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Understanding Consumers’ Acceptance of Mobile Payments:
A Theoretical Model and Empirical Validation

The thesis is submitted in partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy of the University of Portsmouth.

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Whilst registered as a candidate for the above degree, I have not been registered for any other research award. The results and conclusions embodied in this thesis are the work of the named candidate and have not been submitted for any other academic award.
Abstract

This research investigates consumer acceptance of mobile payments. Mobile payments offer an alternative payment method for consumers, and allow consumers to make point-of-sales payments through mobile devices, such as mobile phones and Personal Digital Assistants (PDAs). It aims to present a better understanding of mobile payments, developing a consumer acceptance model for mobile payments. Moreover, it offers a reference and a source of literature for the industry and academic researchers in this new information systems research domain. This thesis focuses on consumer acceptance of mobile payments, and explores and investigates the factors that influence consumer acceptance of mobile payments.

The lack of literature and empirical research in the field of mobile payments encouraged the development of a research framework to elucidate the acceptance of mobile payments by consumers. The present research has been conducted in order to offer a more in-depth understanding of consumers’ perspectives on mobile payments. The Technology Acceptance Model (TAM) and Innovation Diffusion Theory (IDT) have been introduced into this research, offering a solid foundation for this research and the development of a research model.

A mixed methods approach was adopted for the research in this thesis. The research started with a qualitative method, using a focus group to investigate potential mobile payment users concerning usage, issues and adoption via open-ended questions. This process was followed by an example of mobile payment being identified and explored to understand mobile payments: a closed-ended questionnaire was used in this part of the research study. Study two is a case study, the selected case being ZOOP mobile payments. At the time of this research, ZOOP was a successful commercial infrared-based mobile payments system. These two studies offer rich information regarding the attitude and behaviour of mobile payments users toward mobile payments, and the expectations and concerns of potential users. The data and results from study one and study two were important as background material and for reference, and they also offer a context for the interpretation of the data from study three. Therefore, through these processes, a solid foundation for this research has been established. The proposed research model has been used in study three to address the research question.
in conjunction with evaluating the research model. The relationships between the potential factors in the research model have also been identified. The conceptual framework presented in this research is based on two well-known theories, IDT and TAM. Study three obtained two sets of data. The first survey was for all mobile payments users around the globe, and the second survey focused on one particular mobile payments service in the UK. The second set of data is designed to confirm the result from the first set of data. This rigorous process provides a solid model of consumer acceptance of mobile payments. The data has been analysed through Structural Equation Modelling (SEM) via Linear Structural RELationships (LISREL) computer application software. The study has successfully evaluated the research model and obtained results. Moreover, the survey instruments used have also been validated in this study.

This empirical research is used to improve the understanding of the phenomenon of mobile payments. Moreover, it offers insight into the attitudes and behaviour of consumers towards using mobile payments. In study one, focus group studies identified the reasons for adopting mobile payment systems, for example, a convenient service. Concerns about using the services, for instance, security, have also been identified. Furthermore, the second study surveyed ZOOP mobile payment users in South Korea: it also identified that convenience, ease of use, and a safe service would attract consumers to use the service. Both studies have provided valuable information for academics and the industry to understand why consumers would like to use mobile payments and also their concerns. The results of the study have confirmed the importance of the identified factors for consumer acceptance of mobile payments. Apart from TAM and IDT, respondents note that perceived costs, perceived trust, perceived system quality, and social influence are important to them.

The results of this research study should be of interest to both academic and business communities. The research in this thesis expands the usage of the TAM model in Information Systems (IS) research, validates and extends the TAM model within the mobile payments domain, and develops a new model of mobile payment adoption. Moreover, the results are of value to the business communities interested in developing and implementing mobile payment systems. Potential service providers would benefit from an improved understanding of these aspects. The identification of
important factors concerning mobile payments in this study will assist them to develop and implement their systems to ensure the full acceptance and continuous use of the systems. The research framework can also be used for future research related to mobile payments or mobile commerce.
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Chapter One: Introduction

1.1 Motivation of the Research

Technology is transforming people’s daily lives, and, increasingly, people are able to benefit from the use of technology (Van der Heijden & Sorensen, 2005). Mobile technology in particular is playing an important role in this transformation. For example, mobile phones are used around the world, from Asia and Europe to America.

The new payment method, mobile payments, provides a new and exciting business opportunity for many organisations. Mobile payment services offer the facilities for consumers to make point-of-sales payments over mobile devices, such as mobile phones and personal digital assistants (PDAs). The rapid growth of the use of mobile devices provides a platform for implementing and deploying this service. Moreover, some financial institutions already use mobile devices to transmit financial information, which gives them the ability to meet customers’ needs in a mobile manner, regardless of the customers’ location. It provides flexibility for both consumers and financial institutions.

The advantages of mobile payments are self-evident (Herzberg, 2003; Ondrus & Pigneur, 2005). The most common incentive is convenience. Moreover, it also offers mobility, with cost effective and location free services (Herzberg, 2003; Ondrus & Pigneur, 2005). Nevertheless, mobile payment is still a rare application worldwide. There are some clear-cut obstacles: security issues, privacy concerns, lack of standardisation and the suitability of use. However, there is also extreme competition in the mobile payments market because of the different industry sectors, such as mobile network operators and financial institutions, attempting to dominate this application. Moreover, within the sector, a range of different ideas and applications exist. For example, Simpay was founded by a group of mobile operator in order to provide a universal platform for mobile payment systems. Simpay failed because the mobile network operators have different interests in the mobile payments market.
(Sherriff, 2005). If mobile payments service providers cannot illustrate the nature of their services, consumers will be resistant to these services.

Mobile payments will become an important form of payment transaction in the financial industry, but this system is still in its infancy (Chen & Adams, 2004a; Choi, 2006). Growth in this sector can only be stimulated if consumers and long-term businesses realise the benefits for the payment industry. Its path to expansion is similar to that of e-commerce (Poon & Swatman, 1999). Therefore, understanding the factors that determine the acceptance of mobile payments by consumers could lead to more effective and meaningful strategies that would allow mobile payment systems to expand significantly and remain competitive.

Despite the tremendous business opportunity for mobile payments, the application has not yet taken off. This problem is not caused by a single factor: a range of issues must be taken into account. For example, service providers are required to consider technology selection, business cases and infrastructure. In e-commerce research, Internet security was found to be the major barrier to e-commerce development (e.g. Turner, Zavod, & Yurcik, 2001). Not surprisingly, mobile payments face the same issue that e-commerce has encountered in the last decade. The question of how to attract consumers will be crucial. Moreover, the mobile environment is different to the Internet environment. However, the mobile environment has provided a platform for users to widely access information and communication. Therefore, the challenge for any organisation is to control other systems in the environment.

The rationales for conducting this research are as follows:

First, in the mobile environment context, consumers are aware of and know what value and service they seek in mobile services (Carlsson & Walden, 2002), which indicates that understanding what consumers want or need is a key factor for the success of mobile services and to satisfy consumers (Kalakota & Robinson, 2001). Thus, if mobile technologies and services are improved, more consumers will be attracted and will adopt them.

Second, the acceptance and adoption by consumers of a new innovation or service reflects the value of the service. As any new technology services require a rigorous
development process and a large investment for the associated Research and Development (R&D), if the services are unable to meet the expectations of consumers and to satisfy them, service providers will lose their core competence and values (Shapiro & Varian, 1999).

Third, Rogers (1995) concludes that adoption is a decision process, and the decision process depends on many external factors related to the services, for example, lifestyle (Ajzen & Fishbein, 1980; Davis et al., 1989). Therefore, there is an urgent and vital need to understand and identify these factors. More understanding of these factors would be of benefit for service providers to build more constructive relationships with customers in order to fulfill the adoption target set by the service providers.

Finally, at this stage, the question that confuses the industry and researchers today is: what factors contribute to the acceptance by consumers of mobile payments?

The research in this thesis enhances the understanding of the factors that influence consumer acceptance of mobile payments in the light of the Technology Acceptance Model (TAM) and Innovation Diffusion Theory (IDT) (Davis et al., 1989; Davis & Venkatesh, 1996; Mathieson, 1991; Rogers, 1995).

New technology creates enormous business opportunities, and the mobile payments service is such an exciting and valuable application. However, the customer is the one to determine the value of the business (Drucker, 1954), and customers and their use of mobile products and services, rather than advances in mobile technology, could lead to a new era of mobile business (Jarvenpaa et al., 2003).

1.2 Scope of the Research

The research presented in this thesis is concerned with consumer acceptance of mobile payments. Mobile payment is a new domain in information systems research, but given the extensive research in e-commerce during the last decades, it is clearly
important to start investigating the usage and impact of mobile payments at an early stage.

This research aims to identify and explore key factors that affect consumers’ decisions of whether to accept mobile payment systems. Mobile payment refers to the use of mobile devices to conduct payment transactions. Users can use mobile devices for remote and proximity payments; moreover, they can purchase digital contents as well as physical goods and services.

The advantages of using mobile devices for business activities and personal communications are clear, as they offer convenient, fast, location free services for users. Moreover, mobile devices offer potential opportunities and new channels for new business applications. The mobile payment service is one of the exciting new applications to emerge. The application has the potential to be widely utilised to establish a new payment market as well as a next-generation payment solution by financial institutions, telecommunication operators, device manufactures and independent payment service providers.

The increasing use of mobile devices, especially mobile phones, in recent years has resulted in organisations implementing their mobile services and goods, for example mobile ring tones, through a new channel: mobile/wireless networks. With the increasing sophistication of mobile handsets and rising numbers of mobile network subscribers, it is unsurprising that Mobile Network Operators (MNOs) and financial institutions see this as a major opportunity to increase their business revenues.

It is difficult to access and obtain results or information from mobile payment service providers, as a result of business confidentiality. More importantly, the majority of services did not highlight some aspects of consumer resistance to mobile payments. Thus, this research is very important for investigating consumer acceptance of mobile payments.

In order to make mobile payments a must-have, offering unique services, mobile payment service providers have to improve their services substantially. For instance, interoperability is a key issue for implementing the service. In the long term, mobile
payments will undergo convergence. However, some consumers are unwilling even to try these systems. There is an urgent need to address this problem at the introductory stage of this service. That is why the present research has been proposed.

1.3 Research Objective

The adoption of information systems by users and the rate of diffusion of technology have been investigated and researched intensively (e.g. Gefen & Straub, 2000; Karahanna, Straub, & Chervany, 1999; Taylor & Todd, 1995a; Van de Heijden, 2004; Van de Heijden & Verhagen, 2004). Moreover, these research papers represent the essential characteristics and value of information systems (Orlikowski & Iacono, 2001). The intent in this thesis is to conduct research on an emerging and dynamic topic, the adoption of mobile payments from the consumer’s perspective. This research lies in the domain of information systems research, and aims to identify the critical factors influencing the decision-making process of consumers regarding the acceptance of mobile payments. In particular, this research aims to investigate the behaviour of consumers concerning using mobile payment.

A number of companies are planning or have already provided mobile payments services for their customers, including MNOs, financial institutions, and independent service providers. For example, Simpay, a mobile payments service, was set up by some major European MNOs, Orange, Vodafone, T-Mobile and Telefónica Móviles in 2003. It offered mobile phone users the ability to make purchases of under €10 per transaction via their phone bills (Qpass, 2004). Moreover, LUUP, a mobile payment service, was launched in May 2006 (Luup, 2006). This service is provided by an independent service provider, Contopronto. It allows users to pay or transfer money via SMS. However, Simpay has collapsed and the programme was closed on June 24, 2005, one of the reasons being insufficient business volume from mobile content service transactions (Sherriff, 2005). It can be interpreted that this service could not attract many mobile phone users to use it. LUUP is still a new application, and it remains to be seen whether it succeeds or not. The mobile payments market is still attractive and has the potential for growth. Before this potential is turned into reality, there are many issues that need to be addressed. The research in this thesis focuses on the following two objectives:
A. To develop a consumer acceptance model for mobile payments using IS theories as a foundation.

B. To evaluate the proposed research model.

### 1.4 The Purpose of This Research

Mobile payment is a new and highly profitable payment channel, and early adopters will have a potential competitive advantage in the market. Mobile payment transactions involve disclosing personal information and payment information. The information created, processed and obtained by any organisation is one of its most valuable assets. If a transaction is compromised, it could severely damage the reputation of the organisation and the trust of customers, and possibly represent a breach of laws and regulations. Therefore, before mobile payment systems mature, there is a need for a great deal of research and investigation.

In today’s business world, business systems are not simple. They inevitably involve complex constructs, such as technical and social aspects. Thus, it is necessary to incorporate social and technical considerations into today’s research.

Technology adoption and system use are ongoing topics and recurrent issues in IS research. User attitude is often linked with the research. In the context of mobile payments, the system can be defined at two levels. The first involves the availability of the payment application. The second depends on the payment activities needed in the mobile payment environment. There are few extensive studies or articles in the literature regarding successful mobile payments. However, a research study has identified that system use is a good indicator of the success of e-commerce (Liu & Arnett, 2000). E-commerce and mobile payments share some similar characteristics: for example, they both use new channels to conduct business activities, and this work therefore provides a reference for mobile payment research. Because of the gap in the literature regarding mobile payments, an understanding of consumers’ behavioural incentives and factors that influence consumer acceptance will be valuable.
To summarise, this research is intended to identify factors that influence consumer acceptance of mobile payments. The proposed research model will be tested to elaborate on the hypotheses, as presented in section 3.8.2.

1.5 Organisation of Thesis

This thesis consists of seven chapters. This chapter presents the research topic and why this research needs to be conducted.

The second chapter reviews the mobile commerce (m-commerce) applications and technology, possible technologies and infrastructure for mobile payments, and the issues surrounding mobile payments. It presents a full picture of mobile payments, and discusses the potential technologies and infrastructure that can be used in mobile payment systems. This chapter inform and lead in to the next chapter, which presents the research framework and research model for the research in this thesis.

Chapter three introduces the theoretical base for this study, wherein the relevant theories will be presented. The other factors that contribute to the proposed research model are also introduced. The adoption of IDT and TAM offers a strong theoretical foundation for this research. Moreover, the research model and hypothesis will be presented. The chapter sets the theme for the research in this thesis by presenting the proposed research model.

Chapter four discusses the research methodology for this research. It puts the research topics in perspective as far as information systems research is concerned. It also discusses the choice of research approach as well as the research design.

Chapter five presents the implementations of the research for the three studies in this thesis.

Chapter six presents the data analysis and results from study one and study two.
Chapter seven presents the findings from study three. The proposed research model is evaluated through two different sets of data at this stage. Moreover, this chapter also presents a summary and discussion of this part of the research.

Chapter eight draws together the research findings and the implications for theory and practice, and outlines the contribution to knowledge. Moreover, it states the limitations of the research in this thesis and future research possibilities.
Chapter Two: Literature Review

2.1 Introduction

The main purpose of the research in this thesis is to identify and explore key factors that influence consumer acceptance of mobile payments. This research focuses on consumers’ perception of and attitude toward mobile environments. The aim of this chapter, therefore, is to give an overview of mobile commerce and mobile payments, which is essential to provide a comprehensive understanding of mobile applications at present.

At the outset of this chapter, an overview of mobile commerce and a range of definitions of mobile commerce will be introduced to build an understanding of its conceptualisation. Its characteristics will then be outlined, wherein the main differences between mobile commerce and electronic commerce will be identified, followed by a discussion of the development of mobile commerce from different perspectives. Various concerns and challenges surrounding mobile commerce will also be identified.

Next, mobile payment will be introduced and an overview given, along with an account of its scenarios. The characteristics of mobile payments will be discussed, followed by the potential players and mobile payment standards. Subsequently, an overview of wireless technologies will be given and the short-range wireless technologies that could be used for mobile payment applications will be summarised. Problems and issues relating to short-range wireless technologies and mobile payment acceptance will then be identified. Moreover, how trust and system quality influence mobile payment acceptance will be stressed.

2.2 Mobile Commerce Overview

The Internet is playing an increasingly important role in people’s daily life. One important feature provided by the Internet is that it creates an innovative channel, called electronic commerce, which has opened up a world of business opportunities to
enhance operating efficiency, reduce costs, and improve communication (Araujo & Araujo, 2003; Ogawara, Chen, & Chong, 2002). The Internet has offered a tremendous opportunity for individuals to conduct businesses using an electronic channel. E-commerce can be defined as any type of business transaction involving the transfer of information via the Internet (Maamar, 2003). However, mobile commerce, the extension of electronic commerce, puts forward the feasibility of outstretching services that enable users to interact with other users or to conduct business transactions driven by the penetration of wireless devices, especially mobile phones (Kini & Thanaritiporn, 2004; Liang & Wei, 2004). The development of sophisticated mobile commerce offers even more benefits to people’s daily activities without restrictions of time and space through various devices such as personal digital assistants (PDAs) and mobile phones (Liang & Wei, 2004; Mallat, 2004; Senn, 2000; Tsang, Ho, & Liang, 2004).

M-commerce employs wireless networks to allow users to transfer data between mobile and other computing devices deprived of wired connection (May, 2001; Tsang et al., 2004). The growth of m-commerce has provided opportunities for business and has already proven to be successful, such as the enormous use of Short Messaging Service (SMS) in China (Coursaris, Hassanein, & Head, 2003), the numerous acceptance of SMS by the Global System for Mobile communications (GSM) in Europe (Kavassalis et al., 2003) and in Taiwan (Tsang et al., 2004), the Octopus electronic payment card for the underground railway in Hong Kong (Liang & Wei, 2004), ring tone and logo downloading by DoCoMo NTT in Japan (Lee & Benbasat, 2004; MacDonald, 2003), and the intriguing success of Zoop m-payment in Korea (Chen & Adams, 2005a). Apart from these successful examples, mobile applications also provide users a wide range of services, for instance, multimedia message service, emailing, games, global positioning service, banking, ticketing, music, fund transfer, stock trading, product ordering, and infotainment (Anckar & D’Incau, 2002; Herzberg, 2003; Hung, Ku, & Chang, 2003; Liang & Wei; 2004; Okazaki, 2005b; Scornavacca, Barnes & Huff, 2006).
2.3 Mobile Commerce Definition

Although the mobile commerce industry is in its infancy, various definitions are already offered in the literature for the main terms (e.g. Durlacher, 1999; Hosbond & Nielsen, 2005; Mohsin, Muqtadir, & Ishaq, 2003; Sadeh, 2002). Okazaki (2005b) summarises one major problem in mobile commerce research, which is the shortage of standardisation in terms, concepts, and theories. Though the definition of mobile commerce is not yet standard, “any transaction with a monetary value that is conducted via a mobile telecommunications network” can be defined as m-commerce (Durlacher, 1999). This definition given by Durlacher (1999) has been used widely in the mobile commerce literature (Munusamy & Hiew, 2002; Okazaki, 2005b). Hosbond and Nielsen (2005) share the same view as Durlacher (1999) and also include the term of business activities (Hosbond & Nielsen, 2005; Okazaki, 2005b). According to Mohsin et al. (2003, p. 2), the definition of m-commerce is broader than the term business activities and includes “business-related communication among individuals and companies where financial transactions do not necessarily occur”.

However, the definitions of mobile commerce stated by Durlacher and Mohsin are narrow. Mobile commerce is defined by Sadeh (2002) more broadly as “the emerging set of applications and services people can access from their Internet-enabled mobile devices.” Moreover, Kemper and Wolf (2002) denote that the term mobile commerce can be defined in analogous terms to e-commerce. Similarly, Stanoevska-Slabeva (2003) views mobile commerce as an additional channel for electronic commerce.

2.4 Characteristics of Mobile Commerce

Drawing on the published research, conference reports, working papers and online journals focused on m-commerce and e-commerce, it is clear that m-commerce and e-commerce business activities are indistinguishable since they involve much of the same practice in relation to facilitating e-commerce over the Internet (Coursaris et al., 2003; Ogawara et al., 2002).
On the other hand, though certain differences between e-commerce and m-commerce are not yet clearly identified (Okazaki, 2005b), there is some dissimilarity in terms of communication, Internet access devices, and technologies applied for each individually to support its own environment (Chun & Wei, 2004). Tsalgatidou and Piloura (2001) propose that in contrast to e-commerce, there are six advantages m-commerce can provide to users, which are location-awareness, ubiquity, personalisation, broadcasting, multi-engagement and adaptivity. Mohsin et al. (2003) take a different view, that m-commerce involves much less information technology literacy and is easy to use. Balasubramanian, Peterson, and Jarvenpaa (2002) state the benefit of m-commerce arises as a result of time and space aspects. They finalise that business activities can gain flexibility, together with temporality and space created by mobile technology. Fan et al. (2005) argue that the added value of m-commerce also includes convenience and cost-savings.

The distinctive significances generated by m-commerce have been acknowledged by many scholars (e.g. Barnes & Scornavacca, 2004; Fan et al., 2005; Hung et al., 2003; Lee & Benbasat, 2004; Varshney & Vetter, 2001). In consequence, m-commerce has great potential due to its personalisation (Barnes & Scornavacca, 2004; Anil et al., 2003), ubiquity, mobility and flexibility (Chun & Wei, 2004; May, 2001).

2.4.1 Personalisation

A mobile phone is usually used in an individual environment (Fan et al., 2005; Anil et al., 2003) because users carry their mobile phone anywhere they go (Barnes & Scornavacca, 2004). Mobile users rarely share their mobile phones in the same way that they share computers (Lee & Benbasat, 2004). The value offered by this nature of mobile devices makes them an exemplar for context-specific services specially customised to each individual (Clark III, 2001). In essence, this special characteristic should enable mobile users to receive only information that is of interest to them (Stanoevska-Slabeva, 2003). Ho and Kwok (2003) propose that the efficiency of m-commerce strategy can be crucially enhanced by personalisation, and therefore improve consumers’ perception of the usefulness of mobile services (Anil et al., 2003).
2.4.2 Mobility and Ubiquity

One of the most important aspects of the nature of mobile phone is that users can connect to the Internet or reach other people wherever and whenever they want (An & Papavassiliou, 2001; Tsalgatidou & Piloura, 2001). With this feature, mobile users are likely to be rewarded with respect to location and time services (Fan et al., 2005), and consumers’ perceived usefulness is likely to be significantly enlarged (Chun & Wei, 2004). Lee and Benbasat (2004) indicate that the growth and scale of m-commerce will beat e-commerce in the near future, due to flexible interactivity allowing the users more control over what they experience in the e-commerce environment (Barnes & Scornavacca, 2004). Perceived freedom and control of conducting services and transactions wherever and whenever symbolises a modern trend and the users may perceive social image (Lu et al., 2003).

2.4.3 Portability

Chun and Wei (2004) highlight that the Internet access devices used are the most significant difference between m-commerce and e-commerce, as m-commerce involves wireless interactions with other users or businesses, whereas wired e-commerce is employed normally through desktop and laptop computers. The development of device has instead become portable (Gebauer & Shaw, 2004). The features of wired devices outline the scope of e-commerce and provide the opportunity for m-commerce to become increasingly important in business (Hung, et al., 2003). Fan et al. (2005) add that with the help of mobile devices, the portability of m-commerce allows users’ business activities to be carried out irrespective of space and time. These value-added activities, furthermore, could transform into an improved quality of life (Clarke III, 2001). This life improvement could have a conclusive impact on consumers’ affective attitudes toward mobile services (Fan et al., 2005).

The characteristics of m-commerce described above have offered the comparison to Internet-based commerce, resulting in different formats of usage compared with those of the Internet.
2.5 Mobile Commerce Development

The development of mobile communication technology is explained in terms of generations (May, 2001; Stanoevska-Slabeva, 2003). Analogue cellular systems were the first generation networks, followed by the second generation, known as digital cellular systems, such as the GSM (Gera & Chen, 2003). Later on, the third generation, known as 3G systems, was developed to provide a global standard (Coursaris & Hassanein, 2002). The rapid development of mobile communication technology has offered a platform for the growth of mobile commerce.

In order to understand mobile commerce more comprehensively, the background to mobile commerce from different perspectives should be drawn together and discussed as a whole before being put forward into the specific objective of this thesis. The following section reviews the development of mobile commerce from different perspectives.

2.5.1 Business Perspective

Mobile marketing has been studied from the perspectives of different disciplines: for example, the nature of mobile marketing (Kavassalis et al., 2003; Leppaniemi et al., 2005), mobile commerce adoptions (Wang & Cheung, 2004), consumer attitudes toward mobile advertising (Tsang et al., 2004), consumer acceptance (Bauer et al., 2005), trust in mobile commerce (Dahlberg, Mallat, & Oorni, 2003), mobile commerce value chain (Barnes, 2002b; Coursaris & Hassenein, 2002), and mobile advertising adoption (Okazaki, 2005a).

In the marketing communication environment, Bauer et al. (2005) note that SMS has globally reached initial expectations and has become a significant market success. The use of SMS has remarkably risen since the year 2001 (Tsang et al., 2004) and many leading international brands have become increasingly interested in using mobile phones as a new medium for marketing communication (Bauer et al., 2005). Barnes and Scornavacca (2004) are convinced that mobile marketing will be as familiar a medium as the television or newspaper in the near future. However, what mobile users
think about advertising messages on their mobile phones is uncertain (Tsang et al., 2004) since a mobile phone is an individual device.

Much of the anonymous mobile advertising is unwelcome by mobile users, influencing them to refuse the messages. In order to avoid interrupting users with undesired messages, marketers should build trust and create long-term relationships with their customers (Barnes & Scornavacca, 2004; Slyke, Belanger, & Comunale, 2004). Thus, the concept of permission marketing is one of marketing strategies based on mobile users allowing the marketers to advertise their products (Bauer et al., 2005; Kavassalis et al., 2003). It distributes a novel platform for yielding individual-based target marketing (Barnes & Scornavacca, 2004). In addition to this concept, Tsang et al. (2004) put forward that mobile marketing can also be either incentive-based or location-based advertising. Incentive-based advertising offers a special bonus to those individuals who agree to receive news and promotions.

With the technology known as the satellite-based global positioning system (GPS), which makes it possible and practical to locate a specific mobile user, location-based advertising gains the benefit from this feature of tracking the users to certain positions (Orkazaki, 2005a). Mobile advertising can deliver to users tailored services and promotional offers based on the location of the user (Tsang et al., 2004). Some researchers (e.g. Clarke III, 2001; Fan et al., 2005; Ho & Kwok, 2003), however, indicate that mobile users would agree to allow service providers to keep hold of their profiles only if they realise the advantages of personalised services.

2.5.2 Technology and Application Perspective

There are two fundamental factors that affect the implementation and acceptance of mobile devices and mobile commerce: interface characteristics and network capabilities (Fan et al., 2005; Sarker & Wells, 2003). Interface design is important for IS, especially concerning the physical limitations of mobile devices. Poor network quality is also delaying the use and adoption of mobile services (Churchill & Munro, 2001; Sarker & Wells, 2003).
In the context of mobile commerce technologies, the wireless application protocol (WAP) is one of the main communication protocols for delivering Internet-based content and advanced value-added services to wireless devices (Barnes, 2002b; Coursaris & Hassanein, 2002; Hung et al., 2003; May, 2001). It is a key platform enabling the delivery of Internet services via mobile phones (Hung et al., 2003), such as emailing, paying bills, checking account balances and making balance transfers, and being informed of the current stock market situation (Barnes, 2002b). Massoud and Gupta (2003) claim that WAP is the most favoured Internet-allowing technology being selected by service providers.

However, WAP also has weaknesses in its memory, power, and capability (Jonasan & Eliasson, 2001). Compared with e-commerce technology, a wired network connection is more stable and more available than WAP services (Coursaris & Hassanein, 2002). Moreover, Hung et al. (2003) indicate that the number of handsets providing WAP services is smaller than the number of handsets supporting SMS. Tarasewich, Nickerson and Warkentin (2002) identified that the failure of the acceptance of WAP services in Europe was possibly due to user-unfriendly interfaces, applications that are difficult to use, and unstable connections. The most common issues, Anil et al. (2003) conclude, are that service cost is unacceptable to users, the access speed is slow, and the screen is hard to read.

The deployment of third-generation wireless technology (3G) is expected to provide a higher degree global roaming and supports a faster transmission speed compared with WAP (Coursaris et al., 2003; Ghosh & Swaminatha, 2001) as well as providing global standardisation (Stanojevska-Slabeva, 2003). The multimedia messaging service (MMS) offers users the ability to send and receive text, images, graphics, sound and video (Leung, Chan, & Chan, 2003). The capability of handling more information and a greater efficiency supports advanced data services (Barnes, 2002b). These services include video on demand, interactive games, delivery news, and distance education (Liang & Wei, 2004). The wide range of Internet and multimedia applications offered by 3G not only provides technical challenges, but also implicitly notes that the behaviour of consumers is changing (Massoud & Gupta, 2003).
Even though 3G could provide global standardisation, NTT DoCoMo’s i-mode has taken off with its own successful solution, the first Japanese mobile Internet solution (Coursaris & Hassanein, 2002). The Japanese approaches have been outstandingly successful, while the WAP approach has not gained wide markets (Stanoevska-Slabeva, 2003).

In addition to the weaknesses of mobile commerce technology mentioned above, wireless users have also experienced other issues which are great barriers to the development of m-commerce, such as trust, security, privacy, usability, compatibility, and system quality (Agarwal & Venkatesh, 2002; Dogac & Tumer, 2002; Ghosh & Swaminatha, 2001; Lee & Benbasat, 2004; Venkatesh, Ramesh, & Massey, 2003). These issues will be properly addressed at a later stage.

2.6 Concerns and Challenges of Mobile Commerce

The future for mobile commerce is considerable for those organisations which are well realized and mindful of the concerns and challenges that may adversely impact the growth of mobile commerce (Coursaris et al., 2003; May, 2001; Mohsin et al., 2003; Rupnik & Krisper, 2004). In understanding the concerns of m-commerce, prior research and studies on the context of m-commerce have determined many issues that may affect its adoption (Eklund & Pessi, 2001; Krogstie et al., 2004; Mohsin et al., 2003; Tarasewich et al., 2002), as follows:

2.6.1 Concerns Related to Mobile Devices

The physical characteristics of mobile devices are obviously different from desktop computers in various ways (Coursaris, et al., 2003). Although these mobile devices are small and portable, the input capabilities, such as the visual display and network processing capabilities, are restricted by the screen size (Manusamy & Hiew, 2002; Taresewich et al., 2002). Supposing that mobile technology develops, the features of mobile devices will become comparable with those wired computers, apart from the screen size (Venkatesh et al., 2003). Krogstie et al. (2004) add that input capabilities
are also limited by the size and the multifunctionality of the keypad in comparison to a desktop computer.

Without most mobile devices having a mouse, Manusamy and Hiew (2002) identify the interaction technique as another important concern to be taken into account. Moreover, the size of mobile devices also imposes limitations, such as limited storage, limited size of information, battery life, surfability, and the capacity for the running of mobile applications (Rupnik & Krisper, 2004). Stanoevska-Slabeva (2003) also includes in the limitations the difficulty of data entry, particularly for long messages and the browsing of information.

These issues are special challenges for designing an effective user interface (Rupnik & Krisper, 2004). The development of user interface modelling has increasingly focused on and facilitated some common models (Banavar & Bernstein, 2002; Fan et al., 2005; Liang & Wei, 2004). As a result of usage environment and mobile device constraints, the study of 7C framework proposed by Rayport and Jaworski (2002) has been widely accepted in developing a customer interface: their 7C framework consists of context, content, community, customisation, communication, connection, and commerce (e.g. Georgiadis, Mavridis, & Manitsaris, 2005; Lee & Benbasat, 2004; Liang & Wei, 2004; Venkatesh et al., 2003). The study of Lee and Benbasat (2004) extends the 7C framework in stating that the interface design also needs to take account of the mobile setting and mobile device constraints.

2.6.2 Concerns Related to Wireless Communication Infrastructure

With reference to the communication infrastructure, the main barrier to adopting m-commerce seems to be “the ability to provide seamless and adaptive quality of service in such a heterogeneous environment” (Gao, Wu, & Miki, 2004, p.24). Since the increase in wireless communication, many scholars have paid particular attention to research regarding issues and future opportunities: for example, Ramanathan and Redi (2002) present a brief overview of ad hoc networks in relation to challenges and directions; Hui and Yeung (2003) propose challenges associated with migrating to 4G mobile systems; Naqvi and Riquidel (2004) address great challenges regarding security for heterogeneous network environments; and Zhang et al. (2003) and
Chakravorty et al. (2004) present how to overcome the integration of networks between cellular Wide Wireless Area Networks (WWAN) and Wireless Local Area Networks (WLAN) to provide a range of m-commerce.

Unlike its wired counterpart, security is another important barrier to the development of mobile systems, as wireless communications are more at risk (Horn & Preneel, 2000; Ravi et al., 2004). In recent years, security concerns in m-commerce have varied in different areas such as security in wireless networks (Tarasewich et al., 2002; Varshney, 2002), security in mobile agents (Borselius, 2002), security in wireless terminal-based transactions (Veijalainen et al., 2004), security in wireless sensor networks (Deng, Han & Mishra, 2003; Slijepcevic et al., 2002), wireless privacy (Coursaris et al., 2003), and virus attack on wireless devices (Brewin, 2000).

Furthermore, the huge investment required to implement and operate a mobile wireless network is a major issue for organisations (Tarasewich et al., 2002). According to the studies of the attitude of consumers toward e-commerce (Becherer & Halstead, 2004; Kannan & Kopalle, 2001), organisations should also take into account perceived security, that consumers are likely not to purchase expensive goods on their mobile devices (Coursaris et al., 2003). Therefore, understanding the costs and benefits of mobile commerce is essential (Becherer & Halstead, 2004).

**2.6.3 Concerns Related to Mobile Application Usability**

Numerous concerns must be addressed when developing mobile applications (Munusamy & Hiew, 2002; Olla & Atkinson, 2004). Mobile applications have been well classified into ten different classes by Varshney and Vetter (2002) in order to discuss network requirements in support of m-commerce. Contextual information such as spatial location in mobile devices is one of the challenges to increase the usefulness of mobile applications (Jones & Brown, 2004; Tarasewich, 2003b). The context-sensitive nature of the mobile devices should be carefully examined and current applications must be restructured to be efficient across different devices, platforms, and networks, in order to assist mobile users in achieving their tasks successfully (Manusamy & Hiew, 2002).
With a variety of mobile devices that continue to drop off in size and weight, the usability of the devices is more challenging (Venkatesh et al., 2003). Moreover, there is still an unanswered issue concerning classical mobile applications, as the applications should be able to adapt based on the needs and demands of the user and be suitable for a state of mobility (Olla & Atkinson, 2004; Rupnik & Krisper, 2004). Rupnik and Krisper (2004) emphasise that the key challenge in the mobile applications context and the likelihood of running a mobile application by user’s demands the development of information support contributed by information systems.

An appropriate mobile payments system is also a challenging factor in the growth of mobile commerce (Herzberg, 2003; Van der Heijden, 2004) because in the field of financial mobile applications, such as mobile banking, mobile payments, and mobile e-salary, mobile devices operate as a powerful medium (Mohsin et al., 2003). Hence, it is very important to design mobile applications carefully to meet the requirements of the potential users (Stanoevska-Slabeva, 2003).

### 2.6.4 Concerns Related to Mobile Consumers

Consumer concerns add another layer of complexity to the issues in m-commerce (Tarasewich et al., 2002; Vrechopoulos et al., 2003). Examining these concerns involves determining their different aspects: connectivity is one dimension that must be taken into consideration (Liang & Wei, 2004). The concerns that revolve around connectivity include security, reliability, cost, and download time (Coursaris et al., 2003; Horn & Preneel, 2000; Siau & Shen, 2003).

The personal information exchanged over a wireless network raises consumer concerns about misuse of their personal data, especially for those services such as mobile banking, mobile payments, and emailing (Badamas, 2001; Ghosh & Swaminatha, 2001). The quality of wireless connections is also important in relation to transferring data through mobile devices, as data can be lost as a result of terminal malfunctions (Badamas, 2001). Gillick and Vanderhof (2000) identify the loss of the connection as being as important as the loss of data, such as essential data used in financial transactions. Mobile users must be assured that their financial information is secure and that transactions are safe. Tarasewich et al. (2002) argue that the cost of
connecting to the network and the speed of downloading are also major issues for consumers adopting wireless services.

With the characteristic of ubiquity, mobile devices allow consumers to be reached at any location at any time (Liang & Wei, 2004). At the same time, they put consumers at risk of SMS spam, delivered by unauthorised parties like advertisers (Bauer et al., 2005; Coursaris & Hassanein, 2002). Location-based services that target consumers based on their geo-location could irritate consumers, as those services deliver without regard for permission (Tsang et al., 2004). Coursaris and Hassanein (2002) identify that information should be suitable regarding the needs and environment of the consumers. Moreover, with the benefits given by GPS technology, Minch (2004) suggests that privacy concerns are also raised because of such ability. Such fears are of the locations of consumers being tracked as well as the monitoring of consumer Internet-browsing behaviour, which could lead to a ‘Big Brother’ society (Margulis, 2003).

2.7 Mobile Payments Overview

The strong growth of wireless transformation and the escalation of mobile commerce provide great evidence that mobile devices are becoming a vital element of the digitalised world (Kreyer, Pousttchi, & Turowski, 2003; Ondrus, Bui & Pigneur, 2005). The high penetration rate of mobile device use has had a positive impact on the promotion of mobile commerce applications (Rupp & Smith, 2002). The spectrum of mobile phones bodes well for the future of mobile commerce (Wu & Wang, 2003).

Mobile payment is defined by Pousttchi (2004, p260) as “the type of payment transaction processing in the course of which the payer employs mobile communication techniques in conjunction with mobile devices for initiation, authorisation or realisation of payment”. Moreover, the Mobile Payment Forum (MPF) has given the following definition for mobile payments (MPF, 2002), “A mobile payment is the transfer of an electronic means of payment from the payer to the payee through the use of an electronic payment instrument, which is a mobile
New wireless and mobile technologies offer various mobile applications (Kreyer, Pousttchi, & Turowski, 2002). The business applications of mobile payment include parking tickets, vending machines, points of sale and digital content. Numerous different industry sectors have become interested in mobile payments (Baek, 2003; Pousttchi, 2004; Vilmos & Karnouskos, 2003). Mobile payment can be implemented via different solutions, such as premium SMS, infrared and so on (Chen & Adams, 2004b). These solutions claim to offer easier, faster and more secure methods than do competing solutions, though this is arguable (Ding & Unnithan, 2002).

The SMS is part of the GSM service: it allows mobile devices to send and receive short messages (Ondrus et al., 2005). SMS is one of the most popular services used by mobile phone users. Moreover, SMS can deliver different types of application, such as ring tones, logos, and voicemail notification. SMS has the potential to be used to implement mobile payment services (Dahlberg & Mallat, 2002).

On the other hand, WAP allows mobile device users to connect to the Internet via a mobile network. WAP is an open standard developed by the WAP forum (Mallat et al., 2001). It can deliver a range of services to users, for example, e-mail. The abilities of WAP have enabled the development of advanced services and applications, including mobile commerce (Dahlberg & Mallat, 2002). However, there are some limitations to the use of WAP, such as limited speed and premier service charges by a MNO. Recently, however, widespread use of the General Packet Radio Service (GPRS) has increased WAP usage. Thus, WAP offers a platform to implement mobile payment services (Krueger, 2002).

Mobile payments system represents another opportunity for the mobile industry and for financial service companies and, perhaps in the near future, will be a service that users will demand (Baek, 2003; Sue & Wu, 2005; Wu & Wang, 2003). Most mobile devices have an inserted chip that can be independently employed to provide secure authorisation and identification without the use of a modem, card reader, or even personal computer (Ding & Hampe, 2003). As a result, many scholars have predicted...
that mobile devices could take the place of any means of payment (Kreyer et al., 2003; Pousttchi, 2004; Sue & Wu, 2005; Wu & Wang, 2003).

Some factors support the mobile payments development and diffusion of mobile payments. First, financial institutions could save costs in different ways by offering mobile payments: for example, they would not need to issue plastic cards with chips. Second, mobile network operators could attract more people to sign up for their services. Third, mobile payment services offer more flexibility and freedom for consumers. However, mobile payment services are not currently popular globally. The mobile payments market is still immature. A number of reasons underlie these problems. For example, there is still no standard for mobile payments systems. Service providers are attempting to use different infrastructures and technologies to implement the service. However, a convergent service would be best for consumers, each having the same access to the network in order to utilise the service.

2.8 Mobile Payments Scenarios

Pousttchi (2004) proposes that mobile payments can be used to make purchases in different scenarios. They can be used in point-of-sale transactions and mobile commerce (Tarasewich, 2003a). They can also be used to purchase digital services and digital content in an e-commerce scenario and physical goods in a stationary merchant scenario (Kreyer et al., 2003). With the variety offered by mobile payments, consumers can obtain more convenience and flexible payment services (Ondrus & Pigneur, 2006).

MNOs form one of three categories of potential mobile payments service providers, in addition to financial institutions and a specialised intermediary (Pousttchi, 2004). Payments for digital content or services depend on the duration of the service or types of items to be delivered. For example, mobile gaming is one of the popular services available for consumers. In this case, MNOs normally act as mobile payment service providers to conduct the process (Ondrus & Pigneur, 2005).
In payment for e-commerce services, Lukkari, Korhonen, and Ojala (2004) note that mobile devices can be used to authorise payments instead of credit cards, debit cards or other electronic payment methods. This scenario can be implemented using SMS or dual slot phones (Aalto et al., 2004). Dual slot phones comprise two card slots, one for MNOs, while the other is for payment details. However, Lukkari et al. (2004) propose that this solution has significant drawbacks. Mobile subscribers have to purchase dual slots phones. These phones would be more expensive than other handsets and the size of the phones would be increased as well. This is not a good solution, either for consumers or for mobile payment service providers (Dahlberg & Mallat, 2002).

Compared with the above payment scenarios, point of sale/proximity payments will be vital for mobile payments service (Chen & Adams, 2005a; Pousttchi, 2004). This is because this scenario will be vital for the development and growth of mobile payments at a later stage (Chen & Adams, 2005a). Mobile payments can be used to pay for goods or services at retail shops, for transport tickets, taxis or parking, matters involved in people’s daily lives. This scenario would be operated differently from the above two scenarios (Kreyer et al., 2003): it could be implemented using short-range wireless technologies, such as Bluetooth, Infrared and so on. Moreover, using wireless technologies could reduce the operation cost for all parties (Plouffe, Hulland, & Vandenbosch, 2001). This issue will be discussed in the next section.

The next section presents the characteristics of mobile payments, and is followed by a discussion of the potential players in mobile payment systems.

2.9 Characteristics of Mobile Payments

In the study of Ondrus et al. (2005), mobile payments are classified into several categories as follows:

Content type
In theory, mobile payments can pay for digital goods (e.g. music), physical goods (e.g. computers), ticketing (buses), and services (e.g. dental treatment). It can offer
different use cases for consumers. These services could attract users easily because of the convenience provided by mobile payments (Ding & Hampe, 2003).

**Transaction value**

The industry has defined two types of content value, micro-payment and macro-payment: micro-payment refers to transaction values of less than 10 Euros (Kreyer et al., 2003). This differentiation of the two types is suitable for determinations of consumer acceptance (Pousttchi, 2004) and it allows better implementation of services and provides easy-to-use applications (Pousttchi, 2004). However, Ondrus et al. (2005) argue that a mobile payment solution should be able to support both macro-payment and micro-payment.

Ondrus and Pigneur (2006) note that micro-payment is a good payment solution for some payment situations because credit cards are not employed for small transaction costs: only cash or debit cards are used. On the other hand, macro-payment (higher than 10 euro) builds more revenues (Kreyer et al., 2003), since the bigger transaction fee for credit card use can usually be abandoned (Ondrus & Pigneur, 2006).

Mobile payments can be implemented using two levels of security (Pousttchi, 2004). For micro-payment, the purchase is easy, quick and has a low necessity for security, whereas because macro-payment involves more risk than micro-payment, a stronger security mechanism therefore has to be implemented (Ondrus et al., 2005).

**Payment methods**

Ondrus et al. (2005) identify that mobile payment users have the flexibility to select how they pay for items. They can select among debit-card accounts, credit-card accounts, bank accounts and mobile-phone billing accounts. Users have the benefit of choosing different accounts depending on what they purchase.

**Transaction channels**

Mobile payments can be implemented using different technologies, such as WAP, SMS, dual slot handsets (smart card enabled) and short-range wireless technologies (Ondrus & Pigneur, 2006). Different technology options offer a wide range of business cases for mobile payments (Pousttchi, 2004). Kreyer et al. (2003) suggest
that mobile payments can implement more than one technology in their systems. For example, a consumer might buy a ring tone and pay for it through SMS. On the other hand, when using mobile devices as bus tickets, Near Field Communications (NFC) can be deployed.

2.10 Potential Players in Mobile Payments

The payment process is a highly complex system (Ondrus & Pigneur, 2005) and involves different parties. Consumers are, of course, one of the participants in the mobile payment process (Kreyer et al., 2002). Pousttchi (2004) proposes that mobile payment acceptance by consumers and merchants is the main barrier to enlarged usage and acceptance. Consumers tend to use this application to pay for digital or physical services or goods, in either a digital or a physical context, if there are a large number of merchants accepting the system (Sue & Wu, 2005).

Kreyer et al. (2002) note that retailers act in the same way as in traditional payment methods. They can forward the payment request to the payment service provider. The payment service provider is responsible for payment processes via mobile devices (Ding & Unnithan, 2002). This is a critical component of mobile payment systems: thus, many organisations, such as MNOs, financial institutions, and even independent payment vendors, attempt to act as payment service providers (Kreyer et al., 2002; Pousttchi, 2004).

Finally, a trusted third party is required for mobile payments to conduct the authentication of payments and transactions (Pousttchi, 2004). Kreyer et al. (2002) point out that the party that obtains the consumer data is vital. Ondrus and Pigneur (2006) suggest that MNOs and financial institutions can play this role. The mobile payment process could be viewed as similar to credit-card transaction processes, which also involve different players in the transaction process (Pousttchi, 2004). However, in mobile payments, there are too many potential players attempting to dominate the market using different standards and business models (Kreyer et al., 2002; Pousttchi, 2004). Therefore, Ondrus and Pigneur (2006) indicate that there is
still a long way to go before a universal mobile payment system for consumers is identified.

Mobile payment systems offer challenging opportunities for MNOs. The role of an MNO in mobile payments can vary from simple and passive to very active in the application. An MNO could simply offer mobile payment service providers access to their customers. In additional to this, an MNO could have a more important role, acting as a mobile payments service provider and offering the services to their customers directly.

Clearly, MNOs have established a sophisticated billing system, and already have large customer bases (Ondrus & Pigneur, 2006). If operators implement this service, the cost can simply be added onto the customers’ phone bills. Some operators have already benefited from selling content over these networks (Kreyer et al., 2003). For example, the Japanese network operator NTT DoCoMo has been very successful in selling content to its subscribers (Lee & Benbasat, 2004; Macdonald, 2003). As there is a high level of competition in core business of mobile operators, they have to identify new ways to add value to their business (Dahlberg & Mallat, 2002). Mobile payments are among the potential services that could enhance business growth for MNOs (Aalto et al., 2004).

MNOs have faced major competition from financial institutions such as banks (Poussstchi, 2004). However, MNOs can be involved in this business in different ways. They can operate as service providers and supply mobile payment systems (Aalto et al., 2004). Alternatively, MNOs can work closely with financial institutions to provide supporting services (Ondrus & Pigneur, 2006). MNOs are anxious to expand their business activities in order to increase their revenue streams (Lee & Benbasat, 2004; Sanz, 2003). The study of Poussstchi (2004) clarifies that European legislation does not clearly classify the role of mobile network operators in financial services in terms of whether they can act as banks and perform all banking functions. Furthermore, compared with financial institutions, operators need to gain more knowledge and experience of risk management (Kreyer et al., 2003). Therefore, competition with the financial institutions will be unavoidable. Poussstchi (2004) note that financial institutions such as banks have already established sophisticated banking and payment
infrastructure; moreover, they have rigorous credit systems in place. These facilities will make it easier for financial institutions to implement mobile payments (Dahlberg & Mallat, 2002). However, as mobile devices are the channels for the delivery of this service, financial institutions cannot work alone in this arena (Pousttchi, 2004). Depending on the business models that financial institutions implement, they would have to cooperate with MNOs or mobile handset manufactures (Kreyer et al., 2003).

Wu and Wang (2003) put forward the view that it is essential to understand and explore consumer acceptance of mobile payments. This aspect will affect the design and use of this payment method (Ondrus et al., 2005). Lukkari et al. (2004) note that new technologies will allow more sophisticated applications to be used in mobile payments. Business models for mobile payments are still not clear (Varshney, 2003); and the industry has not yet produced a best option for mobile payments. However, some consortiums have been set up to discuss the technologies and infrastructure solutions for mobile payments (Tsang et al., 2004).

### 2.11 Mobile Payments Standards

A wide range of technologies are available for developing mobile payment applications, such as SMS, Bluetooth and Infrared (Kempster, 2003; Krueger, 2002). However, this variety creates an issue for developers (Pousttchi, 2004). The question of the best technology for mobile payments is not easily answered and so far no answer has been provided (Ondrus & Pigneur, 2005). In the long term, service providers have to consider solutions that can interact with other solutions, so that a single “universal” network can be built (Henkel & Zimmermann, 2001). Both service providers and consumers will benefit from this approach (Ding & Hampe, 2003).

