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Erkki Kurkinen

On the Exploration of Mobile Technology Acceptance among Law Enforcement Officers using Structural Equation Modelling (SEM)

A Multi-group Analysis of the Finnish Police Force

JYVÄSKYLÄN YLIOPISTO

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ABSTRACT

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The use and intention to use new technology in the non-voluntary context is one of the growing areas in information technology research today. This trend in research follows the exploding developments in the utilization of mobile information systems among law enforcement users, although the consumer market has been utilizing mobile devices and systems for some time. Hence, the need to understand the professional users demographic and factors which affect the decision to use or not to use modern technology on a personal level, has become evident, especially when the user does not have a clear choice to make between the different technologies or systems available. A research framework was developed to study those factors affecting the intention to use mobile technology. It combined three concepts: firstly, pre-prototype testing to test the technology without a real working system; secondly, a technology acceptance model (TAM) was needed, with external variables for compatibility and social influence to measure the user intentions; and thirdly, an application for moderator effect was required to measure the differences between various user groups. Based on this framework a measurement model was constructed to verify the hypotheses among Finnish Police officers working in field operations. A good model fit confirmed that the model reliably explained the variances among target users. The two factors, compatibility and the social influence of a team member, were found to influence intentions to use mobile technology, in addition to TAM variables, were found to be as hypothesized. Compatibility was found to replace perceived usefulness as being the strongest determinant of intention.

Keywords: technology acceptance model, structural equation model, multi-group comparison, law enforcement, police

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The roots of this dissertation are at one turning point in my private life three years ago when my then employer made refinements in the company strategy resulting large lay-offs. This unhappy incident as such offered me an opportunity to move to work in a research project in the University of Jyväskylä with some of my colleagues. During that project I was able also to start my studies leading to this dissertation. The idea of this dissertation originates from the time already before that when I was part of the international marketing and sales organization doing business with police organizations globally. I could not help wondering why the end user perceptions of the mobile communication systems were deviating between countries and between individuals. As a responsible salesperson I was not necessarily able to respond on customer expectations resulting loosing important customer cases. All these adversities happened, even though the end user requirements seemed to be equivalent. The same device equipped with similar features and applications was very well accepted in some country, but was rejected in another by the end users. This led me to think about the differences of perceptions of the technology on personal level as well. When I finally learned, thanks to the methodology courses of IHME (Ihmistieteiden Metodikeskus), how I can measure latent factors in practice, I found myself writing the research plan for this study.

Firstly I would like to thank the substantial inspirer and supervisor of this dissertation, professor Pekka Neittaanmäki of his initiative to start this endeavour. He originally introduced the research project to me, encouraged to start the study, and has given never-ending suggestions and encouraging support to me during the process. And all this, of course, with his own personal style! Without his peculiar attitude towards my work this might not be in its current state. Secondly I would like to thank my second supervisor professor Rauno Kuusisto of his joyful comments and various proposals for improvements to this thesis. I cannot ignore the positive effects of the enjoyable discussions with him on my working experience during this effort as our debate themes ranged from philosophy of science to renovation of houses. I am very grateful to both of my supervisors for supporting me.

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Käpyniemi, Konnevesi
November, 2012

Erkki Kurkinen

To my departed parents,
who never had opportunity for decent schooling.

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

CFI	Comparative Fit Index
CFA	Confirmative Factor Analysis
CMV	Common Method Variance
DOI	Diffusion of Innovations
ERP	Enterprise Resource Planning
HALTIK	Hallinnon Tietotekniikkakeskus
ICT	Information and Communication Technology
IDT	Innovation Diffusion Theory
IS	Information Systems
IT	Information Technology
MANOVA	Multivariate Analysis of Variance
MAPS	Model of Acceptance With Peer Support
NFI	Normed Fit Index
NNFI	Non-normed Fit Index
PEOU	Perceived Ease of Use
PU	Perceived Usefulness
RMSEA	Root Mean Square Error of Approximation
SEM	Structural Equation Modelling
SRMR	Standardized Root Mean Square Residual
TAM	Technology Acceptance Model
TAM2	Technology Acceptance Model 2
TAM3	Technology Acceptance Model 3
TLI	Tucker-Lewis Index
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Actions
TTF	Task Technology Fit
UTAUT	Unified Theory of Acceptance and Use of Technology

