision made by the urban drivers and result in inefficient use of road capacity, as consequences, drivers continuously suffer from gridlock and poor traffic flow. According to Ben-Akiva and Abou-Zeid (2016a) and Friman, Olsson, *et al.* (2017), if this issue continues, it will have a negative effect on people's life satisfaction and economic growth. At present, traditional or online traveller information services are not enough for the solution of current urban roadway congestion, that requiring real-time information and alerts channel (Soriguera, 2014; U.S. Department of Transportation, 2015; Soriguera and Miralles, 2016). The current traditional or online traveller information services restricted urban drivers to obtain real-time and localized traffic information (Pronello and Camusso, 2017). The above problem shows that it is time for the transportation sector to put close attention on the current mechanism of data collection and dissemination of mobility-related information to the public. Further, Bifulco *et al.*, (2016), Pronello *et al.*, (2017) and U.S. Department of Transportation (2018) state that the current trends in dissemination real-time information to urban drivers are via smartphone-based traveller information systems (STIS). With STIS, urban drivers are not restricted to obtain an update on current roadway conditions in terms of time and place. It is important for urban highway networks and major streets operation management, especially during peak hours or festive seasons. It is because, according to the U.S. Department of Transportation (2017), an efficient and reliable real-time information can provide powerful and cost-effective ways to improve travel demand management. However, the long-term development of STIS relies on users' continued usage, where psychological mechanisms believed to be the most impactful in current smartphone transportation apps use.

Therefore, the growing demand for the creation and management of real-time traffic information is likely to place urban facilities management (UFM) as one of the key actors in the delivery of this objective for the transportation sector. With cities at the challenge of achieving smart mobility, the UFM role is required to provide economical and effective management of transportation support services and

facilities-related mobility that is hassle-free, healthy and tailored with current citizens' need. In light of the requirements, all facility managers within transportation service responsible for managing the execution, direction, and coordination of all information technology (IT) services within the transportation sector. This includes integrating drivers, routes, and traffic management processes in an effective way by enhancing real-time traffic information dissemination. Disseminating real-time and localised traffic information is the central goal of what the worldwide transportation sectors and urban management bodies do in influencing smarter driver routing and urban drivers' interactions with the transportation systems in urban highways and major streets. The smartphone transportation apps such as Waze, Google Maps and the like are the ideal choice for urban road users (Chang, Jones, Mora, Rive G, et al., 2015). Previous literature (e.g. Gao et al., 2014; Zhao et al., 2015; Soriguera et al., 2016; U.S. Department of Transportation, 2018) suggests that the expanding smartphone transportation apps usage is potentially valuable to maximise efficiency and capacity of current urban transportation system information to drivers, reduce the impacts of congestion and increase safety by alerting urban drivers of upcoming hazards. In other words, existing roads capacity can be used efficiently if STIS successfully accepted and continues to be used, and conclude that urban transportation management should pay equal attention to both STIS use and continuance in decision-making. At this time, urban traffic management is becoming electronic and real-time information focused, since the interaction between drivers and transportation system become more essential. This can be further complicated in urban transportation management, if STIS users' continuance intention may not be aligned with the obligations of the transportation sector.

Though ideally expected to influence travel choices and urban drivers' behaviours, smartphone apps use often deployed a psychological mechanism such as cognitive and emotional impacts in influencing continuous use (U.S. Department of Transportation, 2018). As the facilities management principles from the macro scale are to focus on the urban facilities development, it is management and sustainability for an urban precinct. Thus, there is a need for the UFM field to focuses on psychological mechanisms as an intangible component of a mobile traveller information service. As to date, no specific research deeply investigated the determinants of continuance intention to use STIS which is valuable for the

intangible aspects of STIS service. Moreover, although the expectation-confirmation model (ECM) has been confirmed by previous mobile service studies to be a robust model for explaining continuance intention of the services, still, current IS users' behaviours intention also affected by other perceived value dimensions such as emotional value (Chang *et al.*, 2016). Besides, Bhattacherjee (2001) has stated that affective appraisal which resulting from a cognitive appraisal of the expected performance is temporal and need further refined from time to time. Moreover, although evidence exists (e.g. US Department of Transport, 2015; Metcalfe and Dolan, 2012; Solof, 2010) and had identified psychological mechanisms is the most impactful factors to influence on smartphone transportation apps use, however, no specific research on smartphone apps uses not deeply investigate the impacts of psychological mechanisms on smartphone transportation apps use in the transportation sector (US Department of Transport (2018).