On the other hand, different consortiums have been established, such as Mobile Electronic Transactions (MET), the Mobile Payment Forum (MPF), Simpay, and PayCircle (Ondrus & Pigneur, 2005). These consortiums are working toward establishing an industry standard and implementing the application (CTT, 2002; Herzberg, 2003). However, Ding and Unnithan (2002) propose that these consortiums have different perspectives, views and directions for mobile payments because
different organisations are involved in different aspects of the service. For example, MET aims to implement friendly, secure and interoperable payment services using mobile devices (MET, 2005; Ondrus & Pigneur, 2005). The majority of its members are mobile handset manufacturers (ePaynews, 2002; MET, 2005), which indicates that the group is more focused on the technical solutions in terms of how mobile payments can be integrated with mobile devices (Ondrus & Pigneur, 2006). Moreover, MET focus on proximity transactions using NFC technology (MET, 2005).

In contrast, MPF was founded by mobile network operators and financial institutions, which have a different approach to MET (ePaynews, 2002; MPF, 2006). MPF intends to address the trusted relationships issue in mobile payments, and develop and implement a framework that enables interoperable and global mobile payments to become available to the general public (MPF, 2006). Thus, it can be seen that the mobile payments market is very competitive (Pousttchi, 2004).

The infrastructure and the players involved in mobile payments are still very complex (Anckar & D’Incau, 2002). Many organisations could potentially be involved in this system, such as MNOs, financial institutions, and independent service providers (Dahlberg & Mallat, 2002). Krueger (2002) notes that these organisations can work either together or individually to implement such services. However, due to conflicts of interest between different players, the situation will take some time to sort out (Krueger, 2002).

2.12 Wireless Technologies Overview and Related Work

Wireless technologies seem destined to make a large and continuing impact on our lives (Barnes, 2002a; Brewin, 2000; Coursaris et al., 2003). The development and convergence of wireless technologies has provided opportunities for related applications (Deng et al., 2003). The potential of these technologies in the commercial market is huge (Gao et al., 2004).

This section will examine the potential of short-range wireless technologies for mobile payments systems. It will identify the opportunities and issues for mobile
payments using short-range wireless technologies (CTT, 2003). Finally, the future development of mobile payments using short-range wireless technologies will be discussed.

Selecting suitable wireless technologies to implement mobile payment systems will be one of the important factors in developing a system (Coursaris et al., 2003; Deng et al., 2003). The following section will describe a range of technologies that may be applicable to mobile payment systems.

Mobile devices, computers, and related electronic devices have become important parts of our digital life (Barnes, 2002b). Gera and Chen (2003) note that wireless data transfer is highly preferred for personal and business purposes: it offers users flexibility and convenience (Venkatesh et al., 2003). To meet the demand, various wireless technologies have been developed (Gera & Chen, 2003).

As background knowledge, the following section examines and summarises the possible short-range wireless technologies for mobile payments applications and for exploring the main characteristics of these technologies.

### 2.12.1 Bluetooth

Srisjanthan, Tan and Karande (2002) note that Bluetooth research began in 1994, and the Bluetooth standard was developed by the Special Interest Group (SIG). Salonidis et al. (2001) put forward the view that the members of this group are the leading players in the computing and telecommunications industries: they are driving this technology forward to the market (Bay, 2002). Bluetooth operates at the 2.4 GHz industrial, scientific and medical (ISM) frequency band (Darabi et al., 2001). This band is unlicensed and is available worldwide (Bray & Sturman, 2002).

Basagni and Petrioli (2002) propose that Bluetooth provides the opportunity for *ad hoc* connections between wide ranges of personal electronic devices such as mobile phones and laptops. It has also been implemented in home automation systems (Sriskanthan et al., 2002). Bluetooth operates at a short distance — up to 10 metres.
By increasing the transmission power to 100 mW, the range can theoretically be extended to 100 metres (Bray & Sturman, 2002).

Bluetooth could be implemented in mobile payment systems: the low power consumption of Bluetooth is one of its strengths (Bray & Sturman, 2002). Furthermore, as the semiconductor industry has managed to produce Bluetooth chips at low prices, by 2005 there may be as many as 700–1200 million Bluetooth devices in the worldwide market (Jason, 2003). The decrease in price has provided a unique opportunity for Bluetooth devices to penetrate and be accepted in the market (Leopold et al., 2003). It has also created a unique market position for mobile payments (Toye et al., 2005). Moreover, Bluetooth uses the Frequency Hopping Spread Spectrum (FHSS) method to avoid interference (Toye et al., 2005), which would help payment systems to provide a reliable service (Marson et al., 2002).

In 2001, Ericsson cooperated with Eurocard AB in Sweden to test a Bluetooth-based mobile payments system. Bluetooth-enabled mobile phones were equipped with a virtual “Eurocard”, and consumers used their phones at a terminal as they passed through the retail checkout (Ericsson, 2001).

On the other hand, Bluetooth security is a major concern for wireless applications (Potter, 2003a; Jakobsson & Wetzel, 2001), and it is relatively difficult to configure (Vaxevanakis, Zahariadis, & Vogiatzis, 2003).

2.12.2 Infrared Data Association (IrDA)

Infrared technology uses infrared light to set up a wireless communication channel (Chen & Adams, 2004b). To standardise infrared communication, the IrDA was established in 1993 (IrDA, 2004). IrDA is one of most mature and established players for cable replacement applications (Malladi & Agrawal, 2002). This point-to-point method of communication between devices has been widely used (IrDA, 2004). Many electronic appliances, such as electronic-device remote controls, PDAs and laptops, use infrared (IrDA, 2004). It offers high throughputs of 1.152 Mb/S, 4.0 Mb/s and 16 Mb/S respectively (Val, Peyrard, & Mission, 2003).
Val et al. (2003) identified infrared as another competitive player for mobile payments systems for two reasons. First, infrared provides low power consumption (Val et al., 2003), and battery life is a critical design factor for mobile devices (Sun & Sauvola, 2005). Second, infrared is already well known in the industry (Malladi & Agrawal, 2002): around 100 million infrared devices have been installed (IrDA, 2004). Clearly, it provides a new mechanism to implement mobile payments systems (Malladi & Agrawal, 2002). Moreover, infrared is relatively easy to use and configure (Sun & Sauvola, 2005; Val et al., 2003).

On the other hand, infrared has limitations, since it cannot penetrate objects such as walls (McAlister & Xie, 2005). Infrared devices have to operate in line-of-sight and at short range in order to set up communication channels (Bray & Sturman, 2002).

In South Korea, Harex InfoTech provides a mobile payment system called “ZOOP”. It combines mobile devices and wireless technology to create a mobile wallet that allows consumers to make payments via IrDA mobile devices (Zoop, 2002).

2.12.3 Radio Frequency Identification (RFID)

RFID has been around since the Second World War (Land, 2001). RFID is a technology that uses electromagnetic fields that are coupled with the radio frequency (Lowry, 2003). The basic RFID system has three components: an antenna, a transceiver, and a Radio Frequency (RF) (Lewis, 2004). The antenna is the “bridge” between the Tag and the Transceiver. RFID works at different frequency ranges, including 125 KHz, 13.56 MHz, 2.45 GHz and 5.8 GHz, and 860–950 MHz (Morgenroth & Hales, 2004). It also offers read ranges from a few centimetres to 5 metres, depending on the frequency of the devices (Hori & Matsumoto, 2004).

RFID is one of the potential players for mobile payment systems (Hori & Matsumoto, 2004). Nokia and MasterCard have tested mobile payments based on RFID in the U.S. (Paypass, 2003). RFID is suitable for mobile payment systems because it requires no contact and also no line-of-sight conditions (Zhu, Wang, & Sheng, 2005). RFID is automated, ready and easy to use (Lowry, 2003; Morgenroth & Hales, 2004). Zhu et al. (2005) propose that if RFID is deployed in mobile payment systems, the systems
will be simple for consumers to operate. Moreover, RFID can operate under a variety of conditions such as ice, fog, and so on (Lowry, 2003). In addition, it also provides high-speed reading and writing of data (Ryosan et al., 2005). The demand for RFID is growing (Morgenroth & Hales, 2004), which contributes to RFID becoming more popular in the market (Zhu et al., 2005). Lowry (2003) notes that this popularity provides a platform for RFID to implement mobile payment systems.

Nokia and MasterCard launched a trial of mobile payments in the U.S. in 2003 (Zhu et al., 2005). The cover of the Nokia handset contains an embedded RFID chip, which contains MasterCard payment account information (Hori & Matsutomo, 2004). When consumers wave their handsets at the RFID-enabled point of sale, payments are transmitted to the terminal (Paypass, 2003). This service offers the convenience of using mobile phones as wallets for consumers (Hori & Matsutomo, 2004).

However, there are some concerns about using RFID in payments applications (Ichinose, 2004): privacy is the key issue (McGinity, 2004), with privacy advocates worried about the loss of personal information during payment transactions (Lewis, 2004). The cost of the chip set is another issue for RFID, and some companies and vendors believe that RFID is still expensive (McGinity, 2004).

2.12.4 Near Field Communications (NFC)

NFC is an open global infrastructure for easy access to wireless services and data anywhere and at any time (Karnouskos et al., 2004). Through very short-range wireless technology, NFC provides more secure and easy communication between various devices with no need for user configuration (Karnouskos et al., 2004). Valcourt, Robert, and Beaulieu (2005) note that NFC offers a convenient connection for all types of electronic devices. A built-in security mechanism makes it ideal for payment/financial applications (Philips, 2004).

NFC works in the 13.56 MHz frequency band (Zmijewska, 2005). It can provide a 3 to 30 cm working range and is compatible with RFID technology (Chhor, 2003). NFC offers a less costly solution for the implementation of wireless products. It supports file transfer and data transfer (Sony, 2003).
Zmijewska (2005) notes that NFC can be implemented in mobile payments systems as well as RFID for three reasons. First, it provides very low power consumption (Philips, 2004; Karnouskos et al., 2004). Second, it offers an excellent security mechanism for applications (Mallat, 2004). Finally, the NFC device is easy to use and connections are easy to establish (Walko, 2005; Zmijewska, 2005). NFC thus enables rapid and easy communications, and is an ideal solution for controlling data environments such as mobile payment systems (Chhor, 2003).

In January 2004, Philips and VISA presented an NFC-based mobile payments application (Visa, 2004). Mobile phones can be used to pay for items simply by holding the phone next to the terminal, while the NFC chip in the phone transfers the payment details to the terminal (Me & Schuster, 2005). It also deploys an authentication service based on standard 3D security to provide a secure service for consumers (Visa, 2004).

NFC has limitations, however (Chhor, 2003; Zmijewska, 2005). It only works at very short distances (Chhor, 2003), which limits its applications and is the main drawback to the implementation of an NFC-based mobile payments system.

2.13 Summary of Possible Short-range Wireless Technologies for Mobile Payment Applications

It has been mentioned above that short-range technologies are competitive (Gao et al., 2004) and they are potential players in the mobile payments industry (Deng et al., 2003). Malladi and Agrawal (2002) suggest that some technologies have already been implemented in payment systems which are up and running; one example is IrDA in ZOOP (Chen & Adams, 2004b). It is intended that the others, including NFC, are implemented in this industry as soon as possible (Walko, 2005).

The following Table 1 summarizes the main characteristics and specifications of the above-mentioned short-range wireless technologies. These characteristics are relevant to mobile payment systems.
Clearly, it would be possible to incorporate many short-range wireless technologies into the exciting arena of mobile payment applications (Barnes, 2002a). Therefore, this is a highly competitive area, and the applications may require the convergence of wireless technologies (Porcino & Hirt, 2003). Abramowitz (2004) points out that there are several factors to consider in choosing a suitable wireless technology. The standard is one of the most important factors, particularly in terms of whether it has a profile that supports mobile payment transactions (Abramowitz, 2004). For example, the IrDA has defined a special profile for mobile payment applications – Infrared Financial Messaging (IrFM) – in order to penetrate and secure the mobile payments market. This profile aims to cut transaction costs and provide a simpler and more secure environment for mobile payments (IrFM, 2003).

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<tbody>
<tr>
<td>Infrared</td>
<td>IrDA</td>
<td>1.152 kbps – 4 Mbps</td>
<td>1 – 5 metres</td>
<td>(Infrared light)</td>
<td>$2</td>
<td>Very low</td>
<td>Agilent, Microsoft, Motorola and Sony Ericsson Mobile</td>
<td>Data exchange, devices remote control, payment systems.</td>
</tr>
<tr>
<td>Bluetooth</td>
<td>IEEE 802.15.1</td>
<td>720 Kbps – 1 Mbps</td>
<td>10-100 metres</td>
<td>2.45 GHz</td>
<td>$5</td>
<td>Low</td>
<td>Ericsson, IBM, Intel, Nokia Toshiba</td>
<td>Data exchange, electronic devices remote control, payment systems.</td>
</tr>
<tr>
<td>RFID</td>
<td>ISO/IEC 14443</td>
<td>4-128 Kbps</td>
<td>10 feet</td>
<td>120-140 KHz</td>
<td>$3-$10</td>
<td>Very low</td>
<td>Honeywell, Texas and Philips</td>
<td>Access control inventory control</td>
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<tr>
<td>RFID</td>
<td>10 feet</td>
<td>13.56 MHz</td>
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<td>$0.5 - $5</td>
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<td>Access control Smart cards</td>
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<tr>
<td>RFID</td>
<td>40 feet</td>
<td>869-956 MHz</td>
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<td>$0.75</td>
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<td>Railroad car monitoring, Toll collection systems</td>
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<tr>
<td>NFC</td>
<td>ECMA 340, ISO/IEC 18092</td>
<td>424 Kbps</td>
<td>Up to 20 cm</td>
<td>12.56 MHz</td>
<td>20 cents</td>
<td>Very low</td>
<td>Philips &amp; Sony</td>
<td>Data exchange, contact less smart card</td>
</tr>
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Table 1 Main Characteristics of Wireless Technologies

The frequency spectrum is another important factor, particularly in terms of whether it is unlicensed (Rappaport et al., 2002). Slijepcevic et al. (2002) note that some wireless technologies operate in a license-free band. Bluetooth, which uses the 2.45 GHz ISM band, is an example (Valcourt et al., 2005). Rappaport et al. (2002) view that this
feature is attractive for both manufactures and service providers because they do not need to pay a license fee for using this frequency band.

Toh (2001) claims that battery life is a critical design factor for mobile devices. Consumers do not expect to charge their mobile devices more often because of using mobile payments (Papadopouli & Schulzrinne, 2001). Kreyer et al. (2002) argue that wireless data transmission range and throughput must also be taken into consideration. The decision about which technology is the most appropriate for mobile payments depends on the type and size of the system and application (Valcourt et al., 2005). Zmijewska (2005) suggests that some applications may not require long-range communication: for example, Philips and VISA presented an NFC-based mobile payment application designed for use in local public transpiration. Mobile phones can be used to pay for items simply by holding the phone next to the terminal (Chen & Adams, 2004b) and only require very short distance data handling (Zmijewska, 2005).

Cost is one decisive factor for a new wireless technology when it comes to penetrating and dominating the market (Plouffe et al., 2001). For instance, in the mobile communication market, GSM is the current dominant standard in the European wireless market (Cingular, 2004). There are more than 1.2 billion mobile subscribers worldwide (EMC, 2003). Mobile phone usage has increased dramatically in the past few years (Lee & Benbasat, 2004; Varshney & Vetter, 2001). Due to reduced hardware costs, mobile handsets are becoming increasingly cheaper compared to first generation phones (Plouffe et al., 2001). Bhagwat (2001) speculates that Bluetooth has reduced the chip-set cost dramatically because of improvements in productivity, which has helped Bluetooth to easily penetrate the mobile payments market.

The key players in different wireless technologies have an important role to play in the development of mobile payment systems (Sun & Sauvola, 2005), because they are influential companies in the computer and communication industries (Anckar & D’Incau, 2002). Dahlberg and Mallat (2002) and Krueger (2002) note that it is likely that they will select the most profitable technology for mobile payment applications.
2.14 Issues for Short-range Wireless Technologies

A number of issues have arisen during the development of mobile payments (Dahlberg et al., 2003; Ding & Unnithan, 2002). Pousttchi (2004) note that one of the challenges to be faced by the operators of mobile payments systems is how to handle the conflicting interests of the varied and powerful parties involved. Another is how to construct a standard and interoperable payment model (Varshney & Vetter, 2000). These factors will affect the confidence of users in the mobile payment concept (MPF, 2002).

Short-range wireless technologies provide an enormous opportunity for implementing mobile payment systems (Cingular, 2004). However, some new technologies are not yet sufficiently mature for implementing mobile payment systems, and it takes times for commercial markets to accept new technologies (Paulson, 2000). Clearly, there are some key issues that need to be addressed before system implementation (Varshney & Vetter, 2000). These issues include interoperability (Varshney, 2002), security (Ding & Hampe, 2003), reliability (Corbitt & Han, 2003) and availability (Sirdeshmukh, Singh, & Sabol, 2002).

Gera and Chen (2003) believe that various companies are producing their own electronic products that are embedded with wireless technologies: however, interoperability is an issue with these electronic products (Varshney, 2002). For instance, different IrDA electronic devices may not communicate with each other because they are manufactured by different companies (Val et al., 2003). Darabi et al. (2001) claim that this issue also arose with Bluetooth devices in the early stage of development. It is important that devices are compatible with each other, even though they are produced by different manufacturers (Chakravarty & Dubinsky, 2005). Some technologies have their own standardisations (Ding & Hampe, 2003). The industry has already realised the existence of this issue (Ding & Unnithan, 2002; Ondrus et al., 2005). Moreover, Schwarz et al. (2004) state that the industry has set up special task groups in order to test the compatibility of the products. For example, Bluetooth SIG has provided guidelines and a platform for members to test the interoperability of Bluetooth products (Bluetooth, 2004).
Not surprisingly, security is a major issue for wireless technology (Horn & Preneel, 2000; Potter, 2003b; Rubin, 2003). Moreover, wireless network security is very different from wired security (Schmidt & Townsend, 2003): for example, the security architecture of some wireless technologies does not define threat models using a standard body (Arbaugh, 2003). This issue has to be resolved before the system is developed (Deng et al., 2003). For instance, some researchers and industry players have discovered security loopholes in Bluetooth devices (e.g. Dogac & Tumer, 2002; Laurie, 2004; Seo et al., 2002).

However, the vulnerabilities of Bluetooth are due to system implementation mistakes and software errors (Jacobsson & Wetzel, 2001). It is likely that attackers will exploit these weaknesses in the Bluetooth protocol in the near future (Potter, 2004). Security is a very sensitive topic for the payments industry (Dahlberg et al., 2003), which is reluctant to accept new technologies and applications (Chou, Lee & Chung, 2004). As a result, these technologies need improved security protocols (Potter, 2004). Typically, it is necessary to focus on the financial transaction environment (Pousttchi, 2003; Wu & Hisa, 2004), and to this end, IrDA has developed a special profile, IrFM, for mobile payment applications (IrFM, 2003).

Finally, reliability and availability are key factors of wireless network performance (Corbitt & Han, 2003; Sirdeshmukh et al., 2002). These factors have been proven to be very important in wireless application development (Snow, Varsheny, & Malloy, 2000). In a mobile payments system, an application has to perform a set of functions under certain conditions and at any given moment (Okazaki, 2005b), as they are vital for any payment transaction application (Chou et al., 2004).

### 2.15 Issues of Mobile Payments Acceptance

The issues of user acceptance of the mobile payment context have been discussed extensively in the literature (e.g. Chou et al., 2004; Kreyer et al., 2002; Pousttchi, 2003). Kreyer et al. (2002) and Pousttchi (2003) categorise the relevant issues concerning mobile payment into three factors: cost, security, and convenience. Dahlberg and Mallat (2002) focus on the concerns related to security and pricing in
order to drive consumers to adopt new payment solutions. However, Dahlberg et al. (2003) consider that there are still other issues concerning the development of mobile payment such as technical issues, marketing issues, and actor issues. Some issues concerning mobile payment are discussed in the next sections.

2.15.1 Cost

Cost is a crucial concern in the establishment of successful mobile payment (Ding & Hampe, 2003) and has been addressed by many scholars (e.g. Ding & Hampe, 2003; Kreyer et al., 2002; Ondrus, 2005). This principle can be applied to any new service (Chen & Hutt, 2002; Plouffe et al., 2001). The acceptance of mobile payment relies directly on those users who are willing to pay the extra cost (Chou et al., 2004), which can be very off-putting (Ondrus & Pigneur, 2005). Undoubtedly, without effective value-added services, it is not easy to convince consumers to pay extra costs (Ondrus et al., 2005). These costs include fixed costs and transaction costs together with the cost of the technical infrastructure for the customer (Kreyer et al., 2002; Pousttchi, 2004).

2.15.2 Security

The study of Ding and Unnithan (2002) highlights that lack of security is the most important obstacle to the growth of mobile payments. Dahlberg and Mallat (2002) propose that this security demands user-specific PIN numbers, secured network traffic and payment transaction certificates (Horn & Preneel, 2000). However, the high standard of secure payment argued by Ding and Hampe (2003) includes encryption, data integrity, authentication and confidentiality. Moreover, security includes not only the features mentioned above, but also the issue of subjective security from the consumer’s viewpoint (Pousttchi, 2003). The study of Pousttchi (2004) put forward that data confidentiality is proved to be the central security feature of every mobile payment procedure, including confirmation of payment either through e-mail or SMS, the possibility of cancellation and of anonymity. Anonymity, as noted by Chou et al. (2004), is a primary right of consumers because consumers’ identity should not be disclosed to third parties unless consumers are willing to grant that privilege.
2.15.3 Convenience

Convenience and ease of use are crucial to stimulating the adoption of a new technology (Ondrus & Pigneur, 2005). It is clear that consumers prefer something that is easily used and not complex (Ding & Hampe, 2003). Pousttchi (2004) indicates that consumers may be unwilling to accept the service due to its complexity. The convenience issues also include any other issues in conjunction with ease and comfort of use (Kreyer et al., 2002). Pousttchi (2003) proposes easy handling and fast processing to be the significant criteria, while the ability to make payments abroad and no requirement for pre-registration are shown to be of least interest to consumers. In terms of ease of use, Dahlberg and Mallat (2002) refer to mobile devices as trusted personal devices. Venkatesh et al. (2003) focus on understanding the stages of the life-cycle of adoption that may affect perceived usability.

2.15.4 Standardisation

Many scholars (Ding & Hampe, 2003; Ding & Unnithan, 2002; Ondrus et al., 2005) propose that the lack of a common standard presents obvious problems in developing mobile payment. The lack of a consistent platform for the future would possibly cause delay in market growth (Costello, 2002). Furthermore, consumers are confused as a result of the various solutions offered (Kreyer et al., 2002). Ding and Unnithan (2002) note that a standard interface is important because commonality of experience and ease of use are keys to drive the acceptance of new technology. Without standardisation, Henkel and Zimmermann (2001) argue that the adoption of mobile payment and the growth of mobile commerce may possibly slow down. The solution to promote mobile payment is to provide a universal way to pay (Ondrus & Pigneur, 2005). Therefore, the practicability to pay anyone together with providing ubiquity of services requires universality and standardisation (Ding & Hampe, 2003; Ondrus et al., 2005).

Having mentioned the four main obstacles to the growth of mobile payments, in brief, we can conclude that from the point of view of consumers, cost is one of the major concerns determining the use of mobile payment (Chen & Hitt, 2002; Ondrus et al., 2005; Shneiderman, 2000). It is likely that cost will be one of factors potentially
influencing the decisions of consumers regarding mobile payments usage (Chou et al., 2004).

Second, security is another concern for consumers regarding the use of mobile payments (Ghosh & Swaminatha, 2001; Moores & Dhillon, 2003), especially in financial transactions, because the payment method employs a non face-to-face payment transaction (Pousttchi, 2003). Consumers might not feel safe, as they cannot physically view and examine the actual transactions (Wu & Hisa, 2004).

Furthermore, in the case of mobile payment services, the limitations of the device used have undoubted impacts on perceived ease of use and convenience (Pousttchi, 2003). Mobile payment procedures need to take into account the needs of users, so they should be easy to handle, and easy to use and process (Henkel & Zimmermann, 2001).

Finally, the lack of standards is one of the major problems with mobile payments (Ding & Unnithan, 2002), which could slow down mobile payment adoption together with the spread of the mobile commerce market (Henkel & Zimmermann, 2001).

2.16 Trust

Trust plays a critical role in motivating consumers to make a purchase over the Internet (Ba & Pavlou, 2002; Friedman et al., 2000; Teltzrow et al., 2003). Unlike in the electronic market, the retailers use the Internet to reach consumers around the world. Quelch and Klein (1996) point out how the Internet offers consumers a worldwide range of products and services.

Having noted that mobile commerce shares some characteristics with e-commerce (Coursaris et al., 2003), the literature review on e-commerce adoption has found that trust is a variable that has extensively been emphasised in prior research (Biong & Selnes, 1995; Sirdeshmukh et al., 2002; Smith, 1997). It provides a useful basis for investigating online consumer trust (McKnight et al., 2002; Slyke et al., 2004),
concerning which Lu et al. (2004) believe that perceived trust in a wireless mobile environment also impacts on user acceptance.

Many researchers have demonstrated that consumers lack trust in e-commerce, and this affects a consumer’s confidence in conducting business online (Gefen, 2000; Lee & Turban, 2001; Pavlou, 2003). Hoffman et al. (1999) conclude that the most important reasons for consumers distrusting online shopping are related to the issue of control of action over access, especially with regard to their personal information. In general, most consumers are not willing to provide personal information and financial details over the phone or the Internet (Hoffman & Novak, 1998). Consumers want to have a full control over their spending and behaviour (Baronas & Louis, 1988; Pikkarainen et al., 2004). Consumers want to know and control what kind of data is collected, and how it is processed (Kobsa, 2002).

Lu et al. (2004) note that the perception of trustworthiness is a vital factor of mobile user acceptance and also affects the perception of the usefulness of the technology. Welty and Becerra-Fernandez (2001) examined how interaction technology can enlarge the interplay between trust and technology (Ba & Pavlou, 2002). They point out that “while technology reduces transaction cost, trust may do it faster” (Welty & Becerra-Fernandez, 2001, p. 69).

Numerous risks and barriers face consumers who simply do not trust merchants enough to engage in relational exchanges involving both their money and personal data (Hoffman et al., 1999). Some of the risks that users face include personal risk, privacy risk, performance risk, and financial risk (Kim & Prabhakar, 2004).

Therefore, the most efficient way for merchants to develop and maintain profitable relational exchanges with consumers is to gain their trust (Ratnasingham, 1998), because trust reduces perceived risk and increases user acceptance (Doney et al., 1998; Jarvenpaa & Tractinsky, 1999). As confirmed by the study of Lu et al. (2004), an understanding of wireless trust will help to improve the mobile environment, thus promoting services and commercial activities.
2.17 System Quality

Assessing use is of vital importance for online retailers selling and using services in the Internet environment (Davis, 1989). Agarwal and Prasad (1998) believe that a positive experience relates to adoption by consumers. McKnight et al. (2002) agree that a positive experience provides the consumer with a feeling that dealing with impersonal merchants is normal and safe.

Consumers accept new technology on the basis of whatever they know (McKnight, Cumming, & Chervany, 1998): therefore, if consumers perceive that the service provides them with high quality, the consumers will gain positive perceptions and acceptance of that technology will be formed. As noted by Lee and Turban (2001), who have a similar understanding to Hoffman et al. (1999), the potency of third-party trust certification bodies, the key encryption infrastructure for verifying secure transactions and privacy protection, is undoubtedly a central factor in building consumer acceptance.

On the other hand, in Corbitt and Han’s (2003) study, perceived system quality is reflected in the ability to perform tasks adequately in terms of speed, reliability, and availability. The empirical research of Sirdeshmukh et al. (2002) found that consumer acceptance of information systems might be high when merchants handle transactions without error. Carr and Smeltzer (2002) also address the importance of the online operator’s understanding of the medium, process, and characteristics that drive the behaviour of the system.

The cost of improper and incorrect information can be high. If consumers discover untrustworthy information or a lack of integrity, they can pass along this experience through word of mouth (Corbitt & Han, 2003).

Moreover, the security of the communication between consumers and merchants is very important (Claessens, Preneel, & Vandewalle, 2004). Turner, Zavod and Yurcik (2001) argued that consumers need to recognise just how easy it is for someone to use their personal information to commit fraud and organisations need to recognise that it
is a privilege to have access to the personal information of customers. They need to determine where the sensitive information exists within their organizations, because information could reside on myriad servers and storage systems.

Regrettfully for merchants, perceived security has a clear impact on sales volume (Lu et al., 2004). Companies therefore need to examine their systems and guard against vulnerabilities to both forms of attacker to reduce the level of perceived risk (Harding, 2003).

2.18 Network Effects on Mobile Payments

A mobile payment system is a very complicated payment application requiring different parties to work together to make it work, such as MNOs and financial institutions. Payment service providers cannot operate without technology infrastructure suppliers, and vice versa. In the information economy, information and related technologies are two important factors, and the new information economy is driven by the economics networks (Shapiro & Varian, 1999).

If the value of a product for a user depends on how many other users there are, economists confirm that this product displays network externalities, or network effects (Shapiro & Varian, 1999). In particular, technology is subject to strong network effect and could display long lead times followed by progress growth. For example, e-mail communication exhibits network externalities. Network externalities can also be applied to mobile payments: when this becomes a popular payment method, it will attract more people to adopt it and consumers will further accept this payment method.

Network externalities can be described as large networks in information systems that can more easily attract users than small ones (Shapiro & Varian, 1999). Potential mobile payment service providers are aware of this issue: they therefore try to establish a large network. For example, two competitive mobile payment alliances have been set up to develop mobile payment systems: Mobile Payment Forum (MPF) and Mobile Electronic Transaction (MET). MPF was set up mainly by mobile manufactures, whereas MET was set up by financial institutions. Both of them have
the ability to create a large network for mobile payments: assembling a group of powerful strategic partners could help to achieve critical mass (Shapiro & Varian, 1999). Therefore, it is difficult to predict who will win this battle to operate and develop the ‘winning’ system for users, as two powerful organisations attempt to win in this competitive market. This situation demonstrates how complicated a mobile payment system is. On the other hand, Shapiro and Varian (1999) state service providers must focus not only on their competitors, but also on their collaborators. Mobile payment service providers could work with different organisations within the payment industry, for example, merchants, in order to promote and develop payment systems that are more accepted.

From the point of view of merchants, joining a large network is valuable. It is reasonable to assume that the greater the number of users and merchants that interact with one another through mobile payments, the higher the value will be (Katz & Shapiro, 1994; Pant & Ravichandran, 2001). Moreover, as more merchants adopt mobile payments, a bigger platform can be provided for consumers to use mobile payment services. Thus, mobile payment system providers can attempt to attract merchants to join their services in order to create a larger network. On the other hand, most merchants already have established payment systems so it would be a challenge to persuade them to add one more new payment system, such as mobile payments: they would consider the cost of the new infrastructure, maintenance of the system, and also the cost for training staff to operate the new system. Switching costs are significant for the information economy (Shapiro & Varian, 1999).

Positive feedback is very important in the information economy because of the concept of the network. Some of the networks in IT products are virtual networks. For example, if computer users can use the same software and share the same files, they are in the same network (Shapiro & Varian, 1999). This can also apply to mobile payments. Moreover, Shapiro and Varian (1999) stated that the number of people connected to the network can decide the value of connecting to that network.

Shapiro and Varian (1999, p13) summarised that “positive feedback makes the strong get stronger and the weak get weaker”. Different players compete in the mobile payment market, each offering different models and different standards: however,
economists have concluded that in this case, only one player can win this competition (Shapiro & Varian, 1999). This pattern results from positive feedback: when a product’s user base grows, more and more users find the adoption of that product worthwhile and eventually the product achieves critical mass. This concept could indicate why the mobile payment system is still not mature and commercialised: mobile payments have yet to establish the positive feedback.

Apart from technology and social factors, as mentioned in the previous sections, it has been identified that network effects could play a vital role in consumer acceptance of mobile payments.

2.19 Summary

It has been stated that mobile commerce enhances the feasibility of extending services that enable users to interact with other users or to conduct business transactions driven by the high penetration of wireless devices, especially mobile phones (Liang & Wei, 2004): mobile commerce employs wireless networks to allow users to transfer data between mobile devices and/or other computing devices deprived of wired connections (Tsang et al., 2004).

The literature review has identified that the growth of m-commerce has proven to be successful and provided opportunities for business such as SMS (Coursaris, et al., 2003; Kavassalis et al., 2003; Tsang et al., 2004), the Octopus electronic payment card in Hong Kong (Liang & Wei, 2004), ring tone and logo downloading (Lee & Benbasat, 2004; MacDonald, 2003), and Zoop mobile payment in Korea (Chen & Adams, 2005a).

From the mobile commerce context, there are various definitions offered in the literature for the main terms (e.g. Durlacher, 1999; Mohsin et al., 2003). Nevertheless, the study of Okazaki (2005b) summarises one major problem in mobile commerce research, which is the shortage of standardisation of terms, concepts, and theories.
Regarding the characteristics of mobile commerce, it is undoubtedly true that m-commerce and e-commerce business activities are similar since they involve much of the same practice in relation to facilitating e-commerce over the Internet (Coursaris et al., 2003). However, there is some dissimilarity in terms of communication, Internet access devices, and technologies applied for each individually to support its own environment (Chun & Wei, 2004). The distinctive significances have given mobile commerce great potential due to personalisation (Barnes & Scornavacca, 2004; Anil et al., 2003), ubiquity, mobility and flexibility (Chun & Wei, 2004).

Mobile payment services are one of the necessary support services that will enable the development and growth of mobile commerce (Sue & Wu, 2005; Wu & Wang, 2003); moreover, they can offer flexibility and alternative payment methods for mobile device users (Ondrus & Pigneur, 2006). At the moment, the mobile applications that can be viewed as mobile commerce are those used by mobile network subscribers to download digital content from MNOs, and the payment service provided by MNOs (Ondrus & Pigneur, 2005). However, these applications form a limited single-use case (Ondrus & Pigneur, 2005). There are many potential business cases available for mobile payments that can be used more widely (Chen & Adams, 2005a; Pousttchi, 2004). However, at the moment, only a few organisations are working to develop and promote a common mechanism and standard for the implementation of mobile payment services (Krueger, 2002).

The development of mobile commerce has normally been explained from different two perspectives: the business perspective and the technology and application perspective (Kavassalis et al., 2003; Tsang et al., 2004). However, the future of mobile commerce is considerable for those organisations that are well organised and mindful of the concerns and challenges that may adversely impact the growth of mobile commerce (Mohsin et al., 2003; Rupnik & Krisper, 2004). Those concerns are related to mobile devices (Manusamy & Hiew, 2002; Taresewich et al., 2002), which include the physical characteristics of mobile devices such as screen size, input capability and battery life.

The concerns related to wireless communication infrastructure have been researched intensively in different areas, such as ad hoc networks (Ramanathan & Redi, 2002),
security (Brewin, 2000; Naqvi & Riquidel, 2004), WLAN and WWAN (Chakravorty, 2004). Moreover, the huge investment required to implement and operate a mobile wireless network is also a concern for organisations (Tarasewich et al., 2002), due to high transaction costs (Mohsin et al., 2003). According to the studies of the attitude of consumers toward e-commerce (Becherer & Halstead, 2004; Kannan & Kopalle, 2001), understanding the costs and benefits of mobile commerce is essential (Becherer & Halstead, 2004).

Moreover, there are concerns about mobile application usability (Olla & Atkinson, 2004). Venkatesh et al. (2003) propose that the usability of the devices is made more challenging by the variety of mobile devices that continue to decrease in size and weight, and perceived difficulty in using mobile devices could turn into user frustration (Rupnik & Krisper, 2004). Therefore, Stanoevska-Slabeva (2003) concludes that it is very important to design mobile applications carefully to meet the requirements of the potential users.

The concerns of consumers are issues in mobile commerce that cannot be overlooked (Tarasewich et al., 2002). These concerns include connectivity issues relating to security, downloading time, costs, and reliability (Coursaris et al., 2003). Furthermore, misuse of personal information (Badamas, 2001), particularly for mobile payments, is an important issue, as is the quality of the wireless connection (Ghosh & Swaminatha, 2001). The ubiquity feature in mobile devices, which allows consumers to be reached at any location at any time (Liang & Wei, 2004), also puts consumers at risk of SMS spam (Bauer et al., 2005; Coursaris & Hassanein, 2002). Consumers are also irritated by location-based services that target consumers based on their geolocation, as those services deliver without regard for permission (Tsang et al., 2004).

Mobile payments services are a sub-set of mobile commerce (Hayashi, 2006). Sue and Wu (2005) view mobile payments as representing another opportunity for the mobile industry and for financial service companies, and, in the near future, it will perhaps be a service that users will demand (Wu & Wang, 2003). Mobile payments can be implemented via different solutions, such as premium SMS, infrared and RFID (Chen & Adams, 2004a).
Furthermore, not only can mobile payments be classified into several categories such as content type, transaction value, payment method and transaction channel (Ding & Hampe, 2003; Ondrus et al., 2005), but they can also be used to make purchases in different scenarios (Pousttchi, 2004). With the variety offered by mobile payments, consumers can achieve more convenience and flexibility for payment activities (Ondrus & Pigneur, 2006).

On the other hand, there are several potential players concerning the operation of mobile payment services (Kreyer et al., 2002), which involve consumers, merchants, payment service providers, and trusted third parties (Ding & Unnithan, 2002; Pousttchi, 2004). However, in mobile payments, there are too many potential players attempting to dominate the market using different standards and business models (Kreyer et al., 2002; Pousttchi, 2004). Essentially, business models for mobile payments are still not clear, and the industry has not yet produced a best option for mobile payments (Varshney, 2003). However, some consortiums have been set up to discuss the technologies and infrastructure solutions for mobile payments, for example, MET (Tsang et al., 2004).

Mobile payment applications still lack proper regulation and standardisation. At present, some billing solutions provided by MNOs are unregulated and incompatible with the systems of banks and financial services. Billing systems for mobile network subscribers, for instance, are either based on monthly payments with limited credit checks or they are pre-paid (Lukkari et al., 2004). No standard has been set yet, although some organisations, for example Simpay, have been set up to investigate the best infrastructure for the mobile payment systems (Sherriff, 2005). However, due to the complex nature of mobile payments schemes and the highly competitive environment, Simpay collapsed in July 2005 (Sherriff, 2005). This situation and environment will not help to construct a standard and an interoperable payment model because the most influential players – financial institutions, MNOs, and mobile devices manufacturers want to be the centre of the system in order to gain the maximum profit (Dahlberg & Mallat, 2002). There are numerous challenges to be overcome (Anckar & D’Incau, 2002; Chen & Adams, 2004b; Dahlbeg & Mallat, 2002; Krueger, 2002). For instance what is the best business model for a mobile payments system? Government agencies could offer recommendations for potential
mobile payments service providers. For example, they could publish guidelines and regulations for the industry as soon as possible, which would help the mobile payment markets to make significant progress. The European Central Bank has published guidelines for mobile payment implementation (ECBS, 2005). It seems that there will be a battle to control mobile payments, involving financial institutions, MNOs and start-up payment service providers (Krueger, 2002). However, ZOOP mobile payments, which were presented in study two of the research in this thesis, demonstrate positively how competitive players can work together to offer a successful mobile payments system.

The mobile payments market offers much potential and mobile payment systems are still being developed, although there are many challenges (Kreyer et al., 2003; Poussettchi, 2004; Sue & Wu, 2005; Wu & Wang, 2003). At present, there are numerous available technologies that might be applied to these systems, and there are a variety of options for building the system infrastructure (Chen & Adams, 2004b; Krueger, 2002). Making a decision about which technology is the most appropriate for mobile payments is not an easy task. Of course, the decision depends on the type and size of the system and applications. It may also be significantly influenced by the company and business sectors that develop the technology and by bureaucratic and political influences (Krueger, 2002). The “winning” system may not offer the best technology or be the one that offers the most convenience for consumers (Chen & Adams, 2004b).

It is essential to understand and explore consumer acceptance of mobile payments (Wu & Wang, 2003). This aspect will affect the design and use of this payment method (Ondrus et al., 2005). New technologies will allow more sophisticated applications to be used in mobile payments (Lukkari et al., 2004). There are many technologies available for implementing mobile payment services, but wireless technology is one of the obvious choices for service providers to implement (Chen & Adams, 2004b). Therefore, selecting suitable wireless technologies to implement mobile payment systems will be one of the important factors in developing a system (Coursaris et al., 2003). The possible short-range wireless technologies for mobile payments applications include Bluetooth (Sriskanthan et al., 2002), IrDA (Sun & Sauvola, 2005), RFID (Hori & Matsumoto, 2004), and NFC (Valcourt, Robert, &
Beaulieu, 2005). However, short-range technologies are competitive (Gao et al., 2004) and the applications may require the convergence of wireless technologies (Porcino & Hirt, 2003).

Abramowitz (2004) points out that there are several factors to consider in choosing a suitable wireless technology. The standard is one of the most important factors, particularly in terms of whether it has a profile that supports mobile payment transactions (Abramowitz, 2004). The frequency spectrum is another important factor, in terms of whether it is unlicensed (Rappaport et al., 2002). Other factors include battery life as a critical design factor for mobile devices (Toh, 2001), together with wireless data transmission range (Valcourt et al., 2005). Finally, cost is one of the factors to be considered when selecting the most suitable technology for mobile payment applications (Gera & Chen, 2003).

In order for mobile payment services to be accepted, there are several issues that need to be taken into account (Pousttchi, 2003), which are cost, security, convenience, and standardisation (Costello, 2002; Ding & Unnithan, 2002; Ondrus & Pigneur, 2005; Venkatesh et al., 2003). These issues could slow down mobile payment adoption together with the spread of the mobile commerce market (Henkel & Zimmermann, 2001).

Nevertheless, perceived trust in a wireless mobile environment also impacts on user acceptance (Lu et al., 2004) and affects the perception of the usefulness of the technology (Kim & Prabhakar, 2004). A positive experience relates to consumer adoption (Agarwal & Prasad, 1998): as McKnight et al. (2002) state, it provides the consumer with a feeling that dealing with impersonal merchants is normal and safe. Perceived system quality therefore involves the quality of services, technology competence, security, and privacy (Corbitt & Han, 2003) as a key to building consumer acceptance.

Mobile payment services provide attractive, simple and rapid payment channels for users (Pousttchi, 2004). The battle for control of the mobile payment infrastructure and market is likely to be very fierce, and it has just started. There are many challenges and hurdles that need to be overcome (Ding & Hampe, 2003; Ding &
Unnithan, 2002; Ondrus & Pigneur, 2005). The “winner” is likely to be the one who can command the greatest support from powerful sectors such as financial institutions, companies, governments, and of course, consumers. It may not be the best technology or the cheapest option for consumers, since mobile payment is a potential commoditised market where services are differentiated by marketing rather than technology. The next few years will be vital for these short-range wireless technologies and mobile payment applications (Dahlberg et al., 2003; Ondrus, 2005).

This chapter presents a detailed review of mobile commerce and mobile payments, which is essential to provide a comprehensive understanding of mobile applications at present. In addition to the information from the literature review presented in this chapter, the next chapter will present and highlight four important theories related to mobile payment acceptance. The conceptual framework will then be reviewed.
Chapter Three: Research Framework and Research Model

3.1 Introduction

This chapter presents the theoretical foundation on which the proposed model is based. The theoretical and empirical literature relating to information systems will be reviewed. Conducting information system research within a cumulative tradition is one of the most used methods in this type of research: it uses reference disciplines and theoretical arguments as a foundation (Benbasat & Zmud, 1999, p3).

“In order for IS researchers to be more proactive in a direct sense, it is imperative that the IS research community produce cumulative, theory-based, context-rich bodies of research.”

It is particularly useful for understanding users’ behaviour and attitude towards using new technologies and applications (Bergeron et al., 1995; Trice & Treacy, 1988). This research fits this context well.

User acceptance is one of the most critical factors for the success or failure of mobile commerce (Coursaris & Hassanein, 2002; Pousttchi, 2003). In order to achieve the aim of this research, in-depth consideration of the important factors for the acceptance of mobile payments by users is essential to provide improved application design and a better strategy to minimise the barriers to successful development in mobile payments. In addition, four important theories related to mobile payment acceptance will be highlighted. A review of the literature will be presented before moving on to the conceptual framework.

At the end of this chapter, the conceptual framework that has been developed by reviewing the literature, particularly through the TAM and the IDT, will be provided along with the proposed model and research hypotheses. Some IS research studies have suggested including other factors with the TAM to enhance its explanatory power (e.g. Taylor & Todd, 1995b; Venkatesh, 1999). The proposed research model integrates the TAM and IDT with other significant factors. This research anticipates
that this model would offer a complete picture of consumer acceptance of mobile payments.

3.2 Why This Research

The widespread use of mobile handsets is still restricted to two main services: voice calls and text messaging. Nowadays, academic researchers have started to investigate mobile usage (Coursaris et al., 2003; Tsang et al., 2004). Many researchers have raised and explored the usability issues of mobile devices, many of them identifying limited input and output capabilities (e.g. Manusamy & Hiew, 2002; Taresewich et al., 2002). First, the physical size of mobile devices has resulted in small keypads, keyboards or small buttons. Moreover, these features might be adequate when devices are used only for making a phone call. On the other hand, there are some alternative input methods available, such as predictive text algorithms, optimization of characters, and stylus input. All methods have indeed improved input efficiency but have some disadvantage as well, such as learnability and satisfaction. Secondly, the mobile screen displays limit the amount of information that can be displayed (Venkatesh et al., 2003).

However, the abovementioned research studies do not provide a clear picture of how consumers would accept the use of the same devices in the same distracting environments for new mobile applications, for example mobile payments, rather than SMS or voice calls. If frustration is greater than the benefits of using new services, consumers will refuse to use them, which can be referred to as “perceived value” in marketing terms. Moreover, factors such as financial costs and marketing techniques must also be considered (Coursaris et al., 2003).

Some researchers have already identified that the attitude of users towards and their acceptance of a new IS have a vital impact on systems adoption (Davis, 1989; Pikkarainen et al., 2004; Venkatesh & Davis, 1996). In an organisational context, if users do not want to accept a new IS, this IS therefore will not benefit the organisation (Davis, 1993; Davis & Venkatesh, 1996). It is important to identify and explore the reasons why people want or do not want to use a new system. The findings will assist
service providers and system developers with improved application design and strategy development (Mathieson, 1991).

Two well-established theories, IDT and TAM, will be used in this research. This research was intended to provide both theoretical and empirical analysis to identify factors and to evaluate a model determining consumer acceptance of mobile payments.

The following sections present the TAM and IDT from which the research framework for this research was developed. Moreover, The Theory of Reasoned Actions (TRA) and Theory of Planned Behaviour (TPB) are also introduced, because the TAM has a close relationship with them.

3.3 Theory of Reasoned Actions

![Diagram of Theory of Reasoned Actions](image)

**Figure 1 Theory of Reasoned Actions (Fishbein & Ajzen, 1975)**

Drawing from the social psychology context, the Theory of Reasoned Actions (TRA) is one of the most well-known and influential theories of human behaviour (Venkatesh et al., 2003), as shown in Figure 1. It has been extensively used to predict behavioural intentions (Albarracin et al., 2001; Bock & Kim, 2002; Fishbein & Ajzen, 1975). The TRA considers the behaviour of a consumer as affected by the behavioural intention of the consumer (Fishbein & Ajzen, 1975). There are two core constructs: attitude toward behaviour and subjective norm.

Hansen, Jensen, and Solgaard (2004) note that the TRA predicts intention to perform a behaviour by the attitude of the consumer toward that behaviour as opposed to the attitude of the consumer toward a product or a service. The subjective norm is also
believed to influence the intention of a consumer to perform or not to perform a particular behaviour (Venkatesh et al., 2003). That particular behaviour, noted by the study of Liu et al. (2004), will be linked to a specific outcome. However, Hansen et al. (2004) identify the main contribution of the TRA as the concept that both attitude and subjective norm do not directly predict behaviour, whereas they predict intention, which in turn predicts the actual behaviour of a user.

### 3.4 Theory of Planned Behaviour

The TPB is an extension of the TRA by Ajzen (1991), as shown in Figure 2. The TPB is a widely studied theory of social psychology and many researchers have deployed TPB to investigate behaviour prediction across attitudinal variables (Armitage & Conner, 2001; Khalifa & Cheng, 2002; Koufaris, 2002; Paylou & Chai, 2002). There are three perceptual constructs influencing intentions and actual behaviour: perceived behavioural control, attitude, and subject norm (Ajzen, 1991).