CONTENTS

1 INTRODUCTION

1.1 Background and Relevance of the Topic

This research aims to identify the factors affecting mobile information technology acceptance within the law enforcement forces in Finland. The relevance of the research topic is related to two topical issues which pertain to the investments in mobile information technology of the target research group, the Finnish Police Force. These issues are firstly: the growing demands for better utilization of information and communication technology (ICT) investments made by public organizations, and secondly: the end-users' final acceptance of the mobile information systems which would be provided by relatively large investments in future technology. This research aims to seek ways to understand technology adoption by looking for factors which affect technology acceptance on a personal level in the mobile ICT environment.

The amount of information that the police officers deal with in their work is remarkable (Gottschalk 2006). It has been claimed that information is the most important resource in police investigations. Because such information is critical for police work, the concept of knowledge management plays an important role. It has been suggested that it is not the amount of information, but gaining decent access to it that is the problem (Chen et al. 2003). The use of ICT becomes increasingly more important in parallel with the evolution of knowledge management systems, ranging from totally manual systems to more sophisticated systems (Gottschalk 2006). This huge mass of information is often shared between the law enforcement agencies and organizations. For this reason, investments into police ICT systems with which to manage and utilize such information in a more efficient manner, might be understandable and even profitable, despite the economic recession, where police are required to operate more cost effectively in a changing and evermore demanding society. Police agencies however, have traditionally been heavy users of technology systems (Nunn & Quinet 2002, Chan 2001). In this respect, one could expect that any underutilization of ICT investments due to a missing end-user acceptance might be crucial for the efficient operations of law enforcement agencies.

Technology acceptance in law enforcement is a special case in the professional context. The technology in law enforcement services like the police has traditionally been important (Nunn & Quinet 2002). It has turned police practices upside-down, starting from the introduction of the telegraph in the 1800's and there seems to be no end to this development in the current era of information technology (Chan 2001). One of the major milestones in the use of information technology was the introduction of FBI's National Crime Information Centre in 1967 (Conser, Russell & Paynich 2005), whose impact was seen not only in the USA but also globally. At that time there were 16 consoles, 15 participating agencies and 23,000 crimes were registered in the data base. Today, law enforcement has an abundance of information in different formats and on different systems. Viable access to this information using different technological systems is critical (Hu, Lin & Chen 2005). Today, these systems also include mobile variants for field operations. It is however a fact that if mobile systems are provided within law enforcement for better informational access and the precise input of data, there is no guarantee that the users would utilize these systems fully (Hu et al. 2011). Even though the use of the mobile systems would be made mandatory for users and is currently supposed to be the only method by which they communicate, it is recognized that users often do not use such systems. For this reason, having new methods for increasing the technology acceptance of mobile systems is one of the main challenges faced in the police setting.

Public investments and expenditure on information and communication technology (ICT) are enormous, even in the scale of a small country like Finland having a population of just over 5.4 million inhabitants. In Finland alone, the expenditure of governmental agencies and bodies on ICT in 2010 was 907.6 million Euros (Ministry of Finance 2011). These costs include 3253 full time ICT-personnel, service purchases, equipment rental and leasing, software, hardware and other associated costs. The total amount of workstations numbered in the sector was 98,000. On an average, ICT-costs accounted for 13% of all government operative costs (Ministry of Finance 2011).

Finland has a single law enforcement organization, the Finnish Police. It operates under the tutelage of the Ministry of the Interior, which is responsible for its supervision and guidance. The police have a low, two-tier organization. The first tier, the National Police Board operates under the Ministry of the Interior. The main responsibility of the National Police Board is to guide and direct the 24 local police departments, and this includes guidance on their economic performance. The second tier is formed by the local police departments, national police units, the Police College of Finland and the Police Technical Centre. The national units comprise the Finnish Security Intelligence Service, the National Bureau of Investigation and the National Traffic Police. The limited law enforcement authority can be given also to Finnish Border Guar and Finnish Customs. There are also special units. For the detection and prevention of information security incidents there is a Police Incident Response Team. A special unit for counter terrorism and for special operations is called Special Operations Unit of the Helsinki Police Department. The Finnish Defence Forces have military police force for military operations only. The vision of the Finnish Police for the year 2014 is for Finland to be the safest country in Europe, which will be assured by a professional, willing to serve, reliable, co-operative and efficiently organized police force (Poliisi 2012, Sisäasiainministeriö 2012).

