Mobile Data Services Adoption in New Zealand: Future Predictions

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A thesis submitted to the graduate faculty of
Design and Creative Technologies
Auckland University of Technology
School of Computer and Information Sciences
in partial fulfilment of the
requirements for the degree of
Master of Computing Information Systems.

Auckland, New Zealand
2007

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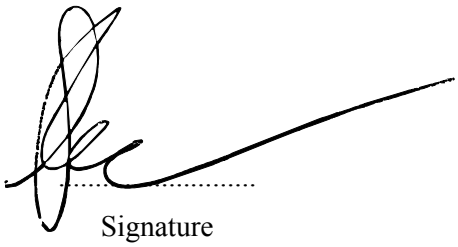
Declaration

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the qualification of any other degree or diploma of a University or other institution of higher learning, except where due acknowledgement is made in the acknowledgements.



Signature

Acknowledgements

I wish to acknowledge the support from many people who in one way or another assisted the completion of this thesis.

First, I would like to thank my supervisor, Dr. Brian Cusack, who kept guiding me along the path, despite various "bugs on the windscreen" that threatened to distract me.

Thanks go to all those people who filled out my surveys, often providing helpful comments and encouragement.

I would like to thank my colleagues at Whitireia Community Polytechnic: Brenda Lloyd and Rob Campbell for help with statistics; Sue Chard and Diane Strode who shared valuable advice on coping with post-graduate research, and practical experience of writing a thesis; Eliza Lagolago who checked all of the printer servey data entry. Also Trish Brimblecombe who supported all of us towards gaining our higher qualifications over many years.

Thanks to Frances O'Connell and Sue Cosgrove, and John Mori for their constructive comments on Chapter One. Also my four year old daughter, Tess Burgoyne, who folded most of the printed surveys, then flattened them out again when they were filled in. Thanks to for support from my two sons, Joel and Aaron Cosgrove, who were always encouraging and never complained when I couldn't give them time because I was working on my thesis. Special thanks to Aaron for last-minute formatting help!

Finally, I wish to acknowledge and express my sincere and deepfelt thanks to my partner, Debbie Burgoyne. Over six years since I started my Postgradute study with Unitec, Deb has always supported me, and kept the family intact whenever I needed time for my study. Her support has been the most important single rock that has held together my Masters study.

Abstract

The fast pace of development in the Mobile Data Services area means innovators have to remain vigilant to stay in the market. There is not time to undertake the usual market development cycles. As a consequence, researchers are looking at various ways to predict the adoption rate of a new product and ways to better forecast adoption in different niche contexts. Rogers' (2003) provides a review of historical trends in innovation and diffusion studies, and the foundational (1962) model he developed. In the context of the most recent literature, it is found that Rogers' generic model still works well, but variations built on his model need to be considered. In particular, the 'Chasm' model, developed by Moore (1999), adapts Rogers model to cope well with the 21st century business environment. Gilbert (2005) has taken the work of both Rogers and Moore and applied the learning to research into adoption rates and characteristics in cross-cultural situations.

In New Zealand the past consumer behaviour when new mobile services have been introduced has shown a number of characteristics and specific problems. Vodafone New Zealand provides mobile services only and they now claim 54% market share (Vodafone 2005`). An early success was to significantly lower the cost of sending text messages (SMS), followed by promotion of that service to the teenage market sector. In contrast to the popularity of SMS, introduction of the WAP mobile Internet protocol was not successful in New Zealand, as was the case elsewhere. The failure is commonly attributed to a lack of services being offered to use the technology. Near the end of 2004 Telecom New Zealand launched a new product, branded 'T3G'. Vodafone New Zealand released 'Vodafone 3G' during the middle of 2005. The technologies behind these products is generally called '3G Mobile', or Third Generation Mobile technology. Operators in Singapore also have 3G networks, commissioned during 2004. Authors such as Salz et el (2004) find evidence to suggest that US network operators need to speed up the adoption of this technology to meet predicted demand. There are unique factors likely to affect in the New Zealand market. The OECD has repeatedly found evidence that broadband Internet adoption in New Zealand is lower than other countries. Introduction of 3G technology provides another way to access broadband Internet. The OECD indicates that pricing is one of the barriers to broadband adoption. Telephone companies will have to consider pricing 3G to appeal as an option to having a fixed Internet option.

The key question to be addressed in this research is: Do the adoption intensions of New Zealanders match those of Malaysia and Singapore for expected data services

use? A related question is: What other factors effect New Zealand's current relatively slow rate of adoption?

Product positioning of mobile data products is going to become more critical, given that some telephone operators are ‘expecting to get 25% of revenues from mobile data within five years’ (Molony, 2001). This Thesis will provide information to assist Mobile Service Providers to predict adoption rates of new services. It will also provide a comparative reference for researchers in other countries to replicate the study, and contribute to an exciting body of international literature. The New Zealand market is characterised by high cost of broadband Internet in general (OECD, TUANZ, and others), proprietary knowledge capture, and regulation, but these issues do not stop research into the intensions of potential adopters.

This thesis will fill part of that research void, by comparing emergent demand for mobile data with existing models, which have previously been used, to predict future demand. New Zealand has a reputation as an earlier adopter of new technologies (Min Economic Dev & others). This thesis will contribute evidence to indicate how New Zealanders plan to adopt mobile data services, and how intensions of adoption compare with parallel studies in Singapore, and other countries.

Table of Contents

Chapter 1 – Introduction

Chapter 2 – Literature Review

Chapter 3 – Research Methodology

Chapter 4 – Research Findings

Chapter 5 – Discussion and Conclusion

List of Tables

List of Figures

List of Abbreviations

1xRTT	Single-Carrier Radio Transmission Technology
3G	3rd Generation technology
3GSM	Committee set up to develop 3G servcies for GSM operators
802.11	Base number defining a range of Wireless Ethernet standards
AMOS	Analysis of MOment Structures
CDMA	Code Division Multiple Access
CDMA2000	Version of CDMA released in the year 2000
D-AMPS	Digital-Advanced Mobile Phone Service
DVC	Desktop video conferencing
EMS	Electronic meeting systems
EvDO	Evolution, Data Only *or* Evolution, Data Optimized
GPRS	General Packet Radio Services
GSM	Global Systems for Mobile communication
IrDA	Infrared Data Acces
OECD	Organisation for Economic & Cultural Development
OoBE	Out of Box Experience
PDA	Personal Digital Assistant
RCA	Radio Corporation of America
SMS	Short Message Service or ‘TXT’
SPSS	Statistical Package for Social Sciences
TUANZ	Telecommunication Users Association of New Zealand
WAP	Wireless Access Protection
W-CDMA	Wideband CDMA
WiFi	Wireless Ethernet
WiMax	Worldwide Interoperability for Microwave Access

Chapter One

INTRODUCTION

1.1 INTRODUCTION TO THIS STUDY

Product suppliers plan how their business will fit in to the market. This research identifies likely future trends in the consumer sector of the New Zealand mobile data services (MDS) market. The market is one characterized by rapid technological growth, unpredictable change, introduction of new products, or variation of existing products, becoming available every few months (OECD, 2000; Williams *et al.*, 2002).

'Mobile data services' (MDS) can be defined in a wide variety of ways. In the broadest sense, a variety of 'non-wired' communication media, such as infra-red communication between devices within two metres of each other, Bluetooth communication up to about 20 metres, various generations of cellular data technology, and wireless Ethernet technologies, can be considered to be MDS. Availability of the latter two technologies is dependant on the provider building a suitable delivery infrastructure. Cellular data is available in New Zealand (and in many other countries) wherever there is cell-phone coverage. High-speed (3G) cellular data, and wireless Ethernet (WiFi) are currently available on a more limited basis in New Zealand. There are two main types of devices used to access MDS. One type is the truly mobile devices such phones and handheld computers (PDAs). These can remain connected to a network at all times, and can 'hand over' from one land-based access point to another. The other type is typically a notebook computer, which is able to connect to MDS, but generally remains in one place while in use (Helal *et al.*, 1999). The term 'portable' can describe such a service. In general, truly mobile devices use cellular services. Portable devices can use cellular or Ethernet services.

Telecom New Zealand and Vodafone control the New Zealand cellular data market. Various companies, including Telecom, offer wireless Ethernet. Within the wireless Ethernet market, there are a variety of technologies. The most widespread is commonly known as 'WiFi', which is delivered using 'hotspots' of availability, each covering a strategic area, typically a radius between 50 and 150 metres. Other wireless Ethernet technologies can offer a service with a radius of several kilometres, primarily targeted at stationary or fixed users, often as a replacement for a wired connection. Currently two companies offering portable connections throughout New Zealand are nzwireless, and Woosh Wireless (nzwireless, 2005; Woosh Wireless, 2005).

As networks get faster, the delivery technology becomes less significant. Telecom and Vodafone are both offering services on their cellular networks, which can be downloaded to a phone very quickly (in the perception of the user). Questions remain about the future demand for 'non-voice' content in the consumer market. Do consumers want their phone to do more? What proportion of consumers care about these new technologies? Are mobile networks going to be a substitute for the fixed Internet access model currently popular? This thesis will address questions such as these.

New Zealand has a reputation as an early adopter of new technologies (MOED, 1999 & others). This thesis asks how New Zealanders will adopt mobile data services, and how intentions of adoption compare with overseas studies. Empirical research within New Zealand can give an indication of likely adoption. A structured survey gauges the general readiness of the consumer to adopt technology, and asks about a range of specific mobile data technologies. This information provides a prediction of future adoption, building on models from the international literature. Currently, there is a limited quantity of published data regarding use of mobile data services. Researchers will find the current work contributes a valuable New Zealand dimension to the established literature in the mobile data field.

1.2 THESIS MOTIVATION

The author regards networks as the future of information technology (IT). The Internet now features daily in both specialised IT and general media. Unfortunately, much of that attention places New Zealand Internet connectivity behind the rest of the world. This thesis is going to contribute towards two significant challenges. The author is a networking specialist, and wants to better understand how others view mobile networks, so he can better convey his passion and enthusiasm for the subject. Secondly, there is a significant lack of New Zealand-based research in the academic literature. The section below describes how these gaps can be diminished.

1.2.1 Author Motivation

New Zealand suppliers of mobile data communications (eg. largely Telecom and Vodafone) have invested heavily in networks, devices, applications, and promotional scenarios to service the perceived needs of customers. Like other telephone network operators around the world, Telecom and Vodafone have both recently launched new '3rd Generation' technology. These technologies enable faster data transfer to mobile devices. Broadly speaking, they are capable of speeds in excess of 3 gigabits/s (about 3,000,000,000 bits per second). At the same time, the mobile phone companies are introducing new devices and applications to the market, to meet the anticipated needs of

diverse customers. At present, the technological advance of mobile data services outruns the customer uptake of these services[1], and research is needed to locate trustworthy forecasting models, which will predict the rate of adoption of new services.

Introduction of new services in this industry has resulted in mixed responses. An early success for Vodafone in the New Zealand market was to significantly lower the cost of sending text messages (SMS), followed by promotion of that service to the teenage market sector. In December 1998 Vodafone had a 17% share of the New Zealand mobile phone market. In 2005, they claimed 54% market share (Vodafone, 2005). On the other hand, the introduction of the WAP mobile Internet protocol was not successful in New Zealand, as was the case the world over (Nysveen *et al.*, 2005; Schultz, 2001). This failure is commonly attributed to a lack of services being offered to use the technology. Effective prediction of consumer desires will assist the telephone companies to provide services and content that will be widely adopted.

There are unique factors likely to affect trends in the New Zealand market for mobile data services. The OECD has repeatedly found evidence that broadband Internet adoption in New Zealand is lower than other countries in the organisation (OECD, 2004). Introduction of 3G technology provides another way to access broadband Internet. Telephone companies could promote the growth of broadband Internet, if they can successfully spread the use of these technologies. The current research will provide comparison between adoption predictions in New Zealand, and similar research that has been conducted in other countries. Media commentators are predicting a continuing rise in the use of mobile data servcies. In the short term, the rise is expected to be driven primarily by the consumer market (Bingemann, 2005; Gohring, 2005; McMillan, 2005; Saarinen, 2005). This thesis will provide valuable data to assist the author and wider research community to analyse the potential of the New Zealand consumer mobile data services market.

1.2.2 Motivation from Academic Research

Relevant research has been conducted elsewhere on mobile data services adoption rates, the determinant factors, and models relevant to the particular market and cultural conditions. The author has identified a wide range of international studies, such as Gilbert & Han (2005), Bingemann, (2005), Zhang & Prybutok (2005). Past research needs to be interpreted and tested in the New Zealand context. The current research reviews the literature, identifies an appropriate adoption forecasting model, and then

[1] Discussion with Paul Tracy, Telecom NZ Mobile Marketing Manager, 29 May 2007.

analyses the results of a survey within New Zealand to test the relevance of international findings to the New Zealand environment.

An extensive literature review has found little available research, other than Gilbert & Han (2005), and, in a very general sense, the OECD, (2004) which has considered the adoption of mobile data services. Parasuraman (2000) initiated, and is continuing to develop and use, a survey that considers respondents' general acceptance of new technologies. The National Technology Readiness Survey provides very useful input to an adoption model, but does not consider actual adoption of a technology. There is extensive reporting of commissioned research, and telephone companies report the results of their own research (invariably to their own benefit).

The mainstream media tends to quote press releases, or has access to other data sources, such as Gartner or IDC research results. (Francis, 2005; King, 2004; Nowak, 2005). When commissioned research is available, a copy of a report can cost several thousand dollars. When looking at the "Cellular Mobile Pricing Structures And Trends", the OECD (2000) draws attention to the volatility of the market, and emphasises that in this rapidly evolving area, picking winners is particularly critical. This situation creates an extremely high demand for accurate, and confidential, consumer information. High demand then drives prices up, or motivates the providers to conduct their own research.

Academic literature, then, does not contain a lot of information about the past, present, or projected uptake of mobile data services. One way in which the academic community can address this situation, is by the community undertaking comparable research, in different countries, and at different times. A fast growing body of empirical research will build a base of data that can be applied to various models, and thereby increase the breadth and depth of the literature.

Much more literature can be found to analyse the general field of adoption of new technologies, particularly in the Information Technology (IT) domain, over the past ten years. Much of the current work is based on Rogers, who proposed an adoption model in 1962, and has developed that model since then (Rogers, 2003). Davis (1985) also proposed a general IT model, and went on to maintain currency in later years. (Davis, 1989, 1993; Davis *et al.*, 1989). While Davis did not reference Rogers directly, Lee *et al* (2003) shows that usage of his model has tended to rely on concepts introduced by Rogers. Moore, (1999) meanwhile, directly modified Rogers' model to cope with the special characteristics of IT. In summary, the current research contributes to the global body of accessible literature considering adoption intentions of mobile data service users, contributing to the issues addressed, and extending the base available for further research.

1.3 PROBLEM DEFINITION

The need for robust planning and research into the future of emerging information technology creates a problem. Which mobile data services (MDS) will consumers adopt? The literature tells us little about the adoption intentions of New Zealand MDS users. The current research addresses that problem by conducting a survey, and considering survey results alongside comparable research from different countries. Researchers have proposed various information technology adoption models. Application of survey data to the current author's model contributes to academic understanding of the value of that model, in a cross-country context. The conclusions can only be applied to the field of mobile data services; however, some indications can be applied to the wider information technology domain.

The fast pace of development in the mobile data services area, and information technology in general, leads to rapid changes in customer needs. This adds to the urgency with which the research community must consider the problem of defining a reliable adoption model.

1.4 RESEARCH APPROACH & FORECASTED OUTCOMES

Possibly the most influential research in the history of diffusion research is Everett Rogers (1962, 2003). The current research draws particularly on the work of Rogers and the thousands of survey responses analyzed by Parasuraman (2000) since 1999. A number of other researchers are also referenced to develop and test a model that will predict the future adoption of mobile data services in New Zealand.

The future adoption model is tested using an anonymous survey. Paper-based and on-line versions of the survey are used to get a wide variety of responses. Statistical techniques are then applied to the survey results to determine the level of support for various hypotheses that will be described in detail in chapters two and three. Two sections make up the survey. Firstly, questions previously tested and refined by Parasuraman are used to determine the technology readiness of the survey participant. Secondly, questions ask about the participants' knowledge of, and intention to adopt, specific services, which might be available on mobile devices.

The expected results are clearly set out in three hypotheses. Diffusion literature from over forty years of research suggests that a person's propensity to accept technology will be directly reflected in their intention to adopt mobile data services. The research of Rogers (1962, 2003) also suggests that people learn about technology in various ways consistent with their readiness to adopt, and as a technology matures, people will be more willing to adopt that technology. The current research will compare technology readiness

and perception of maturity with adoption intention to test these elements of Rogers' model. Finally, the relationship between technology acceptance and intention to adopt will be explored further to determine if it fits closely with the normal distribution predicted by Rogers.

1.5 THESIS STRUCTURE

The body of research briefly outlined above is reviewed in detail in chapter two. Rogers defined this research area, with his generic diffusion model in 1962 (Rogers, 1962), and that has driven a large portion of 'diffusion of innovation' research. Following on from Rogers, other models are outlined, and explored in the context of the literature. Davis (1985) developed a model to predict acceptance of technology, which has some basis in the work of Rogers, while Moore (1999) and Gilbert *et al* (2003 – 2005) tie their models very tightly to Rogers' research, but approach it from an information technology perspective. Some examples of cross-border research are summarised, and the chapter concludes by introducing research questions and hypotheses for this thesis.

On the basis of the general research context already described, Chapter three reviews the methodology of a number of studies, and moves on to describe the methodology of the current research. The research question and hypotheses are described in detail, following a description of the design of the current research, which includes an initial research model upon which this thesis is based. Chapter three also includes details of the survey that is the empirical research instrument being used.

This new research generates some interesting findings, which are presented in chapter four, including an analysis of the survey results and practical implications from the research process. The analysis uses statistical techniques to evaluate the degree to which the initial research model is validated by the empirical research. Chapter four ties together input from the published work of previous researchers, with results from the current author's survey. This produces a result that builds on the literature that will be available to the entire research community.

Chapter five discusses the implications of these results. Using results from the entire research process, the author considers where mobile data services will develop in the future. The thesis concludes with consideration of issues that are still outstanding, and new opportunities for further research.

In order to provide the maximum support to the research community, appendices contain details of the ethics approval process, and questionnaires used in the current survey.

1.6 CONCLUSION

Adoption of mobile data services (MDS) is an interesting and fast-moving area of academic research. Chapter one has set out the path by which the researcher has contributed to the MDS literature. The same path will enable the reader to gain an insight into this exciting field, with suggestions for the reader to go further, building on the current work with their own MDS research.

The rigorous process undertaken by this author leads to a reliable and valid prediction of the future of MDS in New Zealand. Future adoption is the key focus of this research, while providing some guidance for research throughout the Information Technology area. Now that the overall direction of this thesis has been outlined, chapter two will present a review of the literature most relevant to the future intentions of mobile data services users in New Zealand.

Chapter Two

LITERATURE REVIEW

2.1 INTRODUCTION

Mobile Data Services (MDS) adoption can be studied in a variety of contexts. Jantsch (1967) and Gentry (2003) considered technological forecasting models, largely from the perspective of past consumer behaviour. They produced forecasts specifying the likely sales of the technology. Another way to consider MDS adoption is to define the relative rate of adoption, without predicting actual numbers of units. This approach was used by Rogers (2003), when he started his research in the 1950s. Rather than analyse market history to predict absolute adoption numbers, Rogers, and those who build on his research (refer to section 2.4.1.1), forecast an adoption pattern, based on past research.

The model created by Gilbert & Han (2005) is based on the past literature. Their model has been developed using various studies dating back to 2000. It has already been tested in two countries (Singapore and Malaysia), and the current New Zealand research will contribute to the literature. This literature review considers the wider environment within which Gilbert & Han based their model, and puts their research in the context of industry developments in recent years. Research in this field dates back to the 1960s. In the 1990s, a number of researchers considered how the generic research can be applied to information technology (IT). Some of these models are considered below, and the review goes on to look at how these models have been applied to MDS, and related fields.

This chapter defines the terms and context used in the thesis. MDS is defined in Section 2.2 and then consumer forecasting and adoption in Sections 2.3 and 2.4. Section 2.4 is a large section, and the evolution of publications that report adoption models in the Information Systems world are reviewed in detail. A section on international and cross-cultural research is also included. Section 2.5 concludes by identifying common problem areas and possible research questions arising from the research.

2.2 DEFINING MOBILE DATA SERVICES

There is a wide range of wireless communication protocols in use or under development (see Figure 1 below). A subset of this range can be used for mobile data services (MDS). This section defines MDS, and identifies suitable protocols. Most devices offer services in addition to MDS. Protocols that enable these additional services are identified also. The term MDS is defined, followed by an analysis of wireless networking protocols.

2.2.1 Mobile Communication

Computers come in a very wide range of functions, sizes, and capabilities. Increasingly, the boundary of any definition is blurring. Helal et al (1999) define two criteria for the term mobile: A device that supports "… wireless networks that support 'outdoor' mobility and handoff from one network to the next at pedestrian or vehicular speeds." (Helal *et al.*, 1999 p. 1) This definition encompasses both 'handheld', and 'laptop' devices, when the device is communicating using an appropriate network.

2.2.2 Data

Voice communication was the purpose of the telephone system when it was created. Non-verbal data has been transferred on this medium in various forms since the 1950s (Bellis, 2006). Text has been received on a mobile pager, associated with the telephone network, from the 1980s (Bellis, 2006).

Mobile phones are typically characterised in terms of 'Generations'. Answers.com[2] defines the generations thus:

- **1G** First Generation mobile phones used analogue technology, and a cell-based ('cellular') distribution network.
- **2G** Second Generation phones use digital technologies. This increased the amount of information being transferred between the phone and the service operator. 2G phones brought better voice quality, and allowed for the introduction of the Short Message Service (SMS) to enable phone users to send and receive text messages.
- **2.5G** This term describes 2G systems that can transfer data faster than 144 kbit/s, using a packet switched network, while still running on a 2G network infrastructure. Devices other than phones are often used with 2.5G services. The term '2.5G' was created for the benefit of marketing, and does not represent a significant improvement in technology. This contrasts with 2G and 3G that were mandated by an industry committee.
- **3G** Third Generation networks can transfer data at speeds in excess of 3 gbits/s.

This thesis uses the term 'data' to refer to information sent over a packet-based network. In terms of mobile phones, this definition includes 2.5G and 3G.

[2] http://www.answers.com/3G

2.2.3 Services

In the context of this thesis, a 'service' is a product that can be used on a mobile device, and uses the networking facilities of the device. Included are server-based (where a consumer communicates with a central computer), or peer to peer products (where two consumers communicate with each other), considered independently of the delivery infrastructure. This is in line with Alcatel's '2020 Study' (Gupte *et al.*, 2005 p. 3). "We are entering a world of user centric services that allow services to operate across multiple domains, but with greater device control and less network 'visibility' in the delivery of the service."

Table 1: Typical mobile data services

Relationship-oriented	Process-oriented	Knowledge-oriented
Health monitoring	Shipment tracking	Mobile access to documents
Comparison shopping	Vehicle tracking	Personal productivity tools
Entertainment, games, music	Facilities management	Merchandising and sales
	Asset tracking	Meeting, scheduling
In-car navigation and security	Inventory management	Technical support and repair
Investment portfolio tracking		

Source: Adapted by Gilbert & Han (2005, p. 283)

2.2.4 Wireless Networking Protocols

Many 21st century devices support a variety of networks. The Vodafone iMate[3] is an example of a device that can use any of five different network technologies (GSM, GPRS, WiFi, Bluetooth, Infrared – refer Table 2), only two of which provide MDS as defined above. For this reason, the term needs to be considered in relation to the device, rather than the wireless technologies the device uses. Vance (2005), describes technological developments that allow one device to select the most appropriate network currently available. Traditional mobile phone companies promote this solution, as the 'ubiquitous' network is most likely to be a cellular phone network, at a charge of up to $10 per megabyte[4]. Wireless Internet (WiFi) is a technology that is currently becoming common in many cities, in hotels, and, increasingly, in public spaces (Geier, 2005; Griffith, 2005; Red Herring, 2005). The Telecom New Zealand wireless hotspot service[5], charges a maximum rate of $10 per hour. In one hour, a user could download several hundred megabytes. This is an example where WiFi is clearly much cheaper.

[3] http://www.carrierdevices.com.au/products.php?id=9
[4] http://vodafone.co.nz/pricing_plans/mobile_data.jsp?item=mobile_data
[5] http://www.telecom.co.nz

Table 2: A selection of wireless data networking technologies.

Source: Based on http://www.answers.com

Technology	Characteristics	Provides Mobile Data Services?
GSM D-AMPS	'2nd Generation' mobile phone standard, used for voice and text messaging (txt).	No – various services can be built using this protocol, but does not support real-time data transfer.
GPRS CDMA	'2½ Generation' mobile data standard – closely linked to related voice and txt technologies. Slow data speed.	Yes – basic building block of low speed data services.
W-CDMA/3GSM	'3rd Generation' standard, used by Vodafone New Zealand. Medium Speeds – not as fast as CDMA2000.	Yes – higher speeds than earlier standards. Wide range of speeds available.
CDMA2000 (includes1xRTT/EvDO)	'3rd Generation' standard, used by Telecom New Zealand. Medium Speeds offered in New Zealand – higher speeds possible.	
WiFi	Wireless Ethernet standard, commonly used for local area networks (LANs). Speeds comparable to wired networks, though generally a 'generation' slower.	Yes – in areas where WiFI is available, it will meet the definition above. This technology is becoming common in major cities. (Geier, 2005; Red Herring, 2005)
WiMax	Similar in concept, but extends beyond the capabilities of WiFi. Covers greater distances, and is commonly used as a 'last mile' technology, allowing service providers to provide services to customers with fixed addresses.	No – Current usage is generally targeted to deliver service to a fixed location. In theory, WiMax could be considered 'mobile', however it not yet commonly used in this way.
Bluetooth	This radio technology connects devices over distances of up to 100m, at a speed of up to 720 kbp/s..	No – Operates over very short distances, at limited data transfer speed, and has no concept of handoff, as defined in section 2.2.1.
Infrared (IrDA)	Light-based technology that relies on line of sight connection between two devices, typically less that a metre apart. Speed generally limited to 115.2 kbp/s.	No – Very limited application.