![Figure 2 Theory of Planned Behaviour (Ajzen, 1991)]

The TPB extension of the TRA concerns where individuals do not perceive full control over the situation, known as perceived behavioural control (Madden, Ellen, & Ajzen, 1992). The perception of behavioural control is conceptualised as the consumer’s perceived ability to manage an unpleasant matter (Hansen et al., 2004). Hence, the perception of behavioural control is a determinant of both intention and behaviour (Khalifa & Cheng, 2002).
On the other hand, attitude has been suggested to influence behavioural intentions in theories such as the TRA (Fishbein & Ajzen, 1975), the TAM (Davis, 1989), and the TPB (Ajzen, 1991). Attitude toward the behaviour is explained as the individual’s feeling about using the system (Mathieson, 1991). It is determined through an evaluation of an individual’s belief with respect to the outcome of the behaviour and an evaluation of the desirability of that outcome to the individual using the system (Paylou & Chai, 2002).

Mathieson (1991) defined subjective norm as an individual’s perception of social pressure to perform the behaviour. In addition, subject norm can be divided into societal norm and social influence (Ajzen, 1991). Some scholars support the role of subject norm on behavioural intentions (Pavlou & Chai, 2002). The study of Karahanna et al. (1999) shows the remarkable influence of top management, supervisors, and peers on the adoption intention of both potential technology adopters and actual users. Moreover, Karahanna et al. (1999) notice that staff and friends are significant influences on potential adopters, whereas computer specialists play an important role for actual users.

Social influence reflects complying with the opinions of family, friends, and peers, while societal norm reflects a larger circle of influence by societal fashion (Khalifa & Cheng, 2002). Based on the study of Kelman (1958), social influence occurs when the attitude of an individual is influenced by external stimuli. Kelman differentiates three processes of social influence that impact on individual behaviour: compliance, identification, and internalisation. Thompson, Higgins and Howell (1994) employ the term subject norms in their empirical model, and explain its likeness to subjective norm within TRA.

Social influence, however, plays an important role only in the early states of user experience with the technology (Venkatesh et al., 2003), then appearing unimportant with experienced usage (Venkatesh & Davis, 2000). Hartwick and Barki (1994) explain that social influence becoming unimportant over time is due to increasing experience provided by contributory rather than social influence. The study of Jarvenpaa and Tractinsky (1999) suggests first-time electronic consumers may be concerned about ‘social categorisation’ (p.336), size, and reputation. In the case of
multi-channel business, the study of Teltzrow et al. (2003) suggests it is not only the perception of size and reputation that has an impact on the behaviour intention of consumers, it is also positively associated with the offline operations of retailers. Furthermore, the findings of Khalifa and Cheng (2002) highlight the importance of social influence in the adoption of mobile commerce.

### 3.5 Technology Acceptance Model

Davis (1989) developed the TAM to explain user acceptance of new computing technologies in the organization context. This model was extended from the TRA (Ajzen & Fishbein, 1980), as shown in Figure 3.

![Figure 3 Technology Acceptance Model (Davis, 1989)](image)

The TAM is one of the most utilised models in IS research, and it has emerged as one of the most influential models in IS research (Davis & Venkatesh, 1996; Gefen & Straub, 2000; Mathieson, 1991). In the TAM, Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) are two important beliefs for user acceptance of an IS. The TAM has been widely used and modified to predict technology acceptance behaviours regarding different aspects of Information Technology, e.g. Internet services (Agarwal & Prasad, 1997; Lewis et al., 2003), micro-computers (Igbaria et al., 1995), virtual workplace systems (Venkatesh, 1999), information adoption (Sussman & Siegal, 2003), B2C e-commerce web-based stores (Koufaris, 2002), WAP services adoption (Hung et al., 2003), and mobile commerce (Venkatesh et al., 2003).

The TAM suggests the behavioural intentions of users determine actual system use, and the attitudes of users toward using influence the behavioural intentions of users (Davis, 1989). Moreover, perceived usefulness and perceived ease of use have been
accepted to affect the attitudes of users toward use (Gefen & Straub, 2000; Koufaris, 2002; Rose & Straub, 1998). The TAM is a powerful theory to predict user acceptance of technology, as it is supported by a great deal of literature (e.g. Koufaris, 2002; Straub, Keil, & Brennan, 1997; Szajna, 1996; Venkatesh et al., 2003). Chau and Hu (2002) argue the ability of the TAM, compared with TPB and its associated predictive power.

The TAM includes two important factors: perceived ease of use and perceived usefulness (Davis, 1989). Perceived usefulness refers to “the perspective user’s subjective probability that using a specific application system will increase his or her job performance within an organization context”, whereas perceived ease of use describes “the degree to which the prospective user expects the target system to be free of effort” (Davis et al., 1989).

Many researchers have also extended the original TAM to propose a new model (Henderson & Divett, 2003; Lu et al., 2003; Venkatesh & Davis, 2000; Venkatesh & Speier, 1999).

3.5.1 Perceived Ease of Use

Having said that ease of use is important to stimulate the adoption of a new technology (Ondrus & Pigneur, 2005), in order to design and implement an easy-to-use application, the characteristics of the systems need to be understood (Okazaki, 2005b). Chou et al. (2004) propose that an easy-to-use interface is important for any application, especially for mobile devices. Amberg, Hirschmeier, and Wehrmann (2004) draw attention to navigation, display size, and log-in procedure regarding ease of use because of the unique characteristics of mobile devices, such as screen size, input mechanisms and battery consumption (Chun & Wei, 2004; Fan et al., 2005). System developers, therefore, have to give serious consideration to design guidance for mobile applications (Manusamy & Hiew, 2002; Venkatesh et al., 2003). Nevertheless, though the screen size of mobile devices is small, the findings of Amberg et al. (2004) argue the display size is found to be acceptable.
3.5.2 Perceived Usefulness

The study of Davis (1989) demonstrates that perceived ease of use directly guides the acceptance by each consumer of new technology, whereas it indirectly determines the acceptance by each consumer of new technology via the influence of the perception of usefulness. Within the mobile commerce context, Hung et al. (2003) indicate that people are normally looking for convenience, speed, and other rewards for using the systems. A system classified as high in perceived usefulness would lead to a positive user acceptance relationship (Chou et al., 2004). The finding of Gefen et al. (2003) shows the perception of usefulness is a more robust predictor than is the perception of trust in terms of repeated transactions.

There are some differences between TAM and other models, for example, TAM and TPB. With TAM, beliefs about usefulness and ease of use are always the primary factors of actual use. However, TPB suggests that TPB depends on different situations. Moreover, in TAM, no social variables are included in the model. Finally, TAM offers a convenient and cost-efficient way to gather general information regarding users’ perception of an IS (Mathieson, 1991).

TRA has been successfully used in predicting and explaining user behaviour across different IS research. There are some fundamental differences between the TRA and TAM (Pikkarainen et al., 2004). For the TRA, the beliefs are not generalisable, and it is bounded by the context. In contrast, with TAM, the belief is that the factors PEOU and PU have a user acceptance effect for all IS. Moreover, with the TRA, all beliefs are summed in one place. On the other hand, PEOU and PU in the TAM are viewed as distinct constructs.

3.6 Innovation Diffusion Theory

Rogers (1995) presented the IDT for user adoption. This is a well-established theory, and many researchers have adopted this theory for their research (Karahanna et al., 1999; Rai, Ravichandran, & Samaddar, 1998; Taylor & Todd, 1995a). The IDT
identifies the innovation decision process, and it assists in ascertaining the rate of adoption of innovation (Rogers, 1995).

Zaltman and Stiff (1973) discussed that the acceptance and use of new technology or goods by users are two key elements in the IDT, and that these elements help to increase the likelihood of the adoption of an innovation and to facilitate the process of innovation decision (Brancheau & Wetherbe, 1990; Chew, William, & Tote, 2004). On the other hand, Karahanna et al. (1999) argue that key elements in the process of innovation decision encompass the perception of attributes of an innovation, individual beliefs and attributes, together with communications from the social environment. However, Rogers (1995) concludes that five factors could explain the adoption of new technology: relative advantage, complexity, compatibility, trialability, and observability.

These five attributes have been identified as predictors of the rate of adoption of innovation (Chakravarty & Dubinsky, 2005; Cheng, Kao, & Lin, 2004; Rogers, 1995). Rogers (1995) notes that these five factors influence the attitudes and intentions of the potential adopters during the adoption process: however, he also emphasises that the attributes are conceptually different.

*Relative Advantage:* the degree to which an innovation is perceived as better than the existing products.

*Complexity:* the degree to which an innovation is perceived as being difficult to understand and use.

*Compatibility:* the degree to which an innovation is perceived as consistent with the existing values and experience of the potential adopters.

*Trialability:* the degree to which an innovation can be experimented with before adoption.

*Observability:* the degree to which the results of an innovation are observable to others.
Before an innovation can successfully appear in the commercial market, a lot of work is required to convince the potential adopters (Gera & Chen, 2003). Individual users will make a decision whether to adopt an innovation based on knowledge and on the performance of an innovation (Robertson, 1971; Rogers, 1995; Ostlund, 1973). Moreover, the speed of the adoption is also affected by the knowledge and experience potential adopters have of an innovation as well as the knowledge and experience of their close friends and family (Brander & Kearl, 1964; Dickenson & Gentry, 1983; Fogelgren-Perdersen, 2005; Hung et al., 2003).

Furthermore, different adopters have different approaches toward an innovation (Chang, Lee, & Kim, 2006; Fogelgren-Pedersen, 2005). Some adopters will use a new product or service as soon as they receive it. Others adopters may wait and see: if they are not convinced by the services, they will not accept them until they feel comfortable with them (Chakravarty & Dubinsky, 2005).

In short, all these theories have attempted to understand the context of technology acceptance based on a number of emotional and cognitive responses to the environment that influence an individual’s behaviour (Ajzen, 1991; Davis, 1989; Fishbein & Ajzen, 1975; Rogers, 1995).

3.7 Critique of the TAM

Technology acceptance research has been one of the most challenging issues in IS research (Swanson, 1988). Many researchers have attempted to identify usage behaviour (e.g. Fuerst & Cheney, 1982; Lucas, 1991; Srinivasan, 1985). Research user acceptance of new technology is often mentioned as one of the most mature research areas in the contemporary IS literature (Hu et al., 1999; Venkatesh et al., 2003). Moreover, the issues of the resistance of managers and professionals to the use of IT systems were a problem in ‘80s (Attewell & Rule, 1984; Davis et al., 1989; Igbaria & Chakrabarti, 1990), and user acceptance is always the focus point for system developers in determining the success or failure of IS systems (Davis et al., 1989; Igbaria, 1993).
TAM is capable of explaining users’ behaviour across a broad range of end-user computing technologies and user populations in organisations (Algahtani & King, 1999). In an information society, organisations would mandate the use of information technology. This has implications and effects on the TAM because mandatory usage of technology would less concern individual’s behaviour (Rawstorne et al., 2000). When new information technology had been implemented in the organisations, the employer could decide that the employee must accept and use the technology. In this case, users lose the power to make a decision and influence the choice. Hartwick and Barki (1994) and Moore and Benbasat (1991) suggest that this issue related to TAM still lacks research to confirm or reject it. However, for the research in this thesis, mobile payments systems are not used and applied in an organisational context: this research therefore does not face the same issues as when information technology is used in an organisation.

TAM has been widely used and supported in previous IS empirical studies. However, some research studies have suggested that TAM is relatively speculative regarding the factor of perceived ease of use (Chau, 1996; Keil, Beranek, & Konsynski, 1995; Lucas & Spitler, 1999; Gefen & Straub, 2000). These studies recommended that TAM should be used with caution.

Legris, Ingham, and Collerette (2003) identified that TAM only views IS to be an independent issue in organisational dynamics. However, when research involves the subject of innovation, Legris et al. (2003) suggest that technological implementation is associated with organisational dynamics (Orlikowski & Hofman, 1997). Some researchers have identified that TAM is incomplete when it lacks the role of social factors (Davis et al., 1989; Venkatesh & Morris, 2000). Therefore, it is wise to integrate organisational and social factors into a broader model, so it can increase the predictive capacity of TAM (Legris et al., 2003; Orlikowski & Hofman, 1997).

On the other hand, Legris et al. (2003) claimed that most of the research studies on TAM do not measure system use: what TAM actually measures is the variance in self-reported use. However, this is not an accurate measure (Davis, 1993; Subramanian, 1994). Pikkarainen et al. (2004) point out that usage of a new system can be an indictor of IS success and acceptance. Moreover, DeLone and McLean (1992) suggest
that system use as a dependent variable is reasonable when system usage is not compulsory (Pikkarainen et al., 2004). Therefore, the use of mobile payment services was selected as the dependent variable in the proposed research model.

3.8 Research Framework

Adam et al. (1998) point out that IS researchers should not distinguish their work from related research work. Therefore, the research in this thesis builds on and extends the existing body of research on the TAM and IDT.

The following section aims to focus on the framework of the research. The detail of the conceptual framework is discussed first. The Conceptual Model is shown later on. Lastly, statements of all hypotheses tested in this research are provided.

3.8.1 Conceptual Framework

The literature review has found that the TAM theory and the IDT theory are among the most influential theories in predicting and interpreting user behaviour and system use. Moreover, the TAM theory focuses on the intention of technology usage (Van de Heijden, Verhagen, & Creemers, 2003). This research has applied the TAM because of its solid theoretical foundation: moreover, in recent years, a number of technology-based research studies have successfully used the TAM to explore consumer acceptance (e.g. Alavi & Leidner, 2001; Amberg et al., 2004; Bhattacharjee & Premkumar, 2004; Hung et al., 2003). The TAM offers a powerful and parsimonious explanation of users’ behaviour toward IS (Taylor & Todd, 1995a; Taylor & Todd, 1995b). The TAM can also be seen as possessing practical relevance: it predicts IT usage in organisation contexts (Agarwal & Prasad, 1998; Rose, 1998). Moreover, before a system is implemented, potential users could be surveyed to determine the success ratio of the system and attitudes toward using the system (Amberg et al., 2004). Having gathered this feedback, the system could be implemented and appropriate action taken. The original TAM was developed in an organisational context. However, some researchers have also noted that it is necessary to adjust the TAM for different contexts (Hong et al., 2001; Karahanna & Limayem, 2000). Thus,
the research in this thesis extends the current knowledge on technology acceptance, and mobile technology in particular.

The constructs of the TAM reflect the key variables that have been identified as influential in predicting IS research (Chun & Wei, 2004; Fan et al., 2005). Two main key variables, perceived ease of use and perceived usefulness, are distinctive, although they are also strongly interrelated (Igbaria et al., 1996; Taylor & Todd, 1995b). Therefore, the TAM is a valid basis for the research in this thesis.

On the other hand, the IDT has also been widely used in different research studies, such as sociology, communication and marketing (Fogelgren-Perdersen, 2005; Gera & Chen, 2003; Hung et al., 2003; Rogers, 1995). Diffusion is a process in which it is attempted to deliver an innovation to members of a social system using certain channels over time (Zaltman & Stiff, 1973). An innovation is a new idea that is perceived by an individual or another unit of adoption (Chang et al., 2006). Diffusion is achieved through user acceptance into use and continued use of a new idea or object (Zaltman & Stiff, 1973). IS researchers have adopted the theories from social psychology to conduct and evaluate IS usage (e.g. Davis et al., 1989; Harwick & Barki, 1994; Igbaria et al., 1997; Thompson, et al., 1991).

The IDT attempts to identify the innovation decision process, the critical factors of adoption, and the possible adopters (Moore & Benbasat, 1991). Therefore, the IDT could predict the likelihood and rate of adoption of an innovation.

Moreover, the IDT helps to explain the adoption of mobile payments in this research. The innovation attributes (relative advantage, compatibility, complexity, trialability, and observability) are important for this research. However, only three attributes (compatibility, trialability, and observability) have been considered, as these three attributes are consistently connected to innovation adoption (Tornatzky & Klein, 1982). Mobile payment is a new idea and innovation, and it has redesigned the traditional payment methods (Wu & Wang, 2003). Therefore, the IDT is very valuable as the basis for this research because it is associated with technology innovation research (Rai et al., 1998; Taylor & Todd, 1995a).
Although the TAM and the IDT were established from different disciplines, they share some similarities with regard to their constructs (Khalifa & Cheng, 2002; Koufaris, 2002). The study of Moore and Benbasat (1991) is helpful in the construction of the research model. They have identified that the relative advantage construct in the IDT is similar to perceived usefulness in the TAM, and the complexity construct in the IDT is similar to perceived ease of use in the TAM. Therefore, only the compatibility, trialability, and observability of the IDT have been adopted in this research.

The IDT offers the formation of a positive or negative attitude toward an innovation (Rogers, 1995). However, it does not identify how the attitude transforms into a decision (Chakravarty & Dubinsky, 2005), while the TAM offers theoretical relationships among attitude, intention, and actual use (Davis, 1989). Nevertheless, the TAM also lacks the social influence factor regarding technology acceptance. Some empirical research studies have suggested that including other theories would improve its predictive and explanatory power (Mallat, 2004; Taylor & Todd, 1995b; Wu & Wang, 2003).

Therefore, this research adopts the TAM and integrates it with the IDT, together with the perception of trust from the studies of Mayer et al. (1995) and McKnight et al. (2002). The proposed model includes social influence based on the TPB and the studies of Kleijnen et al. (2004) and Venkatesh et al. (2003). Perceived system quality (McKnight et al., 2002; Kleijnen et al., 2004) is also a variable to model acceptance by users of using mobile payments. Based on this rationale, the research model has been developed.

Delone and McLean (1992) suggest that the relevance of the variables to be selected in a research model depends on the research objective and the aspect of IS addressed by the research. Moreover, research studies suggested the capability of TAM to explain users’ usage could be enhanced by extending it to include other factors from the IS literature (Igbaria et al., 1997). In this thesis, twelve compelling variables, which possibly have impacts on mobile payments acceptance, were selected. The objective is to develop a proposed model, shown below in Figure 4. As presented in Figure 4, the three endogenous variables are (1) the actual use, (2) the behavioural
intention, and (3) the attitude. The nine exogenous variables are (1) the perception of usefulness, (2) the perception of ease of use, (3) the perception of costs, (4) the perception of system quality, (5) the perception of trust, (6) social influence, (7) compatibility, (8) observability, and (9) trialability. Through the theories described above and relevant literature concerning consumer acceptance of IS, the research in this thesis develops and evaluates a consumer acceptance model for mobile payments. The proposed research model integrates the TAM and IDT with other constructs mentioned above identified as significant in explaining IS success. The following sections explain the variables as well as the hypotheses developed for this research.

3.8.2 Research Model

Attitude has been noted in many theories, for example, the TAM (Davis, 1989), the TRA (Fishbein & Ajzen, 1975), and the TRA (Ajzen, 1991), to have an impact on behavioural intention. These theories have been strongly supported by numerous empirical studies in various settings (Hung et al., 2003; Kleijnen et al., 2004; Pavlou & Chai, 2002). Davis (1989) emphasised attitude, which is believed to predict and enable understanding of the use of information systems, while Jarvenpaa and Tractinsky (1999) believe that good attitude is assumed to reduce concerns about the adoption of e-commerce. Mathieson (1991) explain attitude toward the behaviour as how users feel about using the system.

According to Fishbein and Ajzen (1975), the attitudes of the user towards behaviour intention are based on an evaluation of an individual’s belief with respect to the outcome of the behaviour and an evaluation of the desirability of that outcome to the individual using the system (Pavlou & Chai, 2002). The study of Bobitt and Dabholkar (2001) suggests that, when conducting research into usage intentions, attitude will be accepted as a more accurate predictor, particularly in studies of electronic, digital, and wireless channels.

The framework of attitude and behavioural intention to use views participation in mobile commerce as an actual use of the system (Hung et al., 2003). This framework suggests that a consumer’s performance of a specific behaviour is determined by that consumer’s intention to perform that behaviour. The actual use of the system, in turn,
is determined by attitude and behavioural intention. Furthermore, usage is an appropriate indicator of systems success (Lucas et al., 1990). Thus, the first two hypotheses of this research are as follows:

**Figure 4 Conceptual Model**

H1: A user’s behavioural intention towards using mobile payment services has a positive effect upon his/her actual use of mobile payment services.

H2: A user’s attitude toward using mobile payment services has a positive effect upon his/her behavioural intention to use mobile payment services.

In the TAM, Davis (1989) suggests that two determinants, perceived usefulness and perceived ease of use, are critical when people accept or reject a particular technology. The study of Taylor and Todd (1995a) agrees that perceived ease of use directly influences user acceptance of information technology. Adams et al. (1992) suggest perceived ease of use has a significant positive influence on use. Davis (1989) notes that the perception of ease of use is the extent to which a user finds a system easy to learn, to set up, or to use. Innovation being perceived to be easier and simple would enhance the chances of it being accepted and used by potential users (Moore &
Benbasat, 1991). Expanding on these beliefs, Kleijnen et al. (2003) proposes that the attitude of users to mobile services will be more positive, and that intention to use mobile services, such as financial services, will increase. Hung et al. (2003) conclude from their empirical study that user acceptance of mobile WAP services needs the satisfaction of ease of use and facilitating conditions.

As mentioned in Section 2.6.1 in the literature review, due to the nature of mobile devices, Krogstie et al. (2004) add that input capabilities are also limited by the size and the multifunctionality of the keypad in comparison to a desktop computer. The size of mobile devices also imposes limitations, such as limited storage, limited size of information, battery life, surfability, and the capacity for the running of mobile applications (Rupnik & Krisper, 2004). Stanoevska-Slabeva (2003) put forward a concern about the limitations imposed by the difficulty of data entry, particularly for long messages and the browsing of information. Perceived ease of use, therefore, needs a clear overview of the entire service, smooth interactions with all service parties, and easy navigation on a small display (Tsalgatidou & Piloura, 2001).

Mobile applications have different environments and contexts compared with e-commerce applications (Okazaki, 2005b), and they can offer a complex service (Tsalgatidou & Piloura, 2001). According to section 2.6.3 in the literature review, it is undoubtedly important for the success of the application that the consumers find it useful and friendly, and that it has begun to be accepted. These assumptions lead to this hypothesis:

H3: A user’s perceived ease of use of mobile payment services has a positive effect upon his/her attitude to the use of mobile payment services.

In the TAM, perceived usefulness can be interpreted as being the way a system could enhance a consumer's job performance (Davis, 1989). Perceived usefulness has a strong impact on system usage (Schultz & Slevin, 1975), as supported by a number of empirical research studies (e.g. Adams et al., 1992; Gefen & Straub, 1997; Igbaria et al., 1995). Mobility is one of the main features that mobile services offer to customers (Barnes & Scornavacca, 2004). The nature of mobile devices offers users the ability to
connect to the Internet or reach other people wherever and whenever they want (Tsangatidou & Piloura, 2001).

In section 2.4, the importance of mobility was raised: mobile users are likely to be rewarded with respect to location and time services (Fan et al., 2005), and perceived usefulness by consumers is likely to be significantly enhanced (Chun & Wei, 2004). In addition, Hung et al. (2003) identify that people are normally looking for convenience, speed, and other rewards for using the systems. A system classified as high in perceived usefulness would lead to a positive user acceptance relationship (Chou et al., 2004; Fan et al., 2005).

Thus, in the context of mobile services, the perception of usefulness could be considered as the view consumers have of how mobile payments could be integrated into their daily lives (Kleijnen et al., 2004). If consumers gain a more positive view of mobile payment services, they would have a positive attitude and intention toward the services. Therefore, it is hypothesised that:

H4: A user’s perception of the usefulness of mobile payment services has a positive effect upon his/her attitude toward using mobile payment services.

Cost is one decisive factor for a new wireless technology when it comes to penetrating and dominating the market (Ondrus & Pigneur, 2005), as presented in section 2.15.1. From the point of view of consumers, service cost is one of the major concerns determining use of mobile payments (Ding & Hampe, 2003). This principle can be applied to any new services (Chen & Hitt, 2002; Plouffe et al., 2001). As indicated in the findings of Chen and Adams (2005a), it is likely that cost will be one of the potential factors influencing the decisions of consumers regarding mobile payments usage.

The high service charge is a critical reason why users are reluctant to use mobile services (Ondrus et al., 2005). The acceptance of mobile payments relies directly on those users who are willing to pay the extra cost, which can be very off-putting (Chou et al., 2004; Ondrus & Pigneur, 2005). Therefore, it is hypothesised that:
H5: The perceived costs of mobile payment services have a negative effect upon a user’s attitude to using mobile payment services.

According to Corbitt and Han (2003), perceived technical competence and performance should be concerned with both the technical and the social subsystems. The subsystems herein embrace the nature of the tasks to be achieved, which includes the technology that enables their achievement. Gefen et al. (2003) concluded that perceived technical competence reflects on the task, the technology and the people involved.

Moreover, quality of service always plays an important role in any mobile service (Hung et al., 2003). Section 2.17 reviewed the importance of system quality. In particular, the bandwidth and download times of a system seem to be vital issues for users (Ding & Unithan, 2002). In mobile payment systems, the perception of system quality is presented as the degree to which the individual users perceive the data connection between mobile devices and receive payment portals or devices as satisfactory (Chen & Adams, 2005a). If a user’s perception of system quality is high, then his/her attitude toward using mobile payment services will become more positive.

Perceived system quality is also presented as how an individual perceives security (Coursaris et al., 2003). Liang and Wei (2004) note that connectivity is one dimension that must be taken into consideration because it revolves around connectivity including security, download time, and misuse of personal data, particularly for those services such as mobile payment services (Ghosh & Swaminatha, 2001). Mobile users must be assured that their information, especially their financial data, is secure and that the transaction is secure (Tarasewich et al., 2002). This leads to the following hypothesis:

H6: The perceived system quality of mobile payment services has a positive effect upon a user’s attitude to using mobile payment services.

Several researchers have claimed that social influence is one of the main factors influencing the behavioural intentions of consumers to use new technologies (e.g.
Fang, 1998; Hung et al., 2003; Karahanna et al., 1999), due to social influence acting as a motivation for users actually to use new technologies (Kleijnen et al., 2004). However, Tayloy and Todds (1995a) argue that to identify technology acceptance, personal influence is preferred as a determinant of subjective norm, while Bhattacherjee and Premkumar (2004) prefer to examine both attributes (personal and external environment attributes).

Hung et al. (2003) indicate that interpersonal influence includes the effect of word-of-mouth communication by family, friends, colleagues, and peers. The cost of improper and incorrect information can be high. If consumers discover untrustworthy information or a lack of integrity, they can pass along this experience through word of mouth (Corbitt & Han, 2003). To identify how social influence has an impact on the behavioural intention of consumers concerning mobile payments, therefore, it is hypothesised that:

H7: Social influence has a positive effect upon a user’s behavioural intention to using mobile payment services.

Section 2.16 offered an overview of trust related to consumer acceptance. The majority of business activities have relied on trust (Butler, 1991; Fukuyama, 1995; Kumar, 1996; Moorman et al., 1992), which helps to speed up business transactions and reduce business negotiation (Ellis, 1996; Hosmer, 1995; Swan et al., 1999). A lack of trust threatens to inhibit management efforts to establish customer relationships (Dasgupta, 2000; Straub et al., 2000) and this affects a user’s confidence in conducting business online (Gefen, 2000; Jones, 2000; Pavlou, 2003).

Online retailers face more risks and uncertainties compared to traditional face-to-face commerce. Perceptions of trust in online retailers therefore have a major influence on consumer perceived risk (Doney & Cannon, 1997; Straub et al., 2000), attitude, and the intention to buy (Mayer et al., 1995) because people will avoid using e-commerce unless they have trust in it. Dahlberg et al. (2003) noted that mobile payments share the same problems with payments as severely as e-commerce because neither e-commerce nor m-commerce transactions can materialise unless services or products purchased can be paid for in a secure, easy, and efficient way, while being
acknowledged and accepted by all transaction parties at the same time (Dahlberg et al., 2003).

This view is not surprising, given that trust has been emphasised extensively in the literature (Gellner, 2000; Moorman et al., 1993; Quelch & Klein, 1996; Saunders et al., 2003). When consumers do not have a clear understanding of the terms and conditions of a transaction, they become vulnerable (Araujo & Araujo, 2003; Glaeser et al., 2000). It is possible that trust interacts with variables, such as attitude determinants, to promote a positive behaviour intention and actual use, and that trust therefore reduces perceived risk (Jarvenpaa & Tractinsky, 1999). Thus, it is hypothesised that:

H8: A user’s perceived trust in mobile payment services has a positive effect upon his/her attitude to using mobile payment services.

When an innovation provides alternative or supplementary products or services, and little effort is required to learn operations or change behaviour, potential adopters are likely to accept it (Plouffe et al., 2001). Chakravarty and Dubinsky (2004) share the same view, that the adoption of innovation can be promoted when an innovation seems to fit in to the present situation of the user, who then seems less doubtful about the inheritor, and furthermore only a short period of new learning may be involved. Using mobile payment systems only requires understanding operation procedures and application areas, and it does not change the behaviour of users concerning payment activities. The study of Chin and Gopal (1995) proposed that compatibility is a more crucial predictor than either perceived ease of use or perceived usefulness of TAM.

Rogers (1995) gives a definition of observability as the degree to which a technology can be experimented with before adoption. An innovation allows users to try a product or service. If this innovation meets an individual’s requirements, such as cost and quality of service, then they are likely to adopt it. Otherwise, they will simply reject it (Khalifa & Cheng, 2002). Plouffe et al. (2001) note that some mobile service carriers arrange booths for potential customers to try out their mobile applications. With trialability, users can gain information about mobile services, such as the limitations, capabilities, and usability (Chen & Adam, 2005a).
Rogers (1995) defines observability as the degree to which the operations and results of innovation are observable, visible or readily communicated to others. Innovations that are not easily observable have potential diffusion and adoption issues (Chakravarty & Dubinsky, 2004). An innovation should attract the attention of the potential users, in order to make them aware of the service (Moore & Benbasat, 1991).

Mobile payments systems are in a good situation, as, when a mobile payments user uses the services in public, it helps the service providers circulate services due to the potential adopters being able readily to observe the innovation (Snieska & Vasauskait, 2005). Khalifa and Cheng (2002) argued that observability is passively informing information, while trialability is the extent in which a user is active. Therefore, observability may be the most common source of adoption of mobile commerce.

These assumptions lead to the following hypotheses:

H9: Compatibility between a user using mobile payment services and the belief, values, and needs of a user has a positive effect upon his/her attitude to using mobile payment services.

H10: The trialability of mobile payment services has a positive effect upon a user’s attitude to using mobile payment services.

H11: The observability of mobile payment services has a positive effect upon a user’s attitude to using mobile payment services.

3.9 Summary

The TAM and the IDT have been widely used and modified to predict technology acceptance behaviours regarding different aspects of Information Technology, including mobile commerce (Hung et al., 2003; Venkatesh et al., 2003). Both are powerful theories to predict user acceptance of technology (Koufaris, 2002). The TAM includes two important factors: perceived ease of use and perceived usefulness.
(Davis, 1989). In the mobile payments context, the characteristics of the systems need to be understood in order to design and implement an easy-to-use application (Okazaki, 2005b). In turn, people are normally looking for convenience, speed, and other rewards for using the systems (Hung et al., 2003). Therefore, a system classified as high in perceived usefulness would lead to a positive user acceptance relationship (Chou et al., 2004).

The IDT put forward by Rogers (1995) proposes that five factors could explain the adoption of new technology: relative advantage, complexity, compatibility, trialability, and observability. Moreover, in order to understand the acceptance of mobile payments, three factors (compatibility, trialability, and observability) have been used to conduct the research in this thesis.

Hence, without an understanding of the acceptance of new technologies by consumers, mobile payment services will simply be put at risk, with no clues to predict the future, only hope and expectation. To gain the development of and learn lessons from e-commerce (e.g. Corbitt & Han, 2003; Gefen, 2000; Hoffman, Novak, & Peralta, 1999), there is obviously an urgent need to investigate consumer acceptance of mobile payments at as early a stage as possible.

The next chapter will present the research methodology that will be applied in this research study.
Chapter Four: Research Methodology

4.1 Introduction

This chapter presents the conceptual and philosophical background for the research in this thesis. It also provides a discussion of the methodological foundations for the research in this thesis. The two main research paradigms and research philosophies in information systems research will be discussed, and the appropriate research approach, research strategy, data collection methods to be adopted in the research studies will be identified. The research in this thesis focuses on the quantitative positivist research approach.

This chapter will begin with a discussion of the two main research paradigms: the positivist and interpretive paradigms. The advantages and drawbacks of these two paradigms when applied to information systems research will be examined and compared. The next section will discuss and explain the reasons for selecting a quantitative positivist method as the main approach for the research in this thesis, followed by the identification of the strategies for the research in this thesis, and an explanation of why the strategies should be employed.

4.2 Research in Information Systems

Research in IS is an emerging field, and many researchers have different standpoints to studying this field. For example, IS research can be seen as a combination of computer science and business management study, with different perceptions and approaches to conducting research (Checkland & Holwell, 1998). On the other hand, Land (1993) and Lee (1999) suggest that IS research can be viewed as multidisciplinary research. Lyytinen and King (2004) also suggest a new concept for IS research, the ‘market of ideas’. They discussed that IS research should focus on information exchange based on system design and management; in addition, the relative technologies that have been implemented in the systems should be considered. Therefore, from these standpoints, IS research could include all relevant research disciplines.
With reference to data, many information systems studies are concerned with the relations between information technology, individuals and organisations. Some studies are concerned with the implementation of information technology in organisations (Franz & Robery, 1984; Markus, 1983). Other studies are involved with understanding how information technology affects individuals’ satisfaction (Baroudi, 1985; Bartol, 1983). Much research has been conducted into the implications of the widespread use of information technology in society (Kling & Iacono, 1984; Turner 1984).

There are several different philosophical perspectives that could be used to conduct research into information systems. Chua (1986) proposes the classification of the assumptions contained in the philosophical arena. In the following sections, these assumptions are used to examine the positivist research and the interpretive research in detail. Chua (1986) presents three sets of beliefs: beliefs about physical and social reality, beliefs about knowledge, and beliefs about the relationship between knowledge and the empirical world respectively.

**Beliefs about physical and social reality.** These beliefs concerned with research into the nature of phenomena. If the empirical world is objective, people are independent in their research. Alternatively, the empirical world is subjective, and people can create and recreate the action through the research.

**Beliefs about knowledge.** These beliefs contain two sets of assumptions, epistemological and methodological assumptions. Epistemological assumptions focus on the criteria of valid knowledge by which a phenomenon may be constructed and evaluated. Methodological assumptions state the appropriate research methods and techniques for data collections.

**Beliefs about the relationship between knowledge and the empirical world.** These beliefs concentrate on the role of theory in the research world. Moreover, they indicate the values of the research and demonstrate what it is that researchers believe is appropriate for the completion of the research.
4.3 Research Paradigms

A researcher’s philosophy would depend on how they think about the development of knowledge, and it will affect the way they conduct their research (Saunders et al., 2003). Saunders et al. (2003) point out that no one research approach is better than another, and the choice of the appropriate approach much depends on the research question.

The research paradigm selection issue has emerged in the IS research (Moody & Buist, 1999). For instance, Benbasat and Weber (1996) encourage the use of a paradigm in IS research in order to keep diversity under control. Moreover, Benbasat and Zmud (2003) propose the ‘core properties’ for IS researchers, with the aim of attaining better governance of IS research. Thus, it is difficult to establish a dominant paradigm in the IS field.

There are two main research paradigms or philosophies: positivist and phenomenological (Collis & Hussey, 2003). However, this thesis will use the term ‘interpretive’ rather than phenomenological. This is because ‘interpretive’ offers a wider philosophical perspective and avoids confusion with the methodology of phenomenology (Collis & Hussey, 2003).

What is a paradigm? In scientific research, ‘paradigm’ refers to the status of a scientific study and the beliefs of the basic system (Guba & Lincoln, 1994). Collis and Hussey (2003) describe a paradigm as the progress of scientific research derived from people’s philosophies and assumptions about the world and the nature of knowledge. Khun (1997) points out that a paradigm offers theories, methods and techniques of defining data. Khun’s view shows that a paradigm is the centre of the scientific progress. Furthermore, in order to classify clearly the uncertainties of paradigms, Morgan (1979) provides three different angles from which to view paradigms in academic research: philosophical, social, and technical. This offers very good definitions for scientific researchers to recognise and understand personal research paradigms, because this will influence a research design.
Orlikowski and Baroudi (1991, p2) summarise that ‘positivist studies are premised on the existence of a priori fixed relationships within phenomena which are typically investigated with structured instrumentation’. Positivist research is used to test hypotheses and generalise the phenomenon from tested hypotheses. Positivist research evaluates causal relationships that form the basis of generalised knowledge (Chua, 1986).

Orlikowski and Baroudi (1991) state that interpretive research is used to identify and investigate the social processes in a social group: this process is used to understand how meanings, beliefs and intentions of the members assist to constitute their social action. Moreover, interpretivist research is capable of obtaining in-depth information in the area of research (Walsham, 1995).

Carson et al. (2001) summarise the criteria that distinguish between a positivist paradigm and an interpretive paradigm. First, a positivist paradigm normally assumes that reality is objective and the research is independent of the researchers and their instruments. However, an interpretive paradigm does not predefine dependent and independent variables: it attempts to identify and understand phenomena via the meaning that people assign to them. Second, in a positivist paradigm, the research may require large samples. In contrast, interpretive research could use small samples. Third, positivist research focuses on testing a theory, but in an interpretive paradigm, the researcher concentrates on building a theory.

Orlikowski and Baroudi (1991) suggest that qualitative research could fall into positivist, interpretive, and critical paradigms. Guba and Lincoln (1994) argue that qualitative research could be sorted into positivism, post-positivism, critical theory and constructivism paradigms. Some researchers, such as Healy and Perry (2000) and Jacob (1988), have adopted this classification in their research. There are multiple realities existing in the academic research domain and they are viewed from different angles.

Some researchers prefer to use both quantitative and qualitative methods (Carson et al., 2001; Fielding & Fielding, 1986; Orlikowski & Baroudi, 1991). Using more than one research method offers more stances on the phenomena to be researched (Carson
et al., 2001). The research in this thesis has used both quantitative and qualitative methods. Due to the nature of the topic of mobile payments, which is such a new and dynamic application, and concerning which little empirical research has previously been conducted, thus the researcher believes that using multi-methods could offer more stances on the phenomenon of mobile payments (Johnson & Onwuegbuzie, 2004). In addition to this, some researchers argue that using traditions and paradigms is inflexible and unhelpful, and is often too positivist in perspective (Atkinson, 1995; Atkinson, Hammersley, & Delamont, 1998; Bhaskar, 1998; Fleetwood, 1999).

4.4 Positivist Research and Interpretive Research in Information Systems

A fundamental source of diversity is the differing philosophies followed by researchers. Interpretive, positivist, critical and critical realist approaches can all be found in IS research (e.g. Mingers, 2003). However, the processes of understanding and analysing the research employ inductive logic or inductive reasoning, and outcomes are reported from the subjective frame of reference of the researchers (Lee, 1999; Walsham, 1993; Walsham, 1995).

In general, positivist research attempts to test established theories in order to gain a better understanding of the predictive phenomena (Orlikowski & Baroudi, 1991). Many IS researchers have adopted a positivist philosophy in their research (e.g. Mingers, 2003; Nandhakumar & Jones, 1997; Walsham, 1995).

The research in this thesis is dominated by the philosophy of positivism in IS research. Moreover, due to the dynamic and emerging nature of this research topic, and the absence of many existing cases for this research, the researcher has attempted to integrate the ‘interpretive’ idea by investigating the context within which the research is conducted. The research in this thesis is thus intended to fit between understanding the reality of the investigated phenomenon and the positivistic observations that have been obtained from the empirical studies.
The following sections discuss two research philosophies, the positivist and interpretive, which have been used to conduct research into IS research.

**4.4.1 Positivist Research in Information Systems**

Positivist research has a good reputation as a research tradition (Halfpenny, 1982). It provides a visible solution to the understanding and analysis of the information systems phenomenon (Araujo & Araujo, 2003; Fung & Lee, 1999; Quaddus & Achjari, 2005). Traditionally, positivism was derived from empirical testing in order to justify theory (Healy & Perry, 2000). Giddens (1974) states that it was originally introduced in social research to explain and predict social phenomena. In the past, a number of information systems researchers have used this approach (e.g. Anderson et al., 1987; Kimmel et al., 1980; Quaddus & Achjari, 2005). Positivist research attempts to explain causal relationships and to use objective facts and statistical and mathematical analysis (Chua, 1986), which would be well suited to answering the research questions. This is because positivist research uses formalised techniques to discover and measure independent facts (Chua, 1986).

Furthermore, Lincoln and Guba (1985, p.36) propose the following precepts of the study of natural phenomena in positivism:

1. The phenomenon of interest is single, tangible, and fragmentary, and provides a unique description of any aspect of the phenomenon.
2. The object of inquiry is independent from the researcher, and observation reports and theory statements are distinct from each other.
3. The scientific concepts are rigorous and invariant in their meanings.
4. Where uni-directional cause-effect relationships exist, the research used hypothetic and deductive logic and analysis to identify and test the relationships.
5. Inquiry is value-free.

However, some of these precepts are problematic where research into social phenomena is concerned, and can compromise some daily research activity (Galliers
& Land, 1987). The next section reveals three philosophical assumptions rooted in this research tradition.

4.4.2 Philosophical Assumptions of Positivist Research

Chua (1986) proposes the classification of the assumptions contained in the philosophical arena. These assumptions are used to examine positivist and interpretive research in detail. Chua (1986) presents three sets of beliefs: beliefs about physical and social reality, beliefs about knowledge, and beliefs about the relationship between knowledge and the empirical world. However, two sets of beliefs from Chua (1986) will be used to examine the assumptions underlying the positivist research philosophy. This will also apply to interpretive research in a later section.

Beliefs about knowledge. These beliefs contain epistemological and methodological assumptions (Chua, 1986). Epistemology refers to the relationship between the reality and the researchers. Epistemological assumptions in positivist research are concerned with the theories and assume it is possible to obtain solid, objective knowledge (Collis & Hussey, 2003). The research focuses on generalisation and abstraction, and uses theories and tests hypotheses. For example, an epistemological assumption would be required to test a theory using empirical events. In order to support an epistemological assumption, a positivist research approach would approve several research methodologies. Methodology refers to the techniques used to conduct empirical research.

At the level of methodology, positivist research focuses on description and explanation (Orlikowski & Baroudi, 1991). It aims to identify an external reality (Boland, 1979). Predominantly, the researchers will use mathematical and statistical methods to conduct research (Malhotra & Birks, 2003). For instance, large-scale sample surveys or controlled experiments may be considered as data collection techniques. However, the validity and reliability of the instruments are vital to the research process (Collis & Hussey, 2003).

Beliefs about physical and social reality. Ontology is the nature of reality (Chua, 1986). Positivism believes that objective and social reality exist independent of
scientists/researchers or, indeed, mankind (Chua, 1986). Understanding research phenomena is initially a problem of measurement, and this is because an appropriate set of constructs are required to identify the essence of the phenomenon (Orlikowski & Baroudi, 1991). Chua (1986) claims that social science is based on human intention and rationality, and most researchers assume that human action is intentional and rational from the positivist perspective.

The different purposes of research studies will require different ontological, epistemological and methodological engagement (Carson et al., 2001). Research into the information systems domain involves investigation into the system infrastructure, and this can be industry or company specific. From the viewpoint of ontology, positivism believes that there is direct access to the real world, and that this is a single external reality.

Positivist research requires researchers to use scientific logic, quantitative and mathematical methods to manipulate pre-defined variables in order to present the statistical output for the research (Collis & Hussey, 2003). These methods are appropriate in scientific research. Quantitative research is capable of determining the correlation between technological, organisational, and individual variables (Orlikowski & Baroudi, 1991).

Positivist research uses the variables to emphasise the issues and research. It does not look at the context to explain the different social consequences in implementing information systems in organisations or society.

However, Gallier and Land (1987) express concern about capacity and feasibility to conduct research into technology, organisations and individuals. This is because an information system is not only a technical system that includes environmental and human factors (Guba & Lincoln, 1994). Moreover, positivist research is unsuitable for investigating social phenomena, as they are not easy to predict and control (Guba & Lincoln, 1994).
4.4.3 Interpretive Research in Information Systems

The view of social constructionists is the core difference between positivist research and interpretive research (Klein & Myers, 1999). The aim of interpretive research is to understand actors through their participation in social processes, and to show how the meaning, beliefs, and intentions of actors, develop their social action (Orlikowski & Baroudi, 1991). Creswell (1994, p7) proposes:

“an inquiry process of understanding a social or human problem based on building a complex, holistic picture, and conducted in a natural setting.”

However, the process of understanding and analysing the research employs inductive logic or inductive reasoning, and outcomes are reported from the subjective frame of reference of the researchers (Lee, 1999; Walsham, 1993; Walsham, 1995).

4.4.4 Philosophical Assumptions of Interpretivist Research

Two sets of beliefs from Chua (1986) will be used to examine the assumptions underlying the positivist research philosophy.

Beliefs about knowledge. Rosen (1991) proposes the epistemological belief of interpretive philosophy, arguing that social process is not engaged in hypothetical deductions, covariance, and degrees of freedom. Instead, understanding social process encompasses getting inside the world of those generating it. This view of interpretive research is totally opposite to that of positivist research. From epistemological viewpoint, the nature of knowledge is subjective (Collis & Hussey, 2003). Interpretive research focuses on the specific and concrete context (Klein & Myers, 1999). Moreover, social and cultural factors are included in the context, and interpretive researchers believe that knowledge is changeable. Thus, understanding the language actors use to describe social reality is very important. Interpretive researchers propose the interacting causality models, and attempt to understand an actor’s view of the social world. Consequently, the research methodology of interpretive research concentrates on understanding and on the interpretation context (Rosen, 1991).
Researchers understand the influence of both the scientific aspect and the daily life experience. Field studies are the most appropriate research method for interpretive research, and can generate knowledge within the context of a social setting. Interpretivist research uses in-depth examination in the field to extract the constructs and reveal the phenomenon. Rowan (1973) points out that participants in positivist research can only respond to pre-defined specific questions and categories, but in interpretivist research, participants are able to express their views in their own words, or even in images. It helps them to present their concepts and experiences (James, Anh, & Smith, 2000).

**Beliefs about physical and social reality.** Interpretive research in information systems assumes that human action and interaction support the social world (James et al., 2000). Moreover, Morgan (1985) asserts that interpretive perspective highlights the importance of subjective meanings. The purpose is to understand individual interaction with socialisation in a social world, and to give it a certain status and meaning. Fay (1987) also suggests that the research participants’ basic conceptions contain certain types of social action.

Interpretive researchers involved in information systems research believe that social phenomena must be understood via interpretations of information systems. The aim of interpretive research is to gather information as to how organisations interact with information systems (Silverman, 2000). As interpretive researchers realise that the meanings of interpretation are negotiable, interpretations of the reality may vary from time to time as circumstances, intentions and constituencies change (Orlikowski & Baroudi, 1991).

However, Nandhakumar and Jones (1997) point out that researchers could interpret actors incorrectly, and actors may not want to raise a set of issues or may possibly mislead a researcher’s understanding.

### 4.5 Research Methods for Information Systems

Research methods can be classified as quantitative or qualitative (Myers & Avison, 2002). Quantitative methods have originated from the natural sciences, and such
research has been conducted in the social sciences through survey methods, laboratory experiments and other methods (Saunders et al., 2003). In general, numbers to represent values and levels of theoretical constructs are always involved. Quantitative methods offer the interpretation of these values to provide positive scientific evidence of why a phenomenon occurs. The quantitative methods and techniques allow researchers to use statistical tools and packages, such as SPSS, to analyse data. The emphasis on numerical analysis is also a necessary condition to meet positivist assumptions.

Qualitative methods have developed in the social sciences and much of this type of research has been conducted to investigate social and cultural phenomenon (Silverman, 2000). This method is essential for understanding the social and cultural contexts within organisations. Case study research is one of the popular qualitative methods (Pare, 2004). Depending on the underlying philosophical assumptions of a researcher, qualitative research could be positivist, interpretivist or critical.

The foregoing sections have outlined the characteristics of positivist research and interpretive research, and discussed the advantages and disadvantages of using each paradigm in information systems research. Both research philosophies offer an insightful perspective into the phenomena of interest in information systems research. What is required is that researchers understand the implications of their research perspective, and act in ways that reflect that knowledge. Researchers should understand and acknowledge the extent to which the perspective they adopt will focus their attention on some things and not others and influence their perception of the phenomena they study.

There is diversity in IS research, especially when it is required to identify philosophical approaches and methods. Burrell and Morgan (1979) point out that research should be developed independently because of the different natures of research subjects, philosophies of science and methods. In addition, diversity would continue to play an important role in IS research, and it adds value to IS research by providing strength and vitality for the IS field (King & Lyytinen, 2004; Lyytinen & King, 2004).
An extensive analysis of the debate concerning research paradigms and philosophical approaches is beyond the scope of the research in this thesis. As Burrell and Morgan (1979) suggest, the identification of appropriate research approaches depends on the research questions and objectives, and Moody and Buist (1999) also emphasise that a research method appropriate to answer the research questions is required.

A positivist philosophy is adopted for the research in this thesis. In IS research, due to the development of new technology, the acceptance and adoption of information technology has been extensively investigated and researched during the last two decades (e.g. Davis et al., 1989; Lyytinen & Yoo, 2002; Taylor & Todd, 1995b). The TAM and IDT have been employed in the research, and it is typically used in positivist science. Moreover, the nature of the objectives of this research study is identifying associations between factors and establishing the cause and effect relationships between the factors. Therefore, the research in this thesis has adopted a quantitative, positivist research (QPR) approach as the main philosophy and methodology to guide the empirical studies.