As stated earlier, law enforcement is highly information intensive. Mobile ICT is in everyday use today in Finland. As an example, police officers often carry at least two different mobile devices with them when on duty in the field. In Finland, the mobile usage of ICT is planned to become a major tool for police field operations in the near future after the implementation of the new police ICT system has been finalized by 2014 (Hallinnon Tietotekniikkakeskus HALTIK 2011). The need to use new mobile technology arises from the productivity requirements of the police. It is estimated that full utilization of the new ICT-systems requires not only the technology itself, but the introduction of new processes and no less than the introduction of new legislation for policing (Sisäasiainministeriö 2012). Such new working processes and procedures will require, among many other things, a knowledge of the end-user intentions to use new technology. This knowledge can be used when new innovations are introduced to professional users.

1.2 Research Problem Statement

Technology acceptance in the context of law enforcement is a new area of study in the field of technology acceptance research and there are only a few studies existing in this area (Hu et al. 2011). However, the use of mobile technology in law enforcement has been seen as important and beneficial for the officers to improve the results of their work. It has been suggested that the use of wireless systems among other things, improve productivity, neighbourhood safety and cost reductions (Easton 2002). However, these results are contradictory to the findings of Garicano & Heaton (2010) who conclude that an investment in ICT within law enforcement is not directly linked to an increase in productivity. For this reason, the study of mobile technology acceptance in law enforcement is highly justifiable so as to gain a deeper understanding of the factors which influence technology acceptance.

In Finland in the forthcoming years, the police organization is entirely renewing its ICT system. The new system will contain a remarkable number of new elements concerning the information management process. In fact, the whole idea of utilizing the information which is stored in the ICT system, will change. The main principle is that information is stored only once onto the ICT system when that information is created. The stored information is then available to all associated parties; not only the police organization itself for investigating the crimes, but it may also for example be available to public prosecutors or prison authorities for prosecuting and punishing those people who are involved in the crimes in question. This means that all of the police processes involved are changing to become electronic. It is believed that by undertaking this change the productivity of the police will grow because the human resources and costs of operations will be better balanced (Sisäasiainministeriö 2012). Moreover, the renewal of the ICT system is planned to be extended to cover all police vehicles. In this way the police in field operations would be better able to manage all of the information related to their assignments in the field using mobile technology. In this context the use of mobile technology is understood as the use of portable communication devices, either installed in police vehicles, or as the use of carry-on personal devices, such as cellular phones, smart phones, laptops, and tablets amongst other things. This essentially technical change will alter the whole nature of policing. The police officers in field operations will not return to their police stations after each assignment in order to complete paper work, rather they are supposed to finalize their reporting work in the field. This new way of working will create a need for new procedures and processes, which in turn requires a change in the mindset of police officers. On the other hand, if the mobile ICT system is made flexible enough, it will give police officers a freedom to work in their own personal and individually preferred working style, whilst fulfilling the demand needs placed upon them to perform at an optimal level in field operations. If the users feel that the new mobile system is compatible with their beliefs on personal expectations, the actual usage intention may increase. Compatibility has been found to clearly explain the user's intentions to use ICT systems. Moreover, it has been found to be an important belief in behaviours of technology acceptance (Karahanna, Agarwal & Angst 2006). Thus the new police mobile ICT system and end-user devices are in the spotlight. The way how new systems are designed for police field operations plays a key role in the end-user acceptance of those new systems. Measuring and evaluating the compatibility variables in a police setting will provide valuable information about the structural relationships of those variables. Currently, there are several measurement models with various parameters available to measure the factors in technology acceptance. To better understand which factors affect the acceptance of mobile ICT systems in police field operations, new research work with new research models and variables is clearly needed.