The importance of understanding the determinants of continuance intention of STIS use is an important step toward successful smart mobility implementation, especially for the urban area. Factors such as cognitive impacts and affective impacts must be considered when providing advanced traveller information services to public users. When determinants are available to influence one's intention to continue using STIS, it can have a significant impact on efficiently roadway capacity. However, when such determinants are lacking, uninformed drivers can create undesirable roadway conditions, such as gridlock and poor traffic flow. Currently, there are no determinants available to explain the user's intention to continue using STIS. Moreover, the US Department of Transport (2018) reveals no empirical evidence on cognitive and affective factors influencing the user's intention to continue using smartphone transportation apps, especially in the urban roadway context. Some researchers purport that there is a theoretical gap in this area of study caused by previous studies in mobile services and devices are not deeply investigated the relationship between cognitive and affective domain. In Lin, Huang and Hsu (2015) study state that the previous studies more focused on the cognitive capabilities rather than affective capabilities, with this inequality, further aggravating the negative effect of daily travel happiness on economic growth. Furthermore, Kim, Kim and Wachter (2013) study had found that most of the previous studies in mobile devices more focus on user's activities and less on user's users' behavioursal intention

through user's motivations. Besides, Soriguera et al. (2016) and U.S. Department of Transportation (2018) reveals investigating determinants of continuance intention of users in the context of mobile traveller information services is currently vital to reduce traffic congestion and ensuring the subjective well-being of urban road users. From the macro scale of facilities management with a focus on urban precinct development, the use of digital technology in the management of transportation operations remains an unexplored space in facilities management studies. Thus, this study attempted to fill the theoretical and practical gaps by focusing on theorizes and validates the theoretical model of STIS continuance since there is no scale developed for measuring this phenomenon in the transportation system context. Therefore, this study examines the determinants of the continuous intention of the user on STIS in the Greater Klang Valley based on the following research questions:

1. What are the determinants of continuance intention to use STIS services?
2. How does the relationship between the identified factors explain the continuance intention for use of STIS?
3. How the dimensions of the STIS continuance model could do influences users' continuance intention?

1.4 Objectives of the Research

The study of consumer behaviours has become an important aspect of information systems (IS) services continuity. However, there are little information regards to the relationships between psychological mechanisms and STIS continuance. The previous research in mobile information services has concentrated on cognitive factor rather than an effective factor. The purpose of this study is to develop and validate a STIS continuance model for investigating continued STIS usage behaviours by extending the set of post-adoption beliefs in the ECM. In this study, the development and validation of the STIS continuance model are based on the below objectives:

1. To investigate determinant factors for smartphone-based traveller information systems (STIS) continuance intention.

2. To determine the structural relationships among the identified determinant factors for smartphone-based traveller information systems (STIS) continuance intention.

3. To develop the STIS continuance model that influences users' beliefs on smartphone-based traveller information systems (STIS) continuance intention.

1.5 The Scope of the Research

The scope of this study only focuses on the determinants of continuance intention of the user on smartphone-based traveller information systems (STIS) in the Greater Klang Valley regions. There are several reasons why mobile TIS via smartphone apps had been selected as the case study. First, the urban roadways have fundamentally different characteristics with regard to the density of road networks, patterns of travel demand as well as IT infrastructure. Furthermore, the efficiency of urban major streets and highways have a huge impact on national economic prosperity and social sustainability, especially for a large city. The main function of the urban major streets is to deliver traffic from the city centre and conurbation to the freeways or expressways at the highest level of service performance, due to the population density and high numbers of vehicles commute. As the middle of the year 2015, worldwide transportation system had started to deploy smartphone transportation apps to influence travel choices and traveller behaviours since it is been identified as behavioursal, economic and psychological mechanisms to influence the current landscape of economic and non-economic decision-making.