The rationale behind this selection is the evidence that QPR is one of the established and robust ways of studying human behaviour and interaction with the use of technology. Straub et al. (2005) summarise that researchers can use QPR to address research questions related to the interaction of humans and computer machines. Moreover, QPR depends on analytical modelling and assumptions to interpret reality.

Second, the nature of the investigating system fits better into a positivist paradigm. Information systems research expects a variety of research approaches in addressing related issues and factors (Nandhakumar & Jones, 1997). Regarding information systems as socio-technical systems, disciplines from social sciences encompassed (Orlikowski & Baroudi, 1991). This research attempts to identify the relationship between the factors present in the research model. It is, therefore, appropriate to use quantitative research, typically using structured instruments to collect data about users’ behaviour. This approach gathers data from formal propositions, measures quantifiable variables, and demonstrates the inferences of phenomena for the general public.
Third, the underlying philosophical assumptions of positivist research are governed by hypotheses and stated theories (Malhotra & Birks, 2003). The research in this thesis intends to investigate whether the TAM and IDT could be applied to mobile payment applications.

Finally, the positivist paradigm views technology adoption as a social and situational process (Chua, 1986). This matches the objective of this research. The current issues in the existing mobile payments research are a lack of studies into users’ attitudes toward mobile payments at the time of the research and the need to identify a user acceptance model of mobile payments that includes behavioural and technological considerations. Scientific and positivist approaches have been chosen and are considered appropriate.

However, these data gathering methods have some limitations for information systems research, given the social-technical nature of the chosen field. Due to the very complex nature of the industry and the mobile payments system itself, it was extremely difficult to obtain information and identify the mobile payment case for this research. As the subject of this thesis is consumer acceptance of an information system product, which is a relatively new application, not much research had been conducted in this field at the time of this research. Thus, supplemental interpretive approaches could be used to support this research, especially concerning more in-depth understanding of what consumers need in a mobile payments system. Therefore, qualitative methods should be included in this research.

In IS research, there is a need to conduct research driven by practice and society, rather than by research theory (Lee, 1999; Moody, 2000). Furthermore, the research in this thesis derives from the real needs of the industry. The adoption and use of new payments systems is a major issue both for academic researchers and industry analysts (Adams & Schvaneveldt, 1991).
4.6 Research Approach

In this section, the research approach that flows from the research philosophy is considered.

There are two different research approaches, the deductive approach and the inductive approach (Saunders et al., 2003). In this thesis, both approaches have been used. In the deductive approach, researchers develop a theory and hypothesis, and design a research strategy to test the hypothesis. On the other hand, in the inductive approach, researchers collect data and develop a theory as a result of the data analysis. The following Table 2 summarises some of the major differences between the deductive and inductive approaches to research.

<table>
<thead>
<tr>
<th>Deductive approach</th>
<th>Inductive approach</th>
</tr>
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<tbody>
<tr>
<td>Scientific principles</td>
<td>Gaining an understanding of the meanings humans attach to events</td>
</tr>
<tr>
<td>Moving from theory to data</td>
<td>A close understanding of the research context</td>
</tr>
<tr>
<td>The need to explain causal relationships between variables</td>
<td>The collection of qualitative data</td>
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<tr>
<td>The collection of quantitative data</td>
<td>Less concern with the need to generalise</td>
</tr>
<tr>
<td>A highly structured approach</td>
<td>A more flexible structure to permit changes of research emphasis as the research progress</td>
</tr>
<tr>
<td>The necessity to select samples of sufficient size in order to generalise conclusions</td>
<td></td>
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</tbody>
</table>

Table 2 Major Difference between Deductive and Inductive Approach to Research (Saunders et al., 2003, p89)

Creswell (1994) suggests that the adoption of an appropriate approach for research depends on the nature of the research topic. In this thesis, a research model is proposed to address the research question, which lends itself more readily to the deductive approach.
4.6.1 Deductive Approach

The deductive approach involves the development of a theory, and it is mostly used in natural science research (Saunders et al., 2003).

Robson (2002, p19) proposes five sequential stages for deductive research, as shown in the following:

- Deducing a hypothesis from the theory
- Proposing a relationship between specific variables in a hypothesis
- Testing the hypothesis
- Examining the specific results of the inquiry
- Modifying the theory in the final finding (if necessary)

The research in this thesis has adopted this synthesis of approaches in its empirical work. Moreover, there are some important factors that need to be considered during the deductive approach (Saunders et al., 2003). First, the causal relationship between variables needs to be established and explained. This research draws from the study of the literature in e-commerce and mobile application-related topics and theory to establish a relationship between variables, thus ensuring the pursuit of the principle of scientific rigour. Moreover, the deductive approach requires the facts to be measured quantitatively. In this thesis, the researcher has strictly defined the questions to evaluate the research question. Finally, because the outcome from the deductive approach is a generalisation, it is vital to select samples of sufficient numerical size. This research has considered this issue seriously and carefully to select the sample for all the studies, which thus allows inferences to be made from the results.

4.6.2 Inductive Approach

Social science researchers are critical of the deductive approach concerning cause-effect links being made between variables: in addition, the way humans interpret their social world is not fully understood (Saunders et al., 2003). Inductive research is an alternative approach, and it has the strength to develop such understanding. The
inductive approach can use a small sample of subjects to conduct the research: moreover, it is more likely to use qualitative data in order to identify and explore different views of phenomena (Easterby-Smith et al., 2002).

Easterby-Smith et al. (2002) conclude that there are three reasons that the inductive approach could be appropriate for a research project. First, it allows the researcher to configure the research and take a more informed decision about the research. Second, the inductive approach is more appropriate to adopt to gain an understanding of why something is happening. Finally, it could assist researchers to conduct research when there is a lack of prior knowledge of the subject. As mentioned earlier, there was a lack of literature related to mobile payments research at the time this research was conducted. It was thus appropriate to include an inductive approach in this research.

4.7 Research Strategy

The research strategy is a general plan for how to answer the research question. It contains clear objectives from the research. This part is crucial, as it indicates why a particular strategy has been adopted (Adams & Schvaneveldt, 1991). The positivist approach is based on natural sciences. Users’ acceptance of a new technology or service is an emerging topic in information systems development. This research addresses the issues surrounding the factors that influence users’ usage in mobile payment systems and attempts to address these issues based on the TAM and IDT theoretical framework. This research is confirmatory in nature. It seeks to test a set of pre-specified relationships. The factors will be justified, and relationships will be identified. The empirical data will be identified and the determinant factors that influence users’ acceptance of mobile payments will be examined.

The research in this thesis consists of three different studies that would answer the research question and achieve the objective. Study one is a focus group study, an interview-based field survey, which, in the classification of Orlikowski and Baroudi (1991), is one-shot cross-sectional work. Potential mobile payment users were targeted for this study. The aim was to explore what they think about mobile payments, and why they would adopt this application. However, it was more
important to identify the attitude and behaviour of existing mobile payment users toward mobile payments. Therefore, a case study was selected as study two, for which ZOOP mobile payment, a large-scale, commercial, and infrared-based mobile payments system, was identified. At the time of this research, it was the only successful commercial proximity payments application to be identified. These two studies will lay the foundations for the final study. Two sets of data were obtained. The followed section presents the reasons for using multi-methods for this research.

Lau (1997) pointed out that there is an increasing number of IS publications that have used alternative theories or methods to conduct research into the development, adoption and use of information systems (Checkland 1981; Lee 1989; Markus & Robey 1988; Orlikowski 1992; Walsham 1995). A mixed-method approach is one such alternative mode of inquiry for information systems research. The purpose of using a mixed-methods approach in this research is to maximise the strengths and minimise the weaknesses in both a single research study and across studies, which is particularly useful to conduct the research in this thesis on an emerging and dynamic application (Johnson & Onwuegbuzie, 2004). The nature of the research topic and the research questions influenced and determined the choice of the research methods.

In this research, a supplementary qualitative method, focus groups research, is used to support the quantitative method, and the results from the qualitative approach in study one would support study two in answering the research question. In study one, the qualitative methods indicate and explore what consumers perceive about mobile payments. This issue is very important, as not many research studies had been conducted in this area at the time of the research, and this study could provide more in-depth information regarding mobile payments, and thus lead in to study three. This research approach has added value to the research. It offers the researcher the ability to investigate the research topics within a real-world situation, and improves the quality of the research (Lau, 1997).

Moreover, information systems are becoming more and more complex, and involve more than one actor in the systems: for example, mobile payments system involves a complex information system, and it includes different actors in the system. The success of the system required a social change that established a new form of
organisation. Thus, qualitative research improves the understanding of real-world problems.

This section presented and justified the multi-methods approach for this research. The researcher argues that due to the nature of the topic, such as dynamic applications, multi-methods are required to accomplish this research. Mobile payments research also needs to be investigated and studied in a real-life setting in a unique situation rather than undertaking experimental research: the outcome will then be more convincing to the industry. Therefore, for this type of research, a multi-methods approach is the most appropriate.

A research strategy should be selected on the basis of the purpose of the research and the nature of the research area (Checkland, 1981), as mentioned in the above discussion.

In the following part of the chapter, research strategies that have been widely adopted in information systems research will be reviewed. Research strategies in information systems research are reviewed because information systems research has been carried out extensively during the last decade. It provides rich information on a variety of aspects, including adoption, consumer acceptance and other issues within the information systems domain.

**4.7.1 Experimental Research**

The experimental approach has been extensively used in natural and social science research (Jarvenpaa & Tractinsky, 1999; McKnight et al., 2000). Moreover, it is associated with the positivist research tradition. In general, the research defines a small number of variables and controls other variables (Malhotra & Birks, 2003). Researchers identify a sample and generalise to a population (McKnight et al., 2000). The aim of this approach is to test the effect of an intervention on a result (Malhotra & Birks, 2003).
Researchers can focus on the particular factors that they are looking for and ensure a controlled environment. Therefore, researchers can test pre-determined hypotheses (Jarvenpaa & Tractinsky, 1999; McKnight et al., 2000).

However, this strategy also has its drawbacks. Sometimes, it is impossible to operate the process in experimental research (Saunders et al., 2003). How can you manipulate research participants to fit into a controlled experiment in a laboratory environment? In particular, in the investigation of trust and security issues in e-commerce transactions, it would be difficult to capture research subjects’ real behaviour and perceptions in a laboratory setting. Hence, research results will not totally convince the target audience. Because of these reasons, it would be not suitable and appropriate to introduce this research.

4.7.2 Case Study

The case study will focus on gaining a more in-depth understanding of the research context (Morris & Wood, 1991; Pare, 2004). Robson (2002) interprets the case study as ‘a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence.’ Case studies can employ a range of data collection methods to gather data, such as questionnaires, interviews and observation. This approach is particularly useful and valuable for exploring existing research theories (Saunders et al., 2003).

Researchers employ case study approaches because they enable them to concentrate on particular instances, so that they can understand the complex issues related to the topics. Moreover, the advantage of using a case study is that it has allowed insights into the use of technology and its impact on people’s lives for information systems research (Morris & Wood, 1991). Yin (1994) also suggests that case studies can assist and contribute to the research theory building process.

A case study is especially useful to gain a rich understanding of the context of the research (Morris & Wood, 1991; Robson, 2002). A case study allows researchers to explore existing theories and also enables them to challenge an existing theory. It can
employ different data collection methods, such as questionnaires, interviews and observation. Walsham (1993) suggests that the method to be adopted in the research must be ‘appropriate and rich’. Therefore, the selection of a typical case in a real-life project setting was required for this mobile payments application where issues and perception practices must be applicable. Study two meets these criteria. The system under study, mobile payments, at the time of the research was a rare application worldwide, and the case selected for this study is considered appropriate and important. Few such commercial payments applications were available at the time of this research, and ZOOP is still being used and indeed has plans to expand the market in the U.S. (ZOOP, 2002).

Study two comprised a single case study, ZOOP, over a six-month period. The purpose of this study was to investigate and explore whether and why consumers are willing to use mobile payments and what they perceive as the risks in using such mobile payments in a real-life context by collecting evidence from a commercial mobile payments system, ZOOP, in Korea. ZOOP is the world’s first commercial mobile payments system using infrared technology. ZOOP provided unique and first-hand information regarding consumers’ perceptions towards mobile payments. This study is a unique setting with a lack of literature in this area at the time of this research. This study offered insights and understanding of the nature of this dynamic application phenomenon. Moreover, the study two provided the development of the initial observations for study three.

Some researchers have suggested that case study research could present and explore a phenomenon (Benbesat et al., 1987; Wynecoop & Conger, 1991). The main purpose of study two was to describe and explore the phenomenon of mobile payments and consumer perceptions towards it. According to Galliers (1990) and Orlikowski and Baroudi (1991), case studies fall under the positivist research paradigm, and this tool could present a detailed description of a case under investigation, in order to make generalisations from the results. The case study in this research is carried out with secondary data and questionnaires.

However, when a single case study is used, the findings from this case study will be difficult to replicate in other situations (Mason, 1992). Moreover, in the case of
mobile payments research, it is extremely difficult to identify and access cases, due to
the confidential nature of business and the limited number of applications available in
the market at the time of this research. This situation occurred in study two: the details
will be presented at a later stage.

4.7.3 Survey Research

There are some reasons behind this popularity. First, a survey allows the collection of
a large amount of data from a reasonably sized population, and it can be conducted in
a highly economical way. Second, the data can be easy to analyse. Often, the data
gathered using a questionnaire are standardised (Lynn, 2003; Saunders et al., 2003).
Galliers (1990) summarises that surveys could be used to obtain snapshots of a
situation at a particular point in time. Normally, questionnaires are used to retrieve
information or events that occur over different time frames.

Saunders et al. (2003) note that the survey strategy is usually associated with the
deductive approach. Moreover, many studies looking at trust and consumer behaviour
and attitude issues have adopted this approach (Gefen, 2000; Lee & Turban, 2001).
Malhotra and Birks (2003) states that this method aims to collect data on consumers’
attitudes, opinions, impressions and beliefs. Furthermore, it allows the testing of
research hypotheses. It offers the collection of substantial amounts of data in different
ways, for example, through questionnaires. The data are in the same format, and will
thus be easy to analyse.

Two types of opinion research have been used in e-commerce/m-commerce studies.
One is used to identify and explore whether e-commerce is useful or to examine
attitudes towards using e-commerce sites (Lee & Turban, 2001). Another type of
opinion research is used to test hypotheses (Koufaris, 2002). This approach could
offer more understanding of a research topic and more contributions to the research.

Using a survey offers the researcher more control over the research process (Saunders
et al., 2003), however, the process is time consuming, and much time will be spent in
designing and piloting a questionnaire (Saunders et al., 2003). Additionally, due to the
limited numbers and types of questions that can be asked, the data collected in this way may not be as wide-ranging as other research strategies (Saunders et al., 2003).

Surveys are seen as the most appropriate method for the purpose of evaluating the proposed research model. It requires a fair amount of data to be gathered to conduct the research and the researcher has minimal control over this phenomenon in this research study.

4.8 Data Collection Methods

4.8.1 Secondary Data

To complete the research objective and answer the research question, two types of data were collected. First, secondary data from over a hundred journals was collected and formed the foundation of the investigation of consumer acceptance of mobile payments. The main purpose of the critical review, as stated by Saunders et al. (2003), is to gain a good understanding of and insight into relevant previous research. In this research, the literature was especially helpful in developing the conceptual framework mentioned in the previous chapter. There are some advantages to using secondary data (Malhotra & Birks, 2003), especially concerning time and cost savings. Moreover, secondary data provides an insight into the relevant context, and is particularly helpful for those who may have no background knowledge of the specific topic (Chisnall, 2001). However, the lack of literature and resources concerning mobile payments at the time of this research created difficulties in locating appropriate and suitable secondary data. It also helps in the design of the sampling and provides some of the details of the primary research method. However, information collected from secondary data may not be wholly appropriate to the research question (Saunders et al., 2003). As a consequence, primary data must also be collected.

Secondary data are data that have already been collected or published for other purposes rather than the research problem at hand (Malhotra & Birks, 2003). Secondary data can be quantitative or qualitative data, and the data are used mostly in case studies or survey-type research (Kervin, 1999). There are many types of
secondary data (Bryman, 1989; Dale, Arber, & Proctor, 1988; Hakim, 2000; Robson, 2002), and Saunders et al. (2003) summarise the following three main categories: documentary data, survey-based data, and multiple sources. Documentary secondary data include written documents, such as books, journals and articles, and non-written documents, for example, video recordings.

Secondary data have been used in the second study of this research, and the aim was to provide more background information and understanding of ZOOP mobile payment. The company web site and online articles were the major sources for this research. This research has not been granted access to the company resources, thus it has not retrieved any of the organisation’s data, for example, concerning how many cities have implemented this service. Moreover, due to the nature of this research, it cannot locate others types of secondary data for this study, for instance, survey-based secondary data. The secondary data have enabled the diagnosis of the research problem (Malhotra & Birks, 2003). Moreover, they have also enabled the research questions and objectives to be addressed and an approach to the problem to be developed.

4.8.2 Focus Groups

Focus group research is conducted in a non-structured and natural manner with a small group of participants, and a moderator sets the purpose of the interview, probes the participants and handles the process of discussion (Malhotra & Birks, 2003; Morgan, 1988). The focus group is a popular and important technique for new product development and advertising development (Drayton & Tynan, 1988; Graee & Schori, 1996). It can offer an amount of creative discussion and generates other activities (Malhotra & Birks, 2003).

In general, a focus group is made up of 6-12 members: Dachler (1997) argues that focus groups could not achieve a cohesive and natural discussion if the number of group members is more or less than these figures. Moreover, the members of a focus group should share some similar characteristics in terms of demographics and socio-economic characteristics (Mazella, 1997; Nelson & Frontczak, 1988). Thus, three different groups have been identified: schoolchildren, university students and
professional workers. These groups represent typical heavy users of mobile phones. It was made easy for the group members to generate and discuss their perceptions toward mobile payments.

There are a number of reasons for selecting the focus group for study one (Greenbaum, 1997; Malhotra & Birks, 2003). First, it has synergistic effect. A group of people together produce a wider range of and more valuable information, especially from the potential mobile payments users. Second, it leads to stimulation. As most of the group members were not used to or familiar with mobile payments, after a brief introductory period and examples, the respondents expressed their ideas and exposed their perceptions as the general level of excitement over the topic increased in the group. Finally, it offers an efficient way to conduct the research. Because a number of individuals are being interviewed at the same time in the same place, the data collection proceeds relatively quickly.

The setting of the focus group is vital. Malhotra and Birks (2003) suggest that a relaxed and informal environment helps participants to forget they are being questioned and observed. The focus group interviews for this research were held in the purpose-built discussion group room, which offered a friendly and informal atmosphere for the group members (Malhotra & Birks, 2003). Moreover, the length of the focus group is important: one and a half to two hours is typical and is comfortable for the majority of the participants (Malhotra & Birks, 2003). The focus group interviews in this research had a duration of between 30 minutes and an hour.

Focus groups would useful in this research in determining and identifying why consumers would adopt mobile payments. In study one, the focus groups were composed of different age groups of potential mobile payments users in the UK. The empirical work was conducted through open questions. The questions were prepared beforehand, and a brief introduction to and an outline of mobile payments were provided to the participants. The material and questions from the focus groups were supported by a review of various types of documentation such as reports, working papers, conference papers and so forth. The focus groups took on average thirty-five minutes. Materials collected during the focus groups focused on how risk is perceived within mobile payments, and what functions the participants are looking for. In order
to understand these dynamics, interpretivist research is important to capture detailed information from the participants, which would only be possible given flexible questioning during the data capture. Therefore, in this focus group study, the use of open-ended questions is preferred. This approach helps to capture the rich context, and it also helps to identify the issues surrounding and perceptions toward mobile payments. Some researchers have applied interpretations in IS research to their field study material in order to fill in gaps and inconsistencies in the materials until everything becomes clear in their minds (Orlikowski 1991, Walsham, & Waema 1994, Myers 1994).

4.8.3 Questionnaires

In this research, the empirical data was collected using questionnaires, the most widely used technique for QPR (Chen & Hirschheim, 2004; Palvia et al., 2004). They were administered by an Internet-based survey.

The questionnaire is a structured technique for data collection that includes sets of questions, written or verbal, that a respondent answers (Malhotra & Birks, 2003). A questionnaire is always associated with a survey strategy. Moreover, experimental and case study strategies can employ these techniques (Saunders et al., 2003). However, for example, Kervin (1999) argues that questionnaires are exclusively for surveys.

Although the questionnaire is one of the most widely used survey data collection techniques, it is very difficult to construct a good questionnaire (Bell, 1999; Oppenheim, 2000). A questionnaire is required to collect the exact data set by the researchers to answer the research questions and to achieve the objectives (Saunders et al., 2003). For example, Dillman (2000) presents a tailored questionnaire-design method in order to maximise response rates, validity and reliability.

Questionnaires can be used for descriptive or explanatory research. Descriptive research is exercised to determine the factors that influence users’ attitudes and opinions toward organisations or services. This information could assist researchers to identify and describe the variability in different phenomena. Malhotra and Birks (2003) note that descriptive research is suitable for pre-planned and structured
investigations, due to the existing formulation of research questions and hypotheses (e.g. Araujo & Araujo, 2003; Ba et al., 1999; Fung & Lee, 1999). On the other hand, explanatory research can enable researchers to examine and explain cause-and-effect relationships (Gill & Johnson, 1997). Study two and study three in this research could be appropriate to the use of questionnaires.

As Saunders et al. (2003) suggest, a questionnaire survey allows the collection of a large amount of data from a sizeable population quickly and in a highly economical way compared to other methods mentioned. Moreover, study three has pre-defined all variables in advance: the survey technique fits well with this situation. This strength of the survey method is vital for this study due to its confirmatory nature.

The criterion of selection for this type of questionnaire was influenced by factors related to the research questions and objectives, and these factors are as follows:

A. Characteristics of potential participants
Questionnaires are used in study two and study three in this research. The targeted respondents are mobile payments users. However, for study two, all the potential responders are resident in Korea. Due to the physical distance between the location of the researcher and the potential respondents, it was appropriate to use self-administered, on-line questionnaires, which saves time and resources and is more efficient. In study three, data set one, all mobile payments users were welcome to participate this study; however, as the literature review indicated, not many existing mobile payment systems are available at the moment. However, it is difficult to target many participants in different geo-locations. Thus, publishing the questionnaire on the Internet could attract more of the targeted respondents, and would offer greater control for the researcher (Witmer et al., 1999).

B. Size of the sample
The size of the sample for the research in this thesis would have implications for confidence in the research outcomes (Saunders et al., 2003). Interviewer-administered questionnaires will generally have a higher response rate than self-administered questionnaires (Saunders et al., 2003). However, as mentioned above, as it was
extremely difficult to get hold of the targeted respondents, an electronic questionnaire would be a good alternative to achieve a substantial number of responses.

C. Type of questions
The questions in the questionnaire for this research are simple to answer and have been tested in pilot studies. Therefore, these self-administered questionnaires are appropriate for the research in this thesis.

The choice to use questionnaires for study two and study three was made for the following reasons:

A. Time availability. Using questionnaires offers the researcher more flexibility and control of the research.

B. Financial implications. Questionnaires have provided a convenient and economic way to conduct the research in this thesis.

C. Ease of automating data entry.

D. Availability of getting access to targeted participants. Due to the lack mobile payment systems, it was difficult to identify appropriate applications and to get in touch with users. For instance, one service provider did not allow the researcher to contact their customers, and the only way they would help was to deliver the questionnaires to potential respondents.

There are different types of questionnaires depending on how they are administered. As shown in Table 3, based on the categories developed by Saunders et al. (2003), there are two main types of questionnaire, self-administered and interviewer-administered questionnaires. The research in this thesis selected questionnaires that are delivered and returned electronically via either email or an online questionnaire (Hewson et al., 2003). For study two and study three, the researcher had decided to administer the questionnaire using the Internet. For example, study three has been publicised through a range of Bulletin Board Systems (BBS) related to mobile
business, e-commerce and mobile technologies areas asking volunteers to fill in the questionnaire.

<table>
<thead>
<tr>
<th>Self-administered Questionnaire</th>
<th>Interviewer-administered Questionnaire</th>
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<tbody>
<tr>
<td>Electronic questionnaire</td>
<td>Telephone questionnaire</td>
</tr>
<tr>
<td>Postal questionnaire</td>
<td>Structured interview</td>
</tr>
<tr>
<td>Delivery and collection questionnaire</td>
<td></td>
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</tbody>
</table>

Table 3 Types of Questionnaires (Saunders et al., 2003)

For example, study three is causal research and also used questionnaires. As mentioned earlier, conclusive research requires a planned and structured design, thus the final study in this research was well planned. It used two different sets of data to test the proposed model in order to identify the relationships between factors. In study three, the survey questionnaire was sent to mobile payments users worldwide: all participants were already using mobile payments systems. The survey was aimed at providing an understanding of the experience of the customers of mobile payments, and their patterns of behaviour with regard to the usage of mobile payments. Moreover, the survey aimed to discern the relationships between these factors.

4.8.4 Sample Selection

It would be impossible to collect or analyse all the data available for many research questions due to constraints of time, money and often access. Thus, sampling techniques offer a set of methods that allow researchers to consider only data from a subgroup (Saunders et al., 2003).

For the research in this thesis, it would be impracticable to survey a large population. First, mobile payment applications were relatively rare at the time of this research, and it was difficult to identify mobile payments cases and users. Second, it was extremely difficult to obtain permission to collect data from mobile payments service providers: in such a competitive industry and with such a competitive application, the service providers do not want to share or publish information. This research has attempted many times to get access to data from ZOOP mobile payment, but it was unsuccessful: the management team did not want to participate in the research.
Finally, the overall cost is a major factor. Therefore, a sample must be selected for this research, and a combination of different sampling techniques should be used. Henry (1990) suggests that using a sample in research could possibly result in higher overall accuracy than obtainable with a census.

The choice samples should be decided by the nature of the research, the topic, and the variability in the population. To answer the research questions and meet the objectives of the research in this thesis require in-depth study to be conducted that focuses on selected cases and subjects. Moreover, limited resources may also result in the decision to use one or a number of non-probability sampling techniques (Saunders et al., 2003). For instance, with the research in this thesis, in the second study, the purposive sampling and self-selection sampling in selecting respondents with particular qualities may be far more effective than any form of probability sampling, due to there not being many commercial and successful mobile payments systems available in the market at the time of the research. This nature matches the requirements for study two in this research. The findings from this study answer the research question and inform the subsequent study. The sampling techniques have been summarised for the research in this thesis, as shown in Table 4.

<table>
<thead>
<tr>
<th>Study</th>
<th>Method</th>
<th>Sampling techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>one</td>
<td>Survey</td>
<td>Quota sampling and convenience sampling</td>
</tr>
<tr>
<td>two</td>
<td>Case Study</td>
<td>Purposive sampling and self-selection sampling</td>
</tr>
<tr>
<td>three</td>
<td>Survey</td>
<td>Self-selection sampling</td>
</tr>
</tbody>
</table>

Table 4 Sampling Techniques

These abovementioned scientific approaches aim to cope with the rapid changes taking place in information technology and the impacts on individuals, organisations, and society in general. They offer an opportunity to investigate the situations (Galliers, 1991). The research in this thesis aims at a better understanding of the phenomenon of the impact of mobile payments on consumers and proposes a consumer acceptance model for mobile payments, which may be applicable to similar,
dynamic, new information systems (Avison et al., 1998). The research in this thesis also generates descriptions of the concepts and phenomenon of mobile payments.

This chapter presents the research design adopted by this research. The philosophy behind the IS research has been presented and discussed, and the appropriate research methods for the research in this thesis identified. A discussion of different types of research design and the rationale for the selection were presented. The next chapter presents the implementation of three different studies in detail.
Chapter Five: Research Implementation

The chapter presents the details of how three research studies in this thesis have been implemented according the discussion in chapter four.

5.1 Study One – Potential Mobile Payments Users’ Focus Groups Interviews

The aim of this study was to gain a better understanding of potential mobile payments users’ expectations and concerns with regard to the use of mobile payments. In order to meet this objective, a focus group was conducted and the results from potential users of mobile payments were analysed. The reason for selecting focus groups to collect the data has been discussed in section 4.8.2. Not surprisingly, as mentioned in the literature review, at the time of this research, there has been relatively little empirical research on mobile payments, especially focusing on the attitude and behaviour of consumers toward mobile payments, and very little research on target users that could assist in understanding potential issues.

Focus groups research has been widely used since the 1940s in a range of disciplines (Auramo, Aminoff, & Punakivi, 2002; Roussos, Peterson, & Patel, 2003; Vaughn, Schumm, & Sinagub, 1996). Focus groups involve relatively small group of people having a focused interview on a specific topic, in this case, mobile payments. A moderator helps to organise and interact with group members (Saunders et al., 2003). In this study, the researcher has acted as moderator.

It is important to introduce the focus groups research in this research. Focus groups can be used at the preliminary or exploratory stages of a study (Kreuger, 1988). This process can encourage potential users to interact and express their thoughts about mobile payments. Morgan (1988) states that focus groups can be used in their own right or as a complement to other methods. In this research, focus group research has used a complement to other research methods in this research. Moreover, the interaction provides not only information about what potential users think about mobile payments, but also why they think that way (Morgan, 1988).
5.1.1 Planning and Conducting Focus Groups

The research in this thesis has adopted the procedure proposed by Malhotra and Birks (2003), as described in Figure 5.

On the other hand, some issues might occur during the process of the focus group interviews (Greenbaum, 1997; Malhotra & Birks, 2003). The unstructured nature of the responses would make coding and analysis very difficult compared with other techniques. Thus, for study one, it was decided to use some key questions and to conduct the activities following these questions. This process offers a relatively convenient platform to complete this study. Furthermore, there were problems in getting potential participants to take part in the research: even though they agreed to participate, it was difficult to get focus group members together at the same time.

![Figure 5 Focus Groups' Plan](image-url)
A focus group involves people’s decision-making processes (Race et al., 1994). Focus groups allow researchers to explore what the key issues are and why these issues are important (Morgan, 1998). Moreover, the gap between what people say and what they do can be identified (Lankshear, 1993). Although focus groups have many advantages for conducting research, there are some limitations. Researchers may have less control over the data produced than in other quantitative research methods (Morgan, 1998). It is also difficult with focus groups to get a representative sample for the research, and in some cases, focus group members do not want to discuss sensitive or personal information with other people (Morgan, 1998).

5.1.2 Research Objectives

The study has employed the focus groups interviews. As most of the participants of this study do not know what a mobile payments system is, the study has presented an example of mobile payments, ZOOP. Members of focus groups have a chance to view and try the mobile payments demo from the ZOOP web site. This payment method allows users to pay for digital and physical items, and it was the first infrared-based commercial mobile payments system in the world. Therefore, it is an appropriate and typical case to present to members of the focus groups. It offers them a clear picture of mobile payments and delivers relevant information before the discussion.

5.1.3 Research Setting

This study was conducted in the city of Portsmouth, UK. The facility, within the University of Portsmouth, has a conference room with tables that seat up to 20 participants. The setting of the conference room was specifically designed to support group discussion.

5.1.4 Recruiting and Sample Characteristics

Given the nature of this study, the researcher has decided to select a particular group of people to represent the targeted potential mobile payments users. This study uses quota sampling and convenience sampling, as mentioned in an earlier section. Hair et al. (2001) and Kinnear and Taylor (1996) suggest that convenience sampling is
suitable and appropriate for an exploratory research study such as this. The participants were recruited from three different groups: schoolchildren, university students and young city workers respectively. These groups of participants have been identified as the potential users for a mobile payments service. Key recruitment points were that all participants owned mobile phones and were aware of the ability to purchase content, goods and services through mobile devices.

A total of 68 people participated, of whom 30 were female and 38 male. There were 24 subjects in the schoolchildren’s group, were aged between 12 and 16. The 24 subjects in the university students’ group were aged between 18 and 23. Finally, the 20 subjects in the city workers group were aged between 21 and 28. The participants’ average age was 20 years. 95% of the participants had not previously participated in a focus group.

All three groups of participants were recruited from the Portsmouth area, and took place between September 2003 and March 2004. For schoolchildren, research posters were displayed in St Luke’s School. Students were invited to participate in this study. The posters were also displayed on the campus of the University of Portsmouth. On the other hand, the approach for recruiting city workers was different: flyers were distributed in Portsmouth city centre, and asked them to participate to this study. The researcher encouraged them to participate in this study. Every participant received a £5 mobile airtime voucher and the chance to win a special prize, a £50 mobile airtime voucher.

Although most participants in this study were students, this was not an issue for this study. In the current context, they are suitable, being experienced users of mobile phones, and a potential target group for mobile payments.

5.1.5 Research Design

For schoolchildren and university students groups, every participant was randomly allocated into a group of 6. There were in total 8 groups of schoolchildren and university students. On the other hand, city workers were assigned to groups of 5.
They were also randomly allocated into groups. Thus, there were a total 12 groups and 68 participants in this focus group research.

5.1.6 Procedures

The focus group moderator followed an identical script for each session with all groups. Participants were asked about their usage of mobile phones and how they would react to a payments service that operated through mobile devices and enabled users to access different funding routes, such as Premium SMS services, Bluetooth and so on. At the end of the session, the participants provided feedback for this research. The focus groups took on average thirty-five minutes. The following basic questions were asked in the focus groups, and led to the discussions.

A. How do you use your mobile phones?
B. What do you expect from mobile payments?
C. Why do you want to use mobile payments?
D. What are your concerns?

5.2 Study Two – Case Study, ZOOP

The first study has explored the expectations of potential mobile payment users and issues related to mobile payments. This study investigates the behaviour and attitude toward mobile payments of existing mobile payments users, and the mobile payments service specified is ZOOP, which is provided by Harex InfoTech, South Korea. The reason for selecting ZOOP as an example is that ZOOP is the first commercial infrared-based mobile payments system. It is different to other trial payment systems. Moreover, it offers both physical and digital payment methods. Thus, ZOOP is the only real option, although ZOOP is operated in South Korea. On the other hand, ZOOP being based in South Korea created many problems and issues for the conduct of this study, such as language barriers. In addition, the service provider, Harex InfoTech, did not want to be involved in this research or to share any information.
This study aims to explore and identify why people want to use mobile payments systems. The overall objective is to investigate the attitudes and behaviour of South Korean ZOOP mobile payment users toward this new payments method. Furthermore, several questions have been raised:

A. **Why do people want to use the ZOOP mobile payments?**

B. **What are users concerned about, in relation to using mobile payments?**

C. **What are the essential attributes that influence users’ use of the ZOOP mobile payments?**

A questionnaire was considered to be the most appropriate data collection technique for this study. The questionnaire was designed to capture users’ usage of ZOOP, and also to understand the reasons for using ZOOP. Furthermore, the research attempts to uncover aspects of mobile payment systems that users are concerned about. The questions were formulated to identify users’ perceptions and opinions using a seven-point Likert scale.

The questionnaire was available over the Internet. The online environment was considered to be the best option by which to conduct this research. This was due to the long distance involved (Hewson et al., 2003). The online questionnaire made it easy for participants to fill in their answers. It provided a convenient, fast and safe means of communication for both parties (Hewson et al., 2003). The questionnaire was online between 1st May 2004 and 20th July 2004. All the questions were closed-ended, and respondents were asked to rate the options or statements.

### 5.2.1 Measurement Development

A questionnaire was developed to include all the possible questions related to this study. The items are written in the form of statements with which mobile payment users are to agree or disagree on a seven-point Likert-type scale. Most of the items were generated from previous studies and modified to fit the context of mobile payments when necessary.
A crucial part of the development of a scale is the assessment of its reliability and validity. Therefore, a set of items was drawn from a number of existing studies (Belanger et al., 2002; Gefen, 2002; Jarvenpaa & Tractinsky, 1999; McKnight et al., 2002). In selecting items, the measures most relevant to the research context were captured.

The following section discusses the development of the scales.

**Section A (Question 1-2):**

Question 1 was used to indicate how long respondents have used this service. Because a mobile payments service was such a new and emerging payment method at the time of the research, this question offers background information for the researchers to consider the results from this study. The respondents were asked to fill in the period they have used the ZOOP mobile payments system.

Question 2 in this section used a seven-point Likert-type scale to determine the degree of the respondents’ how often use the service. As supported by Saunders et al. (2003), scale or rating questions are often used to collect data about opinion, attitude and belief. A Likert-type allows a wider range of possible scores and increases the choice of statistical analyses. This type of scaling technique is easy to construct and understand (Malhotra & Birks, 2003). However, it takes a longer time to complete the questions than other itemised scales because respondents have to read and fully reflect upon each statement (Malhotra & Birks, 2003). This question measured how often the respondents used the ZOOP mobile payments system. The measurement was adapted from the studies of Ajzen and Fishbein (1980) and Davis et al. (1989).

**Section B (Question 3-4):**

All questions in this section also used a seven-point Likert-type scale to indicate attitudes and behaviours toward mobile payments. Two different aspects of consumers’ attitudes and behaviours were addressed, as follows:
The first question (Q3) was designed to identify information concerning the use of the ZOOP mobile payments. Question 3a was designed to indicate the convenience attribute in ZOOP. Question 3b indicates the degree to which respondents consider ZOOP a safe service. Question 3c was designed to indicate the ease of use of ZOOP. The above four questions were gathered from the literature and modified to fit in to the mobile payment context (e.g. Agarwal & Prasad, 1998; Jarvenpaa & Tractinsky, 1999; McKnight et al., 2002). Question 3d relates to the reputation of the service provider, and Question 3e relates to the economic power of the service provider. These two questions were adapted from Doney and Cannon (1997).

Question 4 was designed to indicate the potential issues of using mobile payments. This questionnaire has included three questions based on the research studies by Belanger et al. (2002) and Jarvenpaa and Tractinsky (2002). Question 4a was designed to indicate the users concerns about the quality of the service. Question 4b related to the security problems in mobile payments. Question 4c was designed to indicate the users’ concern about the cost of the services.

Section C (Questions 5-8):

In section C, all questions were closed-ended questions. This section comprised four questions to measure demographic information: multiple-choice items were utilised to ask about gender, age, education level, and occupation. The questions in this section were designed to survey general information.

Additionally, all questions in this section asked respondents about their personal information. The Nominal scale was used to classify respondents’ profiles by certain attributes such as gender, age, education, and occupation.

5.2.2 Questionnaire Translation

According to Banville, Desrosiers and Genet-Volet (2000), when a research project is based on an instrument developed for a different culture, it is necessary for the good of the scientific community to translate the instrument and validate it on the other culture to verify its meaning. The questionnaire for this study was written in the
English language. Due to the fact that the questionnaire participants are located in Korea, the questionnaire has been translated into Korean. This translation was carried out by recruiting two bilingual individuals, who speak both English and Korean, and asking them to perform “forward translations” and “back translation”. One translator translated the English into Korean, and another translator subsequently converted the Korean translation back into English. After that, both of the translators reviewed the forward and backward versions in order to iron out any linguistic differences and agree on the final version in the Korean language. Because using direct translation can lead to discrepancies relating to meaning. The English and Korean version of the questionnaires are presented in Appendix A1 and A2.

5.2.3 Pilot Study

Before the questionnaire was ready for field operation, a pilot test was carried out to assess the questions’ validity and assess the reliability of data collected, thus ensuring that the questionnaire was worded correctly, which can reduce the possibility of getting wrong answers (Saunders et al., 2003). Moreover, it also enables the researcher to obtain a general idea of how to calculate sample size. Saunders et al. (2003) recommend that the minimum number for a pilot study be ten: in this study, 15 pilot questionnaires were tested in the Korean University.

In general, all the respondents could follow the layout of the questionnaire quite well. From the pilot test, it was found that the minimum time that pilot respondents took to finish all of the questionnaire was about 5 minutes, and the maximum time was 8 minutes. The conclusion can be drawn that the average time taken by one respondent to complete one questionnaire was 6.5 minutes.

5.2.4 Sample Design

Due to the drawbacks of the census approach, such as the high budget requirements and the fact that they take a long time to conduct and can be easily misinterpreted (Malhotra & Birks, 2003). Moreover, the targeted respondents were ZOOP mobile payment users in Korea. This study has employed purposive sampling and self-selection sampling. Sampling was employed as a solution to select participants for this
study. However, there are also disadvantages to using sampling. As Malhotra and Birks (2003) note, the population in sampling technique is a subgroup of the population. Therefore, data may not accurately reflect the target population so that the researcher has to carefully select whom and how many people to be surveyed.

Sampling design starts by specifying the target population (Malhotra & Birks, 2003). Chisnall (2001) points out that the concept of sampling is on the basis of the probability that one member will represent a selected group. Malhotra and Birks (2003) also note that the target population is the set of all objects that possess some common set of characteristics relating to the research problem.

In this study, to ensure that the measures were produced based on direct behavioural experience with the object (Davis, 1989), only those who had used the ZOOP mobile payments were requested to complete the questionnaires. Therefore, the target population encompasses both male and female participants of working age who live in Korea.

According to Saunders et al. (2003), sampling means saving time and money by examining only data from a subgroup rather than all possible cases of the whole population. As mentioned earlier in Section 4.8.4, Malhotra and Birks (2003) explain that non-probability sampling is based on the researcher’s judgement rather than on the selection of sample elements. Since this study was unable to define the population frame, non-probability sampling was therefore employed to examine the attitudes and behaviours of those who used the ZOOP mobile payments.

Two types of non-probability sampling were used in this study. Purposive sampling is the form in which the population is chosen based on the judgment of the researcher, and involves selecting participants who are believed to be representative of the target population (Malhotra & Birks, 2003) or particularly knowledgeable about the topic being studied (Saunders et al., 2003). If the sample size seems to be small, as in the case of this study, a purposive sample will be useful, representative and involve more reasonable costs (Saunders et al., 2003), unlike probability sampling. With purposive sampling, the use of one area of a given country can be employed in international research (Craig & Douglas, 2000a). Hence, Sookmyung Women’s University in
Korea was selected, as it provides access to a representative target population because it has implemented the ZOOP mobile payments system in their campus, and the students and staff can use the service both on campus and off campus.

Another type of non-probability sampling used in this study is called self-section sampling. Respondents are selected because they desire to participate the research. In this study, the researcher publicised this study in the University campus in Korea.

### 5.2.5 Sample Size

After deciding who to sample and how to recruit respondents, the next stage was to decide how many respondents were to be surveyed. Malhotra and Birks (2003) describe sample size as the number of elements to be included in the study. Collis and Hussey (2003) describe sample size as a subset of a population, which should represent the main interest of the study.

The minimum sample size can be calculated from the following formula:

\[
    n = \frac{(Z \times SD)^2}{E^2}
\]

Where
- \(n\) = the minimum sample
- \(Z\) = the degree of confidence required
- \(SD\) = population standard deviation estimated from samples
- \(E\) = desired accuracy (amount of error we are willing to accept)

In most situations, a 95% level of confidence is acceptable for \(Z\) (Saunders et al., 2000). \(E\), the amount of error one is willing to accept, is specified in the context of the variables, which was determined as 5% in this study. Based on the responses in the pilot study, the mean, variance and standard deviation of the variables were calculated using SPSS, as shown in Figure 6. The standard deviation of the sample parameter from the pilot study was used as an approximation for the standard deviation of the population statistic. Therefore, the minimum sample size for this study is
\[ n = \frac{(Z \times SD)^2}{E^2} \]

\[ n = \frac{(0.95 \times 8.2155)^2}{(5\% \times 52.7333)^2} \]

\( n = 8.74 \approx 9, \text{ Rounded up number} \)

Based the calculation of the formula recommended by Saunders et al. (2003), the minimum sample size of this study was set at 104 to achieve a more accurate outcome with the statistical methods (Saunders et al, 2003). Moreover, given the limited access and long distance research, this study’s sample size is agreeable and appropriate.

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std Dev</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A2</td>
<td>6.0000</td>
<td>1.1339</td>
</tr>
<tr>
<td>2. B3</td>
<td>5.9333</td>
<td>.9612</td>
</tr>
<tr>
<td>3. B4</td>
<td>5.8667</td>
<td>.8338</td>
</tr>
<tr>
<td>4. B5</td>
<td>6.0667</td>
<td>.9612</td>
</tr>
<tr>
<td>5. B6</td>
<td>6.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>6. B7</td>
<td>5.9333</td>
<td>1.1629</td>
</tr>
<tr>
<td>7. C1</td>
<td>5.6000</td>
<td>1.0556</td>
</tr>
<tr>
<td>8. C2</td>
<td>5.5333</td>
<td>1.0601</td>
</tr>
<tr>
<td>9. C3</td>
<td>5.6000</td>
<td>1.1464</td>
</tr>
</tbody>
</table>

Figure 6 Mean, Standard Deviation, and Variance

5.2.6 Data Collection

In this research, the target respondents were the ZOOP mobile payment users in the Sookmyung Women’s University. The University was contacted and asked for help in distributing the questionnaire. The questionnaire was published through the
University’s website, and encouraging e-mails were also sent to students and staff in the University. Moreover, one of the translators visited the Korean University and distributed posters advertising the survey and providing the web link. Finally, the research offered the chance for eligible participants to win prizes.

5.2.7 Data Analysis

To analyse the data collected from the respondents, this study used the Statistical Package for Social Sciences (SPSS) program to conduct the descriptive analysis and associative analysis.

5.3 Study Three – Mobile Payments Survey

This study was carried out to address the research question for the research in this thesis, and to test the proposed research model and hypotheses. In order to obtain a robust outcome, this study has gathered two different sets of data at different times and locations to test the research model. This study used a survey method to conduct the research. Lucas (1991) suggests when IS researchers attempt to identify causality among variables, longitudinal design should be introduced (Singleton et al., 1993). The first set of data included all types of users of mobile payment systems around the world. This study tested actual behaviour, intentions and transactions. It measured and tested the research model with all the variables. The second set of data focused on one particular mobile payments system’s users in the UK. This study was confirmatory in nature. It aimed to confirm the results of the first set of data, and provided a validation of the research model.

Survey research was the predominant methodology used in this research. For the first survey, the sampling units were individual mobile payments user. In the second survey, the sampling units were individual mobile payments user from one particular mobile payment system. The relevant research constructs were measured using a questionnaire.
The target and potential participants for these studies were very difficult to reach and contact: they were in different geographic locations around the world. Due to financial, time and resource constraints, the survey studies could not be conducted through personal interviews. Moreover, phone interviews are not a realistic solution for the studies, because the cost of making a phone call and allocating the right time to make the calls would be extremely difficult. Thus, in order to access and target mobile payments users and provide a more convenient method for them to use, a Web-based survey was employed. It offers an efficient and minimal-cost approach for the research in this thesis. Moreover, participants have more time to read through all the questions and provide valid answers. Thus, a Web-based survey was selected as the most appropriate data collection method for this research study. The survey site offered high usability in order to provide accuracy and increase response rates (Smith, 1997).

5.3.1 Questionnaire Design

Survey is the primary research methodology used in this study. A questionnaire is developed to include all the items that related to this study. Multi-item scales were applied to this research in order to test the proposed research model. Statements were written for each item, and the participants were required to indicate whether they agreed or disagreed with the statements on a 7-point Likert scale. The following section discusses the development of the scales.

Section A (Questions 1 to 4)

Question 1 identified what mobile payment systems respondents used. The other three questions in this section used a seven-point Likert scale. Question 2 was to determine respondents’ intention to use mobile payments: it was designed to measure the endogenous variable ‘Behavioural intention to use’ and address Hypotheses 1, 2, 3 and 9. The seven-point scale used was Strongly disagree = 1, Disagree = 2, Mildly disagree = 3, Neutral = 4, Mildly agree = 5, Agree = 6, and Strongly agree = 7.

Questions 3 and 4 were to determine the degree of the respondents’ actual use of mobile payments. These two questions used as manifest variables, and were designed
to measure the endogenous variable ‘Actual use of mobile payments’ and address Hypothesis 1. As supported by Saunders et al. (2003), scale or rating questions are often used to collect data about opinion, attitude and belief. A Likert-type allows a wider range of possible scores and increases the choice of statistical analyses. This type of scaling technique is easy to construct and understand (Malhotra & Birks, 2003). However, it takes a longer time to complete the questions than other itemised scales because respondents have to read and fully reflect upon each statement (Malhotra & Birks, 2003).

**Section B (Questions 5-37):**

All questions in this section also used a seven-point Likert-type scale to indicate attitudes and behaviours concerning mobile payments. Ten different aspects of the attitudes and behaviours of consumers were addressed, as follows:

The first four questions (5-8) were designed to determine users’ views of using mobile payments. They were designed to measure the endogenous variable ‘**Attitude toward using**’ and to address Hypotheses 2, 3, 4, 5, 6, 8, 9, 10 and 11.

Questions (9-12) were designed to indicate users’ perceptions of usefulness when using mobile payments. These items were designed to measure the endogenous variable ‘**Perceived usefulness**’ and to address Hypotheses 4.

Questions (13-15) were designed to measure the exogenous variable ‘**Perceived ease of use**’, in other words, to what extent respondents are concerned about the aspect of ease of use, and to address Hypotheses 3.