A summary of wireless networking protocols is reproduced in Figure 1. Table 2 lists a wide range of protocols, and gives an indication of the range of each one. Note that the ranges shown are indicative only, because as technology develops, these details change. In a summary of Metropolitan Mobile Networks, Cisco Systems (Cisco, 2004) claim that

an 802.11 device has a maximum range of 40 kilometres. Figure 1 illustrates the range of protocols that might be used for mobile data services over a time span of four years. Protocols currently in use are listed in Table 2.

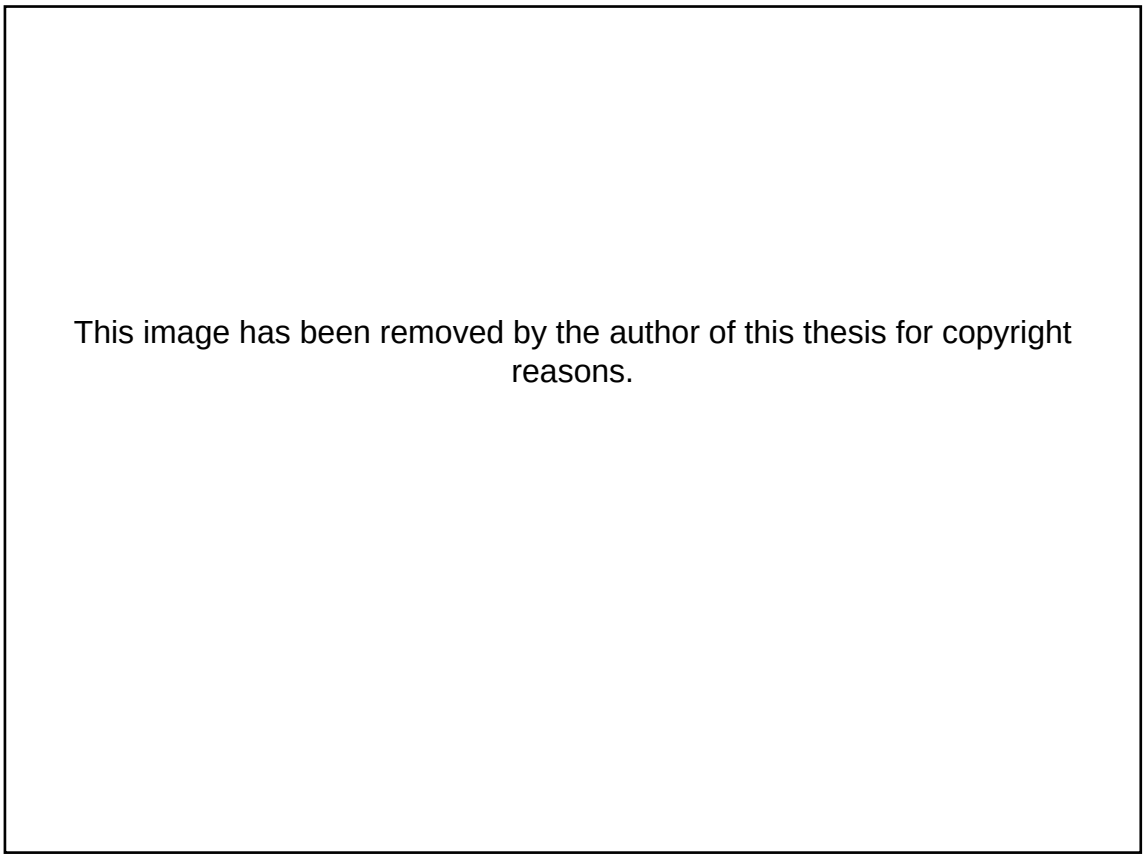


Figure 1 – Key Wireless Networking Protocols. Source: (King, 2004)

2.3 CONSUMER FORECASTING

New technologies do not replace established business practices. Many authors, such as Urban (2003), have argued that the Internet and related technologies augment the 'old economy' practices. There are always new ways of interacting with customers, however, basic principles of market research remain. Urban goes on to claim "Sixty to 80 percent of successful technologically based products have their idea sourced in the recognition of market needs and demands." (Urban, 2003, p. 29). Figures such as these reinforce the need for accurate market research. Surveying is a valid market research tool, capable of producing significantly accurate results, using both traditional paper-based, and electronic, techniques (Kellner, 2004).

High-tech products are often characterised by rapid market growth. The number of mobile phone subscribers worldwide increased by about 50% each year during the 1990s (3GNewsroom.com, 2003) and while the figures quoted by 3GNewsroom.com suggest a slowing of the rate of growth during the 21st century, this is still a rapidly

growing market. Like other high-tech marketplaces, this market is characterised by rapidly changing technology. Equipment suppliers, and other players in high-tech industries, can't rely on a traditional market-driven supply and demand cycle to plan production. Berkhout & Duin (2004) identify five developments that have impacted on innovation in the mobile telecommunications industry. They go on to describe Berkhout's Cyclic Innovation Model, and show an example of how this industry has been forced to adopt product life cycle models that are adapted to rapid changes within the industry.

By the time the market has indicated acceptance or rejection of a product, it will be obsolete. For this reason, surveying in these markets has to focus on consumer intentions. An adoption model is also necessary to help predict demand by putting consumer intentions into a framework. The adoption model chosen must be able to adapt to the rapid changes within the mobile data services market.

2.3.1 Forecasting Philosophies

In his 'framework for technological forecasting', Jantsch defines forecasting as "… the probabilistic assessment, on a relatively high confidence level, of future technology transfer." (Jantsch, 1967 p.15). Jantsch defines two types of forecasting. 'Exploratory' forecasting relies on having a current base usage for a technology. Future adoption forecasts, are then calculated from the base data. 'Normative' forecasting starts with a future path for an innovation, and works back to identify current barriers to that path. Jantsch goes on to describe and analyse the accuracy of various forecasting techniques. Principals similar to Jantsch can be used to study diffusion in industries where there is a clear history and projected product life cycle.

Gentry (2003) applied a number of forecasting models to consider their accuracy when applied to technological innovation. Gentry studied diffusion of various consumer electronics innovations over time. All of the models he chose were exploratory (Gentry, 2003 p. 7), and the timeframe of each innovation is between 17 and 23 years.

The models used by Jantsch and Gentry are appropriate for items that are pre-existing, and experience a steady growth cycle. Often, it is not practicable to consider a timeframe of this order. In the area of mobile data services, many products have no significant history upon which to base forecasts, and timeframes are more likely to be measured in months, rather than years. These limitations make it very difficult to achieve the forecasts, with high confidence levels, as proposed by Jantsch (1967).

The models considered in this thesis are based on a simple initial model, which produces a relative forecast for demand. This technique predicts the dissemination pattern, the

'S Curve' in Figure 2, without putting specific numbers on the axes. On the other hand, Gentry (2003) and Jantsch (1967) extrapolate past patterns to generate absolute forecasts.

2.4 ADOPTION MODELS

A widely used generic model for predicting the diffusion of innovation was developed by Rogers (2003) in 1962. While Rogers has extensively revised his book, through five editions since then, his basic model remains the same. Rogers' model is now described in some detail, and in addition a number of other models are also discussed.

The work of Rogers is used extensively in books such as Crossing the Chasm (Moore, 1999), and in academic papers that consider innovation and adoption. Barnes & Huff (2003) identify a 'general model of technology acceptance' (GMTA), based on Rogers work, along with the work of Fishbein (1967). The GMTA modifies Rogers adoption model to take greater account of the individual's behaviour. Rogers model, among others, including Katz & Shapiro (1985, 1986), was used by (Darnsgaard & Marchegiani, 2004) to better cope with the effect created by the existence of a network of users of a technology (de Marez & Verleye, 2004; Sarker *et al.*, 2005).

The Technology Acceptance Model (TAM), by Davis (1985), gathers a number of external factors, many used by Rogers, to come up with a concept of perceived usefulness, and perceived ease of use, which lead to prediction of actual system use. Geoffrey Moore (1999) built directly on Rogers' model, with an adaptation to make it closely suited to technology applications. Gilbert *et al* built on Moore's work, with a tight focus on mobile data services. In one part of the work, Gilbert *et al* introduces the subject of cross-culture research. The wide ranging work of Geert Hofstede (1984, 1994) is to be discussed, and a narrower example of cross-cultural research by Bajwa *et al* (2002) and Choi *et al* (2005).

2.4.1 Diffusion of Innovation Model: Everett M Rogers

After completing his doctoral dissertation on the topic, Rogers produced the first edition of 'Diffusion of Innovations' (Rogers, 1962). Rogers' diffusion theory is summarised below. Rogers' background is described, his model introduced, and the term 'diffusion of innovation' defined and described. Much of the rest of this thesis considers research in terms of Rogers' model. This section opens with an overview of Rogers' theory development, with the theory being described in general terms. Subsequent sections describe each of the key terms as Rogers uses them. Examples are used from Rogers and other researchers, to show that the model has a sound basis, and is still relevant more than 40 years after it was first postulated.

2.4.1.1 Overview

The study of diffusion of innovation developed strongly in the 1940s to 1960s. Rogers documents the development of this research, with a comprehensive definition, supported by numerous examples of diffusion of innovations from all walks of life. He presents a graph of the "Number of Diffusion Publications by Rural Sociologists …" (Rogers, 2003 p. 47) that indicates a peak of 37 in 1958, and drops to between 1 and 5 during the 1970s. This graph ends at 1981. Research that Rogers was directly engaged in, and most of the literature he cites from the 1950s and 1960s, involved rural communities and agricultural subjects, such as new types of seeds. Moore (1999 p. 10), noted that this field of research has "agrarian roots", but "has thoroughly transplanted itself into the soil of Silicon Valley". Research since the 1980s has found that Rogers' model can accurately predict new, high-tech, innovations.

2.4.1.2 The Diffusion Process

Rogers' definition of an innovation includes four elements: the innovation itself; available communication channels; diffusion over time, and the social system in which the innovation will operate. These elements are explained in section 2.4.1.4. Taken together, they contribute to a graph that Rogers uses to show how an innovation is diffused over time:

The relative path of diffusion over time is shown in Figure 2 below. While the timeframe varies from one innovation to another, Rogers' research found that the shape of the 'S Curve' remains the same. He further refines the categories of adopter, in terms of their 'Innovativeness'. His model uses five categories to define appropriate groups of adoption. For any particular innovation, the time it takes individuals, or other adoption agents, to adopt the innovation follows a normal distribution. The groups fall into multiples of standard deviations from the mean ($\bar{x}$). Graphically, Rogers shows this as the bell curve in Figure 3. He points out that neither Figure 2 nor Figure 3 come to a point of 100% adoption –almost all innovations have a residual societal membership who never adopt.

Figure 2 – The Diffusion Process, (Rogers 2003, p. 11).

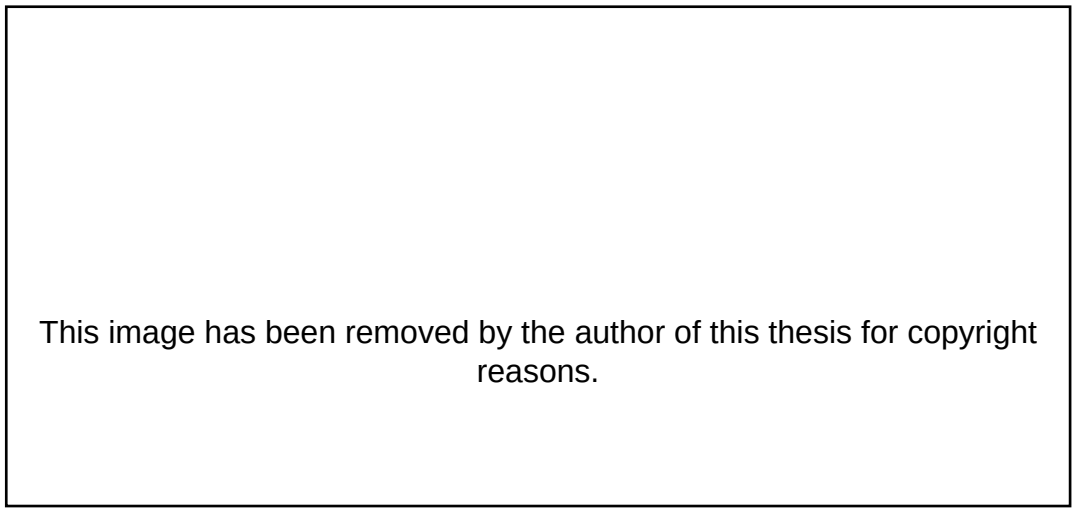


Figure 3 – Adopter Categorization on the Basis of Innovativeness, (Rogers 2003, p. 281).

2.4.1.3 Adopter Categorization

Innovators are adventurous! They will consider an innovation based on its technical potential, with no need to see it in action. While only a small group, Innovators bring in an idea from outside the social system, to where it can then continue to be diffused. Rogers (2003 p. 283) describes their role thus: "… the innovator plays a gatekeeping role in the flow of new ideas into a system."

Early Adopters are a key group, sought by change agents. They are the opinion leaders in a system. While the innovators tend to be outside mainstream influence groups, early adopters are respected by their peers, and have communication networks they can use to spread knowledge and use of the innovation. The early adopters tend to build up a critical mass in terms of production of an innovation.

Early Majority are an important link within the diffusion process. They tend to have wide communication links in the community, but are not opinion leaders. They are open to new ideas, but will consider carefully before adoption. This highlights the value of the link between the early adopters, who adopt quickly, and the late majority, who will only adopt an innovation that has become 'normal' in their system.

Late Majority adopt just after the average of society members. They wait until there is a strong economic or social pressure to adopt. Members of this group want to be sure there are minimal risks in adoption.

Laggards tend to be isolated in the social system. They don't influence others to adopt, and base their decisions on the past. Rogers also suggests that late majority and laggards tend to have less economic power than the earlier three groups.

2.4.1.4 Rogers' Elements of Diffusion

Rogers' model describes four elements that impact on diffusion behaviour. These elements are described here.

Diffusion behaviour is impacted by the nature of the innovation concerned and the communication channels through which knowledge of the innovation is diffused. The relative timeframe of the diffusion process is also considered by Rogers, as is the social system within which the process is occurring. Each of these four elements is described in the following sub-sections. The four elements each need to be considered, and injected into Rogers' model when the model is used in a diffusion study.

2.4.1.4.1 The Innovation

Perception of 'newness' is more important than any objective assessment of the age of an innovation. This is highlighted by Rogers' (1995 p. 345) example of the fax machine. The concept was demonstrated in 1843. At that stage there was no infrastructure to make the idea useful. About 100 years later, RCA came up with a similar concept, but it was not until 1960 that Xerox created a machine that had limited commercial success. Other developments were necessary before a fax became common in business, after Sharp reduced the price to about $US2000 in 1984. From there, the price kept going down, and uptake of the fax gained momentum. Rogers identifies 1987 as the year in which a

critical mass of users was strong enough to drive rapid growth. In the late 1980s, the fax was a 'new' innovation, and the majority of adopters purchased one.

The terms 'Technology' and 'Innovation' are, according to Rogers, often treated as synonyms. He clarifies the difference by defining the technology as being an instrument of change. The innovation is implemented through the technology.

The technology does not have to be 'hardware'. Adoption of philosophies, such as a political philosophy, or religious idea, goes through the same stages as other innovations. In these cases, the technology can be composed entirely of information. Regardless of the type of innovation, Rogers maintains it will go through the same adoption path – the S-shaped "Diffusion Curve" (Figure 2, above).

Many technologies have both 'hard' and 'soft' components. Often the diffusion of an innovation depends on the prior adoption of another (such as the diffusion of a new Playstation game, which depends on prior purchase of the Playstation console). In these situations, the model takes account of these factors.

It is very easy to over-simplify the definition of the innovation. The reality, Rogers maintains, is that there is often one or more of three key issues which must also be considered:

- **Technology Clusters** affect the diffusion of innovation when one technology has an impact (positive or negative) on another. An example is household recycling. A current practice of recycling plastic will affect a person's propensity to recycle paper.
- **Perceived Attributes of Innovations** is further broken down into five observable characteristics. The presence of one or more characteristics can have an affect on the individual's rate of adoption. While analysis of these characteristics is beyond the scope of this paper, Rogers identifies two as being particularly important:
    - relative advantage of the innovation over whatever idea it is replacing
    - compatibility which the potential adopter perceives between the innovation and other technologies in use
- **Re-Invention** considers where early adopters can further refine the innovation. If this redefinition creates new advantages in the minds of potential adopters, then the rate of diffusion will increase.

2.4.1.4.2 Communication Channels

In terms of diffusion, communication is concerned with the sharing of information in order to reach a mutual understanding concerning the new idea (Rogers, 2003 p.18). Various media channels are better suited to different stages of diffusion. Mass media is

effective at the early stages, to create knowledge of the innovation. Some Early Adopters will respond to this advertising. At later stages, it is necessary to use various factors centred on interpersonal channels.

Rogers points out that transfer of ideas is most likely between two people who share values, and have equal social status. He uses the term "homophily" to describe this relationship. This presents a problem for diffusion, as, clearly, for diffusion to occur, one person must know about the innovation, but not the other. Agents promoting an innovation need to consider how to mitigate the effect of this problem.

2.4.1.4.3 Time

Many models used in behavioural science ignore time, according to Rogers (2003). Time is relevant in a diffusion study, and Rogers has identified three ways in which time is involved in diffusion:

- **The Innovation-Decision Process** spans the time from first knowledge of an innovation, through various stages, to confirmation of adoption.
- **Innovativeness and Adopter Categories** determine at which stage in the diffusion cycle an individual is disposed to consider adoption.
- **Rate of Adoption within a social system**. It is important to consider a societal time factor. This is, essentially, the slope of the S-curve in Figure 2. One measure is the total time from knowledge of the innovation to confirmation of adoption by the vast majority of adoption agents in a social system. Calculating the time from knowledge to confirmation for various percentages of agents within the social system, is a technique that will refine the model.

2.4.1.4.4 A Social System

Rogers (2003 p. 23) uses the term 'social' in a wide sense: "*A social system is defined as a set of interrelated units that are engaged in joint problem solving to accomplish a common goal.*" The units within a system can be individuals, or sub-groups of various types. Several factors require special consideration in the context of the Social System. Each of these factors can facilitate or impede the diffusion process, and needs to be understood by those involved.

- **Social Structure** within the social system is a key indicator of how those introducing an innovation should proceed. Cliques of individuals must be identified and targeted.
- **System Norms** exist within any society. They are behaviour patterns embedded into a society. The diffusion of an innovation is likely to be more successful if

the innovation is introduced in a way that is consistent with norms for each social system.

- **Opinion Leaders and Change Agents** must be engaged early in the diffusion process. The opinion leaders will be able to influence the attitudes or behaviour of others in the social system. Those introducing an innovation need to address the fact that opinion leaders often have their own agenda for supporting or opposing an innovation.
- **Types of Innovation-Decisions** also have an impact on diffusion within a social system. The decision can be made individually, collectively within the social system, or be imposed on the units within the system by a powerful authority.
- **Consequences of Innovations** can be classified according to three criteria, according to Rogers' model: Desirable / Undesirable; Direct / Indirect; Anticipated / Unanticipated. While an innovation agent will expect the product to have desirable, direct, and anticipated consequences, consideration must be given to possible undesirable and indirect consequences. The social system must also be monitored during diffusion, to attempt to detect unanticipated consequences. These may be desirable or undesirable, and the innovation agent should take appropriate action.

2.4.2 The Technology Acceptance Model: Fred D Davis

Another example of a consumer acceptance model is Davis' Technology Acceptance Model (TAM). This section introduces TAM, and gives an overview of its development and use. The basic function of Davis' model is described, followed by an outline of the results of a meta-analysis of research that has used the model over the past 17 years.

While the model has been used by a number of researchers, those using it often rely on the work of Rogers as well. TAM is often applied to user acceptance testing, where parameters are well known and quantifiable. Its application is limited in an environment such as MDS, where the users may not have any familiarity with the technologies or applications involved.

2.4.2.1 Development

Davis (1985) choose the Fishbein model (Fishbein, 1967) as a reference for his TAM. In a wide review of behavioural literature, Davis identifies a number of areas where Fishbein makes assumptions that limit the applicability of the model. These assumptions primarily address preheld beliefs of the individuals participating in acceptance research. Davis maintains that whereas those applying Fishbein tend to aggregate the effect of

beliefs, his own model represents various beliefs separately, and can provide greater information regarding how user behaviour is affected by systems features.

One of Davis' objectives was to develop a model to act as a theoretical basis for a practical user acceptance testing methodology. This resulted in other changes from Fishbein's model. In particular, Davis omitted behaviour intention (BI) as an input variable into his model, as he held that the time period generally taken for forming BI is longer than the time available in an acceptance testing context.

The TAM was submitted by Davis for his PhD, in December 1985. Having explained the model, Davis then conducted research to determine its validity, and lay a foundation for further research, all of which is detailed in his PhD thesis (Davis, 1985). The first published papers presenting the TAM appeared in 1989 (Davis, 1989; Davis *et al.*, 1989).

2.4.2.2 The Model

The basic model maintains that Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) contribute towards an attitude about using the technology. These attitudes are a major indicator of whether the subject of the research will actually use the system. While not explicitly clear, the definitions of the key terms in Davis' model (Davis, 1985) appear to be based on Fishbein (1967). Davis (1985 p. 26) describes perceived usefulness, and perceived ease of use as:

> *"the degree to which an individual believes that using a particular system will enhance his or her job performance"*
>
> *"the degree to which an individual believes that using a particular system would be free of physical and mental effort"*

Davis' model is represented by Figure 4, below with arrows showing causal relationships. The design of the test system generates X_1, X_2, and X_3, the external variables for the model. These external variables generate PU and PEOU. There is also a causal link from PEOU to PU, as a system that is easier to use is likely to end up being more useful.

Figure 4 – The Technology Acceptance Model (Davis 1985, p. 24)

As referred to previously, Davis developed the TAM for use in a generic acceptance-testing regime. He identified that current modelling of human factor analysis tended to use objective measures of usability. His model could provide a subjective measure. Use of both objective and subjective models would provide the opportunity for analysis of co-relation of the results.

2.4.2.3 TAM in Use

The externalising of variables means that TAM can easily be adapted to a wide variety of research needs. Davis (1993 p. 483) comments: "Future research should consider the role of additional variables within TAM." In their extensive review of TAM, covering 101 papers from research conducted between 1986 to June 2003, Lee *et al* (2003) identified 25 external variables, which interacted with the basic TAM model, as shown in Figure 5.

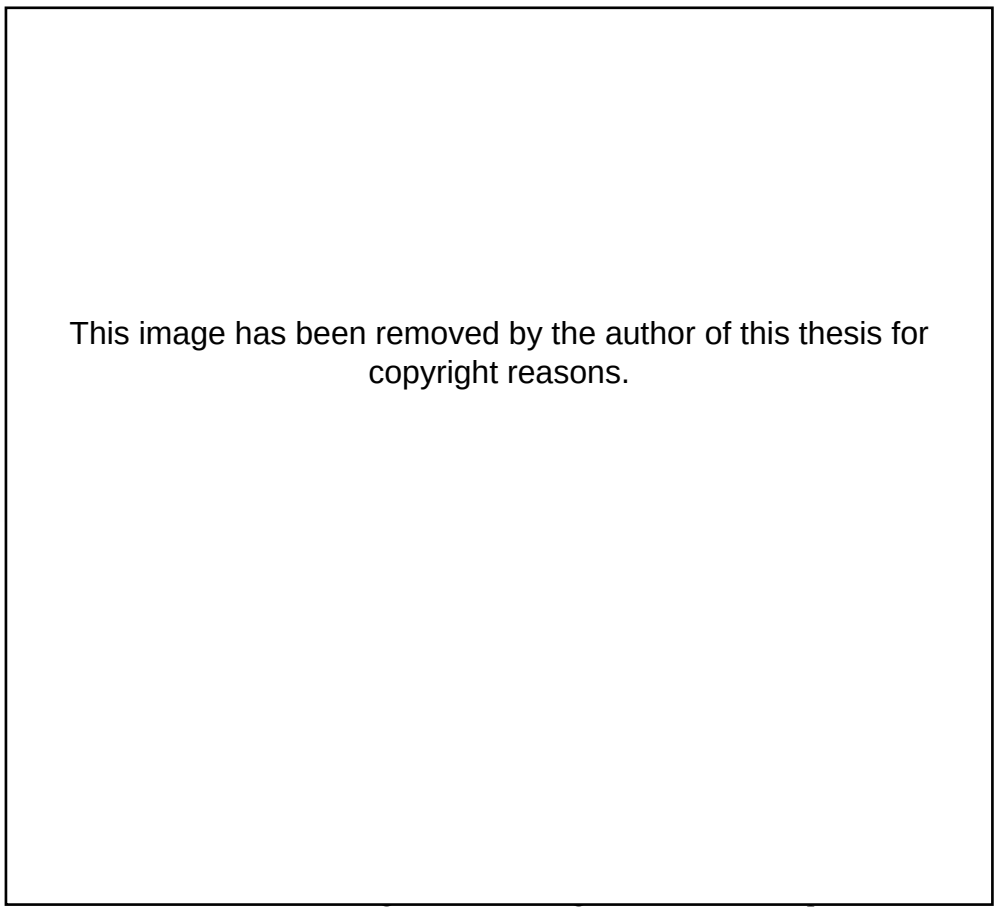


Figure 5 – Relationships Between External Variables and Major TAM Variables Lee *et al* (2003, p. 16)

Further analysis, by Lee *et al*, (2003) of the 25 external variables shown in Figure 5, found that eight of those variables have their origin in Rogers' (1995) research.