Finland is a large and diversified country. There are large cities having characteristics not dissimilar to other main European cities, and at the same time there are large, rural countryside regions with their own specific attributes. Moreover, as the country is elongated, the weather conditions vary widely. In the north in the wintertime, weather can be very cold, windy and snowy. In the summertime, the south and western parts of the country can be hot, resembling more Southern European weather conditions rather than the Northern European climate. The Finnish Police have an obligation to provide an equal service in all parts of the country (Finnish National Police Board 2011). For this reason the context of climate-related working conditions may play an eminent role when the new technology is proposed for use in police field operations. One can easily imagine that operating in an urban city area where the mobile radio coverage is good enough for decent communication is acceptable by the end-users. Using a mobile ICT system in hilly countryside with a perhaps limited functionality may however have an effect on the user's willingness to use such modern technology as planned and obligated by the management. Additionally, the actual use of the ICT system for different ICT interactions which are needed in their assignments varies a lot. The activity within police communication varies depending on the assignment. In some assignments only data base queries may be needed, whereas in some assignments data and text inputs into the ICT system may also be required. These interactions with the mobile ICT system may also affect the preferred way of performing a certain work activity in field operations. Bouwman & van de Wijngaert (2009) suggest that the suitability of different mobile police systems varies according to the context of work, the situation and the task. The Finnish Police operate in various working contexts, having distinct conditions in terms of weather, location and task dependent attributes. These attributes may have their own effects on technology acceptance. Therefore, it is clear that more understanding is needed to help clarify the relationships between the context-based attributes and technology acceptance in police field operations.

The Finnish Police operate normally in patrols of two police officers in field operations. The standard working shift is twelve hours. The two police officers normally work their common working shift together in close co-operation. Thus, the personal relationship, attitude and trust towards their patrol partner may become an important factor in the process of adopting new technology. The patrol members may have different ages, lengths of career, or experience in police operations. Hence, they may have totally different and perhaps opposite views on the use of mobile ICT-systems in policing. These different views may be caused by several factors, such as a general attitude towards technology, or experience of using similar systems in the past. During their working shift they may share their existing beliefs regarding the possibilities of a new technology. Similarly, those beliefs may be changed by the social influence of a patrol partner. The positive impression is suggested to be passed from one team worker to another (Venkatesh & Davis 2000). In such information sensitive work as policing, the impression created by a patrol partner about a mobile ICT system, is worth studying in order to create a view of the social influence they have on each other regarding the utilization of a mobile technology.

The members of police patrols are individuals with diverse background. There are both young and old, experienced and less experienced, and male and female police officers. Due to this diversity they may also have different beliefs on technology acceptance. The young, less experienced police officer may have a better and longer experience in utilizing mobile technology than his or her older and otherwise more experienced patrol partner. The older, more experienced police officer however, may possess a more critical view on the new mobile devices and systems. This view may be created and adapted during their career. The effect of age and experience on using technology has been suggested to have a moderating effect on the technology acceptance model (Venkatesh et al. 2003, Sun & Zhang 2006b). Moreover, Sun & Zhang (2006b) propose that age and experience in regard to using technology, may have more effects on user technology acceptance than other factors. In Finland, the general retirement age of police officers working in field operations is currently 60 years (Sisäasiainministeriö 2011), having previously been 58 years. At the same time, young police officers are no longer recruited into service after their graduation from the Police Academy due to financial pressures. The amount of young, unemployed police officers may increase. Hence, there is a possibility for a future trend in the mean age of the police officers to be increasing (Ibid.). As a result of the increasing age of police officers, the utilization of new mobile technology can be seen in a new light as well. Some results in psychology suggest that older workers are more eager to adopt the opinions of their co-workers than younger workers. They also have less need for autonomy than younger workers (Evans, Kiggundu & House 1979). Additionally, the age of a person has been proposed to be associated with difficulties in processing complex stimuli and in paying attention to work related information (Venkatesh et al. 2003). These results encourage us to find more research evidence for the effects of age on technology acceptance also in mandatory settings. The effect of the length of career may be similar to the effect of the age as the length of career increases in proportion to the increase in age. Knowing the effects of both the factors of age and length of career on technology acceptance, would help both the police and researchers to create a comprehensive view on the possible effects of the lengthening of the careers of the police officers in field operations. These research problems are formulated into research questions in the following chapter.