Questions (16-18) were designed to indicate how mobile payments could fit with the lifestyles of respondents. These items were designed to measure the exogenous variable ‘**Compatibility**’ and to address Hypotheses 9.

Questions (19-21) were designed to indicate the observability of mobile payments. These items were designed to measure the exogenous variable ‘**Observability**’ and to address Hypotheses 11.
Questions (22-24) were designed to measure the exogenous variable ‘Trialability’, which indicates whether respondents have a chance to try out the services, and to address Hypotheses 10.

Questions (25-27) were designed to indicate how important an influence other people could be on the choices made by respondents concerning mobile payments. These items were designed to measure the exogenous variable ‘Social influence’ and to address Hypothesis 7.

Questions (28-29) were designed to indicate how concerned respondents were about the cost of services when using mobile payments. These items were designed to measure the exogenous variable ‘Perceived costs’ and to address Hypothesis 5.

Questions (30-33) were designed to indicate respondents’ perceptions of system quality when using mobile payments. These items were designed to measure the exogenous variable ‘Perceived system quality’ and to address Hypothesis H6.

The last set of questions (34-37), which also employed the seven-point Likert-type scale, was designed to measure the exogenous variable ‘Perceived trust’ and to address Hypothesis H8, to discover to what degree respondents are concerned about different aspects of trust in mobile payments. Users’ concerns about security with mobile payments are addressed by Question 34. Questions 35, 36 and 37 were designed to indicate concern about the personal data obtained by service providers.

Section C (Questions 38-41):

In section C, all questions were closed-ended questions. This section comprised four questions to measure demographic information: multiple-choice items were utilised to ask about gender, age, education level, and occupation. The questions in this section were designed to survey general information.

Additionally, all questions in this section asked respondents about their personal information. The Nominal scale was used to classify respondents’ profiles by certain
attributes such as gender, age, education, and occupation. The questionnaire is presented in Appendix A3.

5.3.2 Instrument Development

Many measures could be used in the TAM based research (Davis, 1989; Davis, Bagozzi, & Warshaw, 1998). For example, performance, productivity, effectiveness, usefulness, and time saving can be used to measure perceived usefulness. Moreover, ease of learning, ease of control, ease of understanding, ease of use and flexibility of use can be used to measure perceived ease of use. Most of the items in the survey were taken from previously published scales with appropriate psychometric properties, as shown in the following Table 5 and Appendix A4; moreover, all of the items were adopted to fit the context of mobile payments. After an extensive literature review on the topic, new items were also developed. This section will describe the development of the list of items by constructs.

_Actual use of mobile payment systems_. Consumers’ frequency of use of a mobile payment system is considered a vital element for this research. Ajzen and Fishbein (1980) recommend measuring how often the system is used and approximately how many times it is used over a given time. Some researchers have employed this method (Davis, 1989; Davis et al., 1989). Applying this method to the research, the participants will be asked to record how frequently they use a mobile payment system on a seven-point Likert scale ranging from “Very Frequently” to “Very Rarely”. The participants using services will then be asked how many times they have used it, based on seven-point Liker scale from “under 5 times” to “Over 51 times”.

_Behavioural intention to use a mobile payment service_. One question has been designed to ask participants the probability of their using a mobile payment system. This is because Ajzen and Fishbein (1980) identify that actual use is influenced by behavioural intention.
<table>
<thead>
<tr>
<th>Construct</th>
<th>Number of items</th>
<th>Source/Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Use</td>
<td>2</td>
<td>Ajzen &amp; Fishbein, 1980; Chen et al., 2002; Davis et al., 1989; Kleijnen et al., 2004</td>
</tr>
<tr>
<td>Behavioural Intention</td>
<td>1</td>
<td>Ajzen &amp; Fishbein, 1980; Chen et al., 2002; Kleijnen et al., 2004</td>
</tr>
<tr>
<td>Attitude</td>
<td>4</td>
<td>Ajzen &amp; Fishbein, 1980; Chen et al., 2002; Davis et al., 1989; Kleijnen et al., 2004</td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td>4</td>
<td>Chen et al., 2002; Davis et al., 1989; Kleijnen et al., 2004; Plouffe et al., 2001</td>
</tr>
<tr>
<td>Perceived ease of use</td>
<td>3</td>
<td>Chen et al., 2002; Davis et al., 1989; Kleijnen et al., 2004; Plouffe et al., 2001</td>
</tr>
<tr>
<td>Compatibility</td>
<td>3</td>
<td>Moore &amp; Benbasat, 1991; Ploffe et al., 2001</td>
</tr>
<tr>
<td>Observability</td>
<td>3</td>
<td>Moore &amp; Benbasat, 1991; Ploffe et al., 2001</td>
</tr>
<tr>
<td>Trialability</td>
<td>3</td>
<td>Moore &amp; Benbasat, 1991; Ploffe et al., 2001</td>
</tr>
<tr>
<td>Perceived costs</td>
<td>2</td>
<td>Constantinides, 2002; Cronin &amp; Taylor, 1992; Jarvenpaa &amp; Todd, 1997;</td>
</tr>
<tr>
<td>Perceived system quality</td>
<td>4</td>
<td>Cronin &amp; Taylor, 1992; Kleijnen et al., 2004</td>
</tr>
<tr>
<td>Social influence</td>
<td>3</td>
<td>Moore &amp; Benbasat, 1991; Thompson et al., 1994; Venkatesh et al., 2003</td>
</tr>
<tr>
<td>Perceived trust</td>
<td>4</td>
<td>McKnight et al., 2002 Smith et al., 1996</td>
</tr>
</tbody>
</table>

Table 5 Items and Their Sources

*Attitude toward using a mobile payment service.* Users’ attitudes can be deduced from their essential beliefs (Ajzen & Fishbein, 1980), and several research studies have used this principle extensively (Davis et al., 1989; Jarvenpaa & Todd, 1997). This research will follow this procedure to measure users’ attitudes. The items are adopted from previous research (Ajzen & Fishbein, 1980; Chen et al., 2002; Davis, 1989), and refined for mobile payment context.
Perceived usefulness of a mobile payment service. The items used to measure perceived usefulness are adopted from previous research (Chen et al., 2002; Davis, 1989) with the contents having been refined to match mobile payment services. Based on the findings of Davis et al. (1989) concerning perceived usefulness, this research argues that using mobile payment will enhance users’ daily activities.

Perceived ease of use of a mobile payment service. The items for perceived ease of use are also developed from previous research (Chen et al., 2002; Davis, 1989). Davis et al. (1989) conclude that perceived ease of use refers to whether a system is easy to learn or to use.

Compatibility. The items for measuring compatibility are adopted from Moore and Benbasat (1991) and Eastin (2002). Rogers (1995) concludes that identifying the compatibility of users’ needs, existing values and beliefs with the new technological innovation is one way to evaluate compatibility.

Trialability. A three-item scale is also adopted from Moore and Benbasat (1991) and Eastin (2002). Rogers (1995) explains that an individual trying out an innovation is one way for a user to understand the system and how it works. The IDT suggests that trialability assists innovation to be adopted more rapidly than if the innovation does not have trialability (Rogers, 1995).

Observability. Again, the items for measuring observability are adopted from Moore and Benbasat (1991) and Eastin (2002). Rogers (1995) asserts that if the results of innovations can easily be shown, users are more likely to adopt the innovations. Mobile payment is a relatively recent innovation for most of the consumers, and it is probable that the systems’ observability will increase the adoption of mobile payment systems.

Perceived system quality. System quality refers to users’ experiences with the system. This research employed a system performance-based measure of system quality. The instruments of items are adapted from previous research (Cronin & Taylor, 1992; Kleijnen et al., 2004) with modifications to adapt them to mobile payment context. The instrument represents systems’ reliability, assurance, and speed of connection.
Perceived trust. M-Commerce has some of the same characteristics as e-commerce, such as non face-to-face transactions and a mobile/digital sales channel. Previous research into e-commerce discovered that consumers are concerned about their personal information, especially payment instruments, and the security of payment transactions (Araujo & Araujo, 2003; Claessens et al., 2004). Unsurprisingly, mobile payment users share the same concerns as investigated in the focus groups research. The items were developed to measure users’ perceived trust in a mobile payment service, and these items were adapted from previous research (McKnight et al., 2003; Smith, Milberg, & Burke, 1996) and converted to make them suitable for a mobile payment situation.

Perceived costs. This construct is measured using a multi-item scale with the items adopted from previous research (Constantinides, 2002; Cronin & Taylor, 1992; Jarvenpaa & Todd, 1997; Kleijnen et al., 2004), and the questions developed to make them suitable for a mobile payment situation.

Social influence. Social influence has a direct impact on users’ behavioural intentions (Venkatesh et al., 2003). This construct is measured using three items, and covers subjective norms, social factors, and image. The questions are developed based on previous research (Moore & Benbasat, 1991; Thompson et al., 1994; Venkatesh et al., 2003).

5.3.3 Pilot Study

Before the questionnaire was ready for field operation, a pilot test was carried out to assess the questions’ validity and assess the reliability of data collected, thus ensuring that the questionnaire was worded correctly, which can reduce the possibility of getting wrong answers (Saunders et al., 2003). Moreover, it also enables the researcher to obtain a general idea of how to calculate sample size. Saunders et al. (2003) recommend that the minimum number for a pilot study be ten: in this study, 15 mobile payments users were invited to participate in this pilot questionnaire.

In general, all the respondents could follow the layout of the questionnaire quite well. From the pilot test, it was found that the minimum time that pilot respondents took to
finish all of the questionnaire was about 10 minutes, and the maximum time was 20 minutes. The conclusion can be drawn that the average time taken by one respondent to complete one questionnaire was 12 minutes.

5.3.4 Sample Design

The non-probability sampling used in this study for the first set of data is called self-selection sampling. Respondents are selected because they desire to participate in the research. In order to collect a second set of data, purposive and self-selection sampling was used. Self-selection is a limitation of this study: however, this limitation can be addressed by matching the demographics of the sample with the demographics derived from known population data concerning mobile payment users, a procedure that has been widely used in Web-based survey research (Bellman et al., 1999; Ridings et al., 2002).

5.3.5 Sample Size

Diamantopoulos and Siguaw (2000) state that the more variables encompassed in one’s model, the greater the sample size requirement; however, Ding, Velicer, and Harlow (1995) argue that a number of studies agree that a minimum recommended sample size when engaging in covariance structure modelling is 100 to 150 subjects. Gefen, Straub, and Bondreau (2000) and Hair, Anderson et al. (1995) also share the same view as Ding et al. (1995) that the required minimum sample size is around 100 to 150 subjects for running LISREL. Thus, the minimum sample size of this study was set at 150 for both sets of data.

5.3.6 Data Collection

Questionnaires were used as the main data collection technique for this study. The purpose of the questionnaire was to gather information about participants’ attitudes and behaviour towards mobile payments systems. This helps to build a clear picture of the framework of consumers’ usage of mobile payments. As mentioned earlier, two sets of data will be used in the analysis. This approach helps to increase the validity
and reliability of the research. Moreover, it also contributes to the process of theory
generation in the field of mobile payments research.

In order to collect the first set of data, several mechanisms were employed. First, the
Sookmyung Women’s University was contacted again and asked for help in
distributing a link to the online survey to students and staff on campus. Second, an
established industrial link, JCB International, was contacted. They have set up a
mobile payments facility for their staff members to use on their premises in Japan.
The online survey link was sent to the contact via email, and they helped to distribute
this link. Third, the online survey link was published to Bulletin Board System (BBS)
related to e-commerce and mobile commerce. Witmer et al. (1999) suggest criteria to
select communities based on the numbers of users. In this study, the researcher has
identified a set of criteria to select the BBS (Ridings et al., 2002). The BBS must have
at least ten posting per day for a week chosen at random, and at least 80% of postings
must have at least one reply for a week chosen at random. In order to distribute the
link to a wide variety of communities, the study has used popular search engines to
identify related BBS. Finally, the survey was signed up with an academic survey
organisation, which owns a mailing list of over a thousands users who occasionally
participate in online surveys around the world. The online questionnaire was
conducted over a period of a month, from 22nd March 2005 to 26th April 2005.

The second set of data attempted to confirm the results from the first set of data. It
targeted a specified mobile payments system, Digital Wallet, provided by Mobile
Payments Limited, UK. The researcher teamed up with this service provider to
conduct the study. Invitation e-mails were sent to users. Again, an online survey was
used for this research. The users were asked to visit the online survey site to
participate in this research. Again, to motivate mobile payment users to participate in
this study, entry into a lucky draw was offered to all participants. The following
section presents brief information about this specific mobile payments system.

Mobile Payments Limited (MPL) is a UK-based payment service provider. It offers
the MPL digital wallet, which enables payments to be made using wireless devices,
for instance, mobile phones via SMS. This is an account-based service. Users can
select different types of accounts depending on their circumstances. The digital wallet
offers different two types of transactions, person-to-person and person-to-business. Uses can buy digital contents, physical goods, and even pay for products from e-commerce sites with retailers who have signed up to this system. The company implemented a market test during September and October 2005 in the South West of England. The purpose of this market test was to assist the national roll-out of the system at a later stage. Users in this market test were invited to participate in this study. (Note: Due to a number of issues and financial constraints, MPL has subsequently terminated the next phrase implementation.)

The questionnaire collected two major types of information. The first part was about participants’ perceptions of each of the constructs in the proposed model, and the second concerned participants’ demographic information. The demographic information includes gender, age, level of education and occupation. The rest of the questionnaire asked for participants’ opinions of each item.

5.3.7 Data Analysis Techniques

Following the response to the online survey, the proposed hypotheses were tested. SEM based analysis techniques were used to analyse the data. Following the two-stage approach suggested by Anderson and Gerbing (1988), the analysis was conducted in two stages. First, the Confirmatory Factor Analysis (CFA) was employed to assess the validity of the measurement for the model; then the proposed model was tested using Structural Equation Modelling (SEM), so that the causal structure of the model could be evaluated. The same technique has been used to analyse both sets of data. The research used Lisrel 8.7 to analyse the measurement model and the structural model.

The chapter presented detailed information regarding how three different research studies have been implemented for the research in this thesis. The following chapters present the results of these three research studies, followed by a discussion.
Chapter Six: Research Findings of Study One and Study Two

6.1 Study One – Focus Group Survey of Potential Mobile Payments Users

6.1.1 Results – Group 1: Schoolchildren

What was interesting about this group was that money had a large impact on their usage of mobile phones and the Internet. They were all very cost conscious due to the limited amount of pocket money they had. Thus, they would use all types of free or very cheap services, for example, pay-as-you-go phones, and would actively search for free or cheap goods and services. As a result, they were heavy users of the Internet and mobile devices for games and free products, such as ring tones and mobile games, and were also very wary of subscription services where they had had bad experiences with unscrupulous merchants.

Usage of their mobile phones was also quite limited, for two main reasons: (1) parents could monitor their spending on the mobile, as they paid for the top-ups; (2) because of limited finances, their main phone usage was for texting or buying low cost goods.

This group is obviously technically awareness and will be the content purchasers of tomorrow once they have their own income. They saw mobile payment services as a liberator, as it could mean that they could access goods and services at a lower cost than they could currently. They were not particularly concerned about security and privacy issues.

Also influential with this age group was the role played by their parents, who are funding the airtime that is currently used by the children.
6.1.2 Results - Group 2: University Students

This group was quite knowledgeable both in terms of technology and its usage. Their main concern, which limited their usage of both the Internet and their mobiles, was lack of trust and security, both in terms of their personal details being available to fraudsters and being overcharged.

Although there was not heavy usage of buying content over the mobile phone, for example, mobile ring tones, they had experienced, or showed interest in, using mobile phones to purchase goods and services, such as train and cinema tickets.

They were also interested in special offers or trials that could be offered by service providers, but were wary as to whether these would really be free or could lead to expensive subscription services, which was the experience of one of them. Therefore, the credibility of the payment provider was a key determinant amongst this group.

A mobile payments service would actually enhance their lifestyles. For example, they liked very much the idea that having a mobile payment service would mean not carrying a purse, as they always took their mobiles wherever they went. Moreover, it is a convenient payment method for them.

Additionally, they liked the convenience that having their purse on you’re their mobile phone would give them, so they could envisage using it to make purchases, especially if it gave them discounted prices from what was currently on offer in the marketplace. Choice of goods and services was a key driver in terms of what would generate and increase the frequency of usage. However, security is a common issue for them. They are not sure how safe payment details will be, and whether their personal information will be leaked to a third party.

6.1.3 Result - Group 3: Professional Workers

This group lived and worked using the latest technology, both in terms of computers and phones. Almost all of them used contract phones and did not like seeing bills for purchasing content and other goods and services appearing on their phone bills. They
also felt that it removed the control of the way they spent money, as they could not find out what they had spent until they received their phone bill.

Although not heavy users of mobile content in terms of ring tones and logos, they quickly identified the benefits that a mobile payments service would bring in terms of convenience, especially in terms of making secure payments from cards, keeping personal details hidden.

Convenience, usability and the latest technology were key. Although not particularly cost conscious, they were value and quality conscious. They were also only likely to try something once or twice: if it did not live up to expectations, they would be unlikely to try it again. However, they viewed themselves as innovators and would try anything once just to see how it worked and if it was worth having or doing.

They allocated a lot of value to word-of-mouth recommendation and saw this working both in terms of information given to them by friends, or from trusted sources, such as websites and Television programmes. Again, security and privacy are the issues in their view.

6.1.4 Summary

The results from the focus groups confirmed the majority of expectations about mobile payments in that the most technically awareness respondents saw the opportunities that this type of payment alternative could bring them in terms of cost benefits and convenience. In general, there are some reasons behind why they want to use mobile payments. First, it offers freedom and flexibility for mobile phone users; second, it offers a convenient service for mobile phone users; third, it enhances their lifestyles.

Additionally, they revealed that the innovators or opinion formers would be the early adopters amongst these different groups and that word of mouth would be the driving element.
About what are they concerned? In terms of cost, this was definitely seen as more important to the younger groups (Groups 1 and 2). Amongst the working professionals, cost was seen as less of an issue, with convenience and innovation being key. Security was a key concern amongst the university students and the workers. However, they wanted to know that mobile payment services themselves were operated by trustworthy organisations and confirmed the view that leveraging off existing trusted brands and suppliers was the way to build that credibility and trust.

Overall, this focus group research identified a lot of issues and findings in the marketplace that are vital in order to build a robust case for this research.

6.2 Study Two - Case Study, ZOOP

This study consists of a two-part investigation. First, the researcher explores the reasons behind the successes of ZOOP mobile payments. Due to limited access to the service providers, the researcher has investigated this system through available documents and references. Second, a questionnaire was designed to capture the attitudes and behaviour of ZOOP mobile payment users and understand the reasons for using ZOOP. Furthermore, the research attempts to uncover aspects of mobile payment systems that consumers are concerned about.

6.2.1 Introduction

Mobile payments services are one of the popular payment methods in South Korea, which is one of the leading countries in the world with respect to providing mobile/contactless payment methods (Joshi, 2003; Payments news, 2006). Koreans can use mobile payments either in person or online, and there are more than 470,000 locations nationwide in Korea accept mobile payments (ITU, 2005; Joshi, 2003). In Korea, some financial institutions and MNOs have formed an alliance to operate mobile payments: an example is ZOOP mobile payments (ZOOP, 2002), its major shareholders including financial institutions, The Korea Development Bank (KDB), Kookmin Bank and HTC Investment. In addition, the shareholders include three major MNOs in Korea, which are SK Telecom, KTF and LG Telecom (Joshi, 2003).
SKT was the first, is the largest and is considered the dominant mobile operator in Korea. KTF is the second-largest mobile network operator. The company has a CDMA licence to operate in the country. LG Telecom is the third mobile operator in the country and operates with a PCS licence. It is the smallest of the three mobile carriers.

6.2.2 Background of ZOOP

Harex InfoTech provides a “proximity payment” system in South Korea (Warwick, 2002). The first trial began in April 2002 in Seongnam city. Now, several cities have been equipped with this mobile payment system, which is based on infrared technology. It can be used in major department stores, coffee shops and restaurants (Mochizuki, 2003), as shown in Figure 7.

At the moment, most of the conventional mobile payment systems are much more dependent on long-distance mobile network systems and extra costs for mobile payment users to make purchases (Warwick, 2002). However, ZOOP offers infrared proximity mobile payments. ZOOP provides a flexible payment service for consumers (Warwick, 2002). It allows consumers to use mobile devices to make purchases anywhere and at any time via infrared technology (ITU, 2005; Warwick, 2002). In some respects, infrared technology offers better security for mobile payments than radio frequency technologies: infrared light beams are directional, compared with the radio waves spread in a 360-degree space (Robertson, 2003).

Figure 7 ZOOP Mobile Payments
ZOOP selected infrared technology as the medium for proximity payments (Warwick, 2002). In order to provide a secure and interoperability environment for this mobile payment, ZOOP has identified the Infrared Financial Messaging (IrFM) standard, which is authorised for financial transactions (Warwick, 2002). Moreover, ZOOP offers a secure payment mechanism for consumers, and the service provider can issue, disabled and reissue financial details wirelessly (Warwick, 2002).

Figure 8 shows procedures concerning how to use the application.

![Figure 8 ZOOP Operation Procedures](image)

### 6.2.3 Why Select ZOOP for this Study?

There were several mobile payment applications available at the time of this research, such as Simpay, Vodafone M-pay, and Eurocard Bluetooth mobile payments. It seems that mobile payments systems were popular applications at that time and the industry would like to invest in and implement them (VISA, 2002). Thus, there is a need to identify a particular mobile payments system and to explore and examine how it works at the early stage of this application. Mobile applications, especially mobile payment research, represent a new domain for IS research. While some research has been conducted with regard to mobile applications concerning different aspects, for example, technology (e.g. Gebauer & Shaw, 2004; Ghosh & Swaminatha, 2001; Petty, 2003) and business applications (e.g. Barwise & Strong, 2002; Brown et al., 2003; Olla & Atkinson, 2004), little literature or empirical research is available concerning mobile payments because mobile payment is a new and emerging application: as it is difficult to identify a suitable and appropriate example of mobile
payments, thus this application is very difficult to study empirically. Therefore, the empirical data and findings from this study is vital for the research in this thesis.

After extensive research through different sources related to mobile payments, such as the Internet, mobile business conferences and industry contracts, this study has identified ZOOP as an appropriate example on which to conduct this study. ZOOP is an infrared-enabled mobile payment system. At the time of this research, there are not many mobile payment systems around. ZOOP is the first truly ubiquitous mobile payments system in the world (Warwick, 2002). Moreover, ZOOP has been fully commercialised in Korea since 2002 (Joshi, 2003), ZOOP has ambitions to expand its market worldwide (Business wire, 2002; USC, 2002), which would allow the application to be widely evaluated. Moreover, most mobile devices have been equipped with infrared modules as standard, which would help with the implementation of this application (Warwick, 2002). This payment application has huge potential for worldwide adoption. Overall, based on the reasons mentioned above, it is appropriate and useful to choose such a unique mobile payment system for this study.

Even though ZOOP has been identified for this study, there are still several challenges to be faced in conducting this study. First, ZOOP was developed by a Korean company and its operation is based in Korea. The long distance to Korea and the language barrier are issues in conducting this study. Second, attempts to make contact with the ZOOP service provider were unsuccessful, even for interviews, because the service provider did not want to share information and had no time to respond to the study. However, this mobile payments system remains a valuable source and furthermore, is the only real option at the time of the research.

In order to address the issues that occurred during the research, an alternative technique has been used. First, an extensive search of the Internet and library was made to locate references related to ZOOP mobile payments. Second, a university that had deployed the ZOOP service on campus was located and identified, and the researcher contacted the related staff. This approach was useful and efficient, and offered a platform from which to conduct this study. Third, students who were native Korean speakers were recruited as research assistants. They helped to translate
documents and research questions. Moreover, a research assistant travelled to Korea and visited the university during this study, and helped to distribute the survey posters on the campuses.

6.2.4 The Successes behind ZOOP

A killer application is required for the mobile payments industry in order to generate more revenues and widespread adoption for this application. Some researchers have suggested that mobile payments will become a major mobile service in the coming future (e.g. Ding & Hampe, 2003; Herzberg, 2003). However, before that day arrives, the mobile payments industry has to address some major obstacles to the development of mobile payments, including technology selection and business model identification (Wrona, Schuba, & Zavagli, 2001), and the lack of an industry standard (Ondrus & Pigneur, 2005).

MNOs and financial institutions are the two potential players in mobile payment markets. For payment schemes, financial institutions, such as banks, are obvious candidates to provide the service. On the other hand, in the mobile context, MNOs seem to be natural candidates to offer the service. Thus, these two powerful sectors can be present in mobile payment markets. These two sectors can work together to implement the service, or compete with each other. Both would like to control this valuable system so as to increase their revenue (Ondrus & Pigneur, 2006). MNOs are planning not only to depend on the traditional voice service to increase their revenue, but also to provide a range of value-added services, such as mobile TV and mobile navigation (Harmer, 2003), which clearly indicates that MNOs have the great advantage in being in the lead in mobile payment markets (Carat, 2000). However, financial institutions do have a sophisticated system to deal with the risks involved in payment processing, something the MNOs do not have expertise in. Therefore, it seems that these two sectors are perfect partners for mobile payments, each having their own competencies with which they can complement each other to implement mobile payment services (Ondrus & Pigneur, 2005). ZOOP is a good example of MNOs and financial institutions working together to offer the mobile payments service.
This section presents the investigation of the successes of ZOOP mobile payments in South Korea. How can ZOOP avoid the disruptions in this competitive market? The success of ZOOP could be a valuable lesson for us. The methodology of Rafii and Kampas (2002) has been used in this study to analyse this mobile payments scheme and to identify its successes. The six steps of this methodology are presented in the following:

**Step 1: Foothold market entry**

Classical payment methods currently dominate the payment market (Humphrey et al., 2003; Williams, 2003). It is difficult for mobile payments to break into this profitable market. Moreover, in order to be profitable, this new payment scheme must be used for transactions on a large scale (Ondrus & Pigneur, 2005). In the case of ZOOP mobile payments, they have established an alliance, as mentioned earlier, where financial institutions and three major MNOs are the shareholders (Joshi, 2003). In the case of financial institutions, they have already established a large customer base and good working relationships. Due to the high penetration of mobile phones in Korea (MIC, 2005a), MNOs have also established a large customer-based service. Therefore, ZOOP has the opportunity to access a wide range of customers, which allows ZOOP to enter the market relatively easily. Moreover, researchers have identified that competition between financial institutions and MNOs would be an obstacle for the development of mobile payments (Chen & Adams, 2004b; Ondrus & Pigneur, 2005; Wrona et al., 2001), but this will not be the case for ZOOP, as these identified actors are participating in ZOOP mobile payments and are working constructively to achieve mass adoption (Warwick, 2002).

**Step 2: Main market entry**

Regulation is another issue for the development of mobile payments. In order to regular this sector, for example, the European Committee for Banking Standards (ECBS) has published business requirements and implementation guidelines for mobile payments (ECBS, 2003; ECBS, 2005), which provide guidelines for banks to implement through a set of frameworks.
However, MNOs need to address the payment types to suit the legal practice (EC, 2004). At the moment, most of the MNOs offer customers the ability to pay for the items using their phone bills. In this case, customers can only pay for small-value items, such as ring tones and mobile games. Moreover, the majority of MNOs do not have the expertise to manage the financial risks involved in large volumes of payment transactions or credit rating (Ondrus & Pigneur, 2005).

In ZOOP mobile payments, because the three major MNOs have teamed up with the banks, ZOOP users can pre-load their ZOOP account using their credit cards, debit cards and bank accounts (Joshi, 2003). This facility offers more flexibility to users, and they have more power to control their payment activities (Joshi, 2003). This way, the MNOs do not need to handle the payment process, and the existing payment infrastructure is used. The banking regulations were addressed in this case. Moreover, as the existing payment infrastructure has been employed, merchants also benefit from this approach (Warwick, 2002): they do not need to pay the huge cost of new infrastructure or extra transaction fees, and ZOOP’s infrared receivers plug into existing point-of-sale terminals using a standard serial port (USC, 2002).

**Step 3: Customer attraction**

The most difficult aspect for a new payment scheme would be to attract customers. Ondrus and Pigneur (2005) suggest that mobile payment systems need to be easy to use, convenient, of a reasonable cost, and standardised in order to attract consumers and merchants to adopt the new payment scheme. ZOOP is easy to use, it offers users more control than they already have, and it allows them to customise the way they pay (Warwick, 2002). For example, users can set the level of security when they make purchases: to pay for a bus ticket takes just the click of one button toward the infrared receiver, but to make purchases in a supermarket may require the PIN to be typed in (ZOOP, 2002). This personalisation feature could encourage users to adopt the service (Ho & Kwok, 2003). ZOOP also offers a convenient service to users (Warwick, 2002) because it allows users to pay in many locations for different purposes, such as in petrol stations and supermarkets, and for bus tickets and underground tickets. As ZOOP uses infrared technology as the medium to transfer data, it reduces the cost for both customers and service providers compared with used other methods to
implement the service, for instance, premium SMS (Warwick, 2002). Moreover, infrared technology has been implemented in this service, and the Infrared Financial Messaging (IrFM) Point and Pay Profile has been used (Joshi, 2003). This is a standard protocol to implement mobile payment services using infrared (IRDA, 2004). It ensures interoperability and compatibility on a global basis. Furthermore, this profile also offers a compatibility path for other wireless technologies such as Bluetooth and RFID (IRDA, 2004; Warwick, 2003). This system provides a positive signal and image to the general public, as standardised applications use an international standard protocol. Overall, ZOOP has addressed the major issues surrounding the development of mobile payments, and it has successfully attracted a substantial number of customers to adopt this service.

**Step 4: Customer switching**

Why do customers switch from classic payment methods to use mobile payments? Consumers could be influenced to adopt the new payments scheme not only by the issues mentioned in the above sections, but consumers’ behaviour associated with culture also plays an important part (Ondrus & Pigneur, 2005). ZOOP is operated within South Korea. In the twenty-first century, South Korea has moved itself to the cutting edge of the digital world (Kado, 2006). Koreans can access information easily from state-of-the-art mobile networks and handsets and the world’s most extensive broadband network. Korea also has one of the most advanced and sophisticated mobile phone markets in the world (MIC, 2005a). The reason behind the rapid growth and development of Korean information and communication is that the Korean Government has extensively and successfully planned and implemented their strategy, and has been determined of transform the digital community in Korea (MIC, 2005b). They have a positive attitude toward new technology. Moreover, the government has also heavily invested in IT-skills education, in order to train more technology awareness users (MIC, 2005b). Thus, it should be easy for the ZOOP service provider to attract and influence users to switch to the new payment scheme.
Step 5: Incumbent retaliation

The involvement of financial institutions and MNOs in the ZOOP mobile payments scheme has offered an opportunity for ZOOP to establish itself as a trustworthy brand. At the moment, most people believe in and trust the classic payments provided by the financial institutions (Carruthers & Babb, 2000; Ondrus & Pigneur, 2005), and they have fewer concerns and issues when dealing with the financial institutions, as these financial institutions have established themselves and their reputations are based on different financial activities (Evans & Schmalensee, 2005; Ondrus & Pigneur, 2005). Moreover, the financial institutions and the three leading MNOs have competitive advantages concerning their brand names and having large customers in Korea. Therefore, using their financial power and established brand names would make it easier for them to offer consumers a trusted mobile payments scheme.

Step 6: Incumbent displacement

The collaboration between the financial institutions and MNOs in ZOOP mobile payments has demonstrated a workable business model for the industry. In general, MNOs depend on financial institutions to perform macro-payment transactions, or they have to obtain a banking licence. Furthermore, MNOs are more interested in micro-payments at the present (Costello, 2003). On the other hand, financial institutions would find it difficult to implement mobile payment services on their own without working with MNOs (Ondrus & Pigneur, 2005). The collaboration of these two sectors has provided a new platform to develop standardised and interoperable mobile payments (Chen & Adams, 2004b; Ondrus & Pigneur, 2005). Therefore, the ZOOP mobile payments business model could be seen as the best option for both service providers and consumers: it is a win-win situation.

In conclusion, careful examination of ZOOP mobile payments indicates that ZOOP has been successful in developing and operating in South Korea. The service provider has addressed the major issues that have been previously identified by researchers. The cooperation between different actors has demonstrated the success of this business model and the technology selection for ZOOP has proved to be popular, as the infrared technology offers flexibility to merchants and consumers as well as
service providers. Moreover, ZOOP has adopted a standard protocol to implement the service. This international standard offers security, interoperability and flexibility to this scheme. This study has provided first-hand information regarding the development of a successful mobile payment scheme, and these findings would be useful and valuable for potential service providers.

The next section presents the results from the questionnaire study concerning ZOOP mobile payments.

### 6.2.5 The Sample

109 ZOOP mobile payment users in Sookmyung Women’s University, South Korea took part in this survey. This university was selected for involvement because it has implemented ZOOP mobile payments across its campus, and the mobile payments service is available for all students and staff on the campus as well as in the city.

The sample includes more females (65.31%) than males (34.69%), and most of the respondents are aged between 20 and 29 years old (57.4%) with the majority being students (77.6%). 49% of respondents have obtained or are working toward a bachelor’s degree. The detailed demographic characteristics of respondents are presented in Table 6.

<table>
<thead>
<tr>
<th>Demographic Categories</th>
<th>Range</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age groups</td>
<td>Under 20</td>
<td>20.4</td>
</tr>
<tr>
<td></td>
<td>20-29</td>
<td>57.4</td>
</tr>
<tr>
<td></td>
<td>30-39</td>
<td>16.1</td>
</tr>
<tr>
<td></td>
<td>Over 50</td>
<td>6.1</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>34.69</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>65.31</td>
</tr>
<tr>
<td>Education</td>
<td>Less than high school</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>High school</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Bachelor’s degree</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Master’s degree</td>
<td>38.8</td>
</tr>
<tr>
<td></td>
<td>PhD, or other advanced degree</td>
<td>10.2</td>
</tr>
</tbody>
</table>
Demographic Characteristics of the Sample

The sample size reached the minimum requirement set by the study. The sample is not representative of all ZOOP mobile payment users in South Korea since it includes self-selected users in one particular university.

6.2.6 Data Analysis

The majority of respondents (87%) had used ZOOP mobile payments for over 6 months. Therefore, most of the respondents have extensive knowledge of this payment scheme.

Why do people want to use ZOOP mobile payments?

In terms of identifying why consumers use ZOOP mobile payments, four items were found to be particularly important. 60% of ZOOP users indicated that they “Strongly agree” or “Agree” that they use ZOOP mobile payment because it is easy to use, one of the most important reasons why users want to use this payment method, as shown in Table 7. This finding gives an important indication for service providers when designing mobile payment applications in the future.

A convenient service is another reason for users using ZOOP mobile payments system. Nowadays, convenience is a crucial factor for most people. Users want to
accomplish tasks as quickly and as easily as possible, without any hassle. 63% of the respondents indicated that they “Strongly agree” or “Agree” that ZOOP mobile payments provide fast payment transactions, as shown in Table 8.

<table>
<thead>
<tr>
<th>Convenient</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>6%</td>
<td>4%</td>
<td>11%</td>
<td>9%</td>
<td>7%</td>
<td>24%</td>
<td>39%</td>
<td></td>
</tr>
</tbody>
</table>

Table 8 A Convenient Service

Overall, 57.2% of respondents indicated that they “Strongly Agree” or “Agree” that ZOOP mobile payment is a safe service, as shown in Table 9. This is one of the factors that influence whether consumers will use mobile payments and is another key attribute that must be taken into consideration when designing and implementing mobile payment systems. Payment systems handle very sensitive information about users, such as personal details and payment details, and users are concerned that this information will be passed to other individuals.

<table>
<thead>
<tr>
<th>Safe service</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>4%</td>
<td>6%</td>
<td>17%</td>
<td>10.8%</td>
<td>35.2%</td>
<td>22%</td>
<td></td>
</tr>
</tbody>
</table>

Table 9 A Safe Service

The background of the shareholders of ZOOP mobile payments was seen as important by most of the respondents. 65.3% of respondents indicated that they “Strongly Agree” or “Agree” that the shareholders of ZOOP mobile payments have a strong economic background, as shown in Table 10. It seems that the shareholders have a considerable influence on the respondents. ZOOP’s major shareholders include three dominant MNOs in Korea; moreover, a state-run development bank is also involved in this scheme. The reputation and financial power of these shareholders certainly delivers a positive image and signal to most of the users.

<table>
<thead>
<tr>
<th>Shareholders’ economics background</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8%</td>
<td>4.3%</td>
<td>6.6%</td>
<td>5%</td>
<td>17%</td>
<td>30.6%</td>
<td>34.7%</td>
<td></td>
</tr>
</tbody>
</table>

Table 10 ZOOP Shareholders’ Background
On the other hand, regarding ZOOP’s reputation in Korea, only 15.2% of respondents indicated that they “Strongly agree” or “Agree” that ZOOP has a good reputation in Korea and 38% of respondents indicated “Neutral” for this statement, as shown in Table 11. This result is not surprising at all, because ZOOP is a newcomer to the market and was also a new company at the time of this research. ZOOP require a process to build their image and reputation through the service, even though they have strong shareholders to support the scheme.

<table>
<thead>
<tr>
<th>ZOOP’s reputation</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5%</td>
<td>14.4%</td>
<td>15.4%</td>
<td>38%</td>
<td>12%</td>
<td>10%</td>
<td>5.2%</td>
</tr>
</tbody>
</table>

Table 11 ZOOP’s Reputation

What are users concerned about, in relation to using a mobile payments system?

Like e-commerce and ATM developments in the past, users are likely to be reluctant to use the new services (e.g. Kolasker et al., 2004; Lewis, 1991; Marshall & Heslop, 1989). For example, ATM banking first emerged in the late 1970s. However, at that time, users were reluctant to use ATM banking instead of being served by a human (Lewis, 1991; Marshall & Heslop, 1989). The issue of whether users want to use a system is related not only to technological factors, but also involves other considerations (Lewis, 1991; Marshall & Heslop, 1989). A similar scenario and situation could also happen to mobile payments. Service providers have to design and build a secure mobile payments system for users and win their trust in the system.

Nearly ninety per cent of respondents indicated that they “Strongly agree” or “Agree” that they are concerned about the security of mobile payment services, and half of the respondents (51%) were “Very Concerned”. This is clearly one of the major fears that consumers have about new payment systems, as shown in Table 12.

<table>
<thead>
<tr>
<th>Security</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0%</td>
<td>1%</td>
<td>1%</td>
<td>3%</td>
<td>7%</td>
<td>37%</td>
<td>51%</td>
</tr>
</tbody>
</table>

Table 12 Security
87.7% of the survey respondents “Strong agree” or “Agree” that they are concerned about the lack of a quality service, as shown in Table 13. This attribute is a vital part of any business model. Users are looking for better service and added value. Mobile payment aims to provide a more convenient and flexible way for consumers to make a purchase.

Unsurprisingly, consumers were concerned about the service charge. The service charges of mobile payment applications could influence users’ choice of mobile payments systems. Therefore, 93.8% of respondents said they “Strongly agree” or “Agree” that they are concerned about the service charge, as shown in Table 14.

In summary, respondents are clearly very worried about their payment details. They do not want unauthorised persons or hackers to access their personal details. Unsurprisingly, the service charge is another attribute that consumers are concerned about. Respondents definitely require a high quality of service. These attributes could significantly influence the attitude and behaviour of consumers toward mobile payment services.

**What are the essential attributes that influence consumers’ use of ZOOP mobile payments?**

Mobile payments are not widely adopted at the moment, and a number of issues are involved. These include technology selection, security issues and regulations. The strategy and implementation process has involved complex business decisions. However, mobile payment applications have the potential to attain widespread adoption across the world in the near future.
The first research question attempted to establish why users want to use ZOOP. In this section, the reasons given by respondents in response to the first question will be examined. Are these attributes significant enough to influence users’ usage of ZOOP mobile payments? First, we will look at the ‘ease of use’ variable. A correlational analysis was carried out between ease of use and how often users use ZOOP. The result shows that the frequency of use of ZOOP is positively related to ease of use, as shown in Table 15. The relationship between frequency and ease of use was found to be positively and strongly related \((r = +0.759, p < 0.001)\).

<table>
<thead>
<tr>
<th>How often do you use &quot;ZOOP&quot;?</th>
<th>Pearson Correlation</th>
<th>How often do you use the &quot;ZOOP&quot;?</th>
<th>ZOOP is easy to use.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Correlation is significant at the 0.01 level (1-tailed).</strong></td>
<td><strong>Table 15 Correlation of Frequency of Use and Ease of Use</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The convenience of the service is another variable that needs to be examined. Again, a correlational analysis was carried out to examine the relationship between how often users use ZOOP and whether they see it as a convenient payment method. The result indicates that the use of ZOOP is positively and strongly related to perception of the system as a convenient payment method, as shown in Table 16. The relationship between frequency of use of ZOOP and speed of the method was found to be positively related \((r = +0.862, p < 0.001)\).

<table>
<thead>
<tr>
<th>How often do you use &quot;ZOOP&quot;?</th>
<th>Pearson Correlation</th>
<th>How often do you use the &quot;ZOOP&quot;?</th>
<th>ZOOP provides fast payment transactions.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Correlation is significant at the 0.01 level (1-tailed).</strong></td>
<td><strong>Table 16 Correlation of Frequency of Use and Convenient Service</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Nowadays, users have received plenty of information related to e-business security issues and negative news from newspapers, magazines or the Internet (e.g. Ghosh & Swaminatha, 2001; Udo, 2001). Furthermore, some users have already had bad experiences when conducting payment transactions over the Internet. Thus, service providers really need to provide a safe service for users, especially with regard to payment transactions (Miyazaki & Fernandez, 2001). The safe service variable was thus analysed. A correlational analysis was carried out to examine the relationship between how often users use ZOOP and how safe they consider the service to be. The results demonstrate that the use of ZOOP is positively related to the perceived safety of the service, as shown in Table 17. The relationship between frequency of using ZOOP and safety of the service was found to be positively and strongly related \((r = +0.862, p < 0.001)\).

<table>
<thead>
<tr>
<th></th>
<th>How often do you use the “ZOOP”?</th>
<th>ZOOP is a safe service.</th>
</tr>
</thead>
<tbody>
<tr>
<td>How often do you use “ZOOP”?</td>
<td>Pearson Correlation</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig. (1-tailed)</td>
<td>.</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>109</td>
</tr>
<tr>
<td>ZOOP is a safe service.</td>
<td>Pearson Correlation</td>
<td>.806(***)</td>
</tr>
<tr>
<td></td>
<td>Sig. (1-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>109</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (1-tailed).

Table 17 Correlation of Frequency of Use and a Safe Service

The economic background of ZOOP’s shareholders is another variable that needs to be examined. Again, a correlational analysis was carried out to examine the relationship between how often users use ZOOP and whether they consider the shareholders have a strong economic background. The shareholders’ reputation could have a huge impact on users’ perceptions of mobile payments. The result indicates that the use of ZOOP is positively and strongly related to the perception of the system as a convenient payment method, as shown in Table 18. The relationship between frequency of use of ZOOP and the economic background of ZOOP was found to be positively related \((r = +0.911, p < 0.001)\).
Correlations

<table>
<thead>
<tr>
<th>How often do use “ZOOP”?</th>
<th>How often do you use the “ZOOP”?</th>
<th>ZOOP’s shareholders have a strong economic background.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>.911(**)</td>
</tr>
<tr>
<td>Sig. (1-tailed)</td>
<td>.</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>109</td>
<td>109</td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (1-tailed).

Table 18 Correlation of Frequency of Use and Shareholders’ Background

In summary, the survey participants indicated that they are looking for easy-to-use and fast services, but system security cannot be compromised: they are also looking for a safe service. In addition, users’ financial details and information must be kept private and safe. Building a safe and reliable service is a step forward towards the establishment of a trusting relationship between users and service providers. Moreover, the reputation of the shareholders has an impact on consumers as well. It is wise to establish a positive brand image to attract and retain consumers.

In study one, focus group studies identified the reasons for adopting mobile payment systems, for example, a convenient service. Concerns about using the services, for instance, security, have also been identified. Furthermore, the second study surveyed ZOOP mobile payment users in South Korea: it also identified that convenience, ease of use, and a safe service would attract consumers to use the service. Both studies have provided valuable information for academics and the industry to understand why consumers would like to use mobile payments and also their concerns. Moreover, due to little literature being available concerning mobile payments research, these two studies have provided valuable information and a reference source regarding mobile payments research. They also inform study three, which will be presented in detail in the next chapter.
Chapter Seven: Study Three - Evaluation of the Research Model

7.1 Introduction

This study attempts to address consumer acceptance of mobile payments by answering these research questions: what factors influence consumer acceptance of mobile payments and how do these factors influence one another?

A research model has been proposed in order to address these research questions, and this chapter presents the evidence collected based on two sets of data, as mentioned in the previous chapter. The demographic data are tested in the form of descriptive analysis using SPSS. The research model will also be examined using the Structural Equation Modeling (SEM). The exogenous and endogenous variables are also analysed. The research hypotheses will be tested using LInear Structural RELationships (LISREL) (Gefen, 2003; McDonald & Ho, 2002). The validity and reliability of the constructs in the measurement model will be assessed.

The data were interpreted with the help of the SPSS and LISREL programs, and may be divided into five parts as follows:

1. Respondents’ characteristics have been identified from the demographic data by descriptive statistics analysis:
   - Gender
   - Age
   - Highest education level
   - Occupation

2. Exogenous variables
   - Perceived trust
   - Perceived costs
   - Perceived system quality
• Perceived ease of use
• Perceived usefulness

• Social influence
• Observability
• Compatibility
• Trialability

3. Endogenous variables
• Actual use of mobile payments
• Behavioural intention to use
• Attitude toward using

4. The research hypotheses

H1: A user’s behavioural intention towards using mobile payment services has a positive effect upon his/her actual use of mobile payment services.

H2: A user’s attitude toward using mobile payment services has a positive effect upon his/her behavioural intention to use mobile payment services.

H3: A user’s perceived ease of use of mobile payment services has a positive effect upon his/her attitude to the use of mobile payment services.

H4: A user’s perception of the usefulness of mobile payment services has a positive effect upon his/her attitude toward using mobile payment services.

H5: The perceived costs of mobile payment services have a negative effect upon a user’s attitude to using mobile payment services.

H6: The perceived system quality of mobile payment services has a positive effect upon a user’s attitude to using mobile payment services.
H7: Social influence has a positive effect upon a user’s intention to use mobile payment services.

H8: A user’s perceived trust in mobile payment services has a positive effect upon his/her attitude to using mobile payment services.

H9: Compatibility between a user using mobile payment services and the belief, values, and needs of a user has a positive effect upon his/her attitude to using mobile payment services.

H10: The trialability of mobile payment services has a positive effect upon a user’s attitude to using mobile payment services.

H11: The observability of mobile payment services has a positive effect upon a user’s attitude to using mobile payment services.

The following section presents the reason for adopting SEM and using LISREL for this study and how it applies to analyse the data in this study.

7.2 SEM

In order to evaluate the hypothesised casual links in the model, an appropriate and suitable statistical tool should be identified. Regression analysis can cope with one dependent variable and can only test the direct effect of each independent variable on the dependent variable (Bagozzi, 1997; Giles, 2002). For this study, a single regression equation is not enough to deal with the complexity of the research model in this study.

SEM has allowed social scientists to perform path analytic modelling with latent variables (LVs), which in turn has led some to describe this approach as an example of “a second generation of multivariate analysis” (Fornell 1987, p. 408). Specifically, SEM provides the researcher with the flexibility to: (a) model relationships among multiple predictor and criterion variables, (b) construct unobservable LVs, (c) model
errors in measurements for observed variables, and (d) statistically test a priori substantive/theoretical and measurement assumptions against empirical data (i.e., confirmatory analysis). Thus, SEM involves generalisations and extensions of first-generation procedures. The application of certain constraints or assumptions on an SEM analysis would then yield a first-generation analysis with correspondingly less flexibility in modelling theory with data (Bagozzi et al., 1981; Knapp, 1978; Wold, 1975).

SEM aims to determine the pattern of a set of dependent relationships between a series of latent variables, which are measured by manifest variables (Kaplan, 2000). SEM enables the evaluation and modification of theoretical models, and it offers an opportunity for furthering theory development (Anderson & Gerbing, 1988). SEM allows the simultaneous analysis of multiple independent variables (Joreskog & Sorbom, 1989). Moreover, SEM can be used in different forms of analysis, such as to estimate variance and covariance and to test hypotheses (Schumacker & Lomax, 1996).

The SEM approach was employed for the data analysis in this study. SEM provides a straightforward method for handling multiple relationships while providing statistical efficiency (Baumgartner & Homburg, 1996; Kline, 2005; Giles, 2002). Moreover, SEM allows the comprehensive identification of a relationship and provides a transition from exploratory to confirmatory analysis (Chang & Cheung, 2001; Joreskog & Sorbom, 1995); SEM is also suitable for testing a series of relationships including a large-scale model and a theory (Bhattacherjee, 2000; Hair et al., 1998; McDonald & Ho, 2002). There are some advantages in using this approach rather than other methods. For example, SEM enables the testing of a theoretical model and the simultaneously testing of structural and measurement models (Bagozzi & Yi, 1989; Gefen, et al., 2000). This study sought to examine the factors influencing consumer acceptance of mobile payments. These research findings could assist researchers and industry practitioners to gain a better understanding of consumer acceptance of mobile payments. Thus, SEM fits well with the purpose of this study.