2.4.3 Crossing the Chasm: Geoffrey A Moore

Thousands of authors cite Rogers' model, showing it has stood the test of time[6]. Generally however, each author tends to start with that model, and consider how it can be adapted to suit the market that the author is investigating. Moore (1999) built on the basic innovation model, to develop a variation particularly suited to high-tech business, the "High-Tech Marketing Model". This book was a bestseller through the 1990s, the 'Dot-com Boom', and beyond[7]. Moore (1999 p. XIX) says in his acknowledgements section "All of the information I use in day-to-day consulting comes to me by way of word of mouth." His book does not document any sources of evidence. Despite this lack

[6] 5,978 references in ISI Web of Knowledge search. Over 2000 of which are from the 21st century.
[7] Moore, in the forward to his 1999 Revised Edition quotes sales of 175,000 copies after forecasts of 5000 before publication. The Revised Edition was reprinted six times up to 2003.

of empirical research, there are over 123 citations in ISI Web of Knowledge, referencing Moore. This suggests the value of his book is recognised by a range of researchers.

2.4.3.1 A High-Tech Adaptation

Moore (1999) takes Rogers' model (Figure 3 - Adopter Categorization on the Basis of Innovativeness, above), and applies lessons learned from his consultancy experience in high-tech sales and marketing. Rogers characterises the adoption patterns of groups as a normal distribution. Using the same categorization, Moore maintains that each of the groups represented in the model has its own reasons for acceptance of an innovation. This adaptation provides another criteria to make it easier to identify the various groups. Of particular interest to Moore is that modifications are required in the marketing processes that work in one sector, in order to work successfully in the next.

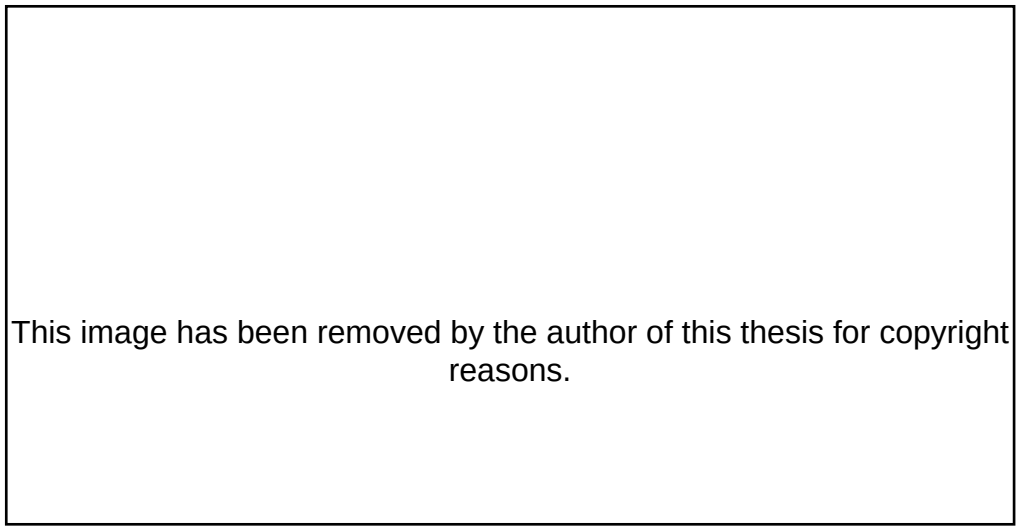


Figure 6 - The *Revised* Technology Adoption Life Cycle (Moore 1999, p. 12).

Innovators, maintains Moore (1999), will adopt an innovation because it is new, has an appealing structure, or some other esoteric reason. Desktop video conferencing (DVC) is an example Moore offers, of an innovation which is stuck in the first section. DVC works. Bandwidth problems have been largely eliminated or mitigated, but very few organisations are using this innovation. Moore maintains this is because there is no compelling business case for its use.

Early Adopters – Visionaries, want a compelling application for the innovation. They also want to be the first to implement this innovation in their industry, because they expect it will give them a strategic advantage. This can be at the expense of a discontinuity from their processes. One of Moore's examples is Federal Express, who pioneered opening their in-house tracking systems to allow customers to track their own items. This was previously unheard-of in the industry and represented a major shift towards customer focus. It was successful, and gave Federal Express an edge over the

competition, until we got the current situation, where we expect item tracking from any courier firm. The Early Adopter does not care about technology – just the business advantage.

Early Majority – Pragmatists are those who want productivity improvements for their current processes. They do not want to be 'debugging' first release software and they want to avoid massive discontinuity. Of particular interest to those marketing to the early majority is that their motivations, and prerequisites for buying, are totally different to those of the early adopters. The early majority want to see stable installations of a system that they are considering, which was purchased by people with a business plan similar to their own. From this description, it is clear that the best reference site for one of the early majority is another member of the early majority. This Catch 22 position is one of the reasons for 'The Chasm', described in section 2.4.3.2.

Late Majority - Conservatives, Moore maintains, are roughly equal in number to the early majority. They will adopt a 'new' technology long after it has stopped being 'new' in the view of half of the market. These people are conservative. They want the world to stay the same, adopting a technology only when it is essential to their business. Moore characterises the resurgence of the mini-computer, specifically the IBM AS/400 and HP3000 ranges, as a typical effect of the late majority. The business has relied on these ranges of computers for decades, and new models are still developed, and supported, in the same way they always have been, so the late majority will not change, yet.

Laggards – Sceptics do not participate in the high-tech marketplace (except to block purchases). Moore goes on to use the example of computerised braking on a car. A laggard will use that particular computer, but the technology has nothing to do with the purchase decision. The laggard will only use an innovation that has been totally assimilated into everyday use, by some means or another.

2.4.3.2 The Chasm

The central issue that makes this categorization of the market critical to high-tech industries is that high-tech products tend, most often, to depend on reference sites and user testimonials to drive sales. To move from one adopter group to another, a new marketing plan is needed. Moore proposes that people in different groups adopt for different reasons. This significantly weakens the ability of any group to act as a reference site for another group.

While these gaps can be challenging to cross between any two groups, the biggest challenge is the jump from early adopters to early majority. Often, according to Moore, a high-tech innovation can be financially successful, sell moderately well (relative to the

market it is in), but never reach the early majority. The early adopter will recognize the benefits of an innovation, and then work out how to manage the introduction of that innovation into their own behaviour patterns. The early majority will not consider this discontinuity from the 'old ways' of doing things. Moore characterises the Macintosh computer as a product stuck with the early adopters. Changing from Microsoft to Apple software is a major discontinuity for a business. Furthermore, Mac users tend to promote 'soft' advantages of the product, which a member of the early majority will reject, as it is tangential, rather than critical, to business needs.

Moore maintains that it is possible to plan for the Chasm, but the effects of an unforeseen Chasm reverberate through an entire company. Research and Development (R&D) focus moves from being innovative, to 'maintenance'. Marketing requirements are different. User expectations are different. The support requirements of the much larger number of Early Majority users are different to those of the Early Adopters. Four major reasons are identified that characterise the early adopter, and differentiate the group from the early majority.

Moore addresses these changes, and others, pointing out what he sees as flaws in the current marketing models of high-tech companies.

1. Lack of respect for the value of colleagues' experiences.
2. Taking a greater interest in the technology than in their industry.
3. Failing to recognise the importance of existing product information.
4. Overall disruptiveness. (Adapted from Moore, 1999, p. 55)

Each of these cases is something the early adopter sees as an asset, but the early majority views them as a major impediment.

2.4.4 Adoption of Mobile Data Services: Gilbert *et al*

Gilbert & Han (2003a) have developed a model based on two of the established models mentioned above. Their research focuses very closely on the market for Mobile Data Services (MDS). An objective for their research is:

> *"Seek an understanding of how to segment the MDS market so that it is possible for operators to match specific MDS products or services with target users, over time."*
>
> (Gilbert & Han, 2003b, p. 4)

Their research process and results are described in this section. They have defined a segmentation model for MDS, based on the results from four studies. This research could be used as the basis for further study, in other countries.

2.4.4.1 Research Outline

Based at the Information Management Research Centre (IMARC) of Nanyang Technological University, Gilbert and his colleagues have been studying diffusion of high-tech innovations since 1998 (Gilbert & Han, 2003a). Their early research looked at emerging MDS markets, then closely studied the mobile entertainment market, and more recently considered cross-border studies (first published in Gilbert & Kendall, 2003). The innovation theory of Rogers (1995) has provided a theoretical perspective throughout this research. Gilbert & Han (2003a) list other sources of perspective, and find their most recent work (Gilbert & Han, 2005), also supports the findings of Moore (1999). Gilbert & Han (2005) describe some of their earlier research, and list the general sequence and protocols followed thus:

1. Identify current market place trends by examining mass media and recent industry publications.
2. Organize focus groups to explore emerging issues, refine research questions, and gather impressionistic data.
3. Design survey instruments to capture data about the most interesting research questions, from the perspective of the relevant theory.
4. Field-test survey questions with members of the target groups, and refine research instruments.
5. Collect and interpret data, avoiding systematic bias to the [greatest] extent possible.

(Gilbert & Han, 2005, p. 329)

2.4.4.2 Results

It is useful to consider the results of Gilbert's various projects (Gilbert & Han, 2005; Gilbert & Kendall, 2003) together. This section describes the results of each of these four studies: SMS and WAP; Two studies of Mobile Gaming, and Replication of the mobile gaming study in Malaysia. As Gilbert et al describe the results of their studies, they find a consistency that forms the basis of their model. This section summarises each study, and describes the resultant model.

2.4.4.2.1 Text messaging (SMS) and early Wireless Application Protocol (WAP) adoption behaviour

This was the first study in the series of four reported by Gilbert & Han (2005). It resulted in a segmentation model, based on Rogers (1995), identifying these segments:

TechnoToy: segment members adopt services to fill needs for hands-on knowledge about emerging technological developments. They seldom use SMS, but will pay for new mobile services. Technical reports and journals influence their decisions.

Mobile Professionals: adopt mobile services, including calendaring, access to email, intranet/extranet services, and entertainment. They are influenced mainly by industry publications, by employer or client decisions to adopt mobile technology, or by opportunities to create new value related to work life.

Sophisticates: adopt services and products that fill status needs, in terms of material style, and are influenced by images projected by celebrity users and in mass media.

Socialites: adopt services to meet their needs to keep in touch while on the go, are influenced mainly by family and friends, but are unwilling to pay for data services.

Lifestylers: members of this segment, whose needs and behaviour partly overlap the segments listed above, fill convenience needs related to mobile lifestyles, such as delivering information or directions to people who are in an unfamiliar location, and helping people fill "dead time" with time-critical tasks or entertainment. Examples of such tasks are messaging and bill paying while waiting in line or on public transport, facilitating meetings among friends who are on the move, and playing games. They view their mobile phones as fashion accessories, and change them frequently.

Misers: members of this segment were unwilling to pay for wireless data services.

Laggards: were the last to know about and adopt new technologies.

(Gilbert & Han, 2005, pp. 330 - 331)

2.4.4.2.2 Mobile entertainment

WAP and SMS are very general sources of mobile data, and were the only ones in common use in 2000. For their second and third studies, Gilbert *et al* narrowed their focus, looking at different aspects of mobile entertainment.

They considered various projections of the demand for mobile gaming (Gilbert & Han, 2005), then used this field to improve the validity of their model in their second (a focus group of 40 participants) and third (broad survey of 300) surveys.

These surveys identified market segmentation in this area, which could be cross-referenced to the first survey:

Mobile Entertainment Segment	Corresponding Segment
1) Dedicated gamers	TechnoToys (but not interested in technology for its own sake)
2) Social gamers	Socialites
3) Casual gamers	Lifestylers

Table 3: Comparison of segmentation, survey 1 with surveys 2 & 3, based on analysis of various Gilbert *et el* research outputs.

Gilbert & Han (2005) point out that their findings from the first three surveys are consistent with the notion of a "chasm" (Moore, 1999) between early adopters and those who follow. Additionally, there are distinct discontinuities between each group, which is consistent with Moore's model.

2.4.4.2.3 International comparison

The fourth survey was a cross-border analysis of Singaporean and Malaysian respondents. Gilbert & Han (2005) investigated the effectiveness of behavioural versus demographic variables as predictors of MDS adoption. Segmentation analysis revealed that demographics were more useful than behavioural indices when used to identify market segments. The conclusion was: "a combination of selected demographic and behavioural variables appears to improve the validity of segmentation".

2.4.4.3 Conclusion

From their research to date, Gilbert and Han (2003a, 2005 p. 333) conclude that:

- Segmentation will be useful for predicting adoption behaviours in today's dynamic markets.
- A deep understanding of the basis of segmentation is required. Evaluation of intrinsic and extrinsic motivations on behaviour both contribute to segmentation.

Based on these findings, they constructed a table showing the characteristics of each market segment (Table 4).

Adopter segment	Order	Source of learning	Influence channel	Market structure	Value proposition
TechnoToy	1	Self-taught	Technical publications	Individual	Intrinsic
Mobile professional	2	Vendor or TechnoToy	Industry or Employers	Collective	Extrinsic
Sophisticate	3	Friends or salesperson	Mass media	Individual	Extrinsic
Socialite	4	Friends	Friends and family	Collective	Intrinsic
Lifestyler	5	Friends	Varied	Collective /individual	Extrinsic /intrinsic
Laggards and misers	n/a	Friends	Special offers	No clear pattern	No clear pattern

Table 4: Segments and forces for mobile data services (Gilbert & Han, 2005, p. 334)

Mapping the analysis shown in Table 4 to Moore's adopter categories (Moore, 1999), Gilbert & Han (2005) developed the model shown in Figure 7.

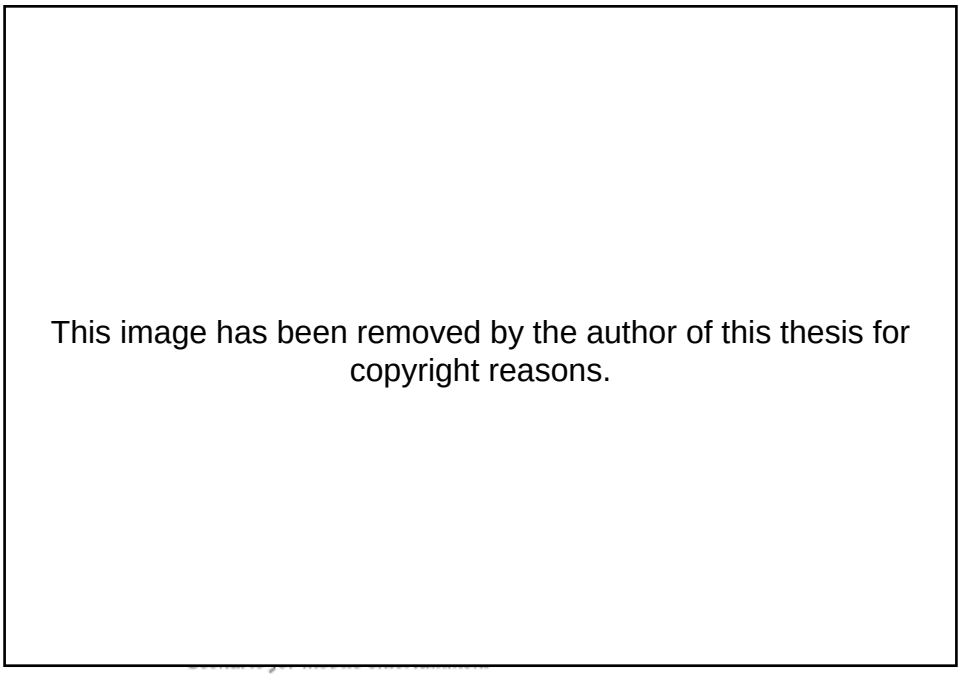


Figure 7: Gilbert & Han's dynamic needs-based marketing model.(Gilbert & Han, 2005)

Like Moore's Innovators, Gilbert & Han's TechnoToys have an intrinsic interest in the technology, and expect radical discontinuity. Their learning, influence, and motivation are all different to the other segments. The parallel continues to the 'chasm' of Gilbert & Han's model, which, like Moore's, is between the second and third segments – Mobile Professionals and Sophisticates. Further analysis confirms the size of this gap. Gilbert & Han conclude that each segment requires a unique business plan to promote the adoption of MDS.

2.4.4.4 Implications

A clear implication of both Moore's segmentation model, and Gilbert & Han's adaptation, is that diffusion of MDS can only get to a certain point without a range of compelling applications. Familiarity with these models can improve the chances of marketing success across multiple segments.

Finally, Gilbert & Han (2005) conclude that providers of mobile data services need to segment the market, based on a combination of demographic and psychographic data. They should also consider the interaction of members of some segments, and how this can be harnessed to accelerate adoption across segments.

2.4.5 A Summary of Cross-Culture Research

Three authors are introduced in this section. Their research considers the cultural differences between various aspects of technology. The major divisions each consider one of the authors' works. Hofstede (1984, 1994) has a very wide-ranging database of cultural influences around the world. Bajwa *et al* (2002) focus on use of collaboration software in Australia and the United States. Choi *et al* (2005) compare various aspects of how people interact with their computers in Korea, Japan, and Finland.

Within the major divisions, there are a number of headings: 'Background' describes the research of each study; 'methodology' summarises the way each study was conducted; a summary of 'Results' follows, and each division is concluded by consideration of the 'Conclusion & Implications' of that study to the overall objectives of this thesis.

2.4.5.1 International differences in work-related values

Geert Hofstede (1984, 1994) has built his consultancy business around research and analysis of the impact of cultural differences in business dealings. His consultancy website claims: "*Geert Hofstede's research gives us insights into other cultures so that we can be more effective when interacting with people in other countries.*" (Hofstede, 2003)

2.4.5.1.1 Background

Between 1967 and 1973, IBM commissioned Hofstede to use surveys to gather statistics regarding values held by workers in each of the countries in which it operated at the time. He then analysed data from these surveys, and determined what that data said about the effect of cultural values on workplace values. The result of the analysis is published in Hofstede (1984, 1994).

2.4.5.1.2 Methodology

Hofstede (1984) describes a very rigorous process that he undertook as a consultant to IBM. He developed and used questionnaires in an attempt to gauge the participants' attitudes in a wide range of areas. Data was gathered between 1967 and 1973. This resulted in a database of about 117,000 survey responses, from 66 different countries. Hofstede determined that responses from 40 countries could be used in his analysis – the other countries had too low a response to be considered.

The major output from Hofstede's research and analysis is an 'index' of each of five classifications. For each one, he identified a number of questions from the survey that reflected the responder's propensity towards that classification. Each index is a single number, derived from analysis of the questions relevant to that classification.

In chapters that focus on each of these characteristics, Hofstede expands on responses to individual questions, and proposes theories to explain differences between countries.

In his second book (Hofstede, 1994), Hofstede added data from studies in 1987 and 1991, totalling 22 countries. Table 5 includes a list of all countries for which Hofstede has created indexes.

2.4.5.1.3 Selected Results

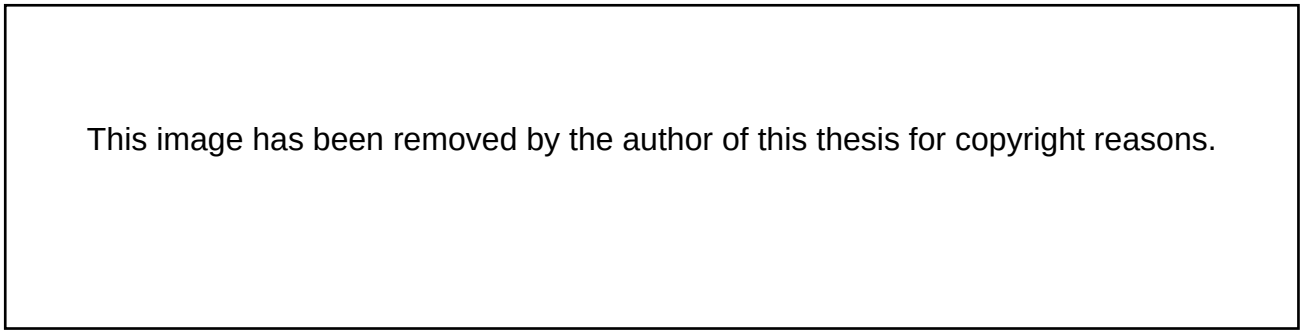
Analysis of responses from these questionnaires leads Hofstede to identify four characteristics for classifying cultures:

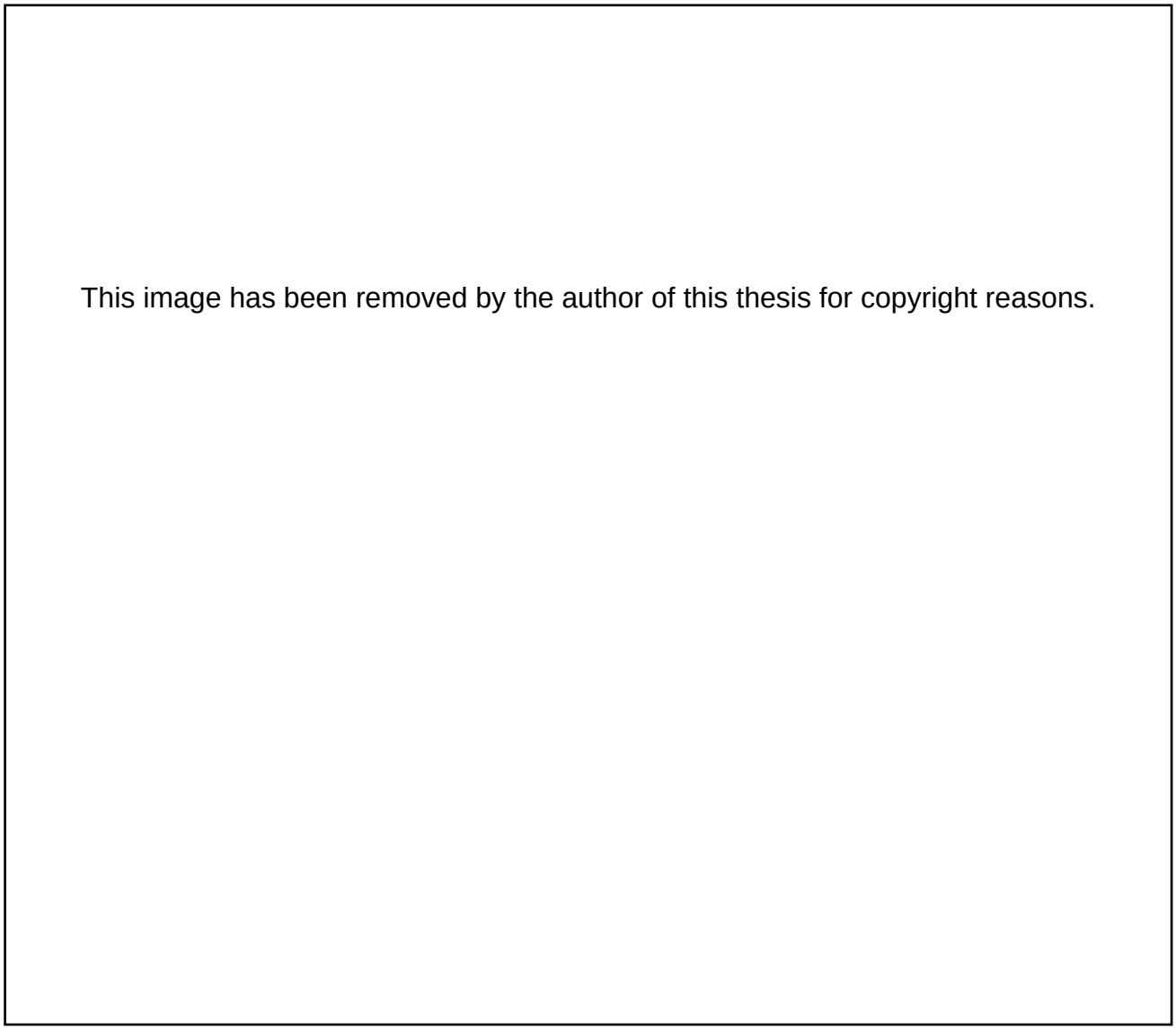
- power distance
- uncertainty avoidance
- individualism
- masculinity

Subsequently, Hofstede added a fifth characteristic: 'long-term orientation' (Hofstede, 1994).

A summary of his resulting indices is shown in Table 5.