1.3 Research Questions

In the current study, research problems are addressed using the following research questions:

1) How well do the traditional variables for technology acceptance combined with additional external variables explain the acceptance of technology among the Finnish Police?
2) To what extent does the length of the career of police officers affect their mobile technology acceptance?
3) To what extent does the age of police officers affect mobile technology acceptance?
4) How does mobile technology acceptance differ in terms of the geographical differences between local police departments?
5) What is the relationship between the context of work activity and intention, in using mobile technology in police field operations?

1.4 Purpose of the Research

The main purpose of this research is to analyze and evaluate the parameters affecting the technology acceptance of the mobile applications among law enforcement users. An integrated research model tuned with additional variables was designed to test the research questions for the purposes of the research. The target users are Finnish Police users who currently utilize mobile technology and applications in their everyday activities. In this context the mobile police applications cover applications for smart phones or cellular phones tailored specifically for police use for their everyday activities. The plan by authorities is to rapidly enlarge that usage in the near future in order to expand the working environment of the police from an office to a mobile environment in the field, using for example a smart phone as an enlargement of the planned new ICT office system. This new system will cover all the functions of authorities such as the Finnish Police, the Judicial and Prosecuting Authority of Finland and the Criminal Sanctions Agency. The actions would cover the management of knowledge, the information involved and its documentation, from the initial recording of offences to managing the enforcement of sentences.

This study can be separated into two parts; theory development and confirmatory parts. In the theory development part, which is presented in the following chapter, prior research in the areas of technology acceptance, especially in the light of law enforcement, is investigated; new variables for police technology acceptance are studied and the research model used in this work is formulated.

The confirmatory part includes the testing of the research model with test users to find and present the answers to the research questions posed.

1.5 Conceptual Framework

This research is related to mobile information technology acceptance adoption in a specific user domain and the conceptual framework of this study has been developed with this in mind. The framework (FIGURE 1), is based on three different concepts which are established from prior research in the area. Those three concepts are, firstly, using pre-prototype testing in predicting the user acceptance of an IT system; secondly, using a technology acceptance model (TAM) interpolated with compatibility and social influence beliefs in measuring a user's intentions to use the prototype system; and thirdly, using length of career, age, location of the police department and contexts of work as moderators to moderate the effects between the constructs of these concepts.

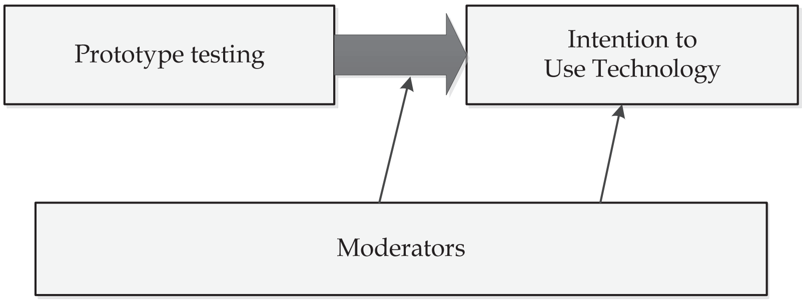

FIGURE 1 Conceptual framework of the research

The use of pre-prototype testing in predicting the user acceptance in IT systems is based on the findings of Davis (2004). The technology acceptance model with compatibility beliefs is based on the concept proposed by Wu, Wang & Lin (2007). Testing the moderator effects in the context of technology acceptance is adapted from Im, Hong & Kang (2011); Teo & Noyes (2010) and Bandyopadhyay & Bandyopadhyay (2011). Length of career, age and location of the police department are considered as moderators in this context and are measured variables. The usage of context-sensitivity as a moderator is based mainly on the characteristics developed and proposed by Bouwman, van de Wijngaert & de Vos (2008). According to them, the context of work is defined as a multidimensional space. Context here means the situation in time and space, where a police officer's work in the field takes place. In the current study those contexts of work are presented using four different attributes: weather, scene, urgency and activity. All attributes have two or three states - the attribute of weather has two states, hot summer or cold winter; the attribute of the scene has two states; in a vehicle or outside a vehicle; the attribute of urgency has two states; urgent or non-urgent, and