SEM has been widely adopted in different research disciplines. It can be found in a number of studies (e.g. Agho, Price, & Mueller, 1992; Spreng, Mackenzie, &
Olshavsky, 1996; Taylor, 1994; Taylor & Baker, 1994). In the IS discipline, SEM has been widely used in different applications such as e-commerce (e.g. Quaddus & Achjari, 2005) and mobile applications (e.g. Gerpott, Rams, & Schindler, 2001). SEM has been selected in this study because of its ability to solve the research problems.

7.3 LISREL

LInear Structural RELationships (LISREL) is computer software to conduct covariance structure analysis (Gefen, 2003; Long, 1983). It is a very powerful research tool and it offers a multivariate technique which includes structural equation modelling and factor analysis modelling. Many researchers have used LISREL to analyse their data (e.g. Chellappa & Sin, 2005; Mukherjee, 2003; Suh & Han, 2003).

LISREL is selected as the computer program used for actually estimating the model in this study. LISREL is the most widely used software for structural equation modelling and indeed is almost synonymous with structural equation modelling (Hair et al., 1998). LISREL is used for estimation of the measurement and structural model (Joreskog & Sorbom, 1995). The LISREL is used to analyse structural models and estimate the coefficients in the structural equations that define the model. It can also define a set of simultaneous equations (Joreskog & Sorbom, 1995). LISREL allows the overall effects of antecedent variables on other variables to be tested by taking account of all the variables in the model (Mak & Sockel, 2001).

The overall objective of the analysis using LISREL is to show that the null hypothesis of the proposed research model is plausible and to reject null hypotheses (Gefen, 2000; Joreskog & Sorbom, 1995). The objective of the technology adoption study in this research should be to maximise the variance explained in the dependent construct, intention to adopt and prediction (Pluoffe et al., 2001; Rogers, 1995). The sample size of this study is larger than the minimum recommended for a covariance-based modelling approach, for example, LISREL (Hair et al., 1998). Moreover, LISREL requires a sound theory base to support the confirmatory research (Mak & Sockel, 2001). In this research study, if the research model is an accurate representation of the technology acceptance phenomenon, then the relationships between observed...
measures of these constructs in the theoretical model should be applied to a LISREL-generated model of no-fit. On the other hand, PLS is another SEM technique based on partial least squares and which is more suitable to predict applications and build a theory, which is different to covariance-based SEM (Chin, 1998; Thompson et al., 1995). Moreover, PLS is more suited for the analysis of small data samples research (Chin, 1998; Thompson et al., 1995). Thus, selecting a suitable analysis method depends on the research objectives, and the limitation imposed by the sample size and distribution assumptions is vital. Therefore, LISREL is well suited for this research study.

In order to ensure the quality and validity of this research study, the comprehensive guidelines provided by Diamantopoulos and Siguaw (2000) were followed. The details of using LISREL for this research are presented in the following section.

### 7.4 Model Conceptualisation

The proposed research model is presented in Chapter three. The theoretical model develops the linkages between latent constructs and the measurable variables, and it leads to the proposed hypotheses. For instance, two latent constructs were **actual use of mobile payment** and **behavioural intention to use**. The actual use of mobile payment is measured by the questions (1) *How often do you use the mobile payments service?* and (2) *How many times have you used the mobile payments service in the last three months?* The behavioural intention is measured by whether the user intends to continue using the mobile payments service in the future. It is hypothesised that a user’s behavioural intention towards using mobile payment services has a positive effect upon his/her actual use of mobile payment services. Table 19 presents the expected linkages between the latent variables in this research. In order to critically determine the relationships among the variables, previous theories and past empirical evidence need to be gathered: Chapter three has details on how these linkages have been developed.
### Table 19 Expected Linkage among latent Variables

<table>
<thead>
<tr>
<th>Exogenous Variables</th>
<th>Endogenous Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual use of mobile payment$^2$ (USE)</td>
</tr>
<tr>
<td>Perceived ease of use$^1$ (PEOU)</td>
<td></td>
</tr>
<tr>
<td>Observability$^1$ (O)</td>
<td>+</td>
</tr>
<tr>
<td>Compatibility$^1$ (C)</td>
<td>+</td>
</tr>
<tr>
<td>Trialability$^1$ (T)</td>
<td>+</td>
</tr>
<tr>
<td>Perceived costs$^1$ (PC)</td>
<td>-</td>
</tr>
<tr>
<td>Perceived system quality$^1$ (PSQ)</td>
<td>+</td>
</tr>
<tr>
<td>Social influence$^1$ (SI)</td>
<td>+</td>
</tr>
<tr>
<td>Perceived usefulness$^1$ (PU)</td>
<td>+</td>
</tr>
<tr>
<td>Perceived trust$^1$ (PT)</td>
<td>+</td>
</tr>
<tr>
<td>Attitude toward using$^2$ (A)</td>
<td>+</td>
</tr>
<tr>
<td>Behavioural intention to use$^2$ (BI)</td>
<td>+</td>
</tr>
</tbody>
</table>

$^1$Exogenous variable; $^2$ Endogenous variable.

A latent variable is different to a manifest variable, and it cannot be directly observed (Kaplan, 2000): it requires the identification of the measured variables and the description of the way in which the manifest variables can represent the latent constructs. In LISREL, manifest variables are assumed as reflective indicators of the latent variables, and a single indicator usually cannot reflect the latent variable (Diamantopoulos & Siguaw, 2000). Thus, this research has selected multiple indicators for the exogenous and endogenous latent variables, except “Behavioural intention” latent variables. Manifest variables are collected during research through various data collection methods. In this study, the manifest variables were gathered from research participants via questionnaires. A rating scale item on a questionnaire is reflected to manifest variables. Moreover, a latent variable is a theoretical construct and it can be determined by a set of measurable variables (Kaplan, 2000). Examples of latent variables in this study are perceived usefulness and perceived ease of use. In SEM, the latent constructs could be classified as “exogenous” constructs and “endogenous” constructs. On the other hand, the implication for this measurement
scheme is that the more variables included in this model, the greater the sample size required (Boomsma, 1987; Diamantopoulos & Siguaw, 2000; Ding et al., 1995). Ding et al. (1995) suggest that 100 to 150 subjects is the minimum sample size for covariance structure modelling. Boomsma (1987) argues that at least 200 subjects are required for structural equation models by maximum likelihood methods. Therefore, this research set a minimum sample size of 250 for covariance structure modelling.

7.5 Path Diagram Construction

In order to have a more efficient approach to the path diagram, this research used conventional LISREL notation to present the path diagram, as shown in Figure 9. Adopting the LISREL notation has offered several benefits for this study (Diamantopoulos & Siguaw, 2000). First, the data analysis output from LISREL is based on standard LISREL notation, so it is convenient to interpret the results using conventional LISREL notation to present the path diagram. Second, using the path diagram with standard LISREL notation enabled the easy construction of the mathematical specification of the model, details of which will be presented in the following section. Finally, this study tests the proposed hypotheses, and the conventional LISREL notation provides a convenient method to demonstrate the hypotheses very clearly. This method uses a thorough data analysis process. The path diagram displays all causal relationships, and the causal relationships have to be theoretically justified. Thus, the path diagram can assist to decrease the possibilities for specification error. For the notations representing the variables in this model, please refer to Appendix B1.

7.6 Mathematical Model Specification

This step outlines the nature and number of parameters to be estimated in the model. It uses mathematical equations to present a set of linear equations that link constructs. Moreover, these mathematical equations enable the translation of the research model into LISREL language in the form of matrices for data analysis, as shown in Appendix B2.
Based on the equations as shown in Appendix B2, the researcher was ready to operate the LISREL program to present the research model. When using LISREL in the research, the hypothesised relationships among the latent variables are accurately specified, and the relationships between the latent variables and manifest variables are
important. It also needs to be determined whether the correlation or variance/covariance matrix is to be used as the input data for LISREL. The covariance matrix is used when the objective is to test a theory, provide comparisons between different populations or samples, or to explain the total variance of constructs needed to test the theory (Hair et al., 1998). However, the interpretation of the results from the covariance is difficult (Reisinger & Turner, 1999): it requires the interpretation of the coefficients of every unit of measurement of the constructs. The correlation matrix allows for direct comparisons of the coefficients within a model. However, it is not used to explain the total variance of a construct as needed in theory testing: it is only used to understand the pattern of relationships between constructs. This research employed a variance/covariance matrix, because a “test of theory” is being performed in this research (Hair et al., 1998).

The first set of data was analysed and is presented in the following section, and the second set of data follows in a later section.

### 7.7 Data Set One

#### 7.7.1 The Sample

205 mobile payment users took part in this survey. The sample comprises females (58.54%) and males (41.46%). Most participants (65.85%) are aged between 20 and 29 years old and a majority are professional. The detailed demographic characteristics of respondents are presented in Table 20.

<table>
<thead>
<tr>
<th>Demographic Categories</th>
<th>Range</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under 20</td>
<td>9.76</td>
<td></td>
</tr>
<tr>
<td>20-29</td>
<td>65.85</td>
<td></td>
</tr>
<tr>
<td>30-39</td>
<td>21.95</td>
<td></td>
</tr>
<tr>
<td>Over 50</td>
<td>2.44</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>58.54</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>41.46</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than high school</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>High school</td>
<td>4.89</td>
<td></td>
</tr>
<tr>
<td>Demographic Characteristics of the Sample</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>85.37</td>
<td></td>
</tr>
<tr>
<td>Master’s degree</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>PhD, or other advanced degree</td>
<td>2.44</td>
<td></td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>4.88</td>
<td></td>
</tr>
<tr>
<td>Academic/Educator</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>Engineer</td>
<td>31.71</td>
<td></td>
</tr>
<tr>
<td>Self-employed</td>
<td>4.39</td>
<td></td>
</tr>
<tr>
<td>Accountant</td>
<td>9.76</td>
<td></td>
</tr>
<tr>
<td>IT</td>
<td>41.46</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>3.9</td>
<td></td>
</tr>
</tbody>
</table>

7.7.2 Assessment of Model Fit

This section presents the assessment of the proposed research model to determine whether the research data is consistent with the model (Diamantopoulos & Siguaw, 2000; Hoyle & Panter, 1995). A range of goodness-of-fit indices are required to examine the overall fit of the model (Gerbing & Anderson, 1993; Hu & Bentler, 1995; Mulaik et al., 1989; Tanaka, 1993).

LISREL has produced a range of data; however, this research examined the key indices recommended by some researchers (Byrne, 1998; Diamantopoulos & Siguaw, 2000; MacCallum et al., 1996). The various goodness-of-fit indices are summarised in Table 21. First, the chi-square value comes to 1411.87 (P = 0.0) with 583 degrees of freedom, which implies that the model is adequate. Second, the root mean square error of approximation (RMSEA) must also be considered. MacCallum et al. (1996) suggest that a RMSEA of less than 0.08 indicates good fit and reasonable errors in the population. In this model, RMSEA = 0.061, which suggests a good fit. Third, Byrne (1998) recommended that the root mean square residual (RMR) should be less than 0.05 to indicate a well-fitting model. In this illustrative model, the value of RMR comes to 0.03, indicating a good fit. Fourth, the non-normed fit index (NNFI) and the comparative fit index (CFI) have a range from 0 to 1, with values close to 1 representing good fit (MacCallum et al., 1996). In this model, NNFI=0.95 and CFI=0.93. These indices indicate a reasonable fit of the model.
### Table 21: Goodness-of-fit Indices

<table>
<thead>
<tr>
<th></th>
<th>Chi-square</th>
<th>Degree of freedom</th>
<th>RMSEA</th>
<th>RMR</th>
<th>NNFI</th>
<th>CFI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1411.87</td>
<td>583</td>
<td>0.061</td>
<td>0.03</td>
<td>0.95</td>
<td>0.93</td>
</tr>
</tbody>
</table>

#### 7.7.3 Assessment of Measurement Model

This section evaluates the measurement of the proposed research model. It emphasises the relationship between the latent variables and their indicators. In this research, the indicators are the items in the questionnaire. The validity and reliability of the items are required to be determined. This process is very important to the research. Validity refers to the extent to which the indicators measure what they are supposed to measure, and reliability reflects the consistency of the measurement (Diamantopoulos & Siguaw, 2000). Thus, before the evaluation of the structural model, the measurement model should be evaluated in detail.

**Validity**

In order to determine the validity of the indicators, the magnitude and significance of the path between latent variables and their indicators will be used (Diamantopoulos & Siguaw, 2000). These values can be found in the output of LISREL, as shown in Appendix B3, and the model, as shown in Figure 10. This figure indicates the value of indicators and the latent variables. LISREL is such a powerful tool that it offers all these data at the same time. Details of what the figures represent in the model will be presented in the following section.
Figure 10 The Consumer Acceptance Model

In this research model, all indicator loadings are significant at p < 0.05, as the t-values are greater than 1.96 in absolute terms (Diamantopoulos & Siguaw, 2000), as shown in Table 22. These data provide evidence of validity for the indicators used to represent the constructs.
Diamantopoulos and Siguaw (2000) also recommend that the magnitudes of the standardised loading be applied to inspect the validity. This information can be obtained from the completely standardised solutions, as shown in Figure 10, and the loading shown in Table 24. The standardised loadings indicate that PEOU3 is the most valid indicator for the “Perceived Ease of Use”, and PU2 is the most valid indicator for the “Perceived Usefulness”. Similar references can be drawn with regard to the indicators of the other latent variables in the model, and the most valid indicators for the latent variables are highlighted in red in Table 23.

Overall, the indicators used for this research are valid.
Reliability

Squared multiple correlations ($R^2$) can be used to examine the reliability of the indicators. A high $R^2$ value represents high reliability for the indicators (Joreskog & Sorbom, 1989). $R^2$ can be obtained from LISREL output, as shown in Appendix B3, and the values of $R^2$ have been listed in Table 25. Thus, the most reliable indicator for “Perceived Usefulness” is PU2, and similar inferences can be drawn for the indicators of the other latent variables. The most reliable indicators for the latent variables are highlighted in red in Table 24.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Loading</th>
<th>Indicator</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>USE1</td>
<td>0.63 ($\lambda_{63}$)</td>
<td>T1</td>
<td>0.73 ($\lambda_{73}$)</td>
</tr>
<tr>
<td>USE2</td>
<td>1.22 ($\lambda_{64}$)</td>
<td>T2</td>
<td>0.80 ($\lambda_{83}$)</td>
</tr>
<tr>
<td>A1</td>
<td>0.96 ($\lambda_{11}$)</td>
<td>T3</td>
<td>0.76 ($\lambda_{93}$)</td>
</tr>
<tr>
<td>A2</td>
<td>0.97 ($\lambda_{12}$)</td>
<td>PC1</td>
<td>0.90 ($\lambda_{145}$)</td>
</tr>
<tr>
<td>A3</td>
<td>0.97 ($\lambda_{13}$)</td>
<td>PC2</td>
<td>0.74 ($\lambda_{155}$)</td>
</tr>
<tr>
<td>A4</td>
<td>0.96 ($\lambda_{14}$)</td>
<td>PSQ1</td>
<td>0.80 ($\lambda_{166}$)</td>
</tr>
<tr>
<td>B1</td>
<td>0.97 ($\lambda_{52}$)</td>
<td>PSQ2</td>
<td>0.82 ($\lambda_{176}$)</td>
</tr>
<tr>
<td>PEOU1</td>
<td>0.63 ($\lambda_{238}$)</td>
<td>PSQ3</td>
<td>0.81 ($\lambda_{186}$)</td>
</tr>
<tr>
<td>PEOU2</td>
<td>0.72 ($\lambda_{248}$)</td>
<td>PSQ4</td>
<td>0.79 ($\lambda_{196}$)</td>
</tr>
<tr>
<td>PEOU3</td>
<td>1.00 ($\lambda_{258}$)</td>
<td>PT1</td>
<td>0.85 ($\lambda_{269}$)</td>
</tr>
<tr>
<td>PU1</td>
<td>0.87 ($\lambda_{104}$)</td>
<td>PT2</td>
<td>0.80 ($\lambda_{279}$)</td>
</tr>
<tr>
<td>PU2</td>
<td>0.91 ($\lambda_{114}$)</td>
<td>PT3</td>
<td>0.79 ($\lambda_{289}$)</td>
</tr>
<tr>
<td>PU3</td>
<td>0.87 ($\lambda_{124}$)</td>
<td>PT4</td>
<td>0.81 ($\lambda_{299}$)</td>
</tr>
<tr>
<td>PU4</td>
<td>0.85 ($\lambda_{134}$)</td>
<td>SI1</td>
<td>0.80 ($\lambda_{207}$)</td>
</tr>
<tr>
<td>O1</td>
<td>0.88 ($\lambda_{11}$)</td>
<td>SI2</td>
<td>0.74 ($\lambda_{217}$)</td>
</tr>
<tr>
<td>O2</td>
<td>0.82 ($\lambda_{21}$)</td>
<td>SI3</td>
<td>0.77 ($\lambda_{227}$)</td>
</tr>
<tr>
<td>O3</td>
<td>0.71 ($\lambda_{31}$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>0.83 ($\lambda_{42}$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>0.92 ($\lambda_{52}$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>0.52 ($\lambda_{62}$)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 23 Standardised Loadings of Indicators
Composite reliability has also been introduced to calculate a value for the reliability of each latent variable (Diamantopoulos & Siguaw, 2000) as a supplement for assessing the reliability of the individual indicators, as mentioned above. The formula for calculating composite reliability is:

\[ \text{Composite Reliability} = \frac{1}{n} \sum_{i=1}^{n} R_{ii} \]

where \( R_{ii} \) is the squared multiple correlation for the \( i^{th} \) indicator. The table below presents the squared multiple correlations for each indicator:

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Squared multiple correlations (( R^2 ))</th>
<th>Indicator</th>
<th>Squared multiple correlations (( R^2 ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>USE1</td>
<td>0.40</td>
<td>T1</td>
<td>0.53</td>
</tr>
<tr>
<td>USE2</td>
<td><strong>1.48</strong></td>
<td>T2</td>
<td><strong>0.63</strong></td>
</tr>
<tr>
<td>A1</td>
<td>0.92</td>
<td>T3</td>
<td>0.58</td>
</tr>
<tr>
<td>A2</td>
<td><strong>0.94</strong></td>
<td>PC1</td>
<td><strong>0.81</strong></td>
</tr>
<tr>
<td>A3</td>
<td><strong>0.94</strong></td>
<td>PC2</td>
<td>0.55</td>
</tr>
<tr>
<td>A4</td>
<td>0.93</td>
<td>PSQ1</td>
<td>0.65</td>
</tr>
<tr>
<td>BI</td>
<td>0.93</td>
<td>PSQ2</td>
<td><strong>0.67</strong></td>
</tr>
<tr>
<td>PEOU1</td>
<td>0.40</td>
<td>PSQ3</td>
<td>0.65</td>
</tr>
<tr>
<td>PEOU2</td>
<td>0.52</td>
<td>PSQ4</td>
<td>0.62</td>
</tr>
<tr>
<td>PEOU3</td>
<td><strong>0.99</strong></td>
<td>PT1</td>
<td><strong>0.72</strong></td>
</tr>
<tr>
<td>PU1</td>
<td>0.75</td>
<td>PT2</td>
<td>0.64</td>
</tr>
<tr>
<td>PU2</td>
<td><strong>0.83</strong></td>
<td>PT3</td>
<td>0.62</td>
</tr>
<tr>
<td>PU3</td>
<td>0.76</td>
<td>PT4</td>
<td>0.65</td>
</tr>
<tr>
<td>PU4</td>
<td>0.73</td>
<td>SI1</td>
<td><strong>0.64</strong></td>
</tr>
<tr>
<td>O1</td>
<td><strong>0.78</strong></td>
<td>SI2</td>
<td>0.54</td>
</tr>
<tr>
<td>O2</td>
<td>0.67</td>
<td>SI3</td>
<td>0.59</td>
</tr>
<tr>
<td>O3</td>
<td>0.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>0.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td><strong>0.86</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>0.27</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 24 Squared Multiple Correlations
\[ \rho_c = \frac{(\sum \lambda)^2}{(\sum \lambda)^2 + \sum (\theta)} \]

where \( \rho_c \) = composite reliability
\( \lambda \) = indicator loadings
\( \theta \) = indicator error variances
\( \sum \) = summation over the indicators of the latent variable

LISREL does not automatically compute composite reliabilities; therefore, manual calculation of the results was undertaken as follows. The variables can be found from the completely standardised solution, as shown in Figure 10, indicator loadings as shown in Table 24, and error variances, as shown in Table 25:

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Error variances</th>
<th>Indicator</th>
<th>Error variances</th>
</tr>
</thead>
<tbody>
<tr>
<td>USE1</td>
<td>0.60</td>
<td>T1</td>
<td>0.47</td>
</tr>
<tr>
<td>USE2</td>
<td>-0.48</td>
<td>T2</td>
<td>0.37</td>
</tr>
<tr>
<td>A1</td>
<td>0.08</td>
<td>T3</td>
<td>0.42</td>
</tr>
<tr>
<td>A2</td>
<td>0.06</td>
<td>PC1</td>
<td>0.19</td>
</tr>
<tr>
<td>A3</td>
<td>0.06</td>
<td>PC2</td>
<td>0.45</td>
</tr>
<tr>
<td>A4</td>
<td>0.07</td>
<td>PSQ1</td>
<td>0.35</td>
</tr>
<tr>
<td>BI</td>
<td>0.07</td>
<td>PSQ2</td>
<td>0.33</td>
</tr>
<tr>
<td>PEOU1</td>
<td>0.60</td>
<td>PSQ3</td>
<td>0.35</td>
</tr>
<tr>
<td>PEOU2</td>
<td>0.48</td>
<td>PSQ4</td>
<td>0.38</td>
</tr>
<tr>
<td>PEOU3</td>
<td>0.01</td>
<td>PT1</td>
<td>0.28</td>
</tr>
<tr>
<td>PU1</td>
<td>0.25</td>
<td>PT2</td>
<td>0.36</td>
</tr>
<tr>
<td>PU2</td>
<td>0.17</td>
<td>PT3</td>
<td>0.38</td>
</tr>
<tr>
<td>PU3</td>
<td>0.24</td>
<td>PT4</td>
<td>0.35</td>
</tr>
<tr>
<td>PU4</td>
<td>0.27</td>
<td>SI1</td>
<td>0.36</td>
</tr>
<tr>
<td>O1</td>
<td>0.22</td>
<td>SI2</td>
<td>0.46</td>
</tr>
<tr>
<td>O2</td>
<td>0.33</td>
<td>SI3</td>
<td>0.41</td>
</tr>
<tr>
<td>O3</td>
<td>0.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>0.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>0.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>0.73</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 25 Indicator Error Variances
<table>
<thead>
<tr>
<th>USE</th>
<th>[ \rho_c = \frac{(0.63+1.22)^2}{(0.63+1.22)^2 + (0.60-0.48)^2} = \frac{3.4225}{3.5425} = 0.966 ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>[ \rho_c = \frac{(0.96+0.97+0.97+0.96)^2}{(0.96+0.97+0.97+0.96)^2 + (0.08+0.06+0.06+0.07)^2} = \frac{14.8996}{15.1696} = 0.982 ]</td>
</tr>
<tr>
<td>PEOU</td>
<td>[ \rho_c = \frac{(0.63+0.72+1.00)^2}{(0.63+0.72+1.00)^2 + (0.6+0.48+0.01)^2} = \frac{5.5225}{6.6125} = 0.835 ]</td>
</tr>
<tr>
<td>PU</td>
<td>[ \rho_c = \frac{(0.87+0.91+0.87+0.85)^2}{(0.87+0.91+0.87+0.85)^2 + (0.25+0.17+0.24+0.27)^2} = \frac{12.25}{13.18} = 0.929 ]</td>
</tr>
<tr>
<td>O</td>
<td>[ \rho_c = \frac{(0.88+0.82+0.71)^2}{(0.88+0.82+0.71)^2 + (0.22+0.23+0.49)^2} = \frac{5.8081}{6.7481} = 0.86 ]</td>
</tr>
<tr>
<td>C</td>
<td>[ \rho_c = \frac{(0.83+0.92+0.52)^2}{(0.83+0.92+0.52)^2 + (0.31+0.14+0.73)^2} = \frac{5.1529}{6.3329} = 0.814 ]</td>
</tr>
<tr>
<td>T</td>
<td>[ \rho_c = \frac{(0.73+0.80+0.76)^2}{(0.73+0.80+0.76)^2 + (0.47+0.37+0.42)^2} = \frac{5.2441}{6.5041} = 0.806 ]</td>
</tr>
<tr>
<td>PC</td>
<td>[ \rho_c = \frac{(0.90+0.74)^2}{(0.90+0.74)^2 + (0.19+0.45)^2} = \frac{2.6896}{3.3296} = 0.808 ]</td>
</tr>
</tbody>
</table>
The overall values for the latent variables are shown in Table 26.

<table>
<thead>
<tr>
<th>Latent Variables</th>
<th>Composite Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Use (USE)</td>
<td>0.966</td>
</tr>
<tr>
<td>Attitude (A)</td>
<td>0.982</td>
</tr>
<tr>
<td>Perceived ease of use (PEOU)</td>
<td>0.835</td>
</tr>
<tr>
<td>Perceived usefulness (PU)</td>
<td>0.929</td>
</tr>
<tr>
<td>Observability (O)</td>
<td>0.86</td>
</tr>
<tr>
<td>Compatibility (C)</td>
<td>0.814</td>
</tr>
<tr>
<td>Trialability (T)</td>
<td>0.806</td>
</tr>
<tr>
<td>Perceived costs (PC)</td>
<td>0.808</td>
</tr>
<tr>
<td>Perceived system quality (PSQ)</td>
<td>0.879</td>
</tr>
<tr>
<td>Perceived trust (PT)</td>
<td>0.885</td>
</tr>
<tr>
<td>Social influence (SI)</td>
<td>0.813</td>
</tr>
</tbody>
</table>

**Table 26 Composite Reliability**

Composite reliability values greater than 0.6 are desirable (Bagozzi & Yi, 1988): thus, it can be concluded that as a set of indicators, the eleven latent variables provide reliable measurement of the construct.
Average variance extracted is another measure used to examine reliability. This value shows ‘the amount of variance that is captured by the construct in relation to the amount of variance due to measurement error’ (Fornell & Larcker, 1982, p.45). The formula to calculate the average variance is as follows: the variables in this formula can be found the in output of LISREL, as shown in Figure 10.

\[
\rho_v = \frac{(\sum \lambda^2)}{\sum \lambda^2 + \sum (\theta)}
\]

where \( \rho_v \) = Average Variance Extracted

\( \lambda \) = indicator loadings

\( \theta \) = indicator error variances

\( \sum \) = summation over the indicators of the latent variable

Again, LISREL does not automatically compute average variance extracted; therefore, manual calculation of the results was undertaken as follows.

**USE**

\[
\rho_v = \frac{(0.63^2 + 1.22^2)}{(0.63^2 + 1.22^2) + 0.6 - 0.48} = \frac{1.8853}{2.0053} = 0.94
\]

**A**

\[
\rho_v = \frac{(0.96^2 + 0.97^2 + 0.97^2 + 0.96^2)}{(0.96^2 + 0.97^2 + 0.97^2 + 0.96^2) + 0.08 + 0.06 + 0.06 + 0.07} = \frac{3.725}{3.995} = 0.932
\]

**PEOU**

\[
\rho_v = \frac{(0.63^2 + 0.72^2 + 1.00^2)}{(0.63^2 + 0.72^2 + 1.00^2) + 0.6 + 0.48 + 0.01} = \frac{1.9153}{3.0053} = 0.637
\]

**PU**

\[
\rho_v = \frac{(0.87^2 + 0.91^2 + 0.87^2 + 0.85^2)}{(0.87^2 + 0.91^2 + 0.87^2 + 0.85^2) + 0.25 + 0.17 + 0.24 + 0.27} = \frac{3.0644}{3.9944} = 0.767
\]
<table>
<thead>
<tr>
<th>Variable</th>
<th>( \rho_v = \frac{(0.88^2 + 0.82^2 + 0.71^2)}{\left(\frac{0.88^2 + 0.82^2 + 0.71^2}{+0.22+0.23+0.49}\right)} = \frac{1.9509}{2.8909} = 0.675 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>( \rho_v = \frac{(0.83^2 + 0.92^2 + 0.52^2)}{\left(\frac{0.83^2 + 0.92^2 + 0.52^2}{+0.31+0.14+0.73}\right)} = \frac{1.8057}{2.9857} = 0.605 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>( \rho_v = \frac{(0.73^2 + 0.80^2 + 0.76^2)}{\left(\frac{0.73^2 + 0.80^2 + 0.76^2}{+0.47+0.37+0.42}\right)} = \frac{1.7505}{3.0105} = 0.581 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>( \rho_v = \frac{(0.90^2 + 0.74^2)}{\left(\frac{0.90^2 + 0.74^2}{+0.19+0.45}\right)} = \frac{1.3576}{1.9976} = 0.68 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>( \rho_v = \frac{(0.80^2 + 0.82^2 + 0.81^2 + 0.79^2)}{\left(\frac{0.80^2 + 0.82^2 + 0.81^2 + 0.79^2}{+0.35+0.33+0.35+0.38}\right)} = \frac{2.5926}{4.0026} = 0.648 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSQ</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>( \rho_v = \frac{(0.85^2 + 0.80^2 + 0.79^2 + 0.81^2)}{\left(\frac{0.85^2 + 0.80^2 + 0.79^2 + 0.81^2}{+0.28+0.36+0.38+0.35}\right)} = \frac{2.6427}{4.0127} = 0.656 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>( \rho_v = \frac{(0.8^2 + 0.74^2 + 0.77^2)}{\left(\frac{0.8^2 + 0.74^2 + 0.77^2}{+0.36+0.46+0.41}\right)} = \frac{1.7805}{3.0105} = 0.591 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

The results for all five latent variables are shown in Table 27. When the average variance extracted is greater than 0.50, then a higher amount of variance in the indicators is measured by the construct compared to that accounted for by measurement error (Diamantopoulos & Siguaw, 2000). In this case, the average variance extracted is greater than 0.50 for all eleven latent variables.
<table>
<thead>
<tr>
<th>Latent Variables</th>
<th>Average Variance Extracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Use (USE)</td>
<td>0.94</td>
</tr>
<tr>
<td>Attitude (A)</td>
<td>0.932</td>
</tr>
<tr>
<td>Perceived ease of use (PEOU)</td>
<td>0.637</td>
</tr>
<tr>
<td>Perceived usefulness (PU)</td>
<td>0.767</td>
</tr>
<tr>
<td>Observability (O)</td>
<td>0.675</td>
</tr>
<tr>
<td>Compatibility (C)</td>
<td>0.605</td>
</tr>
<tr>
<td>Trialability (T)</td>
<td>0.581</td>
</tr>
<tr>
<td>Perceived costs (PC)</td>
<td>0.68</td>
</tr>
<tr>
<td>Perceived system quality (PSQ)</td>
<td>0.648</td>
</tr>
<tr>
<td>Perceived trust (PT)</td>
<td>0.656</td>
</tr>
<tr>
<td>Social influence (SI)</td>
<td>0.591</td>
</tr>
</tbody>
</table>

Table 27 Average Variance Extracted

In conclusion, the assessment of the measurement model indicates the validity and reliability of the latent variables in this research.

7.7.4 Assessment of Structural Model

This section evaluates the structural part of the proposed research model, and focuses on identifying the relationships between different endogenous and exogenous latent variables (Diamantopoulos & Siguaw, 2000). These processes aim to test the research hypotheses. Two main issues are addressed, as follows:

Firstly, the signs of the parameters representing the paths between the latent variables in this research model should be determined, which will indicate whether a positive or negative relationship is hypothesised.

Secondly, the critical ratio value is used to examine whether the research hypotheses have been supported by the data. A critical ratio value greater than |1.64|, |1.94| and
2.32) are statically significant at the 90, 95 and 99 percent confidence levels, respectively. All the information mentioned above could be found in the output of the LISREL, as shown in Figure 11. The following part presents the evidence from the hypotheses testing.

\[
\text{USE} = 0.14*BI, \text{ Errorvar.} = 0.55, R^2 = 0.573 \\
(0.047) \quad (0.15) \quad 2.97 \quad 3.73
\]

\[
l = 0.76*Peou + 0.37*Pu + 0.13*O + 0.25*C + 0.15*T - 0.32*Pe + \\
(0.050) \quad (0.056) \quad |0.054| \quad (0.054) \quad (0.056) \quad (0.050) \quad 15.2 \quad 6.07 \quad 2.407 \quad 4.63 \quad 2.679 \quad 5.517
\]

\[
1.98*PSQ + 0.65*PT, \text{ Errorvar.} = 0.024, R^2 = 0.99 \\
|0.094| \quad (0.063) \quad (0.055) \quad 15.74 \quad 10.317 \quad 0.43
\]

\[
BI = 1.16*A + 0.13*SI, \text{ Errorvar.} = 0.012, R^2 = 1.00 \\
(0.037) \quad (0.052) \quad (0.13) \quad 31.4 \quad 2.5 \quad 0.069
\]

**Figure 11 LISREL Output**

**H1:** A user’s behavioural intention towards using mobile payment services has a positive effect upon his/her actual use of mobile payment services.

For this hypothesis, the sign of the parameter is positive between **BI** and **USE** latent variables. The structural coefficient is 0.14 and the standard error is 0.047. The parameter estimate is significant (at p < 0.05 or better), and the critical ratio value is \(0.14/0.047 = 2.98\) at p<0.05, which is greater than 1.94. Thus, the results of the test show that H1 is supported.

**H2:** A user’s attitude toward using mobile payment services has a positive effect upon his/her behavioural intention to use mobile payment services.

For this hypothesis, the sign of the parameter is positive between **A** and **BI** latent variables. The structural coefficient is 1.16 and the standard error is 0.037. The parameter estimate is significant (at p < 0.05 or better), and the critical ratio value is
\[
1.16/0.037=31.4
\]
at \text{p}<0.05, which is greater than 1.94. Thus, the results of the test show that H2 is supported.

**H3:** *A user’s perceived ease of use of mobile payment services has a positive effect upon his/her attitude to the use of mobile payment services.*

For this hypothesis, the sign of the parameter is positive between \textit{PEOU} and \textit{A} latent variables. The structural coefficient is 0.76 and the standard error is 0.05. The parameter estimate is significant (at \text{p}< 0.05 or better), and the critical ratio value is \[
0.76/0.05= 15.2
\]
at \text{p}<0.05, which is greater than 1.94. Thus, the results of the test show that H3 is supported.

**H4:** *A user’s perception of the usefulness of mobile payment services has a positive effect upon his/her attitude toward using mobile payment services.*

For this hypothesis, the sign of the parameter is positive between \textit{PU} and \textit{A} latent variables. The structural coefficient is 0.37 and the standard error is 0.056. The parameter estimate is significant (at \text{p}< 0.05 or better), and the critical ratio value is \[
0.37/0.056= 6.607
\]
at \text{p}<0.05, which is greater than 1.94. Thus, the results of the test show that H4 is supported.

**H5:** *The perceived costs of mobile payment services have a negative effect upon a user’s attitude to using mobile payment services.*

For this hypothesis, the sign of the parameter is positive between \textit{PC} and \textit{A} latent variables. The structural coefficient is –0.32 and the standard error is 0.058. The parameter estimate is significant (at \text{p}< 0.05 or better), and the critical ratio value is \[
-0.32/0.058=|5.517|
\]
at \text{p}<0.05, which is greater than 1.94. Thus, the results of the test show that H5 is supported.

**H6:** *The perceived system quality of mobile payment services has a positive effect upon a user’s attitude to using mobile payment services.*
For this hypothesis, the sign of the parameter is positive between $PSQ$ and $A$ latent variables. The structural coefficient is 1.48 and the standard error is 0.094. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is $1.48/0.094=15.74$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that H6 is supported.

$H7$: *Social influence has a positive effect upon a user’s behavioural intention to use mobile payment services.*

For this hypothesis, the sign of the parameter is positive between $SI$ and $BI$ latent variables. The structural coefficient is 0.13 and the standard error is 0.052. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is $0.13/0.052=2.5$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that H7 is supported.

$H8$: *A user’s perceived trust in mobile payment services has a positive effect upon his/her attitude to using mobile payment services.*

For this hypothesis, the sign of the parameter is positive between $PT$ and $A$ latent variables. The structural coefficient is 0.65 and the standard error is 0.063. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is $0.65/0.063=10.317$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that H8 is supported.

$H9$: *Compatibility between a user using mobile payment services and the belief, values, and needs of a user has a positive effect upon his/her attitude to using mobile payment services.*

For this hypothesis, the sign of the parameter is positive between $C$ and $A$ latent variables. The structural coefficient is 0.25 and the standard error is 0.054. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is $0.25/0.054=4.630$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that H9 is supported.
H10: The trialability of mobile payment services has a positive effect upon a user’s attitude to using mobile payment services.

For this hypothesis, the sign of the parameter is positive between $T$ and $A$ latent variables. The structural coefficient is 0.15 and the standard error is 0.056. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is $0.15/0.056=2.679$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that H10 is supported.

H11: The observability of mobile payment services has a positive effect upon a user’s attitude to using mobile payment services.

For this hypothesis, the sign of the parameter is positive between $O$ and $A$ latent variables. The structural coefficient is 0.13 and the standard error is 0.054. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is $0.13/0.054=2.407$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that H11 is supported.

In brief, all of the tested hypotheses are accepted, as shown in Table 28, as is the structural model, as shown in Figure 12.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Structural Coefficient</th>
<th>Standard Errors</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>0.14</td>
<td>0.047</td>
<td>Supported</td>
</tr>
<tr>
<td>H2</td>
<td>1.16</td>
<td>0.037</td>
<td>Supported</td>
</tr>
<tr>
<td>H3</td>
<td>0.76</td>
<td>0.05</td>
<td>Supported</td>
</tr>
<tr>
<td>H4</td>
<td>0.37</td>
<td>0.056</td>
<td>Supported</td>
</tr>
<tr>
<td>H5</td>
<td>-0.32</td>
<td>0.058</td>
<td>Supported</td>
</tr>
<tr>
<td>H6</td>
<td>1.48</td>
<td>0.094</td>
<td>Supported</td>
</tr>
<tr>
<td>H7</td>
<td>0.13</td>
<td>0.052</td>
<td>Supported</td>
</tr>
<tr>
<td>H8</td>
<td>0.65</td>
<td>0.063</td>
<td>Supported</td>
</tr>
</tbody>
</table>
From the output of the Completely Standardized Solution, the Correlation Matrix of ETA and KSI (Figure 13) shows that the strongest bivariate relationship is between A (attitude toward using) and PSQ (perceived system quality) among other exogenous variables. Moreover, inspection of the Regression Matrix ETA on KSI (Figure 14) shows that PSQ (perceived system quality) has a greater impact on A (attitude toward using) than do the other exogenous variables, followed by PU, PC, PT, C, PEOU, T, and O. C and PEOU have the same impact on A.
The proposed research model and all hypotheses have been successfully tested. LISREL has been used to test the overall fit of the proposed model. First, a set of recommended goodness-of-fit indices have been introduced to examine the overall fit of the model. These indices indicate a reasonable fit of the model. Second, the validity and reliability of the items have been determined. Squared multiple correlations (R2), composite reliability, and average variance extracted have been used to examine the
reliability of the indicators. Overall, the assessment of the measurement model indicates the validity and reliability of the latent variables in this research. Finally, the structural part of the model has been evaluated. The relationships between different endogenous and exogenous latent variables have been identified. All hypotheses have been supported.

In short, the data obtained has been analysed to support the proposed model and has provided significant results.

### 7.8 Data Set Two

#### 7.8.1 The Sample

165 mobile payment users took part in this survey. The sample comprises 44.24% females and 55.76% males. The MPL’s test market has focused on school, college and university students, thus 55.15% of participants are aged under 20, 30.3% of participants are aged between 20 and 29 years old and a majority are students. The detailed demographic characteristics of respondents are presented in Table 29.

<table>
<thead>
<tr>
<th>Demographic Categories</th>
<th>Range</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Under 20</td>
<td>55.15</td>
</tr>
<tr>
<td></td>
<td>20-29</td>
<td>30.30</td>
</tr>
<tr>
<td></td>
<td>30-39</td>
<td>14.55</td>
</tr>
<tr>
<td></td>
<td>Over 50</td>
<td>0</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>55.76</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>44.24</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Less than high school</td>
<td>18.18</td>
</tr>
<tr>
<td></td>
<td>High school</td>
<td>72.73</td>
</tr>
<tr>
<td></td>
<td>Bachelor’s degree</td>
<td>9.09</td>
</tr>
<tr>
<td></td>
<td>Master’s degree</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>PhD, or other advanced degree</td>
<td>0</td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td>84.24</td>
</tr>
<tr>
<td></td>
<td>Academic/Educator</td>
<td>7.88</td>
</tr>
<tr>
<td></td>
<td>Engineer</td>
<td>1.21</td>
</tr>
</tbody>
</table>
The following section presents results analysis through LISREL: the same procedure as with the first set of data analysed in the previous section was followed.

7.8.2 Assessment of Model Fit

As mentioned earlier in the previous section, this study examined the key indices from the LISREL output recommended by some researchers (Byrne, 1998; Diamantopoulos & Siguaw, 2000; MacCallum et al., 1996). The various goodness-of-fit indices are summarised in Table 30. First, the chi-square value comes to 1282.6 (P = 0.0) with 583 degrees of freedom, which implies that the model is adequate. Second, the root mean square error of approximation (RMSEA) must also be considered. MacCallum et al. (1996) suggest that a RMSEA of less than 0.08 indicates good fit and reasonable errors in the population. In this model, RMSEA = 0.027, which suggests a good fit. Third, Byrne (1998) recommended that the root mean square residual (RMR) should be less than 0.05 to indicate a well-fitting model. In this illustrative model, the value of RMR comes to 0.04, indicating a good fit. Fourth, the non-normed fit index (NNFI) and the comparative fit index (CFI) have a range from 0 to 1, with values close to 1 representing good fit (MacCallum et al., 1996). In this model, NNFI=0.94 and CFI=0.92. These indices indicate a reasonable fit of the model, which is same finding as with data set one in the previous section.
7.8.3 Assessment of Measurement Model

This section evaluates the measurement of the proposed research model. It emphasises the relationship between the latent variables and their indicators. In this research, the indicators are the items in the questionnaire, before the evaluation of the structural model, and the measurement model should be evaluated in detail. In the analysis of the first set of data, the validity and reliability of the items were shown. However, this section repeats the procedure to evaluate the measurement.

Validity

In order to determine the validity of the indicators, the magnitude and significance of the path between latent variables and their indicators will be used (Diamantopoulos & Siguaw, 2000). These values can be found in the output of LISREL, as shown in Appendix B4, and the model, as shown in Figure 15.

Again, in this research model, all indicator loadings are significant at $p < 0.05$, as the t-values are greater than 1.96 in absolute terms (Diamantopoulos & Siguaw, 2000), as shown in Table 31. These match with the results from data set one. These data provide evidence of validity for the indicators used to represent the constructs.

Diamantopoulos and Siguaw (2000) also recommend that the magnitudes of the standardised loading be applied to inspect the validity. This information can be obtained from the completely standardised solutions and the loading shown in Table 33. The standardised loadings indicate that PEOU3 is the most valid indicator for the “Perceived Ease of Use”, and PU2 is the most valid indicator for the “Perceived Usefulness”. Similar references can be drawn with regard to the indicators of the other latent variables in the model, and the most valid indicators for the latent variables are highlighted in red in Table 32. It obtained similar results to those from data set one.
Figure 15 The Consumer Acceptance Model
<table>
<thead>
<tr>
<th>Indicator</th>
<th>t-values</th>
<th>Indicator</th>
<th>t-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>USE1</td>
<td>---</td>
<td>T1</td>
<td>9.66</td>
</tr>
<tr>
<td>USE2</td>
<td>5.39</td>
<td>T2</td>
<td>10.73</td>
</tr>
<tr>
<td>A1</td>
<td>---</td>
<td>T3</td>
<td>10.18</td>
</tr>
<tr>
<td>A2</td>
<td>36.94</td>
<td>PC1</td>
<td>10.40</td>
</tr>
<tr>
<td>A3</td>
<td>36.54</td>
<td>PC2</td>
<td>9.34</td>
</tr>
<tr>
<td>A4</td>
<td>34.59</td>
<td>PSQ1</td>
<td>12.42</td>
</tr>
<tr>
<td>B1</td>
<td>---</td>
<td>PSQ2</td>
<td>12.86</td>
</tr>
<tr>
<td>PEOU1</td>
<td>8.43</td>
<td>PSQ3</td>
<td>12.67</td>
</tr>
<tr>
<td>PEOU2</td>
<td>9.81</td>
<td>PSQ4</td>
<td>12.12</td>
</tr>
<tr>
<td>PEOU3</td>
<td>13.99</td>
<td>PT1</td>
<td>13.28</td>
</tr>
<tr>
<td>PU1</td>
<td>13.78</td>
<td>PT2</td>
<td>12.11</td>
</tr>
<tr>
<td>PU2</td>
<td>14.94</td>
<td>PT3</td>
<td>11.78</td>
</tr>
<tr>
<td>PU3</td>
<td>14.13</td>
<td>PT4</td>
<td>12.78</td>
</tr>
<tr>
<td>PU4</td>
<td>13.52</td>
<td>SI1</td>
<td>11.05</td>
</tr>
<tr>
<td>O1</td>
<td>13.01</td>
<td>SI2</td>
<td>10.21</td>
</tr>
<tr>
<td>O2</td>
<td>11.74</td>
<td>SI3</td>
<td>10.35</td>
</tr>
<tr>
<td>O3</td>
<td>9.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>11.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>12.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>7.04</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 31 t-values
Overall, the indicators used for this research are valid.

Reliability

Squared multiple correlations (R^2) can be used to examine the reliability of the indicators. A high R^2 value represents high reliability for the indicators (Joreskog & Sorbom, 1989). R^2 can be obtained from LISREL output, as shown in Appendix B4, and the values of R^2 have been listed in Table 33. Thus, the most reliable indicator for “Perceived Usefulness” is PU2, and similar inferences can be drawn for the indicators of the other latent variables. The most reliable indicators for the latent variables are

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Loading</th>
<th>Indicator</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>USE1</td>
<td>0.67 (λ_{63})</td>
<td>T1</td>
<td>0.72 (λ_{73})</td>
</tr>
<tr>
<td>USE2</td>
<td><strong>1.16</strong> (λ_{64})</td>
<td>T2</td>
<td><strong>0.80</strong> (λ_{83})</td>
</tr>
<tr>
<td>A1</td>
<td>0.97 (λ_{11})</td>
<td>T3</td>
<td>0.76 (λ_{91})</td>
</tr>
<tr>
<td>A2</td>
<td><strong>0.98</strong> (λ_{12})</td>
<td>PC1</td>
<td>0.87 (λ_{145})</td>
</tr>
<tr>
<td>A3</td>
<td>0.97 (λ_{13})</td>
<td>PC2</td>
<td>0.77 (λ_{155})</td>
</tr>
<tr>
<td>A4</td>
<td>0.97 (λ_{14})</td>
<td>PSQ1</td>
<td>0.81 (λ_{166})</td>
</tr>
<tr>
<td>BI</td>
<td>0.98 (λ_{32})</td>
<td>PSQ2</td>
<td><strong>0.82</strong> (λ_{176})</td>
</tr>
<tr>
<td>PEOU1</td>
<td>0.63 (λ_{238})</td>
<td>PSQ3</td>
<td>0.80 (λ_{186})</td>
</tr>
<tr>
<td>PEOU2</td>
<td>0.73 (λ_{248})</td>
<td>PSQ4</td>
<td>0.78 (λ_{196})</td>
</tr>
<tr>
<td>PEOU3</td>
<td><strong>0.99</strong> (λ_{258})</td>
<td>PT1</td>
<td><strong>0.85</strong> (λ_{269})</td>
</tr>
<tr>
<td>PU1</td>
<td>0.86 (λ_{104})</td>
<td>PT2</td>
<td>0.80 (λ_{279})</td>
</tr>
<tr>
<td>PU2</td>
<td><strong>0.91</strong> (λ_{114})</td>
<td>PT3</td>
<td>0.78 (λ_{289})</td>
</tr>
<tr>
<td>PU3</td>
<td>0.88 (λ_{124})</td>
<td>PT4</td>
<td>0.83 (λ_{299})</td>
</tr>
<tr>
<td>PU4</td>
<td>0.85 (λ_{134})</td>
<td>SI1</td>
<td><strong>0.81</strong> (λ_{207})</td>
</tr>
<tr>
<td>O1</td>
<td><strong>0.89</strong> (λ_{11})</td>
<td>SI2</td>
<td>0.75 (λ_{217})</td>
</tr>
<tr>
<td>O2</td>
<td>0.82 (λ_{21})</td>
<td>SI3</td>
<td>0.76 (λ_{227})</td>
</tr>
<tr>
<td>O3</td>
<td>0.71 (λ_{31})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>0.85 (λ_{42})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td><strong>0.91</strong> (λ_{32})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>0.53 (λ_{62})</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 32 Standardised Loadings of Indicators
highlighted in red in Table 33. The results from data set one in the previous section are similar to those from this set of data.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Squared multiple correlations ($R^2$)</th>
<th>Indicator</th>
<th>Squared multiple correlations ($R^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USE1</td>
<td>0.45</td>
<td>T1</td>
<td>0.53</td>
</tr>
<tr>
<td>USE2</td>
<td>1.34</td>
<td>T2</td>
<td>0.64</td>
</tr>
<tr>
<td>A1</td>
<td>0.93</td>
<td>T3</td>
<td>0.58</td>
</tr>
<tr>
<td>A2</td>
<td>0.95</td>
<td>PC1</td>
<td>0.75</td>
</tr>
<tr>
<td>A3</td>
<td>0.95</td>
<td>PC2</td>
<td>0.59</td>
</tr>
<tr>
<td>A4</td>
<td>0.94</td>
<td>PSQ1</td>
<td>0.64</td>
</tr>
<tr>
<td>B1</td>
<td>0.95</td>
<td>PSQ2</td>
<td>0.67</td>
</tr>
<tr>
<td>PEOU1</td>
<td>0.41</td>
<td>PSQ3</td>
<td>0.66</td>
</tr>
<tr>
<td>PEOU2</td>
<td>0.53</td>
<td>PSQ4</td>
<td>0.62</td>
</tr>
<tr>
<td>PEOU3</td>
<td>0.99</td>
<td>PT1</td>
<td>0.72</td>
</tr>
<tr>
<td>PU1</td>
<td>0.70</td>
<td>PT2</td>
<td>0.65</td>
</tr>
<tr>
<td>PU2</td>
<td>0.82</td>
<td>PT3</td>
<td>0.60</td>
</tr>
<tr>
<td>PU3</td>
<td>0.77</td>
<td>PT4</td>
<td>0.69</td>
</tr>
<tr>
<td>PU4</td>
<td>0.72</td>
<td>SI1</td>
<td>0.65</td>
</tr>
<tr>
<td>O1</td>
<td>0.78</td>
<td>SI2</td>
<td>0.56</td>
</tr>
<tr>
<td>O2</td>
<td>0.68</td>
<td>SI3</td>
<td>0.58</td>
</tr>
<tr>
<td>O3</td>
<td>0.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>0.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>0.83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>0.29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 33 Squared Multiple Correlations

Composite reliability has also been introduced to calculate a value for the reliability of each latent variable (Diamantopoulos & Siguaw, 2000) as a supplement for assessing the reliability of the individual indicators, as mentioned above. It used the same formula as in the previous section to calculate composite reliability.