Table 5: Summary of Hofstede's Cultural Dimensions
(from: http://www.geert-hofstede.com/hofstede_dimensions.php)





2.4.5.1.4 Conclusion & Implications

Hofstede's research has contributed significantly to the incorporation of national culture within business research (Fang, 2003; Jabri, 2005; Sivakumar & Nakata, 2001). There has equally been much criticism of his work. This is summarised by McSweeney (2002) who uses a number of reviews and other research to reach this conclusion:

"Hofstede's apparently sophisticated analysis of extensive data necessarily relies on a number of profoundly flawed assumptions to measure the 'software of the mind' as did Morton's measurement of the hardware, as it were, of the mind. Hofstede's claims are excessive and unbalanced; excessive because they claim far more in terms of identifiable characteristics and consequences than is justified; unbalanced, because there is too great a desire to 'prove' his a priori convictions rather than evaluate the adequacy of his 'findings'."

(McSweeney, 2002, p. 112)

Notwithstanding the limitations of his analysis, Hofstede (1984) provides a model that can be used as one part of a comparison of mobile data service adoption between two countries. Hofstede's constructs of uncertainty avoidance, individualism, and masculinity could well have a direct relevance to the current research. A person's propensity to uncertainty avoidance will influence their adoption of the (often disruptive) mobile services. Choi *et al* (2005) comment on this, and also discuss the implications of individualism when related to the use of mobile devices. Hofstede (1984 p. 186) lists various trends that he considers to be more important for men or for women. Some of these trends could also be visible in adoption intentions compared between men and women, making his masculinity index relevant to the current research.

2.4.5.2 Use of Collaboration IT in Australia and the US

Bajwa *et al* (2002) set out to analyse the types of collaboration being promoted in their target group, how much IT support is provided to assist that collaboration, and what the process of adoption was. They are particularly interested in variations in the conditions and behaviour between Australia and the US.

2.4.5.2.1 Background

The study does not mention any literature relating to the general issue of cross-border research. The authors state that there has been no prior research in the specific area of 'large-scale adoption of collaboration technologies', using similar methodologies to theirs. They do not propose any hypotheses, on the basis that their study is exploratory.

2.4.5.2.2 Methodology

The Bajwa *et al* (2002) study was planned in three phases: a literature review; Instruments developed, and critiqued by an academic panel, and field testing by two successful managers. The survey was then distributed, using email, to an undisclosed number of IT professionals in the US, and posted to 500 randomly selected organisations in Australia. 119 usable responses were received from the US, and 140 from Australian organisations.

2.4.5.2.3 Selected Results

The current paper is interested in Bajwa *et al* (2002) as an example of cross-country research, so only results relevant to that issue are reported here. All of the aspects of collaboration surveyed were supported in each country, however most areas showed significant cultural differences.

Management support collaboration in both countries, however, the US reported increasing support for virtual teams, and general collaboration while Australian support

appears static in both areas. No respondents reported that there was a formal position responsible for managing collaborations. All respondents reported some IT support for collaboration, however a significantly greater proportion of US companies reported support in most categories.

In terms of adoption patterns, Bajwa *et al* (2005) found no significant differences between the rate at which each country adopted e-mail, proprietary groupware systems and electronic meeting systems (EMS). Four other technologies surveyed were all adopted faster in the US than Australia. The technologies were audio teleconferences, videoconferencing, data conferencing, and web-based tools.

2.4.5.2.4 Conclusion & Implications

Detailed results from this research should be treated with caution, as some aspects of the methodology could be questioned. The cross-cultural issues identified in section 2.4.5.2.3 above, however, do show consistency and can safely be used as general indication of divergent trends between the two countries.

2.4.5.3 Cultural Influences on Mobile Data Service Design

Choi *et al* (2005) undertook detailed research considering cultural influences on various aspects of mobile data service design. Their research covered three countries, is backed by extensive use of a small (22 references) body of literature, and is well presented. The localised nature of mobile data services creates a particular need for cultural sensitivity, which, Choi *et al* maintain, is less critical for access to the stationary Internet, which is globally uniform. This research aimed to identify design elements that are important to consider when designing mobile data services for cross-cultural markets.

2.4.5.3.1 Background

Like Bajwa *et al* (2002), Choi *et al* (2005 p. 661) note a lack of research in the area of their study. In this case, more research is needed in cross-cultural influence in human-computer interaction (HCI). From their analysis of existing research, Choi *et al* (2005) maintain, "… most studies have adopted a surface-level approach to interface localisation…". Consumers are likely to expect services delivered on a mobile device to be more sensitive to their culture. Consequently, they will respond well to a user interface that shows more than 'surface-level' localisation.

2.4.5.3.2 Methodology

The research discussed used a qualitative interview technique to record the responses to video tapes showing use of mobile data services. They interviewed eight participants from each of three countries: Korea, Japan, and Finland. Using data from the survey,

Choi *et al* (Choi et al., 2005 p. 662) then used statistical analysis to identify correlations between attributes of mobile data services, and the culture of each interview respondent. Initial interviews found a total of 52 attributes considered significant by one or more interviewee. This list was narrowed by keeping only those attributes that were referred to by seven out of the eight interviewees from each country.

Their definition of culture appears well grounded in the literature. "Culture can be conceptualized as a set of significant variables that informs the responses of individuals in that culture …" (Choi et al., 2005). They provide further details of the culture dimensions they used.

2.4.5.3.3 Results

This paper identified that some attributes of mobile data services are likely to be judged quite differently by people from different cultural backgrounds. This provides guidance for those designing user interfaces, and for further research in this area. The technique of using video clips to prompt views from interviewees worked well for Choi *et al*, but may be problematical for a larger sample size.

A series of limitations is identified by Choi *et al* (Choi et al., 2005). The first, and most obvious, is the small sample size. The authors don't suggest any mitigation for this problem, and indicate an intention to conduct more studies. Other limitations centre on ways the methodology might have influenced the results in various ways. These limitations don't invalidate the results.

2.4.5.3.4 Conclusion & Implications

The research reviewed shows strong evidence that cultural factors are important to users of mobile data services. It seems likely that those cultural factors need to be considered in any study of adoption of mobile data services.

2.5 PROBLEM AREAS

A selection of the world-wide literature relating to technology adoption has been reviewed. Specific questions can be identified that contribute to informed prediction of the future adoption of mobile data services in New Zealand. These questions will be identified in the following sub-sections. Two key questions address the usefulness of a model, and the output requirements from that model. These key questions are presented here, with supplementary questions that can tease out the context of the current study.

2.5.1 What adoption model will adequately predict MDS consumer behaviour?

A theoretical model is a common tool, used to add value to an analysis of factors such as investment in, and use of, a tool, and the value gained from that investment (Lee, 2003). The model must be appropriate (Rogers, 1962), so these questions will consider the adequacy and appropriateness of each of a variety of models.

2.5.1.1 Which of the available models is most appropriate?

This review has outlined Rogers' (1962) Diffusion of Innovation model, derivatives of Rogers' model from Moore and Gilbert (Gilbert & Han, 2003a, 2005; Gilbert & Kendall, 2003), and Davis' Technology Acceptance Model (1985). Elements of Rogers model are identifiable in each of the other ones used. The development of a model based on each of the ones that have been outlined may be feasible.

2.5.1.2 Are the future adoption predictions of consumers a reliable indicator of market segmentation?

Once the most appropriate model has been determined, it is necessary to determine if that model is sufficiently reliable to be used in the context. Reliability measures within the research design are necessary.

2.5.1.3 Has the application of an adoption model changed over time?

The models included in the review have all been used extensively in the past. This thesis will consider whether the most appropriate model for study of MDS can still be applied in the same way it has been applied in the past. Necessary changes can be identified.

2.5.1.4 Does the application of an adoption model change between countries?

Different cultures approach innovation in different ways (Urban, 2003). Results from New Zealand can be compared with applications of the same model in other countries.

2.5.2 Do consumers expect they will adopt Mobile Data Services (MDS)?

Telephones have been in regular use for decades. In the 21st century there is potential for consumers to use the 'telephone' for many data based services available on the Internet. While the technology has changed, the business models used by providers must build on existing business processes to market their services (Wolfe & Genin, 2004). An early stage of that business process will be to gauge market awareness and demand.

This section sets out questions that need to be addressed to anticipate future consumer behaviour.

2.5.2.1 Do consumers know what MDS are available?

Recent promotions, such as a Telecom promotion related to the sinking of a dive attraction on the Wellington South Coast (Wolfe & Genin, 2004) show that consumers are adopting the use of SMS messaging. Telecommunication companies are predicting continued growth across a variety of mobile data services (Gupte et al., 2005). This question will be a starting point to research the relationship between the consumer and MDS.

2.5.2.2 How do consumers learn about MDS?

Section 2.4.3.1 above identifies the various categories of adopter, with indications of how consumers in each category tend to learn about the technology. Gilbert & Han (Gilbert & Han, 2003a) also use this information when segmenting the MDS market. This is detailed in section 2.4.4.2 above. This question will assist in relating the study to the reviewed literature.

2.5.2.3 How do consumers view the relationship between devices, networks, and content with relation to MDS?

In researching consumer demand for networked services, Middleton (2003 p. 1) considers the contribution to demand from content, connection to a network, and the services available. In her later paper (2003) she reviews the part played by the 'Killer App'. This would be one particular service that has acted as a catalyst, with " '*must have' status"* (Bennetts, 2005), Such an application could drive uptake at each stage of the diffusion of various high-tech innovations. Middleton concludes that there is no one application or service that is going to drive broadband update. This question can show whether consumer views support this position, in respect of high-speed MDS.

The OECD has investigated the impact of digital broadband content on various sectors of the economy. Their report on music (OECD, 2005 p. 7), issues a challenge to business "*to develop* [digital music delivery] *models that are attractive to consumers…*". This question will determine where consumers see mobile devices in relation to service delivery models.

2.5.2.4 How does availability of a particular service affect a consumer's decision to purchase a specific phone?

In 2005 promotions Telecom New Zealand offered 500 short text messages between mobile phones (SMS messages) per month and Vodafone offered 'free' SMS messages to other Vodafone customers during the weekends. This market dynamic has lead to consumers purchasing one phone on each network. This question will consider how far

consumers will be persuaded to change their purchasing habits simply to get a particular product or promotion (Bennetts, 2005).

2.5.2.5 Will consumers upgrade their phone specifically to use a particular service?

Handset upgrades are a common marketing target. Telephone companies have frequently offered competitive 'upgrades' such as a Vodafone offer, promoted by GSM Mobile NZ (2005). This question will determine how much affect these promotions have on consumer adoption intentions.

2.5.2.6 How much does cost affect decisions related to adoption of MDS?

In April 2006, Telecom New Zealand lowered prices on its fixed network broadband services. It's only significant competitor for local loop wired connection, TelstraClear, lowered their prices in mid-March. In April Vodafone substantially lowered the cost of data services on its mobile data network, forcing Telecom to match the new prices a few weeks later. This question will gauge how much influence this type of change has on consumer adoption intentions.

2.6 CONCLUSION

The literature reviewed has defined the context of study, elaborated problem areas and left a number of questions for investigation. An introduction to the topic of consumer forecasting was made and three adoption models were considered in some detail, followed by a brief review of the issue of cross-cultural research in the Information Technology field. The background reviews lead to the predicting of the future of mobile data services adoption in New Zealand.

The adoption models detailed in this chapter have each been successfully used to describe high technology consumer characteristics. Rogers (1985) first proposed his now widely used Diffusion of Innovations model. A large body of research has built around his model, and derivatives thereof. One of those derivatives is the Technology Acceptance Model, first proposed by Davis (Davis, 1989, 1993; Davis et al., 1989), and built upon by his later research, (1999) and various other authors. Moore (1999) also based his work on Rogers. However, he developed a model tailored to high-tech products. Moore relies on his consultancy experience, rather than academic study, to identify a 'chasm' that introduces a discontinuity into Rogers' (1962) model. Parts of Rogers (1962) and Moore (1999) have contributed to the research of Gilbert *et al*. Their model divides the market for mobile data services into five segments. They then expand on the five segments, describing characteristics of each one.

Hofstede (1984) carried out analysis of over 100,000 survey respondents in a cross-cultural study. He then documented the method, and carried out the surveys. Once he had the survey responses, Hofstede matched one to three questions to each of a range of cultural attributes. (Bajwa et al., 2002) and (Choi et al., 2005) each studied some of the variations between people of different cultures when they are faced with a potential adoption decision.

In the following Chapter the methodologies used by various authors will be examined for learning and guidance on how to undertake a study in New Zealand. The research question, hypothesis, and sub-questions (foreshadowed in this Chapter) will be refined and operationalised into a framework for field work.

Chapter Three

METHODOLOGY

3.1 INTRODUCTION

Following on from the review of the literature in chapter two, this chapter will evaluate the methodologies used in a number of studies relevant to mobile data services (MDS) research. From the evaluation of other studies, the current research will be clarified to define the best approach and methods. The research questions and hypotheses are also defined and specified. An initial research model is defined in the text, and in a diagram. The research design is then described in detail.

The review section of this chapter has a different emphasis to the broader literature review in the preceding chapter. The current chapter focuses on methodology. First various methodologies are reviewed, and that review leads to the description of how the current research is going to be structured. The MDS problem area is explored from the perspective of previous research reports and the approaches. In this chapter, specific research questions are defined and discussed, the research model defined and the data requirements specified.

3.2 REVIEW

The methodologies used in each of six different studies are briefly reviewed here. For each study, there is an overview, and a summary of the methodology used.

A significant amount of diffusion research refers, to some degree or another, to the work of Rogers (1962). The first study reviewed below describes how Rogers' Diffusion of Innovation model can be used in conjunction with the Technology Acceptance Model (TAM) (Davis, 1985), and other relevant research. After developing his TAM Davis used it as the basis for further research. Section 3.2.2 below describes a 1993 study based on the TAM. It describes how that model can be used in a representative diffusion study.

The previous chapter described Moore's 'Chasm' model. Section 3.2.3 describes a typical application of his model. In chapter two, it was identified that Moore's work (Moore, 1999) has been widely used by those studying technology adoption, despite a lack of academic rigour in his methodology. Moore does not significantly cite the literature, however, analysis of the studies he describes can contribute a better understanding of the diffusion process. The example of Savi Technology, described below, provides an interesting insight into Moore's methodology.

Rogers identifies that readiness to adopt a technology is a key factor in the overall adoption process. This aspect of adoption research has been studied by Parasuraman (2003). His Technology Readiness Index (TRI) is a valuable resource used in the current research. Section 3.2.4 describes the development of the TRI, and its use in Parasuraman's National Technology Readiness Survey.

The methodologies used by two more recent studies conclude this section. Gilbert *et al* published results from a variety of studies between 2003 and 2005. The general nature of their work was described in chapter two. Section 3.2.5 focuses on the methodology used in their studies. Finally, the methodology of Nysveen *et al* (2005) is described. Like Gilbert *et al*, Nysveen *et al* used the literature to develop their own model to explain intention to use mobile services. Each of these researchers identified elements of technology adoption that are relevant to the current research.

The studies reviewed in this section are introduced in chronological order. Each one contributes to the development of the current research methodology that follows.

3.2.1 Diffusion of Innovation

This section briefly summarises the general methodology Rogers used to build the large collection of case studies in succeeding editions of his book (Rogers, 2003). Roberts and Pick (2004) provide an example of research based on the literature, particularly Rogers.

3.2.1.1 Overview

When Rogers (1962) started his graduate research, in 1954, it was in the US state of Iowa, where there had been extensive planting of hybrid seed corn. He had recently completed a bachelor's degree in agriculture, and went back into research in that area. Research for his doctorate saw him interviewing farmers regarding their use of new seeds and chemicals. At that point, he suggests, *"Thus I became a diffusion scholar"* (Rogers, 2003 p. xvi). Through reviews of current literature from other fields, such as diffusion of the kindergarten, and diffusion of driver training in schools, Rogers realised that there were some common elements, and used that for the basis of his seminal book on the topic (Rogers, 2003).

The latest edition of Rogers' book (2003) describes, in general terms, a large number of diffusion case study examples. Rogers uses each one to highlight specific elements of his diffusion model. This is illustrated by the description of 'Diffusion of the Internet'(Rogers, 2003 pp. 346-348), within a chapter that focuses on "Diffusion Networks". Rogers includes statistics throughout this case study. They appear to come from one quoted work, a Doctrinal dissertation, which this author has been unable to source. The case study describes the growth of the Internet in the context of events that

contributed to the rate of growth. In this way, Rogers can relate the diffusion of the Internet to the world-wide environment in which this diffusion was taking place.

Rogers' work is widely quoted, and used as a model for diffusion studies in many disciplines. An example in the Information Systems field is a series of articles published in the Communications of the Association for Information Systems (CAIS) (Wolcott & Goodman, 2003). These articles examine diffusion of the Internet in various countries. They frequently quote Rogers to explain phenomena encountered while studying statistics in each country. These references, like Roger's case study above, relate diffusion theory to the wider context within each country.

The rest of this section is going to review a study by G Keith Roberts and James B Pick (Roberts & Pick, 2004), which the authors describe as based on *"the TAM [Technology Acceptance Model] and innovation adoption/diffusion models"*(p. 1). The study design will be described, followed by a brief summary of the outcomes.

3.2.1.2 Study Design

In their paper "Technology Factors in Corporate Adoption of Mobile Cell Phones: A Case Study Analysis" Roberts and Pick (2004) conduct a case study based in five companies. They study which technology factors are considered important in deciding to adopt and deploy various wireless devices used for information services and mobile telephony.

In describing the background to their study, and review of the literature, Roberts and Pick (2004) list a number of studies, documenting 'refinements' to Davis' original model that the authors used to better fit their own research. They note that the two original inputs used by Davis (perceived ease of use, and perceived usefulness) fit quite well with Rogers' 'complexity' and 'relative advantage'. For their own study, Roberts and Pick (2004) added several additional considerations to the five attributes Rogers identified (detailed in chapter two of this thesis). Perceived risk was considered relevant because mobile phones are vulnerable to security and privacy issues. Cost of using wireless devices can be significant, so that was included. The authors identified that voice and simple Internet use have been the main focus of similar studies, and expanded their own research to include future web connectivity. Also added, (without supporting references to explain the rational) were reliability, technical suitability, and digital standards.

The five companies that participated in this research were from a variety of industries. The authors indicate all are very large 'players' in their respective industries. While not explicitly clear, they appear to be from five different industry sectors. The researchers interviewed the chief information officer (or equivalent) in each company,

and the manager (or managers) who were responsible for policy controlling mobile phones.

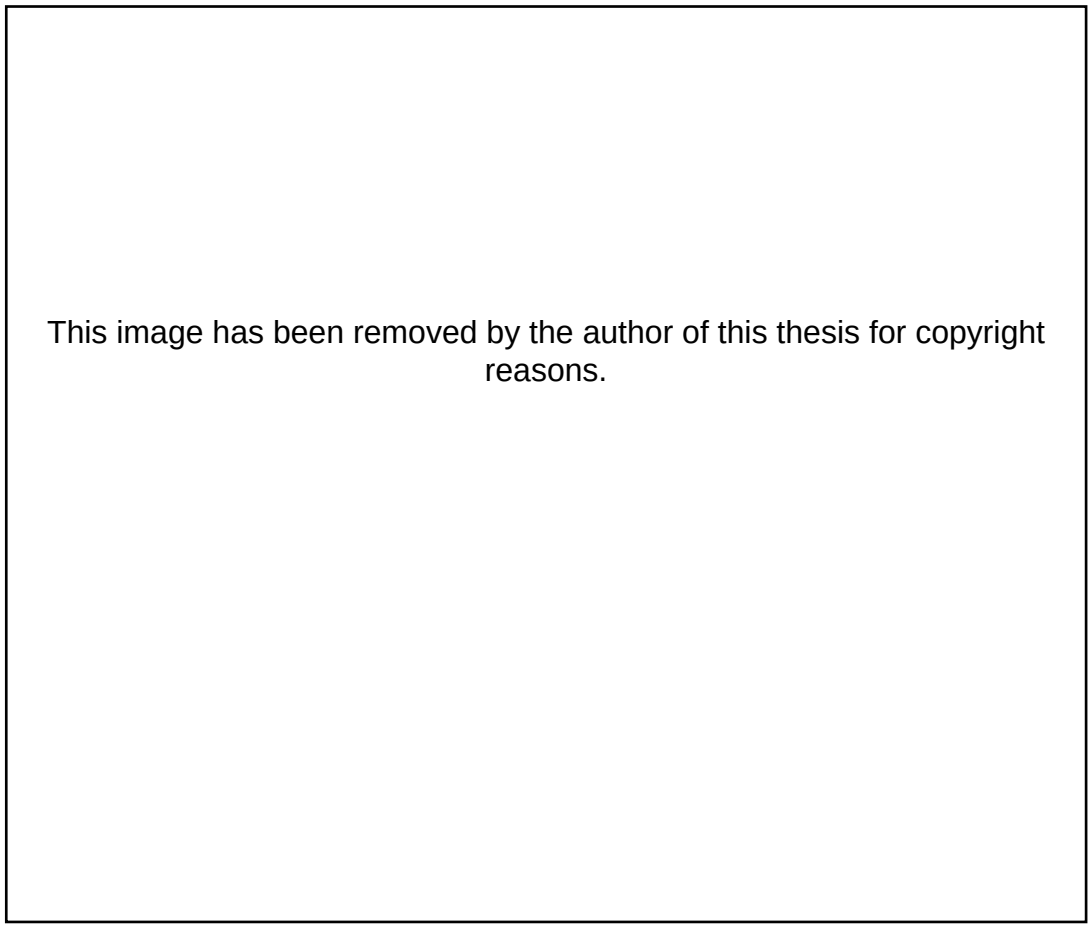


Figure 8 – Summary of Attributes used by Roberts and Pick (2004 p. 3).

The interview results were analysed for construct validity, internal and external validity, and reliability. The authors note that this is an exploratory study, rather than replicating other studies, which limits their ability to test external validity. Results were presented in the form of two tables. One table cross-references a list of interviewees with a list of technology factors that might affect the decision to use mobile phones. The second table cross-references the same interviewees with a list of non-technology factors that might affect adoption. The tables have a graded scale – each reference point is noted 'NA' (Not Applicable) or ranked between 'L' (Low) and 'H' (High). There is no indication within the paper as to how the grade is arrived at. The only numbers quoted in the paper are simple percentages.

3.2.2 Technology Acceptance Model (Davis, 1993)

This is an example of the work of Davis, using his Technology Acceptance Model (TAM) (Davis, 1985). The brief summary of his 1993 research shows how the TAM, which was described in detail in chapter two, can be applied to a particular study.

3.2.2.1 Overview

This study used the TAM to identify influences that affected use of two information systems applications. The systems were an electronic mail (email) system, and a text editor.

3.2.2.2 Study Design

The key factors considered by TAM are: perceived ease of use (EOU); perceived usefulness (USEF), and attitude towards using (ATT). The model hypothesises that these factors indicate the level of actual use of the system (USE). The survey aimed to test seven hypotheses regarding the relationships between the factors considered by the TAM:

Table 6: Hypotheses used by Davis (Davis, 1993 pp. 478 - 479)

H1: Attitude toward using will have a significant positive effect on actual system use.
H2: Perceived usefulness will have a significant positive effect on attitude toward using, controlling for perceived ease of use.
H3: Perceived ease of use will have a significant positive effect on attitude toward using, controlling for perceived usefulness.
H4: Perceived ease of use will have a significant positive effect on perceived usefulness, controlling for system.
H5: System will have a significant effect on perceived usefulness and perceived ease of use.
H6: Perceived usefulness, perceived ease of use, and system will not have significant direct effects on actual system use, controlling for attitude toward using.
H7: System will not have a significant direct effect on attitude toward using, controlling for perceived usefulness and perceived ease of use.

One hundred and twenty employees were invited to respond to a survey. Of the 112 replies (a reply rate of 93.3%) 109 responders used email, and 76 used the text editor. Participants were given a questionnaire to determine their eligibility to comment on each system, elicit their position with regard to the three factors that TAM considers, and determine their actual system usage.

The instruments used to gauge EOU and USEF were tested for reliability and validity in earlier research by Davis (1989). Each consisted of a set of 10 questions. Among the analyses applied to the results of this survey, Davis created the diagram reproduced in Figure 9. This uses regression analysis to illustrate the relationships between the system being tested, and the four factors of the TAM.

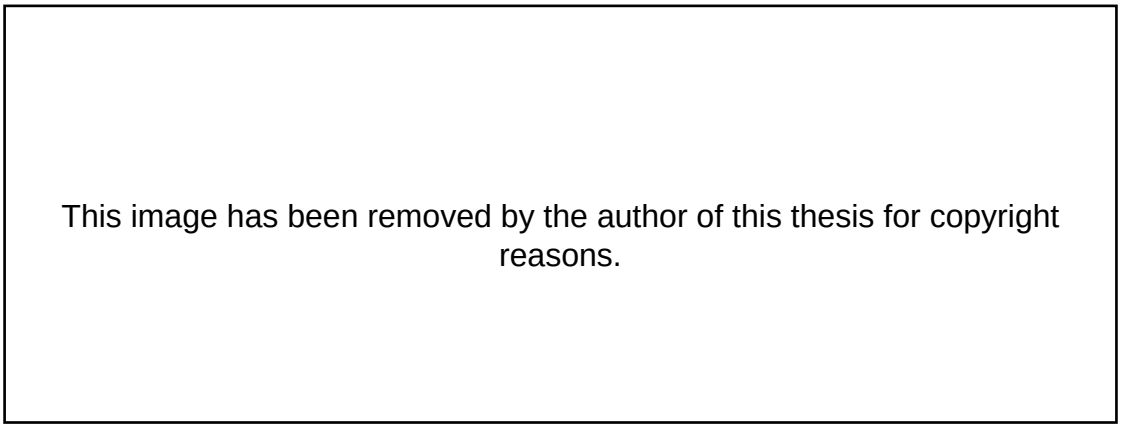


Figure 9 Results of applying regression analysis (Davis, 1993 p. 481)

Hypotheses H1 to H5 were confirmed, except for the link between System and Perceived Usefulness, which does not appear significant. Contrary to hypotheses H6 and H7, the links between Perceived Usefulness, Perceived Ease of Use, and System, does have a significant direct effect on Actual System Use, and System does have a significant direct effect on Attitude Toward Using. Davis expresses surprise that these hypotheses were disproved.