Second, the Greater Klang Valley (KV) region road systems have been implemented for Malaysia National Key Economic and gazetted as a key component of the plan to transform Malaysia into a high-income nation by 2020. IT infrastructure had been invested to transform the region into the highest standards in

every area of business, infrastructure and lifestyle. As a way forward to digital transportation system via mobile and wireless components, STIS has been deployed to ensure drivers' virtual interaction with the transportation system. It is expected to assist the transport sector in handling large demand for travel without compromising the safety and convenience of drivers in line with the MS ISO 9001: 2008, MS ISO 14001 standard: 2004, OHSAS 18001: 2007, MS 1722: 2011 and MS ISO / IEC 27001: 2013. Third, the Greater Klang Valley (KV) roadways also have been identified as having the highest traffic and frequent severe congestions, especially during peak hours. Forth, the Greater Klang Valley (KV) roadways have being a starting point in Malaysia's smarter highway initiative which has undergone several changes and upgrades to enhance mobility sustainability which leads to wellbeing travelling. In Malaysia's information and communication technology strategic plan (ISP), there are four (4) core strategies identified in this ISP development process namely (1) strengthening ICT infrastructure and security, (2) stabilize the application system holistically, (3) strengthen governance, and (4) strengthen digital competence and culture.

Fifth, the current trend of the worldwide transportation sector expending mobile traveller information systems (TIS) use via smartphone transportation apps as a modern way to provide innovative services for public people to select modes of transportation and traffic management. STIS enable the transportation sector to provide better, safer, more coordinated, and smarter road system. Based on the previous studies, the public acceptance towards mobile TIS could lead to sustainable urban living in terms of overall benefits conferred as well as the mobility distributional effects between guided and unguided drivers. STIS enable users to be better informed and they potentially make better travel decisions that could reduce traffic congestion and increase road network capacity. Thereby, it simultaneously benefits both guided and unguided drivers performance and gives positive implication to the road networks. Sixth, the STIS use depends critically on users intention to continue to use the system, as users' emotion surrounding disconfirmation expectation usually coupled with their consumption experienced (Bhattacherjee, 2001; C.P.Lin et al.,2009), and the motivational structure in the environment constrain human use of the technology (Szalma, 2009). Thus, this study focuses on psychological factors to explain the continuance intention of STIS use.

1.6 Research Process

This study adopts the philosophy of positivism to understand the determinants of continuous intention for STIS use through measurable observations. This study assumes that STIS users' continuance intention based solely on their previous experience. This study uses a deductive approach to focus on the psychological mechanisms that could reflect the continued usage beliefs. In order to achieve this study objectives, this study has been carried out using five stages research process, and the below Figure 1.1 explains clearly:-