LISREL does not automatically compute composite reliabilities; therefore, manual calculation of the results was undertaken as follows. The variables can be found from the completely standardised solution, as shown in Figure 15, indicator loadings as shown in Table 33, and error variances, as shown in Table 34:
<table>
<thead>
<tr>
<th>Indicator</th>
<th>Error variances</th>
<th>Indicator</th>
<th>Error variances</th>
</tr>
</thead>
<tbody>
<tr>
<td>USE1</td>
<td>0.68</td>
<td>T1</td>
<td>0.40</td>
</tr>
<tr>
<td>USE2</td>
<td>-0.36</td>
<td>T2</td>
<td>0.39</td>
</tr>
<tr>
<td>A1</td>
<td>0.17</td>
<td>T3</td>
<td>0.41</td>
</tr>
<tr>
<td>A2</td>
<td>0.16</td>
<td>PC1</td>
<td>0.28</td>
</tr>
<tr>
<td>A3</td>
<td>0.16</td>
<td>PC2</td>
<td>0.40</td>
</tr>
<tr>
<td>A4</td>
<td>0.20</td>
<td>PSQ1</td>
<td>0.44</td>
</tr>
<tr>
<td>B1</td>
<td>0.15</td>
<td>PSQ2</td>
<td>0.40</td>
</tr>
<tr>
<td>PEOU1</td>
<td>0.75</td>
<td>PSQ3</td>
<td>0.41</td>
</tr>
<tr>
<td>PEOU2</td>
<td>0.63</td>
<td>PSQ4</td>
<td>0.39</td>
</tr>
<tr>
<td>PEOU3</td>
<td>0.21</td>
<td>PT1</td>
<td>0.33</td>
</tr>
<tr>
<td>PU1</td>
<td>0.27</td>
<td>PT2</td>
<td>0.39</td>
</tr>
<tr>
<td>PU2</td>
<td>0.12</td>
<td>PT3</td>
<td>0.36</td>
</tr>
<tr>
<td>PU3</td>
<td>0.23</td>
<td>PT4</td>
<td>0.32</td>
</tr>
<tr>
<td>PU4</td>
<td>0.15</td>
<td>SI1</td>
<td>0.42</td>
</tr>
<tr>
<td>O1</td>
<td>0.38</td>
<td>SI2</td>
<td>0.40</td>
</tr>
<tr>
<td>O2</td>
<td>0.52</td>
<td>SI3</td>
<td>0.32</td>
</tr>
<tr>
<td>O3</td>
<td>0.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>0.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>0.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>0.47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 34 Indicator Error Variances**

\[
\rho_c = \frac{(0.67 + 1.16)^2}{(0.67 + 1.16)^2 + (0.68 - 0.36)^2} = \frac{3.3489}{3.6689} = 0.913
\]

\[
\rho_c = \frac{(0.97 + 0.98 + 0.97 + 0.97)^2}{(0.97 + 0.98 + 0.97 + 0.97)^2 + (0.17 + 0.16 + 0.16 + 0.20)^2} = \frac{15.1321}{15.8221} = 0.956
\]

\[
\rho_c = \frac{(0.63 + 0.73 + 0.99)^2}{(0.63 + 0.73 + 0.99)^2 + (0.75 + 0.63 + 0.21)^2} = \frac{5.5225}{7.1125} = 0.776
\]
<table>
<thead>
<tr>
<th>Variable</th>
<th>Formula</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PU</td>
<td>$\rho_c = \frac{(0.86 + 0.91 + 0.88 + 0.85)^2}{(0.86 + 0.91 + 0.88 + 0.85)^2 + (0.27 + 0.12 + 0.23 + 0.15)}$</td>
<td>$= \frac{12.25}{13.02} = 0.941$</td>
</tr>
<tr>
<td>O</td>
<td>$\rho_c = \frac{(0.89 + 0.82 + 0.71)^2}{(0.89 + 0.82 + 0.71)^2 + (0.38 + 0.52 + 0.40)}$</td>
<td>$= \frac{5.8564}{7.1564} = 0.818$</td>
</tr>
<tr>
<td>C</td>
<td>$\rho_c = \frac{(0.85 + 0.91 + 0.53)^2}{(0.85 + 0.91 + 0.53)^2 + (0.26 + 0.14 + 0.47)}$</td>
<td>$= \frac{5.2441}{6.1141} = 0.858$</td>
</tr>
<tr>
<td>T</td>
<td>$\rho_c = \frac{(0.72 + 0.80 + 0.76)^2}{(0.72 + 0.80 + 0.76)^2 + (0.40 + 0.39 + 0.41)}$</td>
<td>$= \frac{5.1984}{6.4084} = 0.811$</td>
</tr>
<tr>
<td>PC</td>
<td>$\rho_c = \frac{(0.87 + 0.77)^2}{(0.87 + 0.77)^2 + (0.28 + 0.40)}$</td>
<td>$= \frac{2.6896}{3.3696} = 0.798$</td>
</tr>
<tr>
<td>PSQ</td>
<td>$\rho_c = \frac{(0.81 + 0.82 + 0.80 + 0.78)^2}{(0.81 + 0.82 + 0.80 + 0.78)^2 + (0.44 + 0.40 + 0.41 + 0.39)}$</td>
<td>$= \frac{10.3041}{11.9441} = 0.863$</td>
</tr>
<tr>
<td>PT</td>
<td>$\rho_c = \frac{(0.85 + 0.80 + 0.78 + 0.83)^2}{(0.85 + 0.80 + 0.78 + 0.83)^2 + (0.33 + 0.39 + 0.36 + 0.32)}$</td>
<td>$= \frac{10.6276}{12.0276} = 0.884$</td>
</tr>
<tr>
<td>SI</td>
<td>$\rho_c = \frac{(0.81 + 0.75 + 0.76)^2}{(0.81 + 0.75 + 0.76)^2 + (0.42 + 0.40 + 0.32)}$</td>
<td>$= \frac{5.3824}{6.5224} = 0.825$</td>
</tr>
</tbody>
</table>

The overall values for the latent variables are shown in Table 35.
### Composite Reliability

<table>
<thead>
<tr>
<th>Latent Variables</th>
<th>Composite Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Use (USE)</td>
<td>0.913</td>
</tr>
<tr>
<td>Attitude (A)</td>
<td>0.956</td>
</tr>
<tr>
<td>Perceived ease of use (PEOU)</td>
<td>0.776</td>
</tr>
<tr>
<td>Perceived usefulness (PU)</td>
<td>0.941</td>
</tr>
<tr>
<td>Observability (O)</td>
<td>0.818</td>
</tr>
<tr>
<td>Compatibility (C)</td>
<td>0.858</td>
</tr>
<tr>
<td>Trialability (T)</td>
<td>0.811</td>
</tr>
<tr>
<td>Perceived costs (PC)</td>
<td>0.798</td>
</tr>
<tr>
<td>Perceived system quality (PSQ)</td>
<td>0.863</td>
</tr>
<tr>
<td>Perceived trust (PT)</td>
<td>0.884</td>
</tr>
<tr>
<td>Social influence (SI)</td>
<td>0.825</td>
</tr>
</tbody>
</table>

Table 35 Composite Reliability

Composite reliability values greater than 0.6 are desirable (Bagozzi & Yi, 1988): thus, it can be concluded that as a set of indicators, the eleven latent variables provide reliable measurement of the construct. The outcomes for composite reliability are the same as for data set one. Therefore, it indicates reliable measurement of the construct.

Average variance extracted is another measure used to examine reliability. The formula to calculate the average variance is shown in the previous section, the variables in this formula can be found the in the output of LISREL, as shown in Figure 15.

Again, LISREL does not automatically compute average variance extracted; therefore, manual calculation of the results was undertaken as follows. The variables can be found from the completely standardised solution, indicator loadings, and error variances:
\[
\rho_v = \frac{(0.67^2 + 1.16^2)}{(0.67^2 + 1.16^2) + (0.68 - 0.36)} = \frac{1.7945}{2.1145} = 0.849
\]

\[
\rho_v = \frac{(0.97^2 + 0.98^2 + 0.97^2 + 0.97^2)}{(0.97^2 + 0.98^2 + 0.97^2 + 0.97^2) + (0.17 + 0.16 + 0.16 + 0.2)} = \frac{3.7831}{4.4731} = 0.846
\]

\[
\rho_v = \frac{(0.63^2 + 0.73^2 + 0.99^2)}{(0.63^2 + 0.73^2 + 0.99^2) + (0.75 + 0.63 + 0.21)} = \frac{1.9099}{3.4999} = 0.546
\]

\[
\rho_v = \frac{(0.86^2 + 0.91^2 + 0.88^2 + 0.85^2)}{(0.87^2 + 0.91^2 + 0.88^2 + 0.85^2) + (0.27 + 0.12 + 0.23 + 0.15)} = \frac{3.0646}{3.8346} = 0.799
\]

\[
\rho_v = \frac{(0.89^2 + 0.82^2 + 0.71^2)}{(0.89^2 + 0.82^2 + 0.71^2) + (0.38 + 0.52 + 0.40)} = \frac{1.9686}{3.2686} = 0.602
\]

\[
\rho_v = \frac{(0.85^2 + 0.91^2 + 0.53^2)}{(0.85^2 + 0.91^2 + 0.53^2) + (0.26 + 0.14 + 0.47)} = \frac{1.8315}{2.7015} = 0.678
\]

\[
\rho_v = \frac{(0.72^2 + 0.80^2 + 0.76^2)}{(0.73^2 + 0.80^2 + 0.76^2) + (0.40 + 0.39 + 0.41)} = \frac{1.736}{2.936} = 0.591
\]

\[
\rho_v = \frac{(0.87^2 + 0.77^2)}{(0.87^2 + 0.77^2) + (0.28 + 0.40)} = \frac{1.3498}{2.0298} = 0.665
\]
The results for all five latent variables are shown in Table 36. When the average variance extracted is greater than 0.50, then a higher amount of variance in the indicators is measured by the construct compared to that accounted for by measurement error (Diamantopoulos & Siguaw, 2000). In this case, the average variance extracted is greater than 0.50 for all eleven latent variables. It retrieved the same results as with data set one.

<table>
<thead>
<tr>
<th>Latent Variables</th>
<th>Average Variance Extracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Use (USE)</td>
<td>0.849</td>
</tr>
<tr>
<td>Attitude (A)</td>
<td>0.846</td>
</tr>
<tr>
<td>Perceived ease of use (PEOU)</td>
<td>0.546</td>
</tr>
<tr>
<td>Perceived usefulness (PU)</td>
<td>0.799</td>
</tr>
<tr>
<td>Observability (O)</td>
<td>0.602</td>
</tr>
<tr>
<td>Compatibility (C)</td>
<td>0.678</td>
</tr>
<tr>
<td>Trialability (T)</td>
<td>0.591</td>
</tr>
<tr>
<td>Perceived costs (PC)</td>
<td>0.665</td>
</tr>
<tr>
<td>Perceived system quality (PSQ)</td>
<td>0.611</td>
</tr>
<tr>
<td>Perceived trust (PT)</td>
<td>0.655</td>
</tr>
</tbody>
</table>
In conclusion, the assessment of the measurement model indicates the validity and reliability of the latent variables in this research.

7.8.4 Assessment of Structural Model

This section evaluates the structural part of the proposed research model, and focuses on identifying the relationships between different endogenous and exogenous latent variables (Diamantopoulos & Siguaw, 2000). These processes aim to test the research hypotheses. Again, two main issues are addressed, as follows:

Firstly, the signs of the parameters representing the paths between the latent variables in this research model should be determined, which will indicate whether a positive or negative relationship is hypothesised.

Secondly, the critical ratio value is used to examine whether the research hypotheses have been supported by the data. A critical ratio value greater than |1.64|, |1.94| and |2.32| are statically significant at the 90, 95 and 99 percent confidence levels, respectively. All the information mentioned above could be found in the output of the LISREL, as shown in Figure 16. The following part presents the evidence from the hypotheses testing.

**H1:** A user’s behavioural intention towards using mobile payment services has a positive effect upon his/her actual use of mobile payment services.

For this hypothesis, the sign of the parameter is positive between **BI** and **USE** latent variables. The structural coefficient is 0.16 and the standard error is 0.042. The parameter estimate is significant (at p < 0.05 or better), and the critical ratio value is \( \frac{0.16}{0.042} = 3.81 \) at p<0.05, which is greater than 1.94. Thus, the results of the test show that H1 is supported.
**H2**: A user’s attitude toward using mobile payment services has a positive effect upon his/her behavioural intention to use mobile payment services.

For this hypothesis, the sign of the parameter is positive between $A$ and $BI$ latent variables. The structural coefficient is 1.14 and the standard error is 0.032. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is $1.14/0.032 = 35.63$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that H2 is supported.

**H3**: A user’s perceived ease of use of mobile payment services has a positive effect upon his/her attitude to using mobile payment services.

For this hypothesis, the sign of the parameter is positive between $PEOU$ and $A$ latent variables. The structural coefficient is 0.66 and the standard error is 0.052. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is $0.66/0.052 = 12.69$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that H3 is supported.

**H4**: A user’s perception of the usefulness of mobile payment services has a positive effect upon his/her attitude to using mobile payment services.
For this hypothesis, the sign of the parameter is positive between $PU$ and $A$ latent variables. The structural coefficient is 0.36 and the standard error is 0.056. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is $0.36/0.056=6.43$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that H4 is supported.

**H5: The perceived costs of mobile payment services have a negative effect upon a user’s attitude to using mobile payment services.**

For this hypothesis, the sign of the parameter is positive between $PC$ and $A$ latent variables. The structural coefficient is $-0.40$ and the standard error is 0.060. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is $-0.40/0.060=6.67$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that H5 is supported.

**H6: The perceived system quality of mobile payment services has a positive effect upon a user’s attitude to using mobile payment services.**

For this hypothesis, the sign of the parameter is positive between $PSQ$ and $A$ latent variables. The structural coefficient is 1.67 and the standard error is 0.10. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is $1.67/0.10=16.7$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that H6 is supported.

**H7: Social influence has a positive effect upon a user’s behavioural intention to use mobile payment services.**

For this hypothesis, the sign of the parameter is positive between $SI$ and $BI$ latent variables. The structural coefficient is 0.15 and the standard error is 0.052. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is $0.15/0.052=2.88$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that H7 is supported.
$H_8$: A user’s perceived trust in mobile payment services has a positive effect upon his/her attitude to using mobile payment services.

For this hypothesis, the sign of the parameter is positive between $PT$ and $A$ latent variables. The structural coefficient is 0.89 and the standard error is 0.071. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is $0.89/0.071 = 12.54$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that $H_8$ is supported.

$H_9$: Compatibility between a user using mobile payment services and the belief, values, and needs of a user has a positive effect upon his/her attitude to using mobile payment services.

For this hypothesis, the sign of the parameter is positive between $C$ and $A$ latent variables. The structural coefficient is 0.13 and the standard error is 0.055. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is $0.13/0.055 = 2.36$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that $H_9$ is supported.

$H_{10}$: The trialability of mobile payment services has a positive effect upon a user’s attitude to using mobile payment services.

For this hypothesis, the sign of the parameter is positive between $T$ and $A$ latent variables. The structural coefficient is 0.14 and the standard error is 0.057. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is $0.14/0.057 = 2.46$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that $H_{10}$ is supported.

$H_{11}$: The observability of mobile payment services has a positive effect upon a user’s attitude to using mobile payment services.

For this hypothesis, the sign of the parameter is positive between $O$ and $A$ latent variables. The structural coefficient is 0.16 and the standard error is 0.055. The parameter estimate is significant (at $p < 0.05$ or better), and the critical ratio value is
$0.16/0.055=2.91$ at $p<0.05$, which is greater than 1.94. Thus, the results of the test show that H11 is supported.

In brief, all of the tested hypotheses are accepted, as shown in Table 37, as is the structural model, as shown in Figure 17.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Structural Coefficient</th>
<th>Standard Errors</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>0.16</td>
<td>0.042</td>
<td>Supported</td>
</tr>
<tr>
<td>H2</td>
<td>1.14</td>
<td>0.032</td>
<td>Supported</td>
</tr>
<tr>
<td>H3</td>
<td>0.66</td>
<td>0.052</td>
<td>Supported</td>
</tr>
<tr>
<td>H4</td>
<td>0.36</td>
<td>0.056</td>
<td>Supported</td>
</tr>
<tr>
<td>H5</td>
<td>-0.40</td>
<td>0.060</td>
<td>Supported</td>
</tr>
<tr>
<td>H6</td>
<td>1.67</td>
<td>0.10</td>
<td>Supported</td>
</tr>
<tr>
<td>H7</td>
<td>0.15</td>
<td>0.052</td>
<td>Supported</td>
</tr>
<tr>
<td>H8</td>
<td>0.89</td>
<td>0.071</td>
<td>Supported</td>
</tr>
<tr>
<td>H9</td>
<td>0.13</td>
<td>0.055</td>
<td>Supported</td>
</tr>
<tr>
<td>H10</td>
<td>0.14</td>
<td>0.057</td>
<td>Supported</td>
</tr>
<tr>
<td>H11</td>
<td>0.16</td>
<td>0.055</td>
<td>Supported</td>
</tr>
</tbody>
</table>

Table 37 Hypothesis Testing Results
From the output of the Completely Standardized Solution, the Correlation Matrix of ETA and KSI (Figure 18) shows that the strongest bivariate relationship is between A (attitude toward using) and PSQ (perceived system quality) among other exogenous variables. Moreover, inspection of the Regression Matrix ETA on KSI (Figure 19) shows that PSQ (perceived system quality) has a greater impact on A (attitude toward using) than do the other exogenous variables, followed by PU, PC, PEOU, O, C, T, and PT. C and T have the same impact on the A.
Correlation Matrix of ETA and KSI

<table>
<thead>
<tr>
<th></th>
<th>Use</th>
<th>A</th>
<th>B1</th>
<th>Pmou</th>
<th>Pu</th>
<th>C</th>
<th>T</th>
<th>Pc</th>
<th>Psq</th>
<th>Pt</th>
<th>S1</th>
</tr>
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<tbody>
<tr>
<td>Use</td>
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<td></td>
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<td></td>
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<td></td>
</tr>
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<td>0.43</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Pu</td>
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<td>0.58</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>0.43</td>
<td>0.47</td>
<td>0.47</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>T</td>
<td>0.49</td>
<td>0.47</td>
<td>0.47</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pc</td>
<td>-0.86</td>
<td>-0.86</td>
<td>-0.86</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Psq</td>
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<td>0.78</td>
<td>1.00</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Pt</td>
<td>0.67</td>
<td>0.75</td>
<td>0.75</td>
<td>1.00</td>
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<td></td>
</tr>
<tr>
<td>S1</td>
<td>0.83</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Correlation Matrix of ETA and KSI

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>T</th>
<th>Pc</th>
<th>Psq</th>
<th>Pt</th>
<th>S1</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>T</td>
<td></td>
<td>1.00</td>
<td></td>
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<td></td>
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<tr>
<td>Pc</td>
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<td>1.00</td>
<td></td>
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<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
<td></td>
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<td>S1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
</tbody>
</table>

Figure 18 Correlation Matrix of ETA and KSI

Regression Matrix ETA on KSI (Standardized)

<table>
<thead>
<tr>
<th></th>
<th>Pmou</th>
<th>Pu</th>
<th>C</th>
<th>T</th>
<th>Pu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td>0.41</td>
<td>0.50</td>
<td>0.43</td>
<td>0.43</td>
<td>0.53</td>
</tr>
<tr>
<td>A</td>
<td>0.53</td>
<td>0.68</td>
<td>0.46</td>
<td>0.47</td>
<td>0.47</td>
</tr>
<tr>
<td>B1</td>
<td>0.53</td>
<td>0.68</td>
<td>0.48</td>
<td>0.47</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Regression Matrix ETA on KSI (Standardized)

<table>
<thead>
<tr>
<th></th>
<th>Psq</th>
<th>Pt</th>
<th>S1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td>0.65</td>
<td>0.59</td>
<td>0.53</td>
</tr>
<tr>
<td>A</td>
<td>0.65</td>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>0.84</td>
<td>0.45</td>
<td>0.56</td>
</tr>
</tbody>
</table>

Figure 19 Regression Matrix ETA on KSI

Again, the proposed research model and all hypotheses have been successfully tested through the second set of data. LISREL has been used to test the overall fit of the proposed model. First, a set of recommended goodness-of-fit indices have been introduced to examine the overall fit of the model. These indices indicate a reasonable fit of the model. Second, the validity and reliability of the items have been determined. Squared multiple correlations ($R^2$), composite reliability, and average variance extracted have been used to examine the reliability of the indicators. Overall,
the assessment of the measurement model indicates the validity and reliability of the latent variables in this research. Finally, the structural part of the model has been evaluated. The relationships between different endogenous and exogenous latent variables have been identified. All hypotheses have been supported.

In conclusion, the second set of data obtained has been analysed to support the proposed model and has provided significant results. Therefore, it is clearly shown that the first and second sets of data have the same outcomes through the proposed research model.

These two studies have identified the factors that influence consumer acceptance of mobile payments, perceived ease of use, perceived usefulness, observability, compatibility, trialability, perceived trust, perceived costs, perceived system quality, and social influence. Moreover, the relationships of the factors in the proposed research model have also been evaluated.

7.9 Discussion

This section presents a discussion of the research findings in order to demonstrate how far the research objectives have been achieved. Moreover, the implications of the research findings on mobile payments usage theory and practice will be considered. The findings are illustrated as to the extent to which they provide support for the proposed research model in this thesis. The findings make a useful contribution to the understanding of consumer acceptance of mobile payments. The findings also have the potential to provide practical guidelines to parties interested and involved in the development of the mobile payments market.

The objective of this research is to identify the factors affecting consumers’ acceptance of mobile payments and examine the consumer acceptance model of mobile payments. The literature review explored and identified the important variables, which comprised perceived trust, perceived cost, perceived system quality, social influence and also included variables from TAM and IDT. The literature review was the foundation for developing the research model and hypotheses. Moreover, two
different studies have also been introduced. The results of these studies and the literature review have informed the study three of the research.

In Chapter Three, hypotheses related to the research model were developed. For research study three, a questionnaire survey was designed to gather two sets of data to test the proposed research model. The first set of data was collected from mobile payment users around the globe. The second set of data was obtained from users of a particular mobile payments scheme. A pilot study was carried out to assess the consistency, ease of understanding, and reliability of the questionnaire. Cronbach’s alpha was used to test the reliability of the measurement instrument. The hypotheses were examined via LISREL by using SEM to analyse the structural model and to gain further confidence in the reliability and validity of the measurement model.

As can be seen in Figure 10 and Figure 15, the proposed research model has been accepted and all hypotheses have been supported in the two different data sets. The proposed model has been enhanced based on the studies of TAM and IDT, providing another dimension to investigate in the research of mobile payments.

7.9.1 Determinants of Attitude toward Using

The results show the positive association between a user’s perceived usefulness and attitude to use of mobile payment services, which supports Hypothesis 4, *a user’s perceived usefulness of mobile payments services has a positive effect upon his/her attitude to using mobile payment services*. Moreover, the results also indicted the positive association between a user’s perceived ease of use and attitude to use of mobile payment services, which supports Hypothesis 3, *a user’s perceived ease of use of mobile payment services has a positive effect upon his/her attitude to using mobile payment services*. The antecedent of perceived usefulness (PU) and perceived ease of use (PEOU) are from TAM, which indicates that they are associated with consumer acceptance of mobile payments.

PU was found to be the factor that influenced consumers’ attitude to use and behaviour. The results confirm that consumers would accept a new IS if it were perceived as useful for them (e.g. Chau & Hu, 2001; Chau & Hu, 2002). Therefore,
systems developers are required to design and offer the features of mobile payment systems as actual benefits to consumers.

PEOU was also a strong and dominating factor that influenced consumers’ attitude to use. A number of IS empirical studies have suggested that ease of use is a vital factor in technology adoption and usage (Davis, 1989; Davis et al., 1992; Kwon & Chidambaram, 2000). Therefore, a system perceived as being easy to use is more likely to be used. Efforts to make mobile payment services easier to use would enhance consumers’ motivation to use and increase actual use. PEOU influenced consumers’ behaviour in the early exposure to mobile applications. However, consumers require more hands-on experience and guidelines to operate mobile payment systems.

PEOU towards mobile payments could be enhanced for consumers. Mobile payments service providers and system developers have an important role to play. Mobile payments service providers could offer self-training packages for consumers, the goal being to raise consumers’ ability to operate the systems. Moreover, system developers are required to improve the usability of mobile payment applications, the key reason being the physical size of the mobile devices. Nowadays, as the size of mobile phones gets smaller and smaller, it creates a potential issue for system developers to develop a convenient, flexible, and usable application. Thus, it could be summarised that new systems must be perceived as easy to use in order to become accepted.

In this study, the perception of the ease of use and usefulness of mobile payment systems were found to be the significant factors affecting the attitude of consumers to their use. The research analysis offers a clear view and better understanding for mobile payment service providers regarding consumer acceptance of mobile payment systems. Moreover, the result could also assist mobile payment service providers to improve their business strategy for mobile payment services. The findings suggest that PU was more influential that PEOU in explaining consumer acceptance.

Compatibility, trialability and observability have been introduced to the research model from IDT. The results support three related hypothesises, Hypothesis 9 (Compatibility between a user using mobile payment services and a user’s belief,
values, and needs has a positive effect upon his/her attitude to using mobile payment services.), Hypothesis 10 (Mobile payment services’ trialability has a positive effect upon a user’s attitude to using mobile payment services), and Hypothesis 11 (Mobile payment services’ observability has a positive effect upon a user’s attitude to using mobile payment services). This finding shows that the IDT plays an important part in consumer acceptance of mobile payments.

IDT has been included in the proposed research model. Factors concerning IDT have been evaluated through this research. Compatibility was shown to have influenced consumers’ behaviour significantly. The research in this thesis indicates that consumers require the payment method to be highly compatible with their lifestyle and payment activities. Based on the findings from the research, it could be claimed that consumers could be used to promote the use of mobile payment systems. Agarwal and Prasad (1998) concluded that compatibility requires a substantial change in the work pattern of a potential adopter. The research in this thesis shows that consumers would be prepared to adopt mobile payments if it had high levels of compatibility with their payment styles. Nowadays, people might also be eager to use mobile devices without much concern as part of their daily life.

Mobile devices and applications have changed people’s lives. The compatibility of mobile applications with people’s work and leisure activities would improve consumer acceptance. Moreover, mobile devices are portable and highly visible for the general public, offering a convenient platform to promote the application. Therefore, observability would be important, as indicated by the research. At the moment, most of the mobile payment systems are still at an early stage, and using mobile services is still expensive in some countries. Thus, it would be wise to offer incentives for consumers to use mobile payments, and trialability would be important.

Additional factors have also been tested in the research model, which are perceived costs, perceived system quality, and perceived trust. The results are as follows:

The result indicated a negative association between perceived costs and attitude to use, which supports Hypothesis 5, the perceived costs of mobile payment services has a negative effect upon a user’s attitude to using mobile payment services. Perceived cost
plays an important role in the research model. An explanation for this finding might be that mobile services, such as Premier SMS and mobile Internet service, are still expensive. Consumers assume and have the impression that most mobile applications and services are relatively expensive to adopt.

Hypothesis 6, the perceived system quality of mobile payment services has a positive effect upon a user’s attitude to using mobile payment service, is supported by the result. Service quality is another determinant of consumer acceptance of mobile payments, according to this research. Consumers make an assumption about the services based on the information they can gather. Hence, the quality of information is critical for consumers to predict what to expect from the service. Consumers will choose the service depending on whether service providers can provide accurate and detailed information for consumers and implement a high quality service for consumers.

The result also indicates a positive association between perceived trust and attitude to use, which supports Hypothesis 8, a user’s perceived trust in mobile payment services has a positive effect upon his/her attitude to using mobile payment services. Not surprisingly, perceived trust also influences attitude to use, which indicates that service providers have to set themselves higher standards to win customers. For such an application involving monetary transactions, building trust and offering a positive image to consumers is vital.

When the causal relationships between the eight factors - observability, compatibility, trialability, perceived usefulness, perceived ease of use, perceived costs, perceived trust and perceived system quality - and attitude toward using were considered, all the relationships were found to be significant in the two different sets of data. Moreover, according to the findings, perceived system quality has a greater impact on attitude toward using than other latent variables. This result is not surprising because mobile payment systems will involve transactions with sensitive financial information, for example, payment details. Moreover, the mobile payments service is such a new and emerging application. Consumers cannot physically see how the information will be retrieved and processed compared with conventional payment methods. Therefore, consumers will be more concerned regarding this issue. System quality would be vital
for the development of mobile payments, and service providers and system developers need to give serious consideration to how to enhance system quality to offer a high quality mobile payments service.

Service providers and system developers need to ensure the system is kept useful for users. Moreover, the findings of the positive association of perceived ease of use on attitude toward using and perceived usefulness send a signal to service providers to remember to keep the system easy to use, because this can enhance perceived usefulness and lead to more usage at a later stage.

7.9.2 Determinants of Behavioural Intention to Use

The result shows a the positive association between social influence and intention to use, which supports Hypothesis 7, *social influence has a positive effect upon a user’s intention to use mobile payment services*, and Hypothesis 2, *a user’s attitude toward using mobile payment services has a positive effect upon his/her behavioural intention to use mobile payment services*, are also supported by the research result.

Social influence has been controversial in IS literature. Some have suggested that social influence should be included in research models (e.g. Taylor & Todd, 1995b; Thompson et al., 1991), and some other researchers would not include this construct (e.g. Davis et al., 1989), as some findings suggest that social influence is only significant in a mandatory setting (Hartwick & Barki, 1994; Venkatesh & Davis, 2000). However, social influence has a significant effect on consumers’ behaviour. The results from this research indicate that consumers seem to be easily influenced by their friends or the opinions of family members. Moreover, such a dynamic and exciting application would be easy for the relatively young age group to adopt. Social influence offers challenging opportunities to mobile services providers but leads to the requirement that service providers should not focus only on the perceptions of individual users.

Additionally, the results of the proposed research model show a significant impact of attitude to use on the intention to use. This finding suggests that these two factors have impacted consumer usage of mobile payments. Furthermore, previous research
has identified the same finding (e.g. Chen et al., 2002; Lederer et al., 2000) in technology acceptance studies.

7.9.3 Determinants of Actual Use

Finally, Hypothesis 1, a user's behavioural intention towards using mobile payment services has a positive effect upon his/her actual use of mobile payment services. The model hypothesis is that actual use is directly influenced by behavioural intention to use. In this study, acceptance outcome was measured by current use, and current use was measured by usage frequency and usage volume.

In order to reach a certain level of popularity for a mobile payments system, service providers have to reach and attract mobile device users: more importantly, they must attempt to attract non-mobile device users and late adopters. The technology and infrastructure available would help to achieve this goal: for example, the mass use of mobile phones has provided the platform for mobile payments service providers to offer the service. Moreover, suitable education and promotion to the potential user and lower service charges would also contribute to mobile payments becoming more compatible with the lifestyles and needs of consumers. These concepts have been supported by the results of this research (e.g. Chen et al., 2002; Kleijnen et al., 2004).

Mobile payment service providers have to present and educate about the advantages and risks involved in the service. Not surprisingly, security and privacy concerns are the major obstacles for the success of mobile payments (Gillick & Vanderhof, 2000; Tarasewich et al., 2002). Consumers will accept and use mobile payments when they are equipped with enough knowledge to know how to protect themselves while engaging in mobile payment transactions.

The mobile payments service is one of the most exciting mobile applications for the next few years, but from the previous cases of many new applications and innovations, the practical implementation of the mobile payments concept has preceded theoretical research in this subject area. This research study has attempted to develop a theoretical model of consumer acceptance of mobile payments. To explore and realise the theoretical determinants of consumer acceptance of mobile payments is crucial.
Moreover, understanding the antecedents of the key constructs is vital in assisting the development and implementation of mobile payment systems with a high level of consumer acceptance.

This proposed research model contributes to a mixture of marketing and mobile commerce contexts, and the results from this research study indicate that the model is capable of predicting and explaining consumer acceptance of mobile payments well. Thirteen causal paths defined in the research model were found to be statistically significant. The research study offers first-hand information and provides a better understanding of mobile payment users’ behaviour. These findings provide support for mobile payments implementation by both mobile payments consumers and merchants. The important factors influencing consumer acceptance are also validated.

The findings show a number of factors have an impact on consumer acceptance of mobile payments. Since this study has adopted TAM and IDT for the research model, this study seems consistent with the view that TAM and IDT with those crucial variables lead to consumer acceptance of mobile payments. The research model offers a valid explanation for a consumer’s behaviour toward mobile payment systems. It indicates that existing theories could be used to predict and explain a new system/application through modifications and/or extensions. Moreover, two sets of data offer rigorous results for the research.

This chapter has presented the findings from study three. The results of the study have confirmed the importance of the identified factors for consumer acceptance of mobile payments. Apart from TAM and IDT, respondents note that perceived costs, perceived trust, perceived system quality, and social influence are important to them. Second, two sets of data have been used for this study, and SEM techniques has been employed, which indicate the proposed research model is suitable for the predictors of the measurement of consumer acceptance of mobile payments. Third, using SEM analysis, the research shows that perceived system quality is the strongest factors for attitude toward using. Fourth, the proposed research model is useful for technology acceptance specific to the mobile payments domain and it would be of benefit to the many organisations that are considering the development of mobile payments. Finally, this research model has vital implications for potential mobile payment service
providers in considering the infrastructure and marketing of mobile payments. Mobile device users are frequently experienced, competent users who would like to add value to their devices.

The next chapter presents the conclusion of the research in thesis. Contributions to knowledge will be outlined. Moreover, recommendations for future research will also be identified.
Chapter Eight: Conclusion

This chapter presents the conclusion of the research in this thesis in order to demonstrate how far the research objectives have been met. The discussion of the research implications concerning the areas where the research findings have made a useful contribution to the understanding of the existing theories on mobile payments acceptance will be presented. This chapter also identifies the limitations of the research in this thesis and outlines suggestions for future research.

Since the growth of e-commerce, many researchers and industry analysts have predicted that m-commerce will be another growth application for business (Araujo & Araujo, 2003; Liang & Wei, 2004; Mallat, 2004). However, the m-commerce market has not grown as expected (Coursaris et al., 2003; Mohsin et al., 2003; Rupnik & Krisper, 2004), among the reasons for which are lack of application by businesses, device limitations and network capabilities. The payment system has been a key component of the development of e-commerce in the past. Many organisations have intended to establish new channels of payment for e-commerce: for example, PayPal is one of the most successful and popular payment methods for e-commerce (Milligan, 2004). In a similar way, mobile payments will also play an important role in e-commerce, m-commerce and even traditional face-to-face business. It is an exciting application that has huge potential for business (Kreyer et al., 2003; Ondrus et al., 2005).

As illustrated above, mobile commerce and mobile payments will have huge business opportunities. When mobile commerce starts to take off, we will need to have a better understanding of mobile payments and what would influence consumer acceptance of mobile payments. In addition, these is a gap in the IS research. The research in this thesis addresses these challenging issues. Moreover, what theoretical framework would be appropriate to address this research? Are the TAM and IDT fit for the mobile context? There are unknowns which the research in this thesis attempts to explore.
8.1 Research Studies in This Thesis

The research in this thesis has employed three different studies to investigate such a new phenomenon. The data and results from study one and study two were important as background material and reference, and also offer a context for the interpretation of the data from study three. Furthermore, they assisted the design of study three from a research perspective. This is a good technique and method to enhance research in a new application area, especially for mobile payments research, where at the moment little literature is available.

This research identified and presented the following findings in understanding consumer acceptance and constructing a consumer acceptance model for mobile payments.

- The research in this thesis has identified the key reasons why consumers want to use mobile payments, namely ease of use, convenience, and flexibility and about what they are concerned, namely security, privacy, and cost.

- The factors that influence consumer acceptance of mobile payments have been identified. They include elements of the TAM, namely perceived ease of use and perceived usefulness, and elements of the IDT, namely observability, compatibility, and trialability. Moreover, they also include extended elements, namely perceived costs, perceived system quality, perceived trust and social influence. The relationships between these factors have also been evaluated, as shown in Figure 12 and Figure 17.

- The TAM and IDT have once again been proved valid in explaining and predicting consumer behaviour in the IS context. Moreover, the research expanded the usage of these two theories into the mobile payments context. More specifically, the TAM and IDT can be applied to mobile payments research. Consumer acceptance of mobile payments can be explained and predicted from their intention.
- Social influence has affected consumers’ behavioural intention to use mobile payments.

- Mobile technologies have unique characteristics.

The findings from this research offer a point of reference to and have implication for potential mobile payment services providers. Organisations can apply and adopt the framework of this research to understand and predict consumers’ willingness to accept and use their new applications. This research would also allow them to recognise the potential reasons for low acceptance when they implement services.

The results of this research not only provide new theoretical foundations for investigating the mobile payments phenomenon, but also identify and offer mobile payment systems different factors to increase the chance of consumer acceptance.

### 8.2 Theoretical Contribution to Knowledge

TAM has been widely used in the IT domain within an organisational context. It is a powerful tool to predict consumer behaviour and attitude toward new applications. The TAM has been well established in different IS research. However, the capability of the TAM to explain user acceptance for different systems applications should not be taken for granted, as no prior research studies had adopted TAM in the context of mobile payment systems at the time of this research. The findings extend the external validity of TAM to explain consumer acceptance of mobile payments.

The research in this thesis has used TAM theory with IDT, which promises an understanding of the factors that influence the acceptance of mobile payments. TAM has been adapted in the research in this thesis for use in a different context, the mobile payments context. The mobile payments system is an alternative payment method for consumers. Mobile devices can be used to perform payment activities in different locations. Thus, adopting the TAM in this research would be very different to the extensive previous TAM research because the application is not used in the traditional home or office environment. Mobile technologies are different to other technologies.
For example, mobile devices are personal devices and are required to be easy to use, because mobile devices have relatively small screens and keypads. This research has identified the validity of using TAM for mobile payments research. In this case, it expands the usage of TAM in IS research.

Moreover, IDT has also been included in the research to develop the research model. The research in this thesis has applied IDT in a new context, the mobile payments application. Thus, the research results also indicate that it was appropriate to use TAM and IDT in the mobile payments system research. They are the main tools used to examine the research in this thesis, because TAM and IDT have been seen as important factors in the proposed research model. Moreover, some other factors have also been included in the research model, which may be relevant to the acceptance of other technologies. The results of the research in this thesis should be of interest to the academic communities. This study expands the usage of TAM and IDT.

The integrated model proposed by the research in this thesis and the empirical validation of the model contribute to an understanding of the behaviour of mobile payments users. Furthermore, the research model is valid and can be applied to relevant research. Therefore, the research in itself forms an important theoretical contribution to the disciplines of technology acceptance in a new context, and the development of the research model of mobile payments based on the validation of the survey and responses also makes a contribution to knowledge. The research results could be used in future research to explore the implications of mobile payments use.

Furthermore, this research can create a solid foundation for future research. The fact that a comprehensive structured investigation has not been undertaken in mobile payments research, nor a model created, leaves room for a contribution to the literature (Chen & Adams, 2004a; Chen & Adams, 2004b; Chen & Adams, 2005a; Chen & Adams, 2005b; Chen & Adams, 2005c). This contribution has been achieved by combining existing theories and introducing appropriate research methods.
8.3 Research Methods Contribution

This research contributes to understanding the factors that influence consumer acceptance of mobile payments. Bearing in mind that the mobile payments system is a relatively new and rare application, it is difficult to identify suitable literatures for this research. Different methods are used to conduct this research, due to its complex nature. The research contributes empirically to identifying and establishing a method to implement a new, exciting and rare IT application.

The research of this thesis has also provided an example of conducting a new research application in the IS domain. In response to the scarcity of available literature, the difficulty in accessing the resources and the large distances involved, empirical guidelines are offered in this thesis to tackle these issues. We are living in a globalised and digital world society, and many new IS applications are emerging at any given time. For example, concerning the case study in this research, ZOOP was the only commercial mobile payments service available at the time of the research, and it operates in South Korea. The long distances involved and the issue of languages created many problems for this research. The research in this thesis would offer a reference for conducting the research in such an emerging application area.

Moreover, the research in this thesis has applied robust mechanisms to validate the survey constructs and the results. In study three, SEM has been used to evaluate the proposed research model, while the validity and reliability of the items in the questionnaires have also been verified. In addition, two sets of data have been collected to evaluate the proposed research model, which assists in the validation of the proposed research model. Thus, these mechanisms permit more confidence in the conclusions of the research.

Based on the findings in the previous chapters, some managerial implications were proposed. The limitations of the research were presented and recommendations for future research were also provided.
8.4 Managerial and Industrial Implications

TAM and IDT are established theories in IS research, and it is therefore not a surprise to find that they contribute to consumer acceptance of mobile payments. Apart from these two theories, some additional factors also influence consumer acceptance of mobile payments. The results obtained from this research suggest a few areas the mobile payments industry should consider in order to develop and establish the industry. First, the results showed that trust is one of the factors in implementing mobile payments. To increase the adoption of mobile payments, it is important that customers are provided with a trustworthy environment. Among the many ways that might help to develop trust, mobile payments service providers should consider selecting an appropriate and secure technology solution, so that with the advantage of new technologies, service providers can increase the security of the mobile environment. This enhancement would lead to more people trusting mobile payments once the environment has become more secure. Trust may also be developed through other means such as building a good reputation or having a good company image in order to increase mobile payment users’ trust and hence enhance the likelihood that users will accept mobile payments. Mobile payments service providers should think of ways that could help to develop their reputation and image so that they would attract more mobile payments customers: these approaches will be associated with system quality, as perceived system quality has also been identified as a determinant of consumer acceptance of mobile payments. Good quality of service has always proved important to attracting and retaining customers.

The research has identified and established the factors that influence consumer acceptance of mobile payments via the empirical results of this research study. PU is one of the determinants that influence consumer acceptance of mobile payments. Service providers and system designers should enhance the usefulness of the system in the early stage of the development. This concept also applies to PEOU. There are many different models and sizes of mobile devices, so it is very important that applications can be implemented with a user-friendly mode of operation.
The results obtained from this research also imply that perceived costs in mobile payment services could influence negatively the adoption of mobile payments. Therefore, it is important to address this issue. The industry should consider reducing the costs via adopting appropriate technologies, for example, using licensed free wireless technologies.

Moreover, a range of factors has also been identified concerning consumer acceptance of mobile payments. This research recommends that mobile payment systems endeavour to succeed in the areas that have been identified in this research to achieve a high level of acceptance and business penetration. The identification in this research of important factors concerning mobile payments will assist service providers to develop and implement their systems to ensure the full acceptance and continuous use of the systems.

The results of the research in this thesis should be of interest to the business communities. The results are of value to the business communities interested in developing and implementing mobile payment systems: the identification of important factors concerning mobile payments in this study will assist them to develop and implement their systems to ensure the full acceptance and continuous use of the systems.

8.5 Limitations of the Research

In implementing the research in this thesis, the results obtained are subject to a number of limitations. First, the results should be interpreted in the context of the research setting. The research was carried out in mainly in the UK and South Korea. The results may not be generalisable to mobile payments with reference to all mobile device users.

Second, TAM studies have identified that PU and PEOU are not the only indicators of technology acceptance. Legris et al. (2003) pointed out that many TAM research studies are not consistent and lack some factors that influence adoption. Therefore, some researchers have attempted to extend the original TAM: for example, Venkatesh
and Davis (2000) presented the TAM2, which introduced how subjective norms and cognitive instrumental processes affect perceived usefulness and interventions. The research in this thesis has also included some additional factors in the proposed research model: however, it might still suffer from the fact that other possible factors influencing consumer acceptance of mobile payments were not included in the research model. Moreover, in order to generalise the model to other technologies, additional factors, such as individual socio-economic characteristics and costs of competing technologies, can be considered and introduced to the model for future research. This approach would assist in determining the effects of new technologies on human behaviour.

Third, network effects have been identified in the literature review. However, the research in this thesis did not include further work on network effects because at the time of conducting the research, it was difficult to identify suitable mobile payment applications for this research. Moreover, it was very difficult for the researcher to access the organisations involved in mobile payments. Thus, it could be difficult to analyse the interrelationship between merchant acceptance and consumer acceptance. As mentioned in the literature review, network effects are vital for consumer acceptance of mobile payments: it is therefore necessary to include more in-depth research on network effects in mobile payments when mobile payment systems are more accessible at a later stage.

Fourth, the sample size. The areas of study were chosen based on the researcher’s judgement. As the samples were drawn from a small geographical area, the sample size may not be large enough to represent all mobile payment users, even though the sample size was calculated to represent the target population. The potentially unrepresentative nature of the result may preclude sweeping generalisations being made concerning all mobile payment users. Moreover, the research in this thesis did not identify relationship regarding age differences. Future research is therefore needed to validate the generalisability of this research model.

Finally, errors may have appeared in the questionnaire responses for many reasons, such as the dishonesty of the respondents in answering the questions, or a lack of cooperation from the respondents: they may have felt that the survey was a waste of
their time, so they may have refused to cooperate or rushed when answering the questions. Moreover, it is only a snap-shot in that time of the reseach.

8.6 Directions for Future Research

The research in this thesis presents comprehensive and first-hand information of consumer acceptance of mobile payments, albeit a snapshot view. Moreover, the research could be further enhanced with qualitative studies that investigate the interactions between the proposed model factors through case and action research. Furthermore, a wider approach for a research study into mobile payments could be selected by using political and/or cultural factors of the systems.

The findings of the research in this thesis could possibly be extended and generalised to other mobile-related applications, even IS, because it uses two well-established theoretical foundations, TAM and IDT. On the other hand, when used with different types of system or in different environments and countries, the factors would have different effects on the model. It would be useful to replicate this study in different applications and situations to evaluate the external validity of the research model when the mobile payments market has become more mature. Moreover, different theoretical frameworks, for example ANT, could be applied to this research domain for further research (Latour, 1993; Law, 1994).

While this study identified and examined a model of consumer acceptance of mobile payments, future research should explore other possible factors that may also influence the adoption of mobile payments. These factors could be identified through qualitative studies. For example, advertisements and government regulations are factors possibly related to the adoption of mobile payments by consumers. Moreover, the proposed research model should be used to test different mobile payment schemes in different countries when they become available. Such studies could inform the research community whether the research model is generalisable to all kinds of mobile payment systems.
Future research using a larger sample size and different countries would promote a greater understanding of consumer acceptance of mobile payments. Moreover, future research should focus on demographic characteristics such as gender, age, income, computer literacy, and mobile devices usage so that willingness to adopt mobile payments among different consumer groups may be further compared (Gefen & Straub, 1997; Venkatesh & Morris, 2000). For example, Rogers (1995) summarised that there is no consistent evidence showing the relationship between age and innovation. However, other studies have suggested some links between age and technology use (Assael, 1981; Brancheau & Wetherbe, 1990). Therefore, further research should consider clarifying this issue for consumer acceptance of mobile payments.