3.2.3 Chasm Model of Marketing (Moore, 1999)

While not following typical academic methodologies, Moore's model has received academic support, as mentioned in chapter two. This section describes one anecdote from Moore (1999), which serves to illustrate an aspect of his model.

3.2.3.1 Overview

As Moore develops his model in each section of his book, he cites at least one reference to support the theory in that section. These references can use an example of a product, technology, or company, In his Acknowledgements section, Moore (1999) states that the information he uses comes by word of mouth. He does not document any sources.

Moore refers to "… *tapping into the fund of anecdotes that actually carries business knowledge in our culture*." rather than using formal market segmentation, which, he says, "*takes too long*". (Moore, 1999, p. 95) Notwithstanding this, there is benefit in considering the general nature of those anecdotes that are frequent in his book.

3.2.3.2 Study Design

Analysis of Savi Technology is typical of the examples used by Moore (1999). During Operation Desert Storm – the military operation aimed at expelling Iraq from Kuwait in 1990 – the US Armed Forces lost track of tens of thousands of containers of various supplies (Conahan, 1992). Savi Technology was a small 'start-up' company in Mountain View, California. They developed a radio-frequency identification product that was adopted by the Pentagon to enable fast and effective tracking of containers and their contents (Baron, 1997). Baron goes on to describe how Savi's products had a significant, positive, effect in the deployment of troops to Bosnia in 1995.

Moore (1999) describes the issues faced by Savi Technology at that point. They had a very successful product, with no obvious competition in the market. Their problem, as Moore describes it, is that there is also no demand for their product. In this situation, potential customers are not saying "no", however, neither are they saying "yes". This is a typical characteristic of a company in the 'Early Adopters' segment of their market. In this example, Moore's model dictates there is a 'Chasm' to be crossed. Savi was at the point where they had one highly successful contract (Savi Technology (2006a) states it was worth $US70 million), but the market, defined as military logistics, was not large. There is not another military organisation the size of the US armed forces! Savi needed to invest the income from that contract in a plan to provide sustainable growth.

At this stage Savi Technology identified a target market – management of freight movements by shipping companies, and the target customer in that market – The 'Yard Manager' who was responsible for moving freight efficiently. Savi established a complete solution consisting of their own products and services, working with some products of other companies (Moore, 1999). These are the steps Moore suggests companies supplying the 'Early Adopters' need to take, in order to cross the chasm, and supply to the 'Early Majority'.

Moore does not explicitly state what happened to Savi Technology after that. Use of this case implies a successful conclusion. The company themselves describe their situation in very positive terms (Savi Technology, 2006a, 2006b). Savi Technology did 'Cross the Chasm'.

3.2.4 The National Technology Readiness Survey

The National Technology Readiness Survey (Parasuraman, 2000) considered the interface between people and technology. The following sub-sections elaborate on the methodology.

3.2.4.1 Overview

Parasuraman identified that technology was becoming an increasingly important part of business structure, and was growing. While he could identify several significant studies considering how to design and implement various interfaces between people and technology, he found little research into 'readiness' of people to use such technology. Research reported in Parasuraman (2000) aims to address this gap. Technology readiness is defined as *"people's propensity to embrace and use new technologies for accomplishing goals in home life and at work"* (Parasuraman, 2000 p. 308).

Figure 10 – Triangle and Pyramid Models of Services Marketing (Parasuraman, 2000 p. 308)

In further describing his model, Parasuraman uses the model reproduced in Figure 10. He suggests the 'triangle' model has been used in the past to conceptualise the added complexity of marketing services, rather than marketing goods. By adding a third dimension to be considered, Parasuraman (2000) introduces three new relationships – the relationship of technology to: the company; employees, and customers. The Technology Readiness Index assists in measuring these three new relationships.

3.2.4.2 Study Design

Having identified an urgent need for more research into questions such as "*How ready are people to embrace and effectively use new technologies?*" (Parasuraman, 2000 p. 309), Parasuraman started to develop his 'Technology Readiness Research Program'. Together with Rockbridge Associates (a specialist service and technology research company), he embarked on a significant research program, which took several years to develop, and is now updated annually (Rockbridge, 2007).

Using information obtained during research for one of their clients, Rockbridge identified 44 survey questions (items) that could be used to assess technology readiness. An iterative sequence was applied, where analysis of reliability, and factor analysis, determined how reliability could be improved by removing items from the list. This process reduced the list to 28 items that contributed significantly, and reliably, to prediction of technology readiness. These 28 items were grouped in four categories of what was called the "Technology Readiness Index" (TRI) (Parasuraman, 2000). The initial 28 item list came from research for an Internet-related customer. Other clients commissioned further research that provided data that could be used to further refine the TRI. Application of reliability and factor analysis identified 15 items (from a pool of 38 tested additional items) that broadened the validity of the TRI, to encompass a wider range of technologies.

The TRI was then used in the first execution of the National Technology Readiness Survey. This was a random telephone survey of about 1000 participants. Analysis of the results, combined with earlier analysis, established the reliability of the TRI. Parasuraman went on to consider the validity of the index. Items were included in the TRI to gauge the consumer's ownership or subscription to, use of, or perceived desirability of, various forms of technology. One-way ANOVA tests confirmed that responses to the specific technology adoption items were consistent with responses to the more general technology readiness items in the TRI. This suggests high validity for the TRI.

Overall, responses to the TRI questions in early surveys showed a mean value of 2.88, which is close to the midpoint of the 5-point scale used. The distribution of answers (skew of -.01), and low kurtosis (-.19) suggest results are very close to a normal distribution. Since introduced by Parasuraman (2000), the NTRI has been run at least once a year and regularly reviewed to ensure it is still valid and reliable (Rockbridge, 2007).

3.2.5 Understanding Mobile Data Services Adoption

Reports of field research on MDS provide useful insights into how others have conducted data collection and processing (Gilbert & Han, 2003a, 2005; Gilbert & Kendall, 2003). The following sub-sections review the published reports.

3.2.5.1 Overview

The publications by Gilbert et al document Mobile Data Services (MDS) field research over the period 2000 to 2004 (Gilbert et al., 2005). This same paper introduces Gilbert's 'current' research. The International Management Research Centre (IMARC) of Nanyang Technological University in Singapore, is now looking at 'Out of Box Experience' (OoBE). This research considers how the packaging environment of a mobile device affects the uptake (or not) of the various features available, including use of MDS. Gilbert et al (2005) describes the latest work as preliminary, with many limitations, so it will not be considered in this thesis.

3.2.5.2 Study Design

Each of the IMARC studies followed the same general sequence:

1. Identify current market place trends by examining mass media and recent industry publications.
2. Organize focus groups to explore emerging issues, refine research questions, and gather impressionistic data.
3. Design survey instruments to capture data about the most interesting research questions, from the perspective of the relevant theory.
4. Field-test survey questions with members of the target groups, and refine research instruments.
5. Collect and interpret data, avoiding systematic bias to the [greatest] extent possible.

(Gilbert & Han, 2005 p. 329)

Results from the IMARC surveys (which were described in detail in chapter two) were processed using SPSS analysis software. Application of factor analysis, using Kaiser-Meyer-Olkin and ANOVA tests, lead the researchers to identify five needs-based segments: TechnoToy; Mobile Professionals; Sophisticates; Socialites, and Lifestylers (Gilbert & Han, 2003b). A later publication (Gilbert & Han, 2005), relies on this same model, claiming, simply, that the later surveys reinforced that model. The two 2005 papers cited (Gilbert & Han, 2005; Gilbert et al., 2005) refer to the earlier surveys, but not any substantive research since then.

3.2.6 Intentions to Use Mobile Services: Antecedents and Cross-Service Comparisons

The following research review addresses the issue of customer intentions in adoption (Nysveen et al., 2005). This section concentrates on the methodology they used by Nysveen et al. Subsections review the overall methodology, and explain the design of their study.

3.2.6.1 Overview

In order to explain consumer's intention to use mobile services, Nysveen *et al* (2005) adapted theories from a variety of research fields, to produce an 'integrated' model. This new model is based on the Technology Acceptance Model (TAM) already covered in this thesis. Nysveen *et al* (2005) propose four additional considerations in developing their model. They agree with other authors who maintain that an adoption model should include environmental subjective norms (adapting aspects of the Theory of Reasoned Action (TRA) to achieve this).

Secondly, the TAM does not consider cost to the individual. Use of mobile services will be influenced by charges from both the supplier of the service, and the supplier of the mobile network on which it runs. The Theory of Planned Behaviour (TPB) has elements that can accommodate these costs.

Thirdly, TAM was developed by considering utilitarian values within a business. Mobile services adoption will generally be influenced by nonutilitarian values such as expectations of expressiveness, and enjoyment. The authors aim to include these values in their model by drawing on uses and gratification research, and domestication research.

The fourth observation by the authors is that TAM typically only explains about 40% of the variance in intention to use various technologies. Nysveen *et al* (2005) consider that their use of aspects of TRA and TPB from information systems theory, along with aspects of uses and gratification research, and domestication research, which Pedersen & Ling (2002) attribute to communication theory and social science theory, respectively. The authors conclude that the intentions of consumers to use mobile services can best be explained by developing a model that combines theories from various contexts outlined above.

3.2.6.2 Study Design

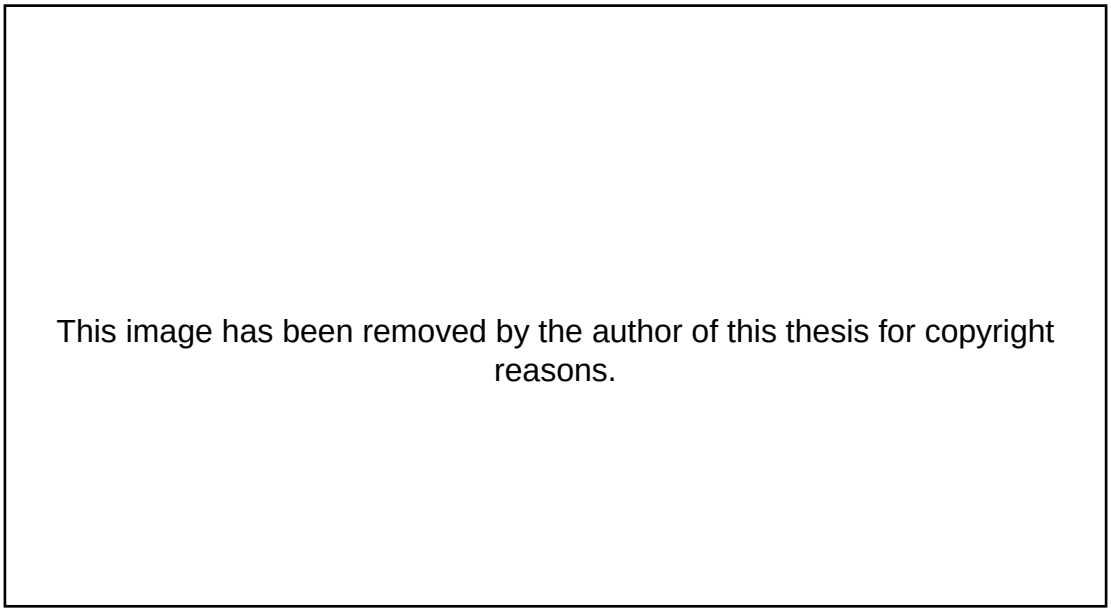
Nysveen *et al* (2005) use 10 hypotheses to explain intentions to use mobile services. These are divided into two categories. Direct and indirect affects on intentions include hypotheses to identify the factors that affect intention to use mobile services (hypothesis

1a), and the attitude toward using them (hypothesis 1b). Hypothesis 1c suggests that attitude toward using mobile services is a mediating influence on the motivation to use.

The second category, cross-service comparisons, considers various target attributes, and hypothesises the relative motivation each target will exert on two types of mobile service. The four mobile services considered are individual text messaging services, group ('Contact Services') text messaging services, use of mobile devices for payments, and playing games.

The remaining seven hypotheses are summarised in Table 7 below.

Table 7: Summary of Hypotheses of Cross-Service Comparisons Proposed by Nysveen *et al* (2005).



Nysveen *et al* (2005) conducted four individual surveys. These used a quasi-experimental setting, and one-group posttest design. Each of the four services referred to above was tested using a different type of survey and different respondents. Text messaging was investigated using surveys conducted, in class time, at three upper secondary schools. A web-based survey was used to gain responses regarding contact services. The survey was publicised extensively online. A Scandinavian mobile phone company provided publicity for the payments service survey. A recruitment message was added when pre-pay subscribers requested an account balance. Subscribers could either go to a web site to complete the survey, or respond by txt, in which case they would be contacted, and posted a paper survey form. Relevant Internet discussion forums were used to elicit respondents for the gaming services survey. This survey, like contact services, was entirely web-based.

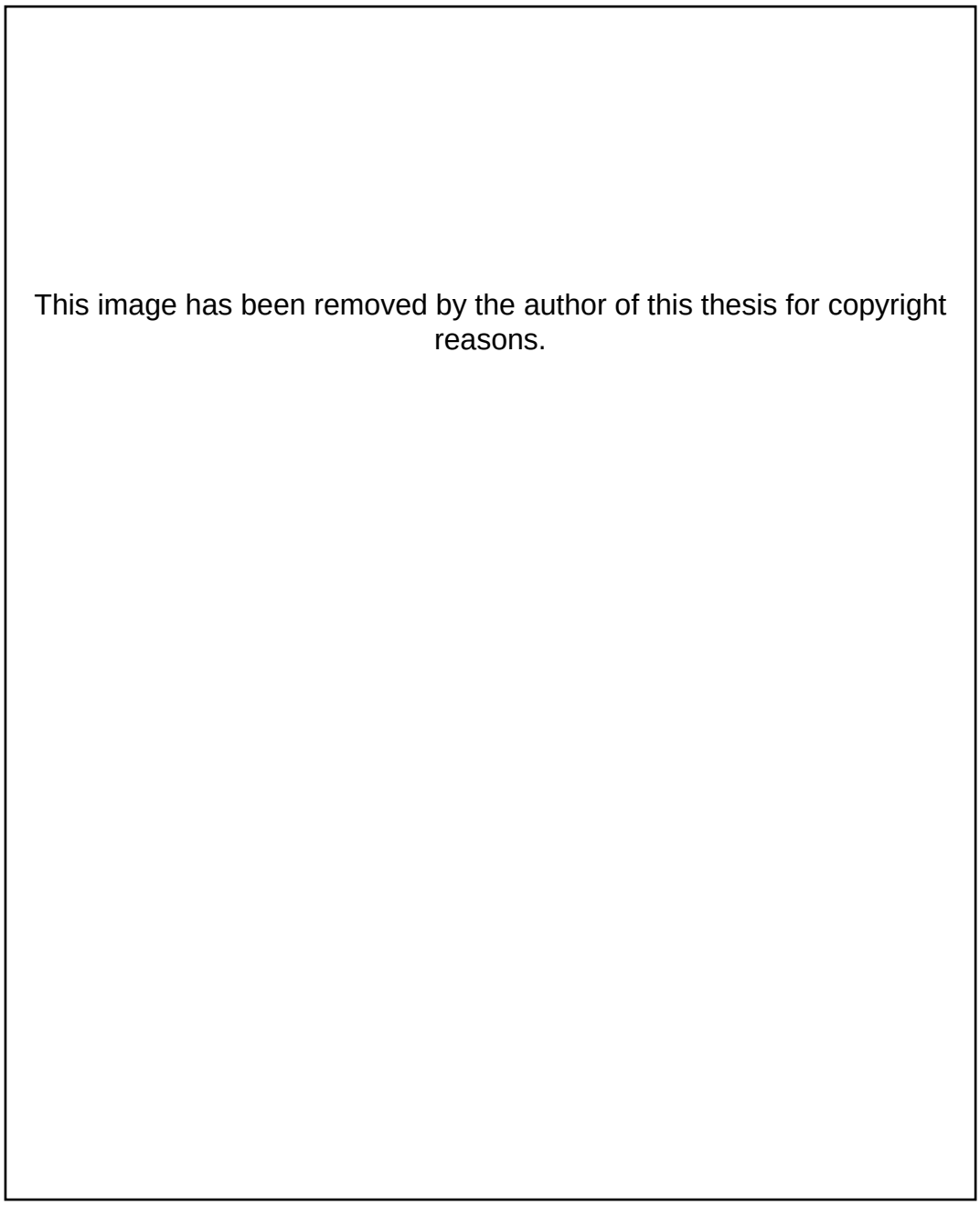


Figure 11 – Model developed by Nysveen *et al* (2005 p. 336).

Most surveys required participants to indicate their agreement to various statements, using a seven-point scale ranging from strongly disagree to strongly agree. Attitude towards use was measured using a seven-point scale to choose between two bi-polar opposites. In order to test the hypotheses, Nysveen *et al* created a model showing the outcomes from their surveys. This model is reproduced in Figure 11 above.

This model shows that, overall, 72.3 percent of intention to use the various technologies being studied is explained by the Nysveen *et al* (2005) model. This contrasts favourably with the 40% explanation they claim is typical of TAM on its own. The motivational variables studied explain 63.2% of the attitude towards using mobile

services. In order to get meaningful comparisons between the four services in this study, a variety of variables must be controlled for. Different types of surveys, and different sample populations, were used to gain data for each service. Overall, all four parts of hypothesis 1 were supported, and there was significant support for five out of seven parts in hypothesis 2.

3.3 RESEARCH QUESTION AND HYPOTHESES

The review of previous research approaches and methods provides guidance on how to go about a field study. Various problem areas were identified in chapter two, where further research is necessary. In order to make future predictions regarding mobile data services adoption in New Zealand, it is necessary to know:

Will consumers adopt Mobile Data Services (MDS) in the future?

This research is going to test whether adoption intentions of the participants are consistent with Rogers' Diffusion of Innovation model (2003). A key element of this model is consumer segmentation based on propensity to adopt technology. The first hypothesis to be tested will assist with this segmentation. Subsequently, other aspects of this research can be tested for consistency with Rogers' model, including his hypothesized segmentation and characteristics of each segment.

H0: Technology Readiness will have a direct effect on adoption.

The main tool used to assess technology readiness is the Technology Readiness Index (TRI) (Parasuraman, 2000). This is a multifaceted questionnaire that has been steadily refined since 1999 (Rockbridge, 2007). Parasuraman (2000) describes the comprehensive process used to develop this survey. The version used in the current research comprises ten questions. The author obtained the TRI survey questions, permission to use the tool, and directions in its use, from Rockbridge Associates Inc., which, in association with Parasuraman, retains copyright on the questions and processes.

Rogers finds that people learn about services that are new to them from various sources (Rogers, 2003). These are detailed in chapter two. Prediction of adoption of MDS will be aided by knowledge of how consumers learn about the services:

H1: Consumers will learn about available MDS from a range of sources consistent with Rogers' research.

Some of the technology readiness questions relate to where consumers source information about an innovation. The current research includes questions to ensure that this hypothesis is addressed clearly. The adoption pattern of Roger's diffusion model suggests total adoption of a technology is constantly growing as the technology becomes more mature. H2 hypothesises that consumer propensity towards adoption will reflect this aspect of the model. Discussion of Rogers (2003) in chapter two pointed out that this

maturity, or, conversely, 'newness' as Rogers refers to it, refers to the perception of the consumer, rather than any objective assessment of the age of an innovation.

H2: Consumers will be more likely to adopt MDS services perceived as being mature.

Survey participants will be asked to rank the maturity of a selection of services available from mobile devices. Segmentation of consumers is central to Rogers (2003) model. The model suggests that adoption overall will follow a normal distribution, and the two largest segments (Early Majority and Late Majority) will each account for one standard deviation on each side of the mean.

H3: Intention to adopt MDS services will follow a normal distribution, consistent with Rogers' research.

Survey participants will be asked to state their current usage of, or the likelihood they will adopt, the same selection of services used in the 'maturity' question. H0, H1, and H2 contribute to a segmentation of the participants, as required by Rogers' model. H3 hypothesizes that this segmentation will form a normal distribution, as described in chapter two.

The relationships between various constructs within these hypotheses are shown in Figure 12 below. Segmentation, into the five segments identified by Rogers, is determined by responses to the Technology Readiness Index (TRI), together with responses relating to knowledge sources about, and perceptions of, Mobile Data Services (MDS). These questions, together, will suggest the likely intention to adopt MDS. Adoption questions will support the extrapolated distribution of the participants intention to adopt.

3.4 RESEARCH DESIGN

This research design is organized into four phases:

Phase One: Syntheses of literature & design of survey.

A literature review and analysis has resulted in definition of: the research question; the initial research model, and the research hypothesis. From that basis, the initial research methodology and survey instrument has been determined.

Phase Two: Refinement of survey instrument.

The survey instrument will be tested by a range of volunteers. It will be refined based on feedback from that group.

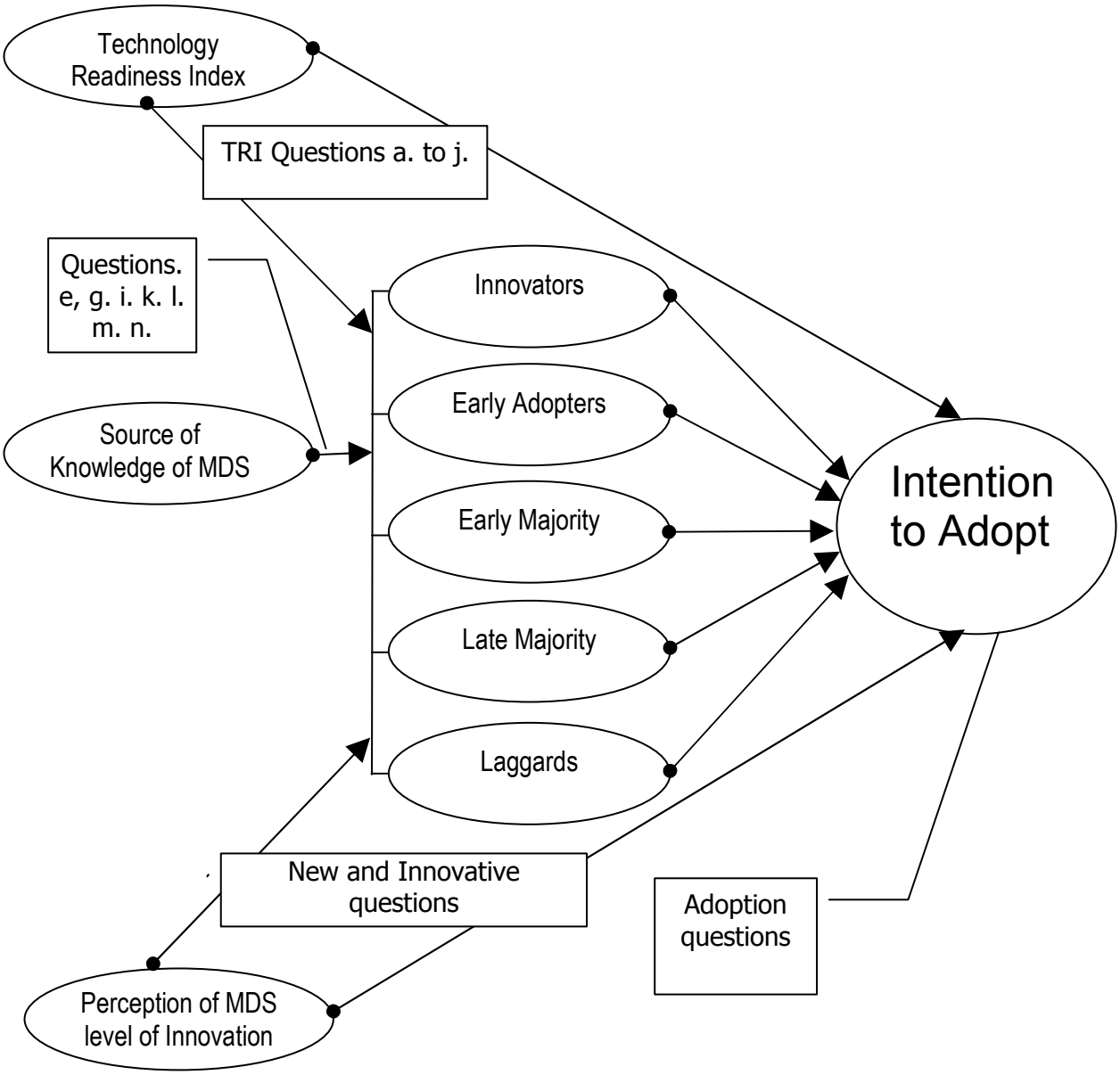


Figure 12 – Initial Research Model.

Phase Three: Data Collection.

The refined instrument will be used to collect quantitative data from a large sample.

Phase Four: Testing the model & hypotheses, presenting the results.