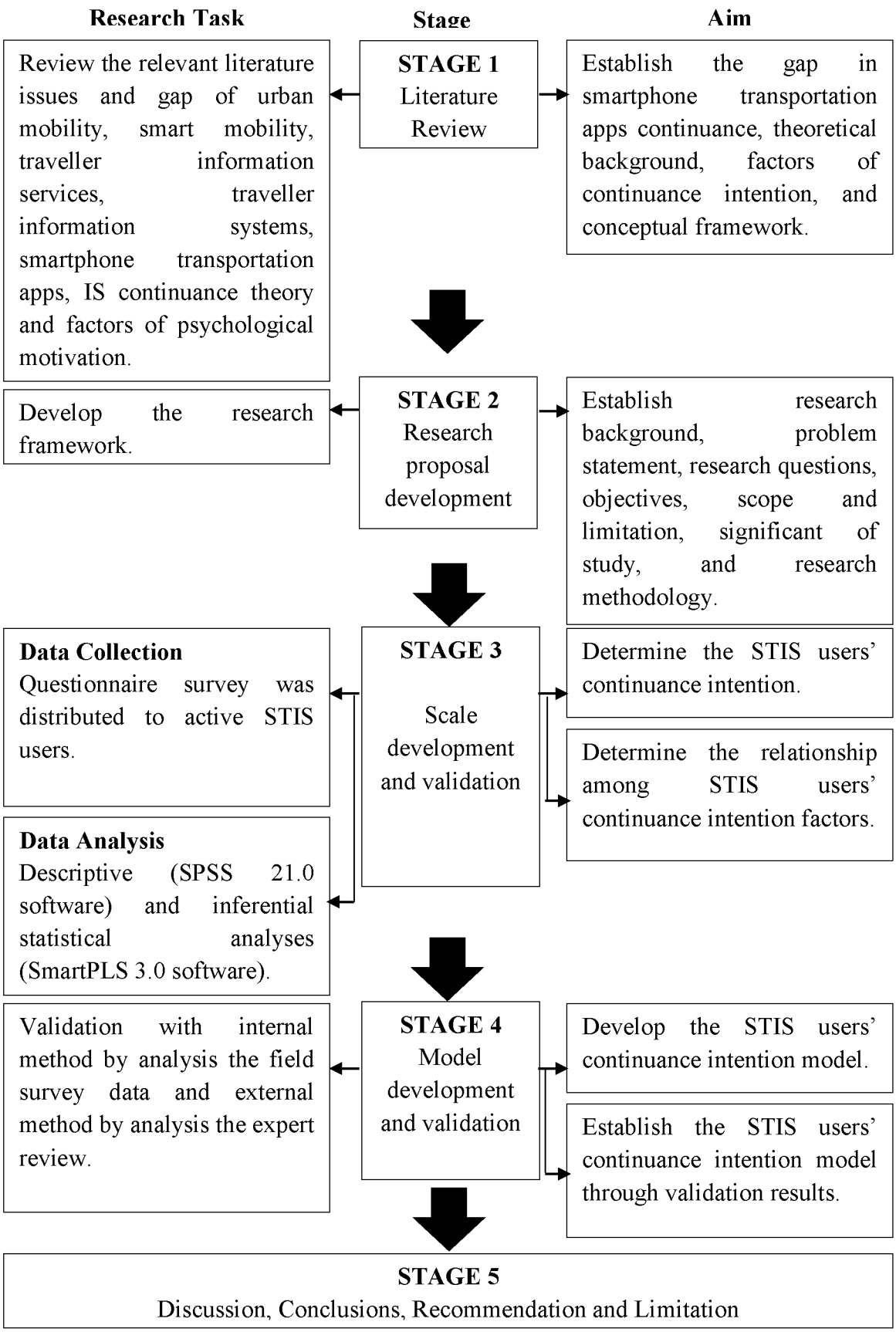

Figure 1. 1: Research Process Flowchart

1.7 Significant of the Study

Information systems (IS) previous studies have shown the importance of individual user continuance intention in maintaining IS success in the electronic or digital services as the ultimate success depends on continued use rather than initial use. This study is vital as there is no research on the smartphone-based traveller information systems (STIS) users continuance intention was conducted before. In order to compile important data as determinant factors of STIS continue usage behaviours, this study provides the necessary information and required data for a better understanding on the effects of the psychological motivation on STIS user continuance intention through latest multivariate data analysis and scientific research. Thus, this study attempts to expand the set of IS post-adoption factors in the expectation-confirmation model (ECM) beyond the cognitive beliefs focus with the inclusion of affective belief, namely perceived enjoyment as stated in several mobile apps literature as an important factor to explain user continuance intention.

Moreover, this study hopes to shed light on a possible formulation of a richer mobile services continuance model for the urban facilities management (UFM) field to response the challenges associated with the smart city development. Thus, practically, it is hoped that this study finding contributes to the road transport development of a more comprehensive account towards smarter mobility option in a smart city. In the view of smartphone applications in the direction of smart mobility, transportation sector researcher and practitioner should give more thoughtful consideration to the unique features of psychology motivation application in the decision-making process of any advance traveller information services since it influences travellers' travel choice and behaviours. Overall, the results of this study are also expected to be a source of reference to the urban transportation sector to improve the performance in delivering real-time traffic and travel information services to all urban travellers through this smartphone-based traveller information systems (STIS) application.

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