The differences between different consumer groups concerning using mobile payments could help to target different market sections. Moreover, a target of the whole population should be included in future studies. Furthermore, the comparison of mobile payment users and non-mobile- payment users should offer more insight into consumer acceptance of mobile payment systems, and a cross-validation of the research results in terms of different types of mobile payment services.


Chang, B.H., Lee, S.E., & Kim, B.S. (2006). Exploring factors affecting the adoption and continuance of online games among college students in South Korea: Integrating


Mochizuki, A. (2003). NTT Data to tie up with Korean venture on infrared mobile phone payment system, retrieved June 10, 2006, from ZOOP web site:


http://www.paypass.com/press/51303_2.html


http://www.semiconductors.philips.com/markets/identification/products/nfc/


Appendix

A1. Questionnaire (Study Two)

Survey on Mobile Payments

This survey is being conducted by Jim Chen of the Department of Information Systems and Computer Applications of the Faculty of Technology at the University of Portsmouth.

The survey will focus on mobile payments users in South Korea. The mobile payments service specified is ZOOP, which is provided by Harex InfoTech, South Korea. This survey investigates the usage of mobile payment services. Please select the most appropriate choices that match your attitudes and behaviours. The questionnaire should only take a few minutes to complete.

The information obtained will only be used for research purposes and will be kept strictly confidential. You will be invited to enter a cash draw on completion of the questionnaire. Please complete the questionnaire by 30th April 2004. Thank you for your cooperation and participation.

The cash prizes that you may win are as follows:
First Prize: £50.00
Second Prize: £30.00
Third Prize: £10.00

The winners will be independently selected at random from all entries collected, and the winner will be notified by email not later than 22nd May 2004.
Section A. Mobile Payments Use

1. How long have you been using the ZOOP mobile payments service?  
   _______ Years ________ Months

2. How often do you use the ZOOP mobile payments service? (Please circle the number that best describes your opinion)  
   Very rarely: __1___ __2___ __3___ __4___ __5___ __6___ __7___: Very frequent

Section B. Attitudes and behaviours towards Mobile Payments

3. How much do you agree with following reasons for using the ZOOP? (Please circle the number that best describes your opinion)

   3a. ZOOP provides a convenient service.  
      Strongly disagree: __1___ __2___ __3___ __4___ __5___ __6___ __7___: Strongly agree
   3b. ZOOP is a safe service.  
      Strongly disagree: __1___ __2___ __3___ __4___ __5___ __6___ __7___: Strongly agree
   3c. ZOOP is easy to use.  
      Strongly disagree: __1___ __2___ __3___ __4___ __5___ __6___ __7___: Strongly agree
   3d. ZOOP’s service provider has a good reputation in Korea.  
      Strongly disagree: __1___ __2___ __3___ __4___ __5___ __6___ __7___: Strongly agree
   3e. ZOOP’s shareholders have a strong economic background.  
      Strongly disagree: __1___ __2___ __3___ __4___ __5___ __6___ __7___: Strongly agree

4. How concerned are you about the following mobile payments issues? (Please circle the number that best describes your opinion)

   4a. Lack of a quality service
Strongly disagree: ___ 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree

4b. Security (e.g. theft of financial details)

Strongly disagree: ___ 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree

4c. Service charge

Strongly disagree: ___ 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree

Section C: Participants’ general information

5. Gender
   A. Male   B. Female

6. Age range
   A. Under 20   B. 20-29   C. 30-39   D. 40-49   E. Over 50

7. Please select your highest level of education (that you have completed or will complete.)
   A. Less than high school   B. High school   C. Bachelor’s degree
   E. Master’s degree   F. PhD, or other advanced degree
   G. Other (please specify) __________

8. What is your occupation? __________

Thank you for your participation in this questionnaire. Any comments on this survey:

_________________________________________________________________

Prize Draw

If you want to enter our lucky draw, please provide us with your full name and email address. We request the name and email because to be able to identify the entrants and notify the winner.

This survey is strictly confidential, and your privacy will be protected. We will not direct any information from the survey or your details to a third party. If you have any concerns or privacy queries, please contact me.
휴대폰 카드 결제에 대한 신뢰도 조사

이 포츠머스 대학 컴퓨터 정보학부의 짐 첸과 칼 아담스 박사에 의해 진행되고 있습니다.

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여러분이 작성해주신 정보는 학술 조사를 위해서만 사용될 것이며 보안을 유지해 드릴 것입니다. 그리고 이 조사에 참여하신 여러분들에게 상품 수령의 기회도 드립니다. 4월 30일까지 이 질문지를 완성해 주실 것을 부탁드리며 여러분의 협조에 감사드립니다.

상품내역
1등: 최신 음악 CD
2등: 포츠머스 대학 티셔츠
3등: 포츠머스 대학 기념 펜

상품 수령자는 2004년 5월 22일이전에 이메일로 개별 통보해 드립니다.
섹션 A. 휴대폰의 일반적인 사용에 대하여.

1. 얼마동안 휴대폰 지불서비스를 이용해 오셨는지요?
   ______년 ______개월

2. 평균적으로 어느정도 자주 휴대폰 카드 지불 서비스를 이용하시나요?

섹션 B. 휴대폰을 지불서비스에 대한 사용에 관하여.

3. 휴대폰 카드 결제 서비스의 사용에 대한 이유를 여러분께 물습니다.
   다음에 제시된 이유들에 얼마나동의하시는지요?

3a. 편리하고 다양한 서비스를 제공

3b. 안전한 결제수단

3c. 쉬운 사용법

3d. 서비스 제공 통신사가 세계적인 회사이다

3e. 주주들이 강력한 경제적 배경을 갖고 있다.

4. 다음 제시된 휴대폰 카드 결제에 관한 문제들에 대해 어느정도 우려하고 계신가요?

4a. 양질의 서비스의 결여

4b. 금융정보의 도난
4c. 수수료

섹션 C. 참여자 여러분의 일반정보

5. 성별 남자 여자

6. 연령대
   o 20 세 미만
   o 20-29
   o 30-39
   o 40-49
   o 50 혹은 그 이상

7. 최종학력을 선택해 주십시오. ( 이미 졸업하셨거나 졸업 예정도 포함)
   o 고등학교 졸업
   o 전문대 졸업
   o 대학 졸업
   o 대학원 졸업
   o 박사
   o 기타 (자세하게) 

8. 당신의 직업은 무엇입니까?

설문조사에 대한 간단한 의견:

행운에 추첨에 참가하고 싶으신 분들은 여러분의 정확한 이름과 이메일 주소를 저희에게 보내주세요. 참여자와 상품수령자를 구분하기 위해 여러분의 정확한 이름과 이메일 주소를 필요로 합니다.

여러분께서 보내주시신 개인정보는 절대로 보안이 유지되게 됩니다. 우리는 다른 제 3자에게 이 조사의 정보를 직접적으로 제공하지 않을 것입니다. 문의 사항이나 궁금한점은 저희에게 이메일을 보내주세요.
A3. Questionnaire (Study Three)

Survey on Mobile Payments

This survey is being conducted by Jim Chen of the Department of Information Systems and Computer Applications of the Faculty of Technology at the University of Portsmouth.

This survey investigates the usage of mobile payment services. Please select the most appropriate choices than match your attitudes and behaviours. The questionnaire should only take a few minutes to complete.

The information obtained will only be used for research purposes and will be kept strictly confidential. You will be invited to enter a cash draw on completion of the questionnaire. Please complete the questionnaire by 30th April 2005. Thank you for your cooperation and participation.

The cash prizes that you may win are as follows:
- First Prize: £100.00
- Second Prize: £50.00
- Third Prize: £10.00

The winners will be independently selected at random from all entries collected, and the winner will be notified by email not later than 22nd May 2005.

Thank you very much for your participation.
Section A. General Mobile Payments Use

1. Which mobile payment services do you use? ________________ (You need to consider this specific mobile payment service when answering all the following questions.)

2. I intend to use the mobile payment service. (Please circle the number that best describes your opinion.)
   Strongly disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7__: Strongly agree

3. How often do you use the mobile payments service? (Please circle the number that best describes your opinion.)
   Very rarely: __1__: __2__: __3__: __4__: __5__: __6__: __7__: Very frequent

4. How many times have you used the mobile payment services in the last six months? (Please select one.)
   A. Under 5 times B. 6-10 times C. 11-20 times D. 21-30 times E. 21-40 times F. 41-50 times G. Over 51 times

Section B. Attitudes and behaviours towards the mobile payments

Please circle the number that best describes your opinion.

5. Using the mobile payments service is good idea.
   Strongly disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7__: Strongly agree

6. I have fun using the mobile payments service.
   Strongly disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7__: Strongly agree

7. Using the mobile payments service is convenient.
   Strongly disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7__: Strongly agree

8. In general, I have a positive opinion about the mobile payments service.
   Strongly disagree: __1__: __2__: __3__: __4__: __5__: __6__: __7__: Strongly agree
9. Using the mobile payments service enables me to complete payment transactions more quickly.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

10. Using the mobile payments service makes it easier for me to make purchases.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

11. Using the mobile payments service gives me greater control over my purchases.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

12. Using the mobile payments service is faster than using other payment methods (cash and cheques).
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

13. My interaction with the mobile payments service is clear and understandable.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

14. I believe that it is easy to get the mobile payments service to do what I want it to do.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

15. Learning to operate the mobile payments service was easy for me.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

16. Using the mobile payments service is compatible with my life style.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

17. I think that using the mobile payments service fits in well with the way I like to make payments.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree
18. Using the mobile payments service is compatible with all aspects of my payment activities.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

19. I have seen what others do using their mobile payment services.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

20. It is easy for me to observe other using the mobile payment services.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

21. I am aware of the mobile payment services from the advertisements.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

22. Before deciding whether to use any mobile payment services, I was able to try it out properly.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

23. I was permitted to use the mobile payments service on a trial basis long enough to enable me to see what it could do.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

24. The mobile payments service was available to me to perform various payment applications adequately.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

25. My friends and relatives experiences of mobile payment services have encouraged me to use the services.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

26. I use the mobile payments service because of the proportion of friends who use the services.
Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree
27. Using the mobile payments service is a status symbol amongst my friends and relatives.
   Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

28. The price charged for the mobile payment service isn’t reasonable.
   Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

29. I can’t get a discount for every purchase I make using my mobile payments service.
   Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

30. The speed of connection between mobile devices and payment portals or devices is good.
   Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

31. The mobile payments service is always available.
   Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

32. The mobile payments service is dependable.
   Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

33. I feel safe in my transaction with the service.
   Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

34. I am concerned about the security of my payment details during payments transmission.
   Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

35. I am concerned that the service provider will misuse my personal information for other purposed without my authorisation.
   Strongly disagree: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ : __7__ : Strongly agree

36. I am concerned that my personal information in the service provider’s Database is not accurate.
Strongly disagree: __1:__ __2:__ __3:__ __4:__ __5:__ __6:__ __7:__ Strongly agree

37. I am concerned that the mobile payments service is collecting too much information from me.
Strongly disagree: __1:__ __2:__ __3:__ __4:__ __5:__ __6:__ __7:__ Strongly agree

Section C: Participants’ general information

38. Gender
A. Male  B. Female

39. Age range
A. Under 20  B. 20-29  C. 30-39  D. 40-49  E. Over 50

40. Please select your highest level of education (that you have completed or will complete.)
A. Less than high school  B. High school  C. Bachelor’s degree
E. Master’s degree  F. PhD, or other advanced degree
G. Other (please specify) __________

41. What is your occupation? __________

Thank you for your participation in this questionnaire. Any comments on this survey:
_________________________________________________________________

Prize Draw

If you want to enter our lucky draw, please provide us with your full name and email address. We request the name and email because to be able to identify the entrants and notify the winner.

This survey is strictly confidential, and your privacy will be protected. We will not direct any information from the survey or your details to a third party. If you have any concerns or privacy queries, please contact me.
### A4. List of Questions

<table>
<thead>
<tr>
<th>Latent Variable</th>
<th>Items</th>
<th>Questions</th>
<th>Measure description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Actual use of mobile payment (USE)</strong></td>
<td>USE1</td>
<td>How often do you use the mobile payment service?</td>
<td>7-point Likert scale</td>
</tr>
<tr>
<td></td>
<td>USE2</td>
<td>How many times have you used the mobile payment services in the last six months?</td>
<td>7-point Likert scale</td>
</tr>
<tr>
<td><strong>Behavioural intention to use (BI)</strong></td>
<td>B1</td>
<td>I intend to use the mobile payment service.</td>
<td>7-point Likert scale</td>
</tr>
<tr>
<td><strong>Attitude toward using (A)</strong></td>
<td>A1</td>
<td>Using the mobile payment service is good idea.</td>
<td>7-point Likert scale</td>
</tr>
<tr>
<td></td>
<td>A2</td>
<td>I have fun using the mobile payment service.</td>
<td>7-point Likert scale</td>
</tr>
<tr>
<td></td>
<td>A3</td>
<td>Using the mobile payment service is convenient.</td>
<td>7-point Likert scale</td>
</tr>
<tr>
<td></td>
<td>A4</td>
<td>In general, I have a positive opinion about the mobile payment service.</td>
<td>7-point Likert scale</td>
</tr>
<tr>
<td><strong>Perceived usefulness (PU)</strong></td>
<td>PU1</td>
<td>Using the mobile payment service enables me to complete payment transactions more quickly.</td>
<td>7-point Likert scale</td>
</tr>
<tr>
<td></td>
<td>PU2</td>
<td>Using the mobile payment service makes it easier for me to make purchases.</td>
<td>7-point Likert scale</td>
</tr>
<tr>
<td></td>
<td>PU3</td>
<td>Using the mobile payment service gives me greater control over my purchases.</td>
<td>7-point Likert scale</td>
</tr>
<tr>
<td></td>
<td>PU4</td>
<td>Using the mobile payment service is faster than using other payment methods (cash and cheques).</td>
<td>7-point Likert scale</td>
</tr>
<tr>
<td><strong>Perceived ease of use (PEOU)</strong></td>
<td><strong>Compatibil ity (C)</strong></td>
<td><strong>Observabil ity (O)</strong></td>
<td><strong>Trialability (T)</strong></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----------------</td>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>PEO U1 My interaction with the mobile payment service is clear and understandable.</td>
<td>C1 Using the mobile payment service is compatible with my life style.</td>
<td>O1 I have seen what others do using their mobile payment services.</td>
<td>T1 Before deciding whether to use any mobile payment services, I was able to try it out properly.</td>
</tr>
<tr>
<td>PEO U2 I believe that it is easy to get the mobile payment service to do what I want it to do.</td>
<td>C2 I think that using the mobile payments service fits in well with the way I like to make payments.</td>
<td>O2 It is easy for me to observe others using the mobile payment service.</td>
<td>T2 I was permitted to use the mobile payment service on a trial basis long enough to enable me to see what it could do.</td>
</tr>
<tr>
<td>PEO U3 Learning to operate the mobile payment service was easy for me.</td>
<td>C3 Using the mobile payment service is compatible with all aspects of my payment activities.</td>
<td>O3 I am aware of the mobile payment service from the advertisements.</td>
<td>T3 The mobile payment service was available to me to perform various payment applications adequately.</td>
</tr>
</tbody>
</table>

7-point Likert scale
<table>
<thead>
<tr>
<th><strong>Social influence (SI)</strong></th>
<th>SI1</th>
<th>My friends and relatives experiences of mobile payment services have encouraged me to use the service.</th>
<th>7-point Likert scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SI2</td>
<td>I use the mobile payment service because of the proportion of friends who use the services.</td>
<td>7-point Likert scale</td>
</tr>
<tr>
<td></td>
<td>SI3</td>
<td>Using the mobile payment is a status symbol amongst my friends and relatives.</td>
<td>7-point Likert scale</td>
</tr>
<tr>
<td><strong>Perceived costs (PC)</strong></td>
<td>PC1</td>
<td>The price charged for the mobile payment service isn’t reasonable.</td>
<td>7-point Likert scale</td>
</tr>
<tr>
<td></td>
<td>PC2</td>
<td>I can’t get a discount for every purchase I make using my mobile payment service.</td>
<td>7-point Likert scale</td>
</tr>
<tr>
<td><strong>Perceived system quality (PSQ)</strong></td>
<td>PSQ1</td>
<td>The speed of connection between mobile devices and payment portals or devices is good.</td>
<td>6-point Likert scale</td>
</tr>
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<td>PSQ2</td>
<td>The mobile payment service is always available.</td>
<td>6-point Likert scale</td>
</tr>
<tr>
<td></td>
<td>PSQ3</td>
<td>The mobile payment service is dependable.</td>
<td>6-point Likert scale</td>
</tr>
<tr>
<td></td>
<td>PSQ4</td>
<td>I feel safe in my transactions with the service.</td>
<td>6-point Likert scale</td>
</tr>
<tr>
<td><strong>Perceived trust (PT)</strong></td>
<td>PT1</td>
<td>I am concerned about the security of my payment details during transmission.</td>
<td>6-point Likert scale</td>
</tr>
<tr>
<td></td>
<td>PT2</td>
<td>I am concerned that the service provider will misuse my personal information for other purposes without my authorisation.</td>
<td>6-point Likert scale</td>
</tr>
<tr>
<td></td>
<td>PT3</td>
<td>I am concerned that my personal information in the service provider’s database is not accurate.</td>
<td>6-point Likert scale</td>
</tr>
<tr>
<td>PT4</td>
<td>I am concerned that the mobile payment service is collecting too much information from me.</td>
<td>6-point Likert scale</td>
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A5. SPSS (Cronbach’s test)

**RELIABILITY ANALYSIS - SCALE (ALPHA)**

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<tr>
<td>36.</td>
<td>TRUST4</td>
<td>5.2000</td>
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**Statistics for**

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<th>Variance</th>
<th>Std Dev</th>
<th>Variables</th>
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</tbody>
</table>

**RELIABILITY ANALYSIS - SCALE (ALPHA)**

Reliability Coefficients

N of Cases = 15.0

N of Items = 36

Alpha = .9783
### Figure A1. Reliability test (Overall Measurement)

<table>
<thead>
<tr>
<th>RELIABILITY ANALYSIS - SCALE (ALPHA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>1. USE1</td>
</tr>
<tr>
<td>2. USE2</td>
</tr>
</tbody>
</table>

Statistics for | Mean | Variance | Std Dev | Variables |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SCALE</td>
<td>10.9375</td>
<td>5.1292</td>
<td>2.5648</td>
<td>2</td>
</tr>
</tbody>
</table>

Reliability Coefficients

N of Cases = 16.0
N of Items = 2
Alpha = 0.9163

### Figure A2. Reliability test (Section A, Questions 3-4)

<table>
<thead>
<tr>
<th>RELIABILITY ANALYSIS - SCALE (ALPHA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>1. ATT1</td>
</tr>
<tr>
<td>2. ATT2</td>
</tr>
<tr>
<td>3. ATT3</td>
</tr>
<tr>
<td>4. ATT4</td>
</tr>
</tbody>
</table>

Statistics for | Mean | Variance | Std Dev | Variables |
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SCALE</td>
<td>23.1875</td>
<td>18.2958</td>
<td>4.2774</td>
<td>4</td>
</tr>
</tbody>
</table>

Reliability Coefficients

N of Cases = 16.0
N of Items = 4
Alpha = 0.8563

### Figure A3. Reliability test (Section B, Questions 5-8)
RELIABILITY ANALYSIS - SCALE (ALPHA)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std Dev</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>PU5E1</td>
<td>5.4375</td>
<td>.9839</td>
</tr>
<tr>
<td>2.</td>
<td>PU5E2</td>
<td>5.3125</td>
<td>.7042</td>
</tr>
<tr>
<td>3.</td>
<td>PU5E3</td>
<td>5.2060</td>
<td>.6375</td>
</tr>
<tr>
<td>4.</td>
<td>PU5E4</td>
<td>5.6250</td>
<td>.9574</td>
</tr>
</tbody>
</table>

Statistics for SCALE
Mean Variance Std Dev Variables
21.8750 6.7833 2.6045 4

Reliability Coefficients

N of Cases = 16.0  N of Items = 4

Alpha = .7844

Figure A4. Reliability test (Section B, Questions 9-12)

RELIABILITY ANALYSIS - SCALE (ALPHA)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std Dev</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>PE001</td>
<td>5.3750</td>
<td>1.0678</td>
</tr>
<tr>
<td>2.</td>
<td>PE002</td>
<td>5.3750</td>
<td>.5851</td>
</tr>
<tr>
<td>3.</td>
<td>PE003</td>
<td>5.5525</td>
<td>1.0308</td>
</tr>
</tbody>
</table>

Statistics for SCALE
Mean Variance Std Dev Variables
16.3125 5.3525 2.5124 3

Reliability Coefficients

N of Cases = 16.0  N of Items = 3

Alpha = .7859

Figure A5. Reliability test (Section B, Questions 13-15)
### RELIABILITY ANALYSIS - SCALE (ALPHA)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Std Dev</td>
<td>Cases</td>
</tr>
<tr>
<td>1. CONF1</td>
<td>5.3750</td>
<td>1.0878</td>
</tr>
<tr>
<td>2. CONF2</td>
<td>5.4375</td>
<td>1.0308</td>
</tr>
<tr>
<td>3. CONF3</td>
<td>5.3125</td>
<td>1.0782</td>
</tr>
</tbody>
</table>

Statistics for Mean Variance Std Dev Variables
SCALE 16.1250 9.8500 3.1385 3

Reliability Coefficients
N of Cases = 16.0 N of Items = 3

Alpha = .9610

---

**Figure A6. Reliability test (Section B, Questions 16-18)**

### RELIABILITY ANALYSIS - SCALE (ALPHA)

<p>| | | |</p>
<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Std Dev</td>
<td>Cases</td>
</tr>
<tr>
<td>1. OBSER1</td>
<td>5.0000</td>
<td>1.0854</td>
</tr>
<tr>
<td>2. OBSER2</td>
<td>5.1250</td>
<td>1.1475</td>
</tr>
<tr>
<td>3. OBSER3</td>
<td>4.9375</td>
<td>.9879</td>
</tr>
</tbody>
</table>

Statistics for Mean Variance Std Dev Variables
SCALE 15.0625 6.8525 2.6198 3

Reliability Coefficients
N of Cases = 16.0 N of Items = 3

Alpha = .7322

---

**Figure A7. Reliability test (Section B, Questions 19-21)**
### Figure A8. Reliability test (Section B, Questions 22-24)

<table>
<thead>
<tr>
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<th>Scale</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>TRIAL1</td>
<td>5.5625</td>
<td>1.0308</td>
<td>16.0</td>
</tr>
<tr>
<td>2.</td>
<td>TRIAL2</td>
<td>5.6250</td>
<td>1.0247</td>
<td>16.0</td>
</tr>
<tr>
<td>3.</td>
<td>TRIAL3</td>
<td>5.5625</td>
<td>1.1529</td>
<td>16.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Statistics for</th>
<th>Mean</th>
<th>Variance</th>
<th>Std Dev</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCALE</td>
<td></td>
<td>Scale</td>
<td>16.7500</td>
<td>7.2667</td>
<td>2.6937</td>
<td>3</td>
</tr>
</tbody>
</table>

Reliability Coefficients

N of Cases = 16.0
N of Items = 3

\[
\text{Alpha} = .7956
\]

### Figure A9. Reliability test (Section B, Questions 25-27)

<table>
<thead>
<tr>
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<th>Scale</th>
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<th>Std Dev</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>S11</td>
<td>5.3125</td>
<td>1.1360</td>
<td>16.0</td>
</tr>
<tr>
<td>2.</td>
<td>S12</td>
<td>5.2500</td>
<td>1.1255</td>
<td>16.0</td>
</tr>
<tr>
<td>3.</td>
<td>S13</td>
<td>5.2500</td>
<td>1.1255</td>
<td>16.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Statistics for</th>
<th>Mean</th>
<th>Variance</th>
<th>Std Dev</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCALE</td>
<td></td>
<td>Scale</td>
<td>15.8125</td>
<td>0.1625</td>
<td>2.6570</td>
<td>3</td>
</tr>
</tbody>
</table>

Reliability Coefficients

N of Cases = 16.0
N of Items = 3

\[
\text{Alpha} = .7963
\]
**Figure A10. Reliability test (Section B, Questions 28-29)**

<table>
<thead>
<tr>
<th>Scale</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC1</td>
<td>5.1875</td>
<td>.8342</td>
<td>16.0</td>
</tr>
<tr>
<td>FC2</td>
<td>5.2500</td>
<td>.8563</td>
<td>16.0</td>
</tr>
</tbody>
</table>

Statistics for Scale: Mean 10.4375, Variance 2.5292, Std Dev 1.5903, Variables 2

Reliability Coefficients

N of Cases = 16.0, N of Items = 2

Alpha = .0659

**Figure A11. Reliability test (Section B, Questions 30-33)**

<table>
<thead>
<tr>
<th>Scale</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSCQ1</td>
<td>5.6250</td>
<td>1.1475</td>
<td>16.0</td>
</tr>
<tr>
<td>PSCQ2</td>
<td>5.5000</td>
<td>1.0954</td>
<td>16.0</td>
</tr>
<tr>
<td>PSCQ3</td>
<td>5.4375</td>
<td>1.1529</td>
<td>16.0</td>
</tr>
<tr>
<td>PSCQ4</td>
<td>5.5000</td>
<td>1.0328</td>
<td>16.0</td>
</tr>
</tbody>
</table>

Statistics for Scale: Mean 22.0625, Variance 15.1292, Std Dev 3.8896, Variables 4

Reliability Coefficients

N of Cases = 16.0, N of Items = 4

Alpha = .2004
Figure A12. Reliability test (Section B, Questions 34-37)
### B1. LISREL Notation

<table>
<thead>
<tr>
<th>( \eta_1 )</th>
<th>Attitude Toward Using</th>
<th>( \xi_1 )</th>
<th>Observability</th>
<th>( \chi_8 )</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \eta_2 )</td>
<td>Behavioural Intention</td>
<td>( \xi_2 )</td>
<td>Compatibility</td>
<td>( \chi_9 )</td>
<td>T3</td>
</tr>
<tr>
<td>( \eta_3 )</td>
<td>Actual use</td>
<td>( \xi_3 )</td>
<td>Trialability</td>
<td>( \chi_{10} )</td>
<td>PU1</td>
</tr>
<tr>
<td>( y_1 )</td>
<td>A1</td>
<td>( \xi_4 )</td>
<td>Perceived Usefulness</td>
<td>( \chi_{11} )</td>
<td>PU2</td>
</tr>
<tr>
<td>( y_2 )</td>
<td>A2</td>
<td>( \xi_5 )</td>
<td>Perceived Costs</td>
<td>( \chi_{12} )</td>
<td>PU3</td>
</tr>
<tr>
<td>( y_3 )</td>
<td>A3</td>
<td>( \xi_6 )</td>
<td>Perceived System Quality</td>
<td>( \chi_{13} )</td>
<td>PU4</td>
</tr>
<tr>
<td>( y_4 )</td>
<td>A4</td>
<td>( \xi_7 )</td>
<td>Social Influence</td>
<td>( \chi_{14} )</td>
<td>PC1</td>
</tr>
<tr>
<td>( y_5 )</td>
<td>BI</td>
<td>( \xi_8 )</td>
<td>Perceived Ease of Use</td>
<td>( \chi_{15} )</td>
<td>PC2</td>
</tr>
<tr>
<td>( y_6 )</td>
<td>USE1</td>
<td>( \xi_9 )</td>
<td>Perceived Trust</td>
<td>( \chi_{16} )</td>
<td>PS1</td>
</tr>
<tr>
<td>( y_7 )</td>
<td>USE2</td>
<td>( \chi_1 )</td>
<td>O1</td>
<td>( \chi_{17} )</td>
<td>PS2</td>
</tr>
<tr>
<td>( \chi_2 )</td>
<td>O2</td>
<td>( \chi_3 )</td>
<td>O3</td>
<td>( \chi_{18} )</td>
<td>PS3</td>
</tr>
<tr>
<td>( \chi_4 )</td>
<td>C1</td>
<td>( \chi_5 )</td>
<td>C2</td>
<td>( \chi_{19} )</td>
<td>PS4</td>
</tr>
<tr>
<td>( \chi_6 )</td>
<td>C3</td>
<td>( \chi_7 )</td>
<td>T1</td>
<td>( \chi_{20} )</td>
<td>SI1</td>
</tr>
<tr>
<td>( \chi_{21} )</td>
<td>SI2</td>
<td>( \chi_{22} )</td>
<td>SI3</td>
<td>( \chi_{23} )</td>
<td>PEOU1</td>
</tr>
<tr>
<td>( \chi_{24} )</td>
<td>PEOU2</td>
<td>( \chi_{25} )</td>
<td>PEOU3</td>
<td>( \chi_{26} )</td>
<td>PT1</td>
</tr>
<tr>
<td>( \chi_{27} )</td>
<td>PT2</td>
<td>( \chi_{28} )</td>
<td>PT3</td>
<td>( \chi_{29} )</td>
<td>PT4</td>
</tr>
</tbody>
</table>

**| \( \lambda \) | The relationship between the latent variables and their indicators. | \( \zeta \) | Errors in equations. |

**| \( \beta \) | The relationship between the endogenous variables. | \( \gamma \) | The relationship between exogenous and endogenous variables. |

**| \( \varepsilon \) | Measurement errors for indicators of endogenous variables | \( \delta \) | Measurement errors for indicators of exogenous variables |
B2. Mathematical Equations

Structural equations
\[ \eta_1 = \gamma_{11}\xi_1 + \gamma_{12}\xi_2 + \gamma_{13}\xi_3 + \gamma_{14}\xi_4 + \gamma_{15}\xi_5 + \gamma_{16}\xi_6 + \gamma_{18}\xi_8 + \gamma_{19}\xi_9 + \zeta_1 \]

Attitude Toward Using = \( f \) (Observability, Compatibility, Trialability, Perceived Usefulness, Perceived Costs, Perceived System Quality, Perceived Ease of Use, Perceived Trust, Error)

\[ \eta_2 = \beta_{21}\eta_1 + \gamma_{17}\xi_7 + \zeta_2 \]

Behavioural Intention = \( f \) (Attitude Toward Using, Social Influence, Error)

\[ \eta_3 = \beta_{32}\eta_3 + \zeta_3 \]

Actual Use = \( f \) (Behavioural Intention, Error)

Measurement equations for the endogenous variables
\[ y_1 = \lambda_{11}\eta_1 + \epsilon_1 \]
A1 = \( f \) (Attitude Toward Using, Error)

\[ y_2 = \lambda_{21}\eta_1 + \epsilon_2 \]
A2 = \( f \) (Attitude Toward Using, Error)

\[ y_3 = \lambda_{31}\eta_1 + \epsilon_3 \]
A3 = \( f \) (Attitude Toward Using, Error)

\[ y_4 = \lambda_{41}\eta_1 + \epsilon_4 \]
A4 = \( f \) (Attitude Toward Using, Error)

\[ y_5 = \lambda_{52}\eta_2 + \epsilon_5 \]
BI1 = \( f \) (Behavioural Intention, Error)

\[ y_6 = \lambda_{63}\eta_3 + \epsilon_6 \]
USE1 = \( f \) (Actual Use, Error)

\[ y_7 = \lambda_{73}\eta_3 + \epsilon_7 \]
USE2 = f (Actual Use, Error)

**Measurement equations for the exogenous variables**

\[ \chi_1 = \lambda_{11} \xi_1 + \delta_1 \]

\[ O1 = f \) (Observability, Error) \]

\[ \chi_2 = \lambda_{21} \xi_1 + \delta_2 \]

\[ O2 = f \) (Observability, Error) \]

\[ \chi_3 = \lambda_{31} \xi_1 + \delta_3 \]

\[ O3 = f \) (Observability, Error) \]

\[ \chi_4 = \lambda_{42} \xi_2 + \delta_4 \]

\[ C1 = f \) (Compatibility, Error) \]

\[ \chi_5 = \lambda_{52} \xi_2 + \delta_5 \]

\[ C2 = f \) (Compatibility, Error) \]

\[ \chi_6 = \lambda_{62} \xi_2 + \delta_6 \]

\[ C3 = f \) (Compatibility, Error) \]

\[ \chi_7 = \lambda_{73} \xi_3 + \delta_7 \]

\[ T1 = f \) (Trialability, Error) \]

\[ \chi_8 = \lambda_{83} \xi_3 + \delta_8 \]

\[ T2 = f \) (Trialability, Error) \]

\[ \chi_9 = \lambda_{93} \xi_3 + \delta_9 \]

\[ T3 = f \) (Trialability, Error) \]

\[ \chi_{10} = \lambda_{104} \xi_4 + \delta_{10} \]

\[ PU1 = f \) (Perceived Usefulness, Error) \]

\[ \chi_{11} = \lambda_{114} \xi_4 + \delta_{11} \]

\[ PU2 = f \) (Perceived Usefulness, Error) \]

\[ \chi_{12} = \lambda_{124} \xi_4 + \delta_{12} \]

\[ PU3 = f \) (Perceived Usefulness, Error) \]

\[ \chi_{13} = \lambda_{134} \xi_4 + \delta_{13} \]

\[ PU4 = f \) (Perceived Usefulness, Error) \]

\[ \chi_{14} = \lambda_{145} \xi_5 + \delta_{14} \]

\[ PC1 = f \) (Perceived Costs, Error) \]
\[ \chi_{15} = \lambda_{155} \xi_5 + \delta_{15} \]
PC2 = \( f \) (Perceived Costs, Error)

\[ \chi_{16} = \lambda_{166} \xi_6 + \delta_{16} \]
PS1 = \( f \) (Perceived System Quality, Error)

\[ \chi_{17} = \lambda_{176} \xi_6 + \delta_{17} \]
PS2 = \( f \) (Perceived System Quality, Error)

\[ \chi_{18} = \lambda_{186} \xi_6 + \delta_{18} \]
PS3 = \( f \) (Perceived System Quality, Error)

\[ \chi_{19} = \lambda_{196} \xi_6 + \delta_{19} \]
PS4 = \( f \) (Perceived System Quality, Error)

\[ \chi_{20} = \lambda_{207} \xi_7 + \delta_{20} \]
SI1 = \( f \) (Social Influence, Error)

\[ \chi_{21} = \lambda_{217} \xi_7 + \delta_{21} \]
SI2 = \( f \) (Social Influence, Error)

\[ \chi_{22} = \lambda_{227} \xi_7 + \delta_{22} \]
SI3 = \( f \) (Social Influence, Error)

\[ \chi_{23} = \lambda_{238} \xi_8 + \delta_{23} \]
PEOU1 = \( f \) (Perceived Ease of Use, Error)

\[ \chi_{24} = \lambda_{248} \xi_8 + \delta_{24} \]
PEOU2 = \( f \) (Perceived Ease of Use, Error)

\[ \chi_{25} = \lambda_{258} \xi_8 + \delta_{25} \]
PEOU3 = \( f \) (Perceived Ease of Use, Error)

\[ \chi_{26} = \lambda_{269} \xi_9 + \delta_{26} \]
PT1 = \( f \) (Perceived Trust, Error)

\[ \chi_{27} = \lambda_{279} \xi_9 + \delta_{27} \]
PT2 = \( f \) (Perceived Trust, Error)

\[ \chi_{28} = \lambda_{289} \xi_9 + \delta_{28} \]
PT3 = \( f \) (Perceived Trust, Error)

\[ \chi_{29} = \lambda_{299} \xi_9 + \delta_{29} \]
PT4 = \( f \) (Perceived Trust, Error)
B3. LISREL Outputs (Data set one)

DATE: 02/02/2006
TIME: 20:56

L I S R E L 8.70

BY

Karl G. Jöreskog & Dag Sörbom

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Latent Variables
Use A Bi Peou Pu O C T Pc Psq Pt Si
Eta-Variables: Use A Bi
Y-Variables: USE1-USE2 A1-A4 BI
Relationships
USE1-USE2 = Use
A1-A4 = A
BI = Bi
PEOU1-PEOU3 = Peou
PU1-PU4 = Pu
O1-O3 = O
C1-C3 = C
T1-T3 = T
PC1-PC2 = Pc
PSQ1-PSQ4 = Psq
PT1-PT4 = Pt
SI1-SI3 = Si
LISREL OUTPUT: RS MI SS SC EF
Path Diagram
End of Problem
LISREL Estimates (Maximum Likelihood)

Measurement Equations

USE1 = 1.00*Use, Errorvar. = 0.60, R^2 = 0.40
(0.17) 5.55

USE2 = 2.24*Use, Errorvar. = -0.48, R^2 = 1.48
(0.53) (0.68) 4.23 -1.49
A1 = 1.00*A, Errorvar. = 0.08, R^2 = 0.92
(0.034) 7.73

A2 = 1.17*A, Errorvar. = 0.06, R^2 = 0.94
(0.036) (0.037) 32.47 7.27

A3 = 1.15*A, Errorvar. = 0.06, R^2 = 0.94
(0.035) (0.036) 32.44 7.28

A4 = 1.11*A, Errorvar. = 0.07, R^2 = 0.93
(0.035) (0.038) 31.51 7.51

BI = 1.00*Bi, Errorvar. = 0.07, R^2 = 0.93
(0.18) 1.59

PEOU1 = 0.75*Peou, Errorvar. = 0.60, R^2 = 0.40
(0.089) (0.11) 8.40 8.04

PEOU2 = 0.96*Peou, Errorvar. = 0.48, R^2 = 0.52
(0.099) (0.12) 9.77 6.77

PEOU3 = 1.24*Peou, Errorvar. = 0.01, R^2 = 0.99
(0.089) (0.14) 14.03 0.092

PU1 = 1.19*Pu, Errorvar. = 0.25, R^2 = 0.75
(0.086) (0.066) 13.91 7.05

PU2 = 1.22*Pu, Errorvar. = 0.17, R^2 = 0.83
(0.081) (0.053) 15.00 5.89

PU3 = 1.19*Pu, Errorvar. = 0.24, R^2 = 0.76
(0.085) (0.063) 14.05 6.93

PU4 = 0.81*Pu, Errorvar. = 0.27, R^2 = 0.73
(0.060) (0.034) 13.50 7.34
<table>
<thead>
<tr>
<th>Variable</th>
<th>Equation</th>
<th>Error var.</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>O1</td>
<td>$1.18 \times O$</td>
<td>0.22</td>
<td>0.78</td>
</tr>
<tr>
<td></td>
<td>(0.091)</td>
<td>(0.11)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.98</td>
<td>3.58</td>
<td></td>
</tr>
<tr>
<td>O2</td>
<td>$1.02 \times O$</td>
<td>0.33</td>
<td>0.67</td>
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PT1 = 0.92*Pt, Errorvar. = 0.28 , R^2 = 0.72  
   (0.070)          (0.051)  
   13.19         6.41  

PT2 = 0.93*Pt, Errorvar. = 0.36 , R^2 = 0.64  
   (0.078)          (0.068) 
   12.03         7.29  

PT3 = 0.95*Pt, Errorvar. = 0.38 , R^2 = 0.62  
   (0.081)          (0.074)  
   11.78         7.43  

PT4 = 0.84*Pt, Errorvar. = 0.35 , R^2 = 0.65  
   (0.069)          (0.053) 
   12.16         7.20  

SI1 = 0.88*Si, Errorvar. = 0.36 , R^2 = 0.64  
   (0.081)          (0.086)  
   10.89         5.08  

SI2 = 0.85*Si, Errorvar. = 0.46 , R^2 = 0.54  
   (0.086)          (0.095) 
   9.94          6.44  

SI3 = 1.00*Si, Errorvar. = 0.41 , R^2 = 0.59  
   (0.097)          (0.12)  
   10.38         5.86  

Structural Equations

Use= 0.14*Bi, Errorvar. = 0.55 , R^2 = 0.573  
   (0.047)          (0.15)  
   2.97          3.73  

A = 0.76*Peou + 0.37*Pu + 0.13*O + 0.25*C + 0.15*T - 0.32*Pc + 1.48*Psq +0.65*Pt,  
   (0.050)          (0.056)          (0.054)          (0.054)          (0.056)          (0.058)          (0.094)          (0.063)  
   15.2          6.07          2.407          4.63          2.679          5.517         15.74         10.317  

Errorvar. = 0.024 , R^2 = 0.99  
   (0.055)           0.43  

Bi = 1.16*A + 0.13*Si, Errorvar. = 0.012, R^2 = 1.00  
   (0.037)          (0.052)          (0.18)  
   31.4          2.5          0.069
Goodness of Fit Statistics

Degrees of Freedom = 583
Minimum Fit Function Chi-Square = 1411.87 (P = 0.0)

Root Mean Square Error of Approximation (RMSEA) = 0.061

Expected Cross-Validation Index (ECVI) = 46.95
90 Percent Confidence Interval for ECVI = (50.28 ; 49.67)
ECVI for Saturated Model = 6.98
ECVI for Independence Model = 182.39

Normed Fit Index (NFI) = 0.87
Non-Normed Fit Index (NNFI) = 0.95
 Parsimony Normed Fit Index (PNFI) = 0.84
Comparative Fit Index (CFI) = 0.93
Incremental Fit Index (IFI) = 0.86
Relative Fit Index (RFI) = 0.84

Root Mean Square Residual (RMR) = 0.03
Standardized RMR = 0.03

Completely Standardized Solution

**LAMBDA-Y**

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### Correlation Matrix of ETA and KSI

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### Regression Matrix ETA on KSI (Standardized)

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### Regression Matrix ETA on KSI (Standardized)

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B4. LISREL Outputs (Data set two)

DATE: 03/03/2006
TIME: 21:12
LISREL 8.70

BY
Karl G. Jöreskog & Dag Sörbom

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Lincolnwood, IL 60712, U.S.A.
Phone: (800)247-6113, (847)675-0720, Fax: (847)675-2140
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Website: www.ssicentral.com

Latent Variables
Use A Bi Peou Pu O C T Pc Psq Pt Si
Eta-Variables: Use A Bi
Y-Variables: USE1-USE2 A1-A4 BI
Relationships
USE1-USE2 = Use
A1-A4 = A
BI = Bi
PEOU1-PEOU3 = Peou
PU1-PU4 = Pu
O1-O3 = O
C1-C3 = C
T1-T3 = T
PC1-PC2 = Pc
PSQ1-PSQ4 = Psq
PT1-PT4 = Pt
SI1-SI3 = Si
LISREL OUTPUT: RS MI SS SC EF
Path Diagram
End of Problem
LISREL Estimates (Maximum Likelihood)

Measurement Equations

USE1 = 1.00*Use, Errorvar.= 0.68 , R² = 0.45 (0.15) 5.79

USE2 = 2.04*Use, Errorvar.=-0.36 , R² = 1.34 (0.38) (0.50) 5.39 1.53

A1 = 1.00*A, Errorvar.= 0.17 , R² = 0.93 (0.035) 7.71

A2 = 1.15*A, Errorvar.= 0.16 , R² = 0.95 (0.031) (0.036) 36.94 7.15

A3 = 1.13*A, Errorvar.= 0.16 , R² = 0.95 (0.031) (0.036) 36.54 7.25

A4 = 1.07*A, Errorvar.= 0.20 , R² = 0.94 (0.031) (0.039) 34.59 7.66

BI = 1.00*Bi, Errorvar.= 0.15 , R² = 0.95 (0.19) 1.34

PEOU1 = 0.75*Peou, Errorvar.= 0.75 , R² = 0.41 (0.089) (0.11) 8.43 8.02

PEOU2 = 0.96*Peou, Errorvar.= 0.63 , R² = 0.53 (0.098) (0.12) 9.81 6.73

PEOU3 = 1.24*Peou, Errorvar.= 0.21, R² = 0.99 (0.089) (0.14) 13.99 0.15

PU1 = 1.18*Pu, Errorvar.= 0.27 , R² = 0.70 (0.085) (0.066) 13.78 7.12

PU2 = 1.21*Pu, Errorvar.= 0.12 , R² = 0.82 (0.081) (0.053) 14.94 5.94

PU3 = 1.19*Pu, Errorvar.= 0.23 , R² = 0.77 (0.084) (0.062) 14.13 6.83

PU4 = 0.81*Pu, Errorvar.= 0.15 , R² = 0.72 (0.060) (0.034) 13.52 7.30
O1 = 1.17*O, Errorvar.= 0.38 , R² = 0.78
   (0.090) (0.11) 13.01 3.57

O2 = 1.02*O, Errorvar.= 0.52 , R² = 0.68
   (0.087) (0.094) 11.74 5.55

O3 = 0.98*O, Errorvar.= 0.40 , R² = 0.52
   (0.099) (0.12) 9.93 7.57

C1 = 1.12*C, Errorvar.= 0.26 , R² = 0.73
   (0.096) (0.13) 11.66 3.76

C2 = 0.83*C, Errorvar.= 0.14 , R² = 0.83
   (0.066) (0.065) 12.57 2.20

C3 = 0.71*C, Errorvar.= 0.47 , R² = 0.29
   (0.10) (0.15) 7.04 8.63

T1 = 0.91*T, Errorvar.= 0.40 , R² = 0.53
   (0.094) (0.11) 9.66 6.54

T2 = 1.10*T, Errorvar.= 0.39 , R² = 0.64
   (0.10) (0.14) 10.73 4.99

T3 = 0.99*T, Errorvar.= 0.41 , R² = 0.58
   (0.097) (0.12) 10.18 5.84

PC1 = 1.07*Pc, Errorvar.= 0.28 , R² = 0.75
   (0.10) (0.15) 10.40 2.47

PC2 = 0.99*Pc, Errorvar.= 0.40 , R² = 0.59
   (0.11) (0.15) 9.34 4.65

PSQ1 = 0.89*Psq, Errorvar.= 0.44 , R² = 0.64
   (0.072) (0.052) 12.42 8.46

PSQ2 = 1.01*Psq, Errorvar.= 0.40 , R² = 0.67
   (0.079) (0.059) 12.86 8.32

PSQ3 = 0.99*Psq, Errorvar.= 0.41 , R² = 0.66
   (0.078) (0.060) 12.67 8.39

PSQ4 = 0.80*Psq, Errorvar.= 0.39 , R² = 0.62
   (0.066) (0.046) 12.12 8.53
PT1 = 0.92*Pt, Errorvar. = 0.33, \( R^2 = 0.72 \)
(0.069) (0.048) 
13.28 6.79

PT2 = 0.93*Pt, Errorvar. = 0.39, \( R^2 = 0.65 \)
(0.077) (0.065) 
12.11 7.54

PT3 = 0.95*Pt, Errorvar. = 0.36, \( R^2 = 0.60 \)
(0.080) (0.072) 
11.78 7.70

PT4 = 0.84*Pt, Errorvar. = 0.32, \( R^2 = 0.69 \)
(0.066) (0.045) 
12.78 7.16

SI1 = 0.89*Si, Errorvar. = 0.42, \( R^2 = 0.65 \)
(0.080) (0.083) 
11.05 5.06

SI2 = 0.88*Si, Errorvar. = 0.40, \( R^2 = 0.56 \)
(0.086) (0.096) 
10.21 6.28

SI3 = 0.99*Si, Errorvar. = 0.32, \( R^2 = 0.58 \)
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10.35 6.09

**Structural Equations**

Use = 0.16*Bi, Errorvar. = 0.60, \( R^2 = 0.17 \)
(0.042) (0.13) 
3.81 4.45

A = 0.66*Peou + 0.36*Pu + 0.16*O + 0.13*C + 0.14*T - 0.40*Pc + 1.67*Psq
(0.052) (0.056) (0.055) (0.055) (0.057) (0.060) (0.10)
12.69 6.43 2.91 2.36 2.46 -6.67 16.7

+0.89*Pt, Errorvar. = 0.075, \( R^2 = 1.02 \)
(0.071) (0.060) 
12.54 1.24

Bi = 1.14*A + 0.15*Si, Errorvar. = 0.053, \( R^2 = 0.99 \)
(0.032) (0.052) (0.19) 
35.63 2.88 0.28
Goodness of Fit Statistics

Degrees of Freedom = 583
Minimum Fit Function Chi-Square = 1282.6 (P = 0.0)
Root Mean Square Error of Approximation (RMSEA) = 0.027
Expected Cross-Validation Index (ECVI) = 46.95
90 Percent Confidence Interval for ECVI = (45.28 ; 48.67)
ECVI for Saturated Model = 7.98
ECVI for Independence Model = 191.19
Normed Fit Index (NFI) = 0.88
Non-Normed Fit Index (NNFI) = 0.94
 Parsimony Normed Fit Index (PNFI) = 0.83
Comparative Fit Index (CFI) = 0.92
Incremental Fit Index (IFI) = 0.89
Relative Fit Index (RFI) = 0.85

Root Mean Square Residual (RMR) = 0.04
Standardized RMR = 0.03

Completely Standardized Solution

**LAMBDA-Y**

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### Correlation Matrix of ETA and KSI

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### Correlation Matrix of ETA and KSI

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### Regression Matrix ETA on KSI (Standardized)

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### Regression Matrix ETA on KSI (Standardized)

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