Once results are available from phase three, the Statistical Package for the Social Sciences (SPSS) will be used to apply various statistical procedures to support or disprove the hypotheses, with a high level of confidence.

3.4.1 Syntheses of literature & design of survey.

This section summarises the steps involved in the first phase of the current research.

3.4.1.1 Consideration of Literature

The current survey instrument contains a selection of ten questions from the Technology Readiness Index. These have been thoroughly tested and refined by Parasuraman (Parasuraman, 2000; Rockbridge, 2007). This tool will be used in the manner recommended by its author.

Davis uses his Technology Acceptance Model (TAM) to evaluate adoption of e-mail and a text editor (Davis *et al.*, 1989). He also compared TAM with the Theory of Reasoned Action (TRA), considering adoption of a word processor (Davis, 1993). Recent research has continued to use TAM. In an analysis of 13 integrative studies of technology acceptance, Yi *et al* (2006) noted that all were based on TAM, adapted with one or more other theories. Information Diffusion Theory (IDT) was considered in eight of the 13 studies. Theory of Planned Behaviour (TPB) was considered in six studies. Other theoretical bases were considered in three or less of the studies. For their own study, Yi *et al* (2005) used the three models they identified as the most common – TAM, IDT, and TPB. Nysveen *et al* (1993), in the study described in section 3.2.5 above, based their model on TAM, TPB, and TRA, in addition to other research disciplines mentioned above. It is noteworthy that most TAM studies, including Davis (Gilbert & Han, 2003a, 2003b, 2005; Gilbert & Kendall, 2003), Yi *et al* and Nysveen *et al*, have tested their models by being able to gather behaviour intention, and then measure actual results.

A different approach has been followed in the various studies lead by Gilbert (Rogers, 2003). These studies were based on Information Diffusion Theory (IDT) (Rogers, 2003), without consideration of the Technology Acceptance Model (TAM) and related models (TPB, TRA). Gilbert *et al* used factor analysis to develop a segmentation model based on IDT.

3.4.1.2 Design of Current Research

This research includes surveying consumer intentions, but analysis of actual buyer behaviour is beyond the current scope. Information Diffusion Theory (IDT) suggests a number of outcomes that could be expected in this situation, so IDT will be used as a research focus. This is consistent with Gilbert *et al*.

3.4.1.3 Participant Selection

Copies of the survey, inviting participants to take part, will be distributed at targeted tertiary education institutes. Each paper survey will be numbered. Participants can fill out the survey on paper, or fill out a web-based version, for which they will need a valid number. Participants do not have to be current students.

3.4.1.4 Survey Objectives and Design

The hypotheses to be tested are listed in section 3.3 above. Results will be judged for fit in the initial research model (Figure 12). While this survey will elicit responses from a wide variety of users, marketing for Mobile Data Services (MDS) is often targeted to the youth market, so this market will be targeted closely by the survey.

The survey instrument will consist of questions requiring the respondents to select options from a list, or select a response from a Likert scale of 1 – 5. Paper-based and web-based options will be available to attract the widest possible response rate from the target audience.

The survey consists of:

- Ten questions that comprise the Technology Readiness Index (TRI) which is copyrighted by A. Parasuraman and Rockbridge Associates, Inc., 1999. This scale is being used with written permission from the authors, who have developed and refined it continuously since 1999. They state that "the questions have been thoroughly tested and are compared to norms where they were asked in another survey. This includes the respondent instructions, attribute wordings and scale anchoring."
- Some of the TRI questions contribute to 'Source of Knowledge' construct. Four additional questions are included to confirm this construct.
- Participants will then be presented with a list of twelve types of Mobile Data Services (MDS), and asked to rank their perception of the innovativeness, or 'newness' of each service. Ranking will be from a Likert scale of 1 – 5, with options for 'do not know of this service', 'prefer not to answer', and 'have no opinion'.
- A final section of the survey uses the same list of types of MDS, this time asking the participant to rank the likelihood they will adopt each technology. This is also a five-point Likert scale, with the same additional options listed for the previous section.

3.4.2 Refinement of Survey Instrument

Pilot feedback will be obtained from two sources: 'expert' stakeholders can comment on the survey instrument from various perspectives, including academic, industry and user views, while 'candidate participants' can comment on various usability aspects of the survey instrument. These people will not be directly asked to fill in the final survey however the anonymous nature of the survey means they cannot be positively excluded.

This feedback will be used to add or delete items in the instrument, and refine layout and presentation.

3.4.3 Data Collection

The researcher will be co-ordinating collection of data directly, with the assistance of an experienced secretary, who has offered to assist with administration. The institutions' Intranets will be used to encourage participants from that institution to use the web-based version of the survey. In addition the researcher and associates will distribute paper-based versions.

3.4.4 Testing the model & hypotheses, presenting the results.

Initial estimates suggest that 120 responses will be necessary to get a power function with 80% performance. Increased number of respondents would provide a more reliable result. The analysis techniques being used do scale well, so increased numbers will be welcome.

Regression testing will be extended by use of structural equation modelling (SEM). This technique takes into account the modelling of interactions within the model, non-linear relationships, correlated independent variables, and a number of other indicators not found by standard multiple regression testing. The hypotheses being tested by this study are represented by the Initial Research Model - Figure 12 above. SEM analysis can lead to acceptance or rejection for asserted relationships between variables and causal influences in the model.

The final test requires completion to see if the initial research model fits the data, The hypothesised relationships can be tested using a variance-covariance matrix and looking for small values. Taking a holistic view of all the measures in relation to the substantive result can be used to address validity. The distribution of results for participants' intention to adopt will determine whether hypothesis H3 is supported.

The final judgement on the results depends on an honest appraisal of the data, the analysis, and the implications in the real world.

3.5 CONCLUSION

This chapter has set out the methodology of the current research. Various methodologies were reviewed, and that it was shown how the reviews lead to the development of a structure for the current research. Specific research questions were defined and discussed. The initial research model was defined, based on previous research, and the current research questions. A quantitative survey is the data collection instrument for this research. It will be available to participants in electronic and paper-based formats.

Analysis of results will be based on structural equation modelling, using the SPSS analysis package. The methodology described in this chapter will be implemented, and then the analysis of findings reported in the next chapter.

Chapter Four

RESEARCH FINDINGS

4.1 INTRODUCTION

This chapter presents the results and analysis of implementing the survey explained in detail in chapter three. Various issues and solutions are discussed in relation to each part of the survey process. That process includes creation of the survey forms, conducting a pilot survey, conducting the main survey, performing statistical analysis on the results, and discussing the implications of the statistical analysis.

Initially, the pilot study will be reviewed. At this stage, various layout and wording issues were raised by the pilot. Strategies were used to address feedback from the pilot and during surveying, some more issues were raised, and addressed. This process is explained. Statistical manipulation of the survey results enabled an analysis of the data, leading to support for some of the hypotheses tested, and the rejection of others. Areas where support was weak are addressed by additional analysis.

The research findings are presented in sections corresponding to the physical stages. The survey was conducted using printed questionnaires, and an online service. This chapter sets out the processes required to administer the survey, and a path is mapped out explaining the survey, data analysis, and conclusions reached. Results from the analysis follow, and a conclusion draws together all of the findings.

4.2 PILOT STUDY RESULTS

The same survey was run with printed and online variations. The author asked 30 people to try each one. Twenty-four people returned feedback, either via email, verbally, or within forms provided in the online survey. The trialists included volunteers from students and academic staff from Whitireia Community Polytechnic, the Information Technology (IT) industry, and volunteers with no technical background. Providing the questionnaire in both printed and online formats worked well, and broadened the reach of the survey, however, supporting two formats also created challenges. The processes involved in creating and supporting a survey with two different media are examined.

The current section addresses all issues relating to the physical characteristics of the survey. There are three sub-sections. They define the issues relating to the printed and online surveys. Common issues are then defined along with implications and solutions. The section ends with a summary of the overall pilot study process.

4.2.1 Printed Survey

The initial trial of the printed survey was presented in a common single page format, printed on both sides of a A4 sheet. Questions ran down the page, in a portrait orientation. One side of the page contained Technology Readiness Index (TRI) questions, from Rockbridge (2007) along with additional "Source of knowledge" questions. While these questions came from two different sources, and were analysed differently, they were presented to the participants as one group. Throughout chapter four, the term 'readiness questions' will be used to refer collectively to the TRI and source of knowledge questions. The other side of the A4 page required participants to indicate their perception of maturity of, and likely adoption of, 14 different mobile data services (MDS). The perception/adoption questions were in two separate tables, and the list of MDS services was provided in each table.

Various minor typographical issues, such as spelling mistakes, or ambiguous wording, were noted and addressed. The most significant issue relating to the first page was a requirement to clarify that questions were addressing technology adoption overall. Some trialists asked if they should only consider online technologies when answering these questions. The intent of the questions was clarified by adding further instructions, including the request that all technologies should be considered, not just online activities. Trialists also felt that text of the readiness section was 'squashed', and hard to read. This was resolved by increasing the font size. The format of the perception and adoption page was unpopular. Trialists complained that the two sections were repetitive. It had been designed this way because each of the two tables was addressing the same services – once to assess perception of maturity and once to assess adoption intentions.

The use of colour enhanced the overall readability of the survey. This allowed use of a wider font for the readiness questions, while leaving less space between questions, so they would fit in the same total space. Alternate lines were shaded yellow, which made them easier to read, despite being closer together. The perception and adoption questions were totally rearranged. Previously, there were two tables of services, with seven options for each of 14 services. After realigning, there was one table, with 13 options for each service. In order to accommodate the longer rows in the perception and adoption section, the orientation was changed to landscape, and the page folded in half. The use of 13 columns became feasible with the introduction of colour to enable participants to easily read the whole length of the lines. In summary, the revised survey consisted of three sections, printed on an A4 sheet folded in half, making an A5 (148mm x 210mm) 'booklet' format. The 'cover' consisted of a brief title, and the readiness questions. Inside the booklet, the perception and adoption section took up the whole A4

spread. The 'back' consisted of necessary ethics and descriptive information. The surveys used were printed on 180gsm light card. Retesting confirmed the new design was easier to use. Participants found it easier to fill out – none expressed any difficulty writing on the form. Other feedback was that it was easier to follow, and no longer seemed repetitive. An example of the final layout of the printed survey is included in Appendix II.

Four demographic questions were included, covering gender, age, income, and occupational status. None of the hypotheses in this research are dependant on these items, however this information allows analysis of subgroups within the survey respondents. There are two reasons for requesting this information: it could aid interpretation of variations in the results, and demographic information can also be used to gauge how closely the sample matches the population. There were no comments about the demographic questions during the survey process. Ten participants chose not to complete the demographic questions.

4.2.2 Online Survey

The service 'SurveyMonkey.com' was selected to collect online responses. Before selecting this service, the author considered: the recommendation of colleagues; observation of online surveys he has been asked to complete and confirmation that SurveyMonkey could meet the needs of the current research. SurveyMonkey met these criteria, and was very reasonably priced. A free version of the service was used for the trial, and the author paid $US20 to gain access to all SurveyMonkey features for the main survey for one month. The extra features enhanced flexibility in the survey design, including branding, and layout options. The author was also able to redirect participants from the final survey page to a web page giving more information about the survey.

Development of the survey instrument followed the pattern used for the printed survey. Initially, the survey consisted of three sections: readiness, perception, adoption. The wording and layout of the readiness section was very similar to the corresponding section on the printed form. The most significant difference was that the order of questions was randomised. This was following instructions provided by the publishers of the Technology Readiness Index. Like the printed form, initially each service was mentioned twice – once in the perception section, once in the adoption section. The trial online survey included additional text boxes to enable trialists to enter comments. After reflecting on feedback from both forms of the survey, the format of the online survey was changed in a similar way to the printed survey – each service was mentioned once only. A separate question was created for each service, with perception and adoption questions for that service on the same screen. This removed duplication, and removed an issue

where participants were required to scroll up and down the screen, meaning the column headings disappeared from view. As mentioned above, text boxes were created to enable trialists to add feedback comments. After due consideration, the author decided that leaving these fields would provide participants with an option to add more information, with no significant negative effect on responses to the survey.

The online format also lends itself to provision of additional information. Following the SurveyMonkey software functionality, 'questions' without responses were used to provide ethics and descriptive information. A brief description of each service was added to each of the perception/adoption questions. Upon completion of the online survey, the participant was taken to a page written by the author, which included research details, and a link to a page listing all the services, with descriptions.

4.2.3 Implications and Solutions from Feedback

It is significant that there was no negative feedback from the ten Technology Readiness Index (TRI) questions. This confirms the value of using questions that have been field tested by thousands of participants, over a number of years (Parasuraman, 2000). The readiness section includes four questions that are not from the TRI. There were three suggestions for minor improvements to these questions, which were applied to the final surveys. One was a typing error, and the others related to ambiguous wording in some questions.

There was one major issue with the last readiness question. Unfortunately, it was noticed after the trial period, too late to incorporate a change to the printed survey. The question is: 'Technology for its own sake has no interest to me. I must have a good reason to buy something new'. This is two questions, and the participant might prefer to make two separate answers. The online survey was changed to reflect the two different questions. Changing the online survey in this way enabled an analysis of the differences between answers to each 'half' of the question. Treatment of this issue will be explained in section 4.4.2.1 below.

One question raised by survey trialists and participants was the necessity of a definition of 'mature' for the perception questions. Rogers (2003) makes it clear that in the context of his adoption model, the individual's adoption decision is a function of the perception of maturity in the mind of the individual. The current research considers adoption intentions in relation to perceived maturity of a service. For this reason, no definition of maturity is necessary.

During the planning phase of this survey, the author considered offering a small incentive to attract participants. Discussion with research colleagues and trial participants suggested an incentive would be unnecessary. It was always recognised that an incentive

could prejudice results by motivating participants to complete incorrect or multiple responses, simply to get the incentive. Data collection experience confirmed that no incentive was necessary. The author had no difficulty getting the required number of responses.

4.3 MAIN SURVEY

Once feedback from the trial was incorporated, the main survey was undertaken. This section provides details of the survey process and analysis. An explanation of the survey process is divided into separate sub-sections for the printed and online media of the survey. There were some different requirements for each format of the survey during the trial period. Likewise, each format required different treatment for the main survey. Those differences are reflected here.

Following the format of section 4.2 above, this section separately describes the processes for the printed and online survey media. The analysis sub-section describes how the output from the two media of the survey was brought together for processing. The combined output is then put in a format for input into analysis software, which leads into section 4.4 below.

4.3.1 Process

This section describes the various methods used to get responses to the printed and online media of the survey. Data was collected during September 2007. The collection process was different for each version of the survey. Collection of data was successful with each version successfully obtaining responses from a range of target participants. There are few commonalities in the collection process between the printed and online media of the survey, so a subsection is allocated to each version.

4.3.1.1 Printed Survey

Survey forms were printed on a colour laser printer. Once both sides of the card were printed, they were run through the printer again to print a three digit sequential number on each form. Numbering each survey form, and numbering the answer options for each question, made it easier to ensure reliability during data entry. Answers for the readiness questions were numbered from 1 to 7. The perception/adoption answers were numbered from 1 to 13.

The author approached the Marketing Group at Victoria University of Wellington to ask about getting permission to run the survey on campus. After consultation with the Head of Ethics, they advised there was no issue with approaching students in public spaces around the university. The marketing group analyst was sent a

copy of the survey as a courtesy. The surveys were distributed on two different days, in the Victoria University Student Union Building, and the University Quad, between the hours of 12:00pm and 2:00pm. The author collected all of these responses, by approaching participants directly. The unstructured method of inviting potential participants to complete a survey made it difficult to calculate a meaningful rate of response. Subjectively, the author observed that approximately 10% of those approached declined to accept a survey form. Of those survey forms returned, a significant number were not fully completed. Section 4.4.1.4 below describes the analysis used to deal with missing values.

Data from the survey forms was entered into an Excel spreadsheet that was laid out in the same format as the printed survey. Fourteen rows were used to enter readiness responses down one column. Two columns, and 14 rows, were used to enter the perception/adoption questions, followed by four rows for the demographic data. This data structure was then manipulated in another worksheet to provide a tabulated format that was easier to process. A lookup function was used to read values from the tabulated format to one that could be directly read into data analysis software. All survey forms were checked against the tabulated data record, to verify there were no data entry or data manipulation errors.

4.3.1.2 Online Survey

Questions were kept the same between the two media of the survey, which resulted in consistent feedback. Participants were recruited from within the Whitireia Community Polytechnic (Whitireia) community. The solicitation methods were targeted at both staff and students.

Ethics approval was needed to run the survey at Whitireia. This required writing an application to the institution's ethics committee, and defending the proposal when it was considered at a meeting. Approval was granted, and the online version of the survey was publicised in an internal newsletter, and as an announcement on the Whitireia student learning system (Blackboard). The survey service provider (SurveyMonkey.com) provided the time, date, and IP address for each completed survey. Cursory observation of the IP addresses and dates suggests that about 20 responses were motivated by the internal newsletter. The newsletter is published on Thursdays, and all responses during that day and the following Friday were from within Whitireia. There were some more internal responses during the rest of the survey period, however most (75%) of the remaining responses came from outside Whitireia. The distribution of IP addresses among participants suggests responses within 36 hours of publishing of the newsletter were likely to be a result of reading the newsletter article. Remaining responses are likely

to have been prompted by the announcement on Blackboard, which students and staff would often read from home.

Data collected online was presented by SurveyMonkey.com in a tabulated format using actual text of the response, rather than an index number. This data was imported into Excel, and lookup tables were used to translate the text fields into index numbers consistent with those used in the printed survey. Additional fields are available from SurveyMonkey.com: RespondentID is a pseudo-random number which can be used to refer to each response; StartDate is the date and time the participant started filling out the survey; EndDate is the date and time the survey was completed or abandoned and IP Address is the apparent Internet address of the computer used to access the survey. These fields have been used in section 4.3.1.2 above to make casual observations regarding the survey process.

4.4 DATA ANALYSIS

Once all data was in a spreadsheet, it could be manipulated as one dataset. This section breaks down the various operations performed on the data, to show how the author was able to generate statistical results necessary to present a valid and reliable interpretation of the survey data. Section 4.3.1 above explained how results from the printed surveys were entered into an Excel spreadsheet in a person-friendly format, then changed to be more software-friendly. Results from the online survey were supplied in a machine readable format, however, they too needed to be manipulated to enable statistical analysis. Figure 14 below depicts the data manipulation necessary to put all observed results, and calculated results, into a single dataset.

Four hypotheses were introduced in chapter three. Analysis of the results of the survey conducted in this research will show the strengths and weaknesses of those hypotheses in the surveyed sample. Conclusions will then be drawn for the population at large. Those hypotheses depend on assessment of interrelationships between a number of variables. Structural equation modelling (SEM) is a technique that enables testing of a range of interrelated variables in a single model (Hair *et al.*, 1998). SEM is used in this section to define, in mathematical terms, the model being tested, and demonstrate how well the data collected fits the initial research model.

Section 4.3.1 illustrated the initial data gathering and entry process for each version of the survey. Once the data was in a consistent state, it could be manipulated as one dataset. The current section defines data manipulation used to test the model fit for this data. Various assumptions are explained, with reference to the literature. Finally, the mathematical manipulation is brought together to present the information necessary to assess the hypotheses that make up the current study. The first sub-section defines the

processing required to arrive at the necessary model constructs. The resulting constructs are used to develop a model that can be used to accept or reject the hypotheses being considered in this thesis. Subsections below show the development of the model.

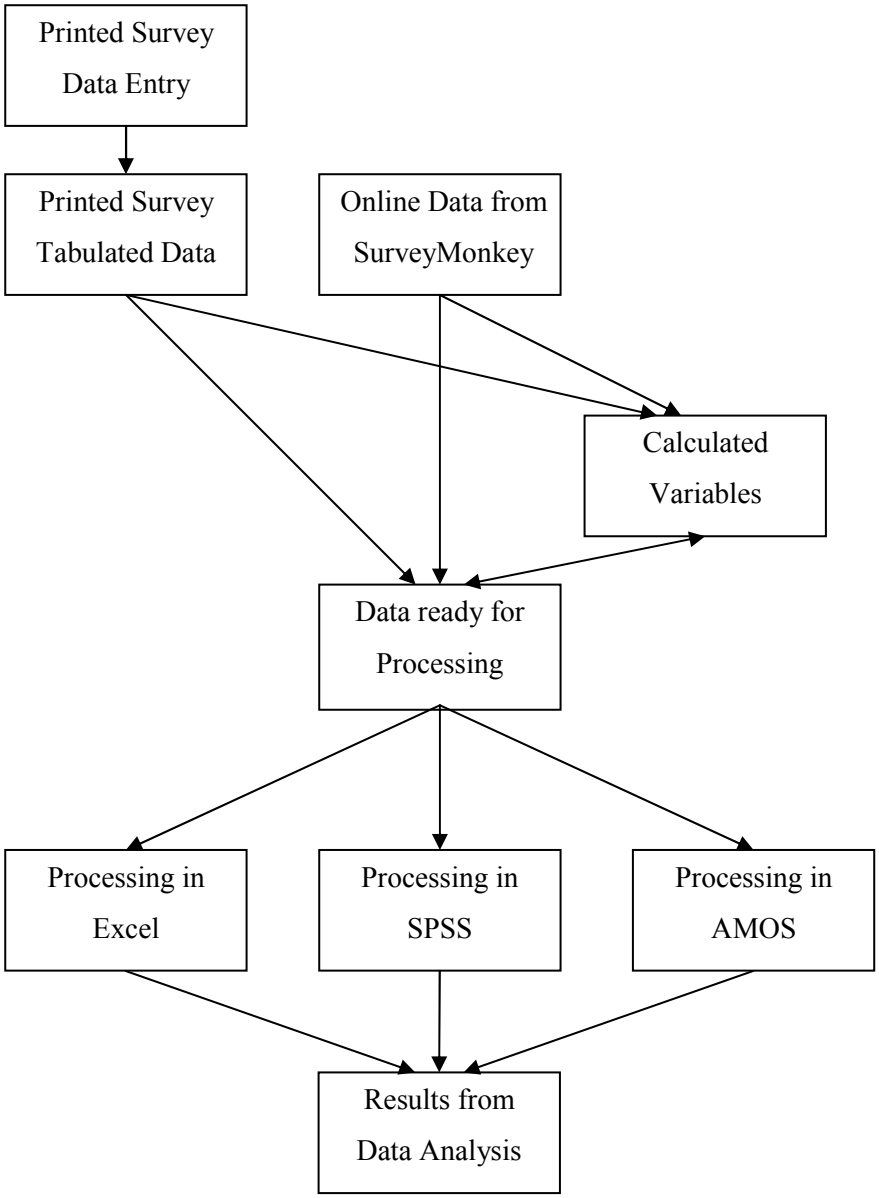


Figure 14 – Overall Data Analysis process.

4.4.1 Calculated Constructs

The constructs in the initial research model each represent an indicator that needs to be calculated from the directly measured items in this survey. The calculation process is described here. Each subsection defines the calculation of one of the constructs.

4.4.1.1 Technology Readiness Index

The research of Parasuraman (2000) has lead to the Technology Readiness Index (TRI). This instrument is copyrighted by A. Parasuraman and Rockbridge Associates, Inc., 1999, and is being used with written permission from the authors. It is incorporated into the current research in the first ten questions of the survey. In unpublished instructions for use of the TRI, Parasuraman describes how to calculate the index. The scale is divided into four sections. Appendix II lists the questions, which are divided in this way: Optimism - questions a. c; Innovation – e. g. i; Insecurity – d. b. f; Discomfort – h. j. Each question is 'scored' out of six, according to the six options in the answer. An average index is calculated for each division, and the TRI is derived from there, by adding the appropriate divisions. Optimism and innovation provide a positive contribution to the TRI, while insecurity and discomfort are negative, and must be subtracted from six to get the necessary result:

TRI = Optimism + Innovation + (6-Insecurity) + (6-Discomfort).

4.4.1.2 Knowledge Source Index

The current research requires testing of a correlation between source of knowledge about technology, and adoption. The principles used to calculate the TRI are extended to develop a measure of source of knowledge, which is required to complete the analysis. Some TRI questions directly relate to sources of knowledge, and some others were added to the readiness section of the survey to give a more accurate picture. Six variables make up the Knowledge Source Index (KSI). Each is on a scale of one to five. Six is deducted from the total of individual scores, to give an overall index starting at 1. Note that KSI question 'm' is asked in negative, so it is reversed in this equation. With reference to Appendix I, the following questions make up the KSI:

KSI = e + g + i + k + l + (6-m) – 6

4.4.1.3 Average Perception and Average Intention

The survey instrument listed 14 examples of mobile data services (MDS). Each participant was asked a number of questions with regard to their perception of maturity (perception), and their actual or likely adoption (intention) of each service. It was necessary to form two constructs from this information. These constructs are called "Perception of MDS level of Innovation" and "Intention to Adopt". The author considered making these constructs from the arithmetic mean of the responses to questions in each category. These were subjected to an assessment of reliability (section 4.4.2 below), which found that removing the survey item TXT Usage would improve the normality and reliability of the Intention to Adopt construct. The affect of

TXT Usage on the average is an anomaly explained by the history of the short text message (TXT) service (described in chapter two of this thesis). TXT is clearly far more pervasive than any of the other services being measured, so it has a disproportionate effect on the average intention to adopt across all services.

4.4.1.4 Missing Values

Parasuraman offered further advice for considering 'Prefer not to answer' and null responses in his unpublished instructions for use of the Technology Readiness Index (TRI). Following Parasuraman's advice, where a participant answered 'Prefer not to answer', or left a question blank, that result was recorded as a neutral '3' for the purposes of calculating the TRI and Knowledge Source Index. The same logic was used when arriving at values for the average perception and average intention constructs. Missing (blank, don't know, prefer not to answer) values were replaced by a neutral value (3.5 for the average perception construct, and 2.5 for the average intention construct).

4.4.1.5 Diffusion of Innovation Segmentation

Earlier chapters of this thesis described the segmentation model developed by Rogers (1962). The initial research model considers the relationships between the constructs described in sections 4.4.1.1 to 4.4.1.4 above. In order to examine this, the survey participants need to be grouped into the five segments defined by Rogers: Innovators; Early Adopters; Early Majority; Late Majority and Laggards. According to Rogers' model, each of these segments makes up a specified portion of the population (Rogers 2003). The portions are based on intervals of a standard deviation from the mean. Calculations for the intervals are shown in the 'Basis for Lower Cutoff' column of Table 8 below.

Three constructs contribute to the segmentation of participants: 'Source of Knowledge'; 'Technology Readiness Index' and 'Perception of Innovation'. These three fields are added together to provide the 'Input Segmentation' index. Table 9 below shows the lower cut-off points used to assign each item to a segment, based on the value of the item. For each item, the segment was selected where the item value was equal to or greater than the cut-off point, but less than the next cut-off point.

The segmentation constructs contribute to the 'Intention to Adopt' construct. In the research model specified in chapter three, each segmentation construct will contribute to the 'Intention to Adopt' in accordance with Rogers model. This contribution will be calculated in the same way as the 'Input Segmentation' above. Cut-off points for 'Intention to Adopt' are shown in Table 9 below.

Table 8 Values used in Scale Segmentation process for Input Segmentation

Characteristics of Input Segmentation		Lower Cut-off	Segment	Basis for Lower Cutoff
Mean:	28.2	0	Innovators	
Std Dev:	4.28	19.687	Early Adopters	Mean - 2 * Std Dev
		24.0	Early Majority	Mean - Std Dev
		28.2	Late Majoriity	Mean
		32.5	Laggards	Mean + Std Dev

Table 9 Values used in Scale Segmentation process for Average Intention

Characteristics of Average Intention		Lower Cut-off	Segment	Basis for Lower Cutoff
Mean:	2.3	0	Innovators	
Std Dev:	0.49	1.36	Early Adopters	Mean - 2 * Std Dev
		1.9	Early Majority	Mean - Std Dev
		2.3	Late Majoriity	Mean
		2.8	Laggards	Mean + Std Dev

The output from this process created the segmentation shown in Table 10 below. The 'Expected Result' in Table 10 shows the theoretical result of allocating items based entirely on a normal distribution. A correlation test was used to determine whether the result from the scaling process was closer to the expected distribution than allocation of segments based entirely on the Knowledge Source Index (described in section 4.4.1.2 above). The result from a Spearman's rank correlation is not as reliable as a Pearson's correlation, however it works with non-parametric data (Collis and Hussey 2003). In this case the Spearman's correlation between the Allocation and Expected columns is -0.667. Between Scaling and Expected, the same test gives 0.872. On this basis, the allocation strategy was abandoned, and items were allocated to segments based on the scaling process.

Table 10 Comparison of methods of Diffusion of Innovation Segmentation

Segment	Input Segmentation		Average Intention		Expected Result	
	Number	Percentage	Number	Percentage	Number	Percentage
Innovators	3	1.4%	4	1.9%	5.225	2.5%
Early Adopters	25	12.0%	31	14.8%	24.035	11.5%
Early Majority	84	40.2%	58	27.8%	71.06	34.0%
Late Majoriity	63	30.1%	72	34.4%	71.06	34.0%
Laggards	34	16.3%	44	21.1%	33.44	16.0%

4.4.2 Analysis of Variables

Analysis is required before any conclusions can be drawn from survey data. Various steps in the analysis process are explained here, leading to a clear picture of the relationship between data collected and the hypotheses and questions posed in this thesis. Underlying variables in a research model need to be reliable and valid. Reliability refers to the ability to repeat the research, and get substantially the same results. Confidence that values actually measure what we say they measure is validity.

All of the observed results, and calculations explained in section 4.4.1 above will be tested to ensure they meet specified integrity requirements. The structured equation modelling (SEM) technique will be used to determine a mathematical model from the initial model used in the current research. The mathematical model will then be tested further, to confirm the degree to which the data fits the model being tested.

4.4.2.1 Reliability and Validity

Four constructs were calculated from the survey results, as described in section 4.4.1 above. General descriptive statistics were calculated, including arithmetic mean, standard deviation, kurtosis, and skewness. George & Mallery (2003) recommend that the kurtosis and skewness should be within the range of ±2.0. They describe ±1.0 as 'excellent'. All of the calculated constructs had kurtosis and skewness that were between 0 and 0.6. Detailed analysis of the items that make up Average Intention (Appendix II) shows that one item, "Intention to use short message services" (SMS), has an exceptionally high kurtosis value (25.178). The high kurtosis, considered in combination with the high negative skew for the same item (-4.955), is explained by the fact that SMS is, without doubt, the most popular mobile data service in current use. The negative skew is the result of a disproportionate number of high values (George & Mallery, 2003). The high kurtosis suggests many values around the mean. This is consistent with the likely scenario that a large majority of survey participants already use TXT services. Empirical evidence, and the author's review of literature, suggest this is not the case for any other services. All other descriptive values for the individual perception/adoption items have skewness and kurtosis values within ±2.

While considering issues of validity and reliability, it was necessary to consider the readiness question 'Technology for its own sake has no interest to me. I must have a good reason to buy something new'. The online survey was changed to ask two questions: OwnSake and GoodReason. The printed survey combined the two into one question (in the order shown). The item was labelled 'OwnSake'. A t-test for Equality of Means between Online OwnSake, and the printed survey responses gave a t-test result of

1.811, and Degrees of Freedom of 207 which, according to tables supplied by Collis & Hussey (2003), does not exclude the means being equal with p=0.05. In addition, the 95% confidence interval of the difference between these two questions does include zero. This suggests that respondents to the printed survey tended to answer on the basis of the first question, so it is reasonable to assume their answer is appropriate for the first question. The 'GoodReason' item was dropped from further processing, while 'OwnSake' was retained.

Reliability was tested, using a variety of analysis tools provided by SPSS. A common indicator of the reliability of a series of items to be analysed is Chronbach's Alpha, also known as Coefficient Alpha, or just 'Alpha'. A value above 0.7 is regarded as acceptable (George & Mallery, 2003; Hair et al., 1998). The initial Alpha value for adoption items was a satisfactory 0.861. When calculating reliability for all items, analysis indicated that TXTUsage had the lowest correlation with other items, and removing that item would improve the Alpha value to 0.870. All other adoption items made a positive contribution to the Alpha value, and, hence, reliability of the Intention to Adopt construct.

The descriptive and reliability statistics both offered support for dropping the TXTUsage item. Applying knowledge of the Mobile Data Servcies (MDS) environment also supported this decision – there is sufficient evidence already presented in this thesis to suggest that short text message service is so prevalent there is no need to include it in the current study. The TXTUsage item was removed from further processing. Table 11 below lists four key constructs, and associated descriptive statistics after removal of TXTUsage.

Table 11 Descriptive Statistics for Calculated Variables

Variable	Number of valid entries (N)	Arithmetic Mean	Standard Deviation	Kurtosis		Skewness	
				Statistic	Standard Error	Statistic	Standard Error
TR Index	209	12.5853	1.79290	0.047	0.335	0.216	0.168
Source of Knowledge	209	12.15	3.253	0.393	0.335	-0.103	0.168
Average Perception	209	3.5148	0.7229	0.94	0.335	0.574	0.168
Average Intention	209	2.2502	0.52556	0.094	0.335	0.309	0.168

Factor analysis is used to determine if the number items in an analysis can be reduced by using unobserved factors, one of which can account for the same variance as several items. If a suitable factor is identified, it would be used in place of the original items (George & Mallery, 2003). This analysis can serve two purposes. The number of items

to be processed could be lowered, as variance, previously represented by several items within the population, could be explained by one factor. Secondly, factors can also provide some 'dimensions' to the data, that might not have been obvious from studying the original items alone (Hair et al., 1998). Eigenvalues are measures of how much each factor accounts for variance within the data. For items in the current study, seven factors were found with an eigenvalue greater than one. A value less than one suggests that a factor accounts for less variance than the item it is replacing, and is ignored in this study. A scree plot gives an indication of the number of factors that should be considered. The example shown in Figure 15 below confirms that there are seven factors with an eigenvalue greater than or equal to one. It is commonly agreed that factors should only be used from the steep part of the scree plot, as use of those in the 'scree' at the bottom would remove a significant variance (George & Mallery, 2003; Hair et al., 1998). After consideration of the factor analysis, and the context of the items in the analysis, it was decided that no changes were justified.

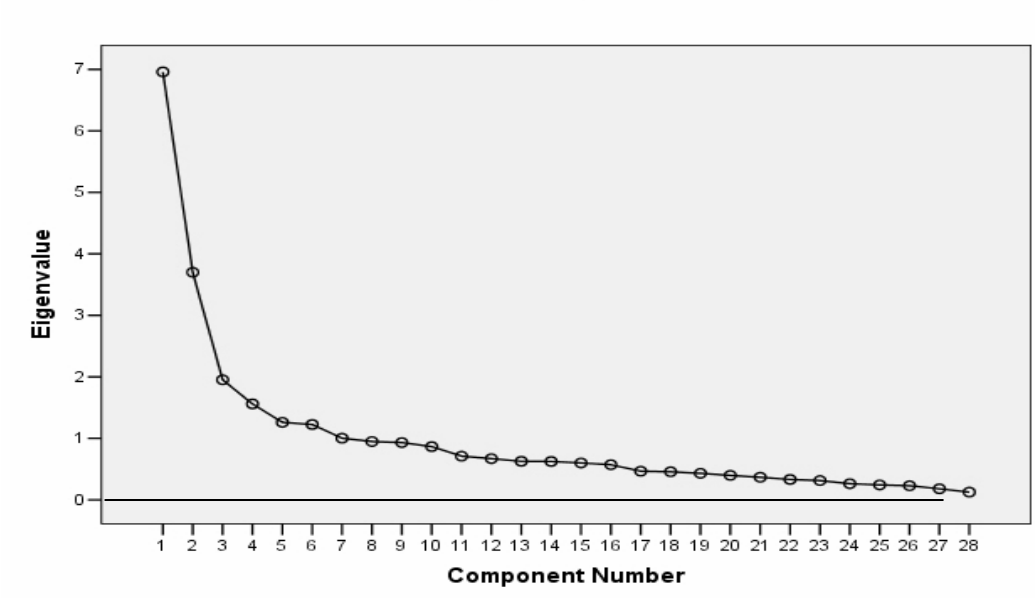


Figure 15 – Scree Plot for Perception and Intention items.

4.4.2.2 Model Fit

A series of causal relationships between constructs in a model can be depicted visually, and so show dependent-independent relationships, correlations, and the degree of effects between constructs (Hair et al., 1998). Such a representation can be shown in a path diagram. The initial research model defined in chapter three will be considered in two stages. Parts of the model are linked by simple dependencies. The model proposes that Technology Readiness Index (TRI) and Perception of MDS Level of Innovation (perception) contribute to an individual's Intention to Adopt (intention) an innovation.

There will be other influences on intention. These influences are represented in the path diagram by an error value. This path diagram is shown in Figure 16 below.

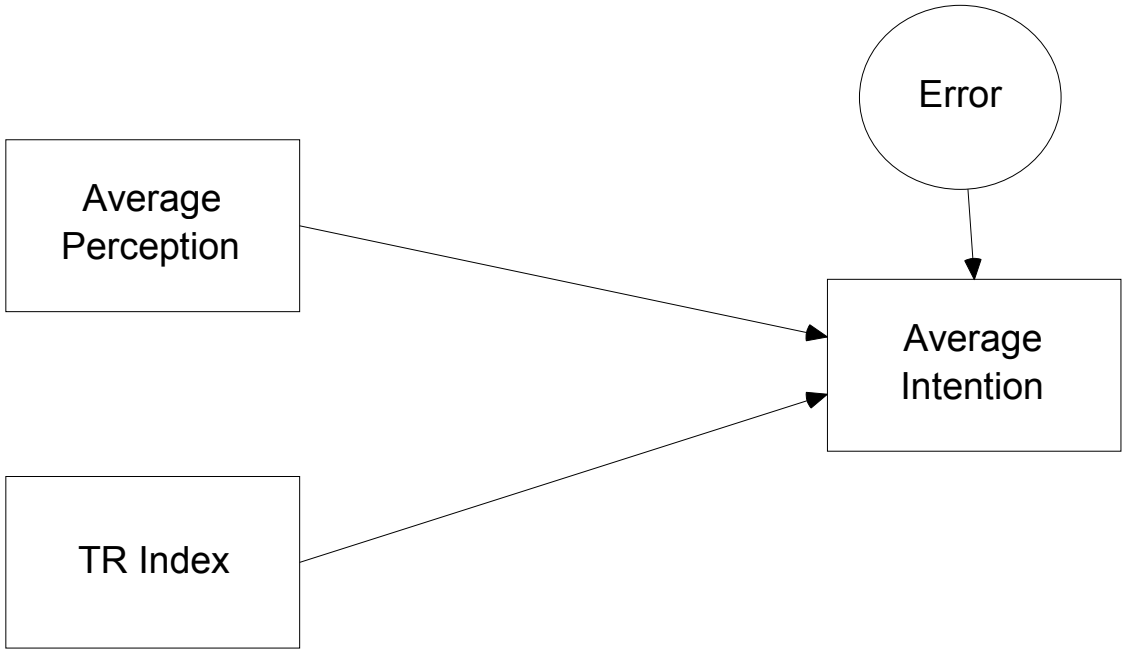


Figure 16 – Path Diagram for Causal Relationships

A number of indices can be used to determine the degree to which a model predicts observed values. A selection of indices have been chosen, based on their appropriateness, as described by Hair *et al*., (1998). The result of applying those indices is shown in Table 12 below. While Hair *et al*., (1998) do not specify an optimal value for Chi square, examples provided suggest 9.571 is a relatively high value. Both 'Adjusted goodness of fit' and 'Normed fit index' are less than the recommended values. From this analysis, it is safe to conclude that the model is not a good fit for the observed values.

Table 12 Indices to predict model fit (based on Hair *et al*., (1998))

Index	**Value**	**Recommend Value**
Chi square (χ^2)	$\chi^2 = 9.571$ df = 1, p = .002	Ratio of χ^2/df should be low.
Goodness of fit	0.971	None specified
Adjusted goodness of fit	0.825	>=0.9
Normed fit index	0.732	>=0.9

The remaining parts of the initial research model depend on segmentation of the survey participants. The method used to calculate the number of participants in each segment is explained in section 4.4.1.5 above. It is shown diagrammatically in Figure 17 below.

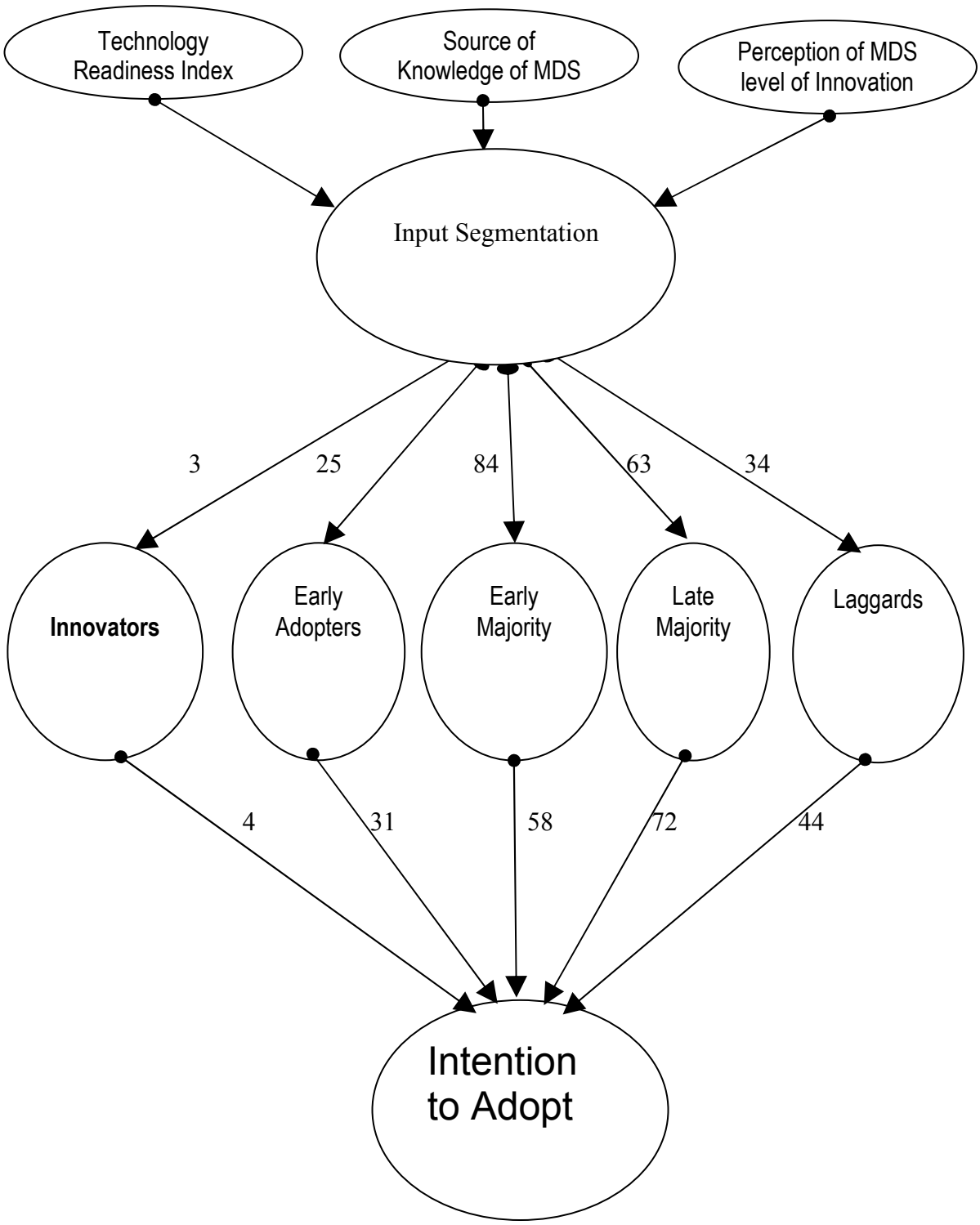


Figure 17 – Estimates of Number of Participants in Each Diffusion of Innovation segment.

Model fit for the segmentation model can be tested by calculating correlation between the two estimates of number of participants. There are two common methods used to calculate correlation. The most popular is Pearson's product correlation coefficient (Pearsons). A common alternative is Spearman's rank correlation coefficient (Spearman's rho) (Collis and Hussey 2003). Pearsons is a more reliable, parametric,

technique, however, it requires the data to be normally distributed, with similar variances. Spearman's rho is non-parametric, and not as powerful, however, it is more accommodating of skewed data. When calculating correlations for this model, the number of items considered is five, which is a small N value when considering normality (Hair *et al*.;1998), and Table 13 below shows that the variance statistics are not similar. The small N value, and different variance suggest use of Spearman's rho is appropriate, however the data does meet other criteria for Pearsons, so a correlation was calculated using each method. The results of the correlations are shown in Table 14 below.

Table 13 Descriptive Statistics for Segmentation Scales

Segmented Variable	Number of valid entries (N)	Arithmetic Mean	Standard Deviation	Kurtosis	Skewness	Variance
Input	5	41.8	31.9	-1.12	0.27	1019.7
Intention	5	41.8	26.1	-0.037	-0.55	681.2

Table 14 Correlation for Segmentation Scales

	Correlation between Input and Intention	Significance
Pearson Correlation	0.89	0.045
Spearman's rho	0.9	0.037
Both correlations are significant at the 0.05 level (2-tailed).		

4.5 EXPLANATION OF FINDINGS

After verifying the integrity of the survey results earlier in this chapter, section 4.4.2 above demonstrated that a participant in this survey is not likely to choose mobile data services (MDS) on the basis of their 'general readiness to adopt new technologies', or on the basis of their 'perception of the level of maturity' of the MDS service being considered. We can be 95% confident of this finding. The same section also showed that participants in the survey are willing to consider technology, with a normal distribution of propensity to adopt. Further analysis confirmed that, overall, participants could be divided into segments consistent with the well established work of Rogers (1962).

4.6 CONCLUSION

The findings explained above show that the survey in this thesis was thoroughly planned and executed. A thoroughly documented process was followed, with a pilot study that uncovered the need to change some aspects of the survey. Two different media were used to gather responses, both getting a satisfactory level of replies. Data was entered or

downloaded into a spreadsheet, where it was checked, and various physical manipulations were carried out. The standard data was imported into SPSS for analytical processing. Various factors had to be created to enable testing of the initial research model as used with this thesis. Missing values were also dealt with during this phase. That data was checked for normality, reliability, and validity. Once checking was complete, data could be tested in a structured equation model, which found that the empirical data collected did not match the original research model.

Following this review and interpretation of the survey process and results, the final chapter will look at the implications of these findings, and consider this study in the wider context of the international literature, and opportunities opened up for further research.

Chapter Five

DISCUSSION AND CONCLUSION

5.1 INTRODUCTION

In June 2007, thousands of people across the United States queued to wait their turn to buy an iPhone (Barylick and Honan 2007). A customer is quoted as saying "Today, I've got three things in my pocket. Tomorrow, I'll have one." The rapid, and often unpredictable growth of mobile data services (MDS) continues. This thesis has studied the history of Rogers' (1962) Diffusion of Innovation theory, and traced the development of that model through the literature, including the 'Chasm' variation by Moore (1999). Research by Gilbert and his colleagues (Gilbert & Han, 2003a, 2005; Gilbert & Kendall, 2003) was used to review progress in the field in Asia. This thesis found there is a lack of available New Zealand research in the field, and briefly reviewed some cross-culture research, to provide a framework for comparing the author's New Zealand research with overseas studies.

An analysis was conducted of the methodologies used by a selection of technology adoption authors. Rogers' (2003) methodology has been studied and enhanced by Davis (1993), Moore (1999) and Nysveen et al. (2005). Parasuraman (2000) has successfully maintained his National Technology Readiness Index for seven years, and supported the work of the current author by allowing the use of the Technology Readiness Index survey questions.

Built upon that research history, this thesis found that adoption intentions in New Zealand do align with the existing literature. It can be gauged with a high level of confidence that New Zealanders will continue to adopt mobile data services (MDS) as they become available. Small text messaging (TXT) is very well established, with an adoption indication in the order of ten times the level of any other service. There is not currently much support for location based services, and the participants show a significant reluctance to receive location based advertising on their mobile devices!

The findings suggest that, contrary to world trends, participants judge a service on 'face value', without a strong concern about how well established the service is. They are generally open to technology. Those who are less comfortable with technology in general will still consider trying new services.

This, the final chapter of the thesis, will report the research findings and consider where this research fits with other international research. The findings showed high reliability and validity values. This reinforces the value of the current research in predicting future trends in mobile data services (MDS) adoption. The predictive value of

the model used will be analysed, and implications explained. There is now more New Zealand research available to the international community. Outstanding issues, and opportunities for further research will be explored. Finally, the conclusion to the current chapter and the thesis will draw together the findings, comparisons, predictions and issues.

5.2 SUMMARY OF FINDINGS

The data collected for this thesis is valid and reliable. Descriptive statistics show an excellent distribution of responses. This thesis will satisfy a key objective to contribute New Zealand findings on mobile data services (MDS) to the international literature. Results were obtained for the four hypotheses (Table 15 below) targeted, with significant levels of confidence.

Table 15: Hypotheses for the current research

H0: Technology Readiness will have a direct effect on adoption.
H1: Consumers will learn about available MDS from a range of sources consistent with Rogers' research.
H2: Consumers will be more likely to adopt MDS services perceived as being mature.
H3: Intention to adopt MDS services will follow a normal distribution, consistent with Rogers' research.

It was hypothesised that data would be normally distributed, consistent with historical literature. The results supported that hypothesis, showing that people living in New Zealand are likely to consider a broad range of MDS, as new technologies are developed and implemented. The common idea that New Zealanders will 'give it a go'. is clearly supported by the failure to prove hypotheses H0 and H2 . Other researchers have commonly found consumers familiar with technology, and the generally 'technology savy' consumers, were significantly more likely to adopt new services. While there is a positive co-relation between these factors, the link is weak – participants indicated they will consider a variety of new MDS regardless of their general technology predisposition. Participants also showed they used a variety of methods to learn about new technologies. Again, this indicated broad acceptance of MDS, regardless of the participant's background.

A number of research questions were introduced in chapter three, section 3.3. The current research has provided answers that will be examined in this section. Will consumers adopt mobile data services in the future? This is the first research question asked. The answer is a clear 'Yes'. Analysis showed a normal distribution of adoption

intentions, suggesting that consumers will proceed along a 'normal' procurement path, with devices being purchased largely in accordance with the normal, and 'natural' distribution.

The current research can address some of the problem areas identified in section 2.5. The adoption of mobile data services is consistent with Rogers' (1962) general innovation model. There is a very deep body of international research around Rogers' model, but his basic model has not changed substantially over the past 55 years. New Zealanders appear to adopt technology at the same rate they have for most of that time. Research by Gilbert *et al*,(2003 – 2005) and Nysveen *et al* (2005) found links between motivations and purchase, which were not discovered in the current research. This suggests that the literature would be enhanced by development of a specifically New Zealand model. Consumers in the current study do appear happy to consider adopting MDS. They showed a very consistent and 'normal' level of knowledge of available services, and indicated that they learn about these services from a variety of sources, again, with an even distribution of sources of knowledge.

The hypotheses presented in this thesis (ref chapter three, section 3.3, and table 14 above) have all been addressed. The most notable discovery is a result that could be interpreted as a 'contempt' for technology. All 14 readiness questions, and 13 of the 14 services questions showed an excellent normal distribution, suggesting those who answered the survey treat these subjects as it would be expected they would treat any other purchase decision. Consumers do learn about available MDS from a range of sources consistent with Rogers' research, and the intention to adopt these services does follow a normal distribution. The remaining hypotheses are rejected. It is not proven that technology readiness has a direct effect on adoption, nor is it proven that consumers will be more likely to adopt MDS services perceived as being mature. While there was a positive correlation for each of these associations, neither had a strong enough correlation to be considered significant. The author had found references from the OECD and Ministry of Economic Development (MOED 1999) which support the informal belief that New Zealanders will attempt a diverse range of activity, without being confined to what they know, or what those around them are already doing. Rejection of H0 suggests that consumers surveyed might be 'always ready' to try something new. They clearly responded well to Parasuraman's Technology Readiness Index (Parasuraman; 2000), being consistent with the thousands of others who have completed this index. However, they went on to suggest, effectively, they would 'give anything a go' in terms of technology. Consumers gave their opinion of the maturity of services consistent with a natural distribution, however, they will adopt a service they feel to be of general interest or use to them, with little regard to their own perceived maturity towards that service.

5.3 COMPARISON WITH OTHER STUDIES

The current survey successfully added to the international literature for study of Mobile Data Services (MDS). This section considers each of the studies analyzed in chapter three, and suggests how the current study can, in combination with each of the earlier studies, help create a 'whole greater than its parts' in the literature.

5.3.1 Diffusion of Innovation

Rogers has updated his 1962 research with five new editions of his seminal work in this field. The author found little New Zealand based research making use of this model. The current survey found support for Rodgers segmentation model, with a very strong correlation between the number of consumers who said they were willing to consider technology, and those who later indicated they have adopted, or will adopt, mobile data services.

5.3.2 Technology Acceptance Model

There are some interesting commonalities between the current research, and the work of Davis (1993). While Davis' model was using quite different instruments, he did (unexpectedly) find links between perceived usefulness and actual system use, regardless of attitude towards using a service. This is consistent with the current findings of consumers being willing to try something, regardless of their general feelings towards technology.

5.3.3 Chasm Model of Marketing

Rogers' (1962) model is at the heart of Moore's Chasm Model (1999). The current research does support the normal distribution and segmentations used by both Rogers and Moore. A more specific survey would be needed to test the type of mobile devices being used in order to locate a 'New Zealand Chasm'.

5.3.4 The National Technology Readiness Index

Significant references have been made in this chapter, and elsewhere, suggesting the current research strongly supports that of Parasuraman (2000). The survey questions provided proved very robust, and responses were reliable and valid.

5.3.5 Understanding Mobile Data Services Adoption

Gilbert *et al* (2003 – 2005) found very strong support for social needs-based segmentation that had some links to Rogers (1962) and Moore (1999). The current research suggests New Zealanders, while covering the full spectrum of adoption intentions, tend not be as heavily influenced by their social environment. They will often decide on adoption based strongly on the service involved, with less emphasis on social concerns. This is consistent with comparisons made by Hofstede (1984) between the Singaporean and Malaysian social environment studied by Gilbert *et al*, and the New Zealand environment, which Hofstede suggested has a predominantly more independent culture.

5.4 OUTSTANDING ISSUES AND FURTHER RESEARCH

The author suggested early in this thesis that there is little available New Zealand based literature regarding adoption of mobile data services (MDS). The current work will contribute to filling that void, and the author is confident his work will assist and motivate other New Zealand based researchers in this field.

Some of the problem areas identified in chapter two remain. While some light has been cast on a fit of the dissemination of innovation theory in New Zealand, more specific research could consider the models suggested by Moore (1999), Davis (1985), and Nysveen *et al* (2005). Parts of each of these models are supported by the current research, but more targeted research considering each one could strengthen the links.

Likewise, this research identified differences compared to those studies from other cultures. This area would also benefit from comparable, and recent, research in those countries that could be directly compared with this New Zealand study.

None of the academic studies examined in this thesis had a strong focus on the costs of mobile data services. This has been identified by other researchers as an issue, and informal discussions with members of the New Zealand Telecommunications industry suggests that suppliers consider cost to be the only significant issue with relation to adoption. This view is moderated by the comment that cost is relative. Consumers will not pay for a service they don't want, no matter how low the cost is.

5.5 CONCLUSION

This thesis started by asking what factors affect the uptake of mobile data services in New Zealand. More is now known about the complicated answer to that question. It can be now be strongly suggested that any perceived reluctance to adopt is not due to inertia on the part of the consumer. Consumers are open to adopt services at steady rate.

Adoption in New Zealand is likely to be constant, and continuous, in a smooth 'normal' pattern. That adoption will be spread across the whole range of cultural and economic differences, staying in touch with a similar natural development of new services and devices.

This survey is planned to be a leading, exploratory, contribution to the literature. The research community now has the opportunity to consider further research, focused on some of the sub-sections of the mobile data services community in this country.

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Appendix I

ETHICS APPROVAL

MEMORANDUM

Auckland University of Technology Ethics Committee (AUTEC)

To: Brian Cusack
From: **Madeline Banda** Executive Secretary, AUTEC
Date: 03 July 2007
Subject: Ethics Application Number 07/104 **Mobile data services adoption in New Zealand: future predictions.**

Dear Brian
Thank you for providing written evidence as requested. I am pleased to advise that it satisfies the points raised by a subcommittee of the Auckland University of Technology Ethics Committee (AUTEC) at their meeting on 18 June 2007 and that the Chair of AUTEC has approved your ethics application. This delegated approval is made in accordance with section 5.3.2.3 of AUTEC's *Applying for Ethics Approval: Guidelines and Procedures* and is subject to endorsement at AUTEC's meeting on 13 August 2007.
Your ethics application is approved for a period of three years until 3 July 2010.
I advise that as part of the ethics approval process, you are required to submit to AUTEC the following:

- A brief annual progress report indicating compliance with the ethical approval given using form EA2, which is available online through *http://www.aut.ac.nz/about/ethics*, including when necessary a request for extension of the approval one month prior to its expiry on 3 July 2010;
- A brief report on the status of the project using form EA3, which is available online through *http://www.aut.ac.nz/about/ethics*. This report is to be submitted either when the approval expires on 3 July 2010 or on completion of the project, whichever comes sooner;

It is also a condition of approval that AUTEC is notified of any adverse events or if the research does not commence and that AUTEC approval is sought for any alteration to the research, including any alteration of or addition to the participant documents involved.
You are reminded that, as applicant, you are responsible for ensuring that any research undertaken under this approval is carried out within the parameters approved for your application. Any change to the research outside the parameters of this approval must be submitted to AUTEC for approval before that change is implemented.
Please note that AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to make the arrangements necessary to obtain this.
To enable us to provide you with efficient service, we ask that you use the application number and study title in all written and verbal correspondence with us. Should you have any further enquiries regarding this matter, you are welcome to contact Charles Grinter, Ethics Coordinator, by email at charles.grinter@aut.ac.nz or by telephone on 921 9999 at extension 8860.
On behalf of the Committee and myself, I wish you success with your research and look forward to reading about it in your reports.
Yours sincerely

Madeline Banda
Executive Secretary
Auckland University of Technology Ethics Committee
Cc: Steve Cosgrove steve@rata.co.nz, AUTEC Faculty Representative, Design and Creative Technologies

Appendix II

SURVEY QUESTIONS

READINESS QUESTIONS

a. You find new technologies to be mentally stimulating
b. If you provide information to a machine or over the Internet, you can never be sure it really gets to the right place
c. You like computer programs that allow you to tailor things to fit your own needs
d. You do not consider it safe to do any kind of financial business online
e. Other people come to you for advice on new technologies
f. You worry that information you send over the Internet will be seen by other people
g. You can usually figure out new high-tech products and services without help from others
h. When you get technical support from a provider of a high-tech product or service, you sometimes feel as if you are being taken advantage of by someone who knows more than you do
i. In general, you are among the first in your circle of friends to acquire new technology when it appears
j. It is embarrassing when you have trouble with a high-tech gadget while people are watching

The questions above comprise the Technology Readiness Index which is copyrighted by A. Parasuraman and Rockbridge Associates, Inc., 1999. This scale may be duplicated only with written permission from the authors."

k. I learn about technology mainly from my friends and colleagues
l. I go out of my way to find out about new technologies that might interest me
m. It is important to me that lots of other are using a technology before I try it
n. Technology for its own sake has no interest to me. I must have a good reason to buy something new

READINESS QUESTIONS

These questions refer to the following mobile data services:

- TXT – Short text messages
- PXT – Message with photo attached
- MMS – Mobile Multimedia Service
- Push to Talk
- Video Calling – See the other person during your conversation
- Download Ringtones
- Download music from your phone company
- Send and receive emails
- Copy music from your computer to your phone
- Location Based services – Find where you are, and directions to meet friends or find a location
- Location Based services – Get advertisements and special offers from shops as you walk past
- Search for nearby services, such as restaurants, or public facilities
- Get general Internet Search results on my phone
- General web surfing

For each of the services above, the participant is asked to choose two options, one from each list:

1. Have never heard of this service
2. Very New
3. Somewhat new
4. Neutral
5. Somewhat mature
6. Very mature
7. Don't know
8. Will never use the service
9. Will Consider using the service
10. Will start using this service soon
11. Already use the service
12. Not Sure about this service
13. Prefer not to answer

EXAMPLE OF LAYOUT – PRINTED SURVEY

The example of layout for the printed survey is shown on the following two pages. Note that it is reduced, to enable it to fit on a bound page of this thesis.

You are helping me complete my Masters thesis at Auckland University of Technology.

The topic of my thesis is
"Mobile Data Services Adoption in New Zealand: Future Predictions"

This survey will give me an indication of present and future use of Mobile Data Services, and enable me to compare New Zealand results with results from other countries.

Please note:

- Completion of the questionnaire will be taken as indicating consent to participate.
- You can change your mind about completing the survey at any time.
- You are welcome to contact me, or my supervisor, if you have any questions about the survey.
- The survey is available online: http://survey.rata.co.nz

Researcher: Steve Cosgrove
steve@rata.co.nz

Supervisor: Dr Brian Cusack brian.cusack@aut.ac.nz

AUT UNIVERSITY

Mobile Data Services Questionnaire

Completion of the questionnaire will be taken as indicating consent to participate

Instructions

Tick one Box to express your response to each statement

What are your general feelings about Technology?

	Strongly Disagree 1	2	Disagree 3	Neutral 4	Agree 5	Strongly Agree 6	Don't Know 7
I find new technologies to be mentally stimulating							
If I provide information to a machine or over the Internet, I can never be sure it really gets to the right place							
I like computer programs that allow me to tailor things to fit my own needs							
I do not consider it safe to do any kind of financial business online							
Other people come to me for advice on new technologies							
I worry that information I send over the Internet will be seen by other people							
I can usually figure out new high-tech products and services without help from others							
When I get technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more							
In general, I am among the first in my circle of friends to acquire new technology when it appears							
It is embarrassing when I have trouble with a high-tech gadget while people are watching							
I learn about technology mainly from my friends and colleagues							
I go out of my way to find out about new technologies that might interest me							
It is important to me that lots of other are using a technology before I try it							
Technology for its own sake has no interest to me. I must have a good reason to buy something new							

Like to take my contact details with you? Then rip this box off.
Researcher: **Steve Cosgrove**
steve@rata.co.nz
Supervisor: **Dr Brian Cusack**
brian.cusack@aut.ac.nz
http://survey.rata.co.nz

What mobile services do you consider are new and innovative?

What do you use your phone for, or What would you like to be able to do?

Listed in this section are a number of Mobile Data Services that you might have heard of
For each one, please tick the column that best reflects your feelings about that service.

	Have never heard of this service	Very New	Somewhat new	Neutral	Somewhat mature	Very mature	Don't know	Will never use the service	Will Consider using the service soon	Will start using this service	Already use the service	Not Sure about this service	Prefer not to answer
	1	2	3	4	5	6	7	8	9	10	11	12	13
TXT – Short text messages													
PXT – Message with photo attached													
MMS – Mobile Multimedia Service													
Push to Talk													
Video Calling – See the other person during your conversation													
Download Ringtones													
Download music from your phone company													
Send and receive emails													
Copy music from your computer to your phone													
Location Based services – Find where you are, and directions to meet friends or find a location													
Location Based services – Get advertisements and special offers from shops as you walk past													
Search for nearby services, such as restaurants, or public facilities													
Get general Internet Search results on my phone													
General web surfing													

Could you also answer some Demographic questions please?
(Remember, this is all anonymous!)

Please select your gender:
- ☐ female ☐ male
- ☐ prefer not to answer

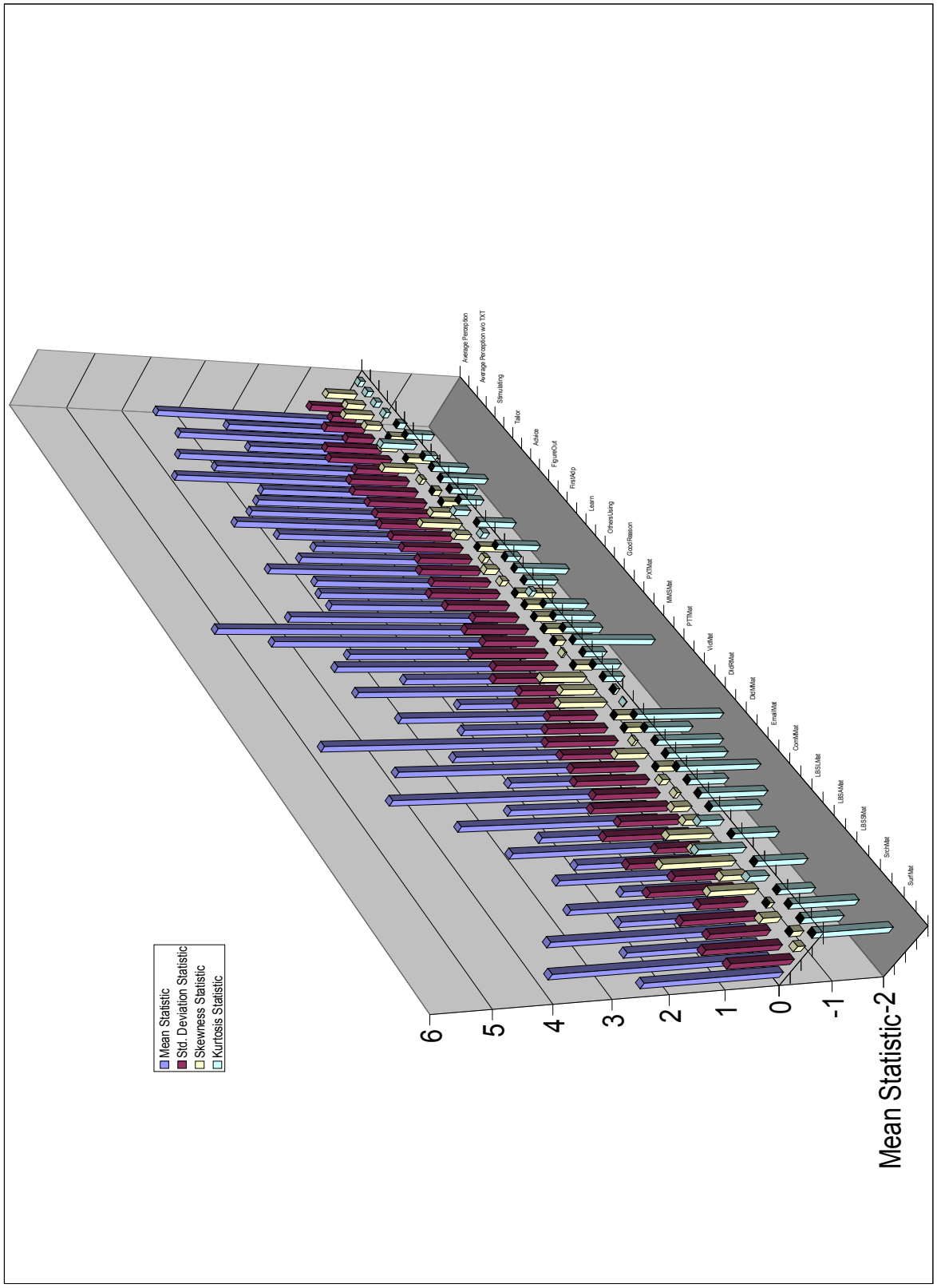
Please indicate your age range:
- ☐ Under 20 years
- ☐ 20 to 34 years
- ☐ 35 to 50 years
- ☐ over 50 years

In which range is your personal annual income?
- ☐ Less than $20,000
- ☐ $20,000 to $34,000
- ☐ $35,000 to $50,000
- ☐ over $50,000

What is your current occupational status?
(Tick all that apply)
- ☐ Self-employed full-time
- ☐ Self-employed part-time
- ☐ Employed full-time
- ☐ Caring for dependant family members
- ☐ Student full-time
- ☐ Retired
- ☐ Unemployed
- ☐ Employed part-time
- ☐ Student part-time

Appendix III

DETAILED STATISTICS



Graph indicating reliability and normal distribution in all data.

Table 16 Descriptive Statistics for Components of Average Intention

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
TXTUsage	184	3.91	.483	-4.955	.179	25.178	.356
PXTUsage	182	3.35	1.018	-.878	.180	-.681	.358
MMSUsage	178	3.15	1.415	-.104	.182	-1.448	.362
PTTUsage	177	2.45	1.434	.665	.183	-.979	.363
VidUsage	176	2.51	1.126	.930	.183	-.180	.364
DldRUsage	179	2.87	1.338	-.321	.182	-1.575	.361
DldMUsage	177	2.40	1.391	.533	.183	-1.213	.363
EmailUsage	180	2.69	1.287	.170	.181	-1.401	.360
ComMUsage	178	2.63	1.326	.359	.182	-1.152	.362
LBSLUsage	177	2.54	1.284	.855	.183	-.450	.363
LBSAUsage	177	2.20	1.486	.958	.183	-.610	.363
LBSSUsage	175	2.38	1.177	1.004	.184	.082	.365
SrchUsage	176	2.64	1.302	.376	.183	-1.161	.364
SurfUsage	175	2.75	1.327	.178	.184	-1.304	.365
Valid N (listwise)	154						

Table 17 Descriptive Statistics for Components of Average Maturity

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
TXTMat	94	4.60	.610	-1.246	.249	.525	.493
PXTMat	147	4.11	.987	-.568	.200	-.897	.397
MMSMat	156	3.44	1.250	-.354	.194	-.671	.386
PTTMat	164	3.49	1.231	-.595	.190	-.415	.377
VidMat	165	3.01	1.059	.443	.189	-.404	.376
DldRMat	113	4.26	.933	-1.007	.227	-.073	.451
DldMMat	156	3.70	1.019	-.144	.194	-.829	.386
EmailMat	127	3.80	1.077	-.257	.215	-1.131	.427
ComMMat	154	3.26	1.170	-.198	.195	-.610	.389
LBSLMat	160	2.76	1.334	.155	.192	-1.106	.381
LBSAMat	167	2.44	1.382	.452	.188	-1.134	.374
LBSSMat	164	2.60	1.400	.354	.190	-1.135	.377
SrchMat	160	3.31	1.223	-.335	.192	-.727	.381
SurfMat	148	3.53	1.192	-.399	.199	-.636	.396
Valid N (listwise)	49						

Table 18 Descriptive Statistics for Readiness questions

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Stimulating[1]	201	3.63	1.027	-.528	.172	-.242	.341
Unsure[1]	198	3.08	1.073	.087	.173	-.974	.344
Tailor[1]	203	4.02	.817	-.760	.171	.646	.340
Financial[1]	207	2.63	1.115	.638	.169	-.244	.337
Advice[12]	205	2.84	1.182	-.017	.170	-.860	.338
InfoSec[1]	207	3.15	1.095	-.132	.169	-.882	.337
FigureOut[12]	205	3.56	1.099	-.546	.170	-.547	.338
TakenAdv[1]	200	2.89	1.120	.197	.172	-.814	.342
FirstAdp[12]	204	2.40	1.081	.563	.170	-.287	.339
Embarrass[1]	206	2.86	1.100	.228	.169	-.845	.337
Learn[12]	205	3.59	.979	-.809	.170	.073	.338
Seek[2]	203	2.92	1.136	.095	.171	-.814	.340
OthersUsing[2]	205	2.97	1.021	.041	.170	-.665	.338
OwnSake[2]	202	2.95	1.269	.064	.171	-1.121	.341
Valid N (listwise)	170						

Table 19 Rotated Component Matrix for Readiness questions

		Component			
		1	2	3	4
Stimulating	**Optimism**	0.431	-0.163	0.54	0.203
Unsure	**Insecurity**	-0.145	0.754	0.112	0.034
Tailor	**Optimism**	0.21	0.207	0.707	-0.038
Financial	**Insecurity**	0.085	0.693	-0.178	-0.257
Advice	**Innovation**	0.697	-0.044	0.286	-0.147
InfoSec	**Insecurity**	-0.11	0.751	0.098	0.05
FigureOut	**Innovation**	0.45	0.02	0.525	-0.172
TakenAdv	**Discomfort**	-0.114	0.555	-0.173	0.275
FirstAdp	**Innovation**	0.781	-0.023	0.056	-0.015
Embarrass	**Discomfort**	0.356	0.217	-0.209	0.654
Learn		-0.368	-0.043	0.046	0.739
Seek		0.837	-0.156	0.076	0.007
OthersUsing		0.149	0.404	-0.541	0.141
OwnSake		-0.348	0.103	-0.275	-0.241
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.					
a Rotation converged in 9 iterations.					
Shaded cells indicate weightings greater than 0.6					

Table 20 Rotated Component Matrix for Maturity / Usage questions

	Component								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
TXTMat	-0.13	-0.08	-0.11	0.07	0.71	-0.01	-0.28	0.00	-0.09
TXTUsage	0.06	0.14	-0.28	-0.01	0.50	-0.06	0.20	-0.07	0.69
PXTMat	0.13	-0.07	-0.02	0.70	-0.02	0.11	-0.15	0.33	0.24
PXTUsage	0.01	0.00	0.21	0.20	-0.14	-0.01	-0.08	0.16	0.75
MMSMat	0.27	-0.05	-0.10	0.35	0.17	0.32	-0.08	0.46	0.35
MMSUsage	0.17	0.09	0.72	-0.06	-0.22	-0.31	0.07	0.07	0.07
PTTMat	0.01	0.13	-0.14	0.19	0.08	0.83	-0.12	-0.05	-0.15
PTTUsage	0.06	0.02	0.91	0.02	-0.04	0.05	-0.02	0.02	0.00
VidMat	0.20	-0.11	0.14	0.63	0.16	0.32	0.34	0.13	-0.19
VidUsage	-0.06	0.11	0.26	0.09	-0.34	-0.27	0.00	0.42	0.32
DldRMat	-0.07	0.11	0.04	0.21	0.77	0.18	0.08	-0.03	0.13
DldRUsage	-0.07	0.20	0.14	0.01	-0.04	0.06	0.13	0.82	0.04
DldMMat	0.33	0.13	0.00	0.25	-0.08	0.63	0.17	0.07	0.18
DldMUsage	-0.01	0.26	0.12	0.08	-0.04	-0.15	0.80	-0.05	0.07
EmailMat	0.20	0.10	-0.13	0.70	0.18	0.22	0.10	-0.24	0.16
EmailUsage	0.06	0.75	0.19	-0.25	-0.11	0.16	0.09	0.08	0.17
ComMMat	0.42	-0.13	0.15	0.08	-0.53	0.29	0.08	-0.28	0.13
ComMUsage	-0.02	0.08	-0.06	0.02	-0.12	0.13	0.84	0.25	-0.07
LBSLMat	0.76	-0.15	0.34	0.02	0.13	0.12	0.27	-0.14	0.07
LBSLUsage	0.06	0.30	0.46	0.47	0.28	-0.11	0.14	0.16	0.11
LBSAMat	0.80	0.24	0.11	0.30	-0.03	-0.07	0.01	-0.03	0.20
LBSAUsage	0.13	0.69	0.09	0.18	0.00	0.26	0.22	0.14	-0.02
LBSSMat	0.86	0.19	0.24	0.01	-0.17	0.08	0.09	0.02	-0.14
LBSSUsage	0.08	0.57	0.33	0.41	-0.16	-0.48	0.02	-0.10	-0.04
SrchMat	0.79	-0.05	-0.14	0.08	-0.18	0.12	-0.18	0.12	0.05
SrchUsage	-0.02	0.50	-0.10	0.15	0.23	-0.13	0.25	0.60	0.06
SurfMat	0.63	0.29	-0.34	0.22	-0.01	-0.03	-0.26	-0.12	-0.17
SurfUsage	0.12	0.67	-0.21	-0.02	0.30	-0.08	0.07	0.25	-0.05

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a Rotation converged in 24 iterations.

Shaded cells indicate weightings greater than 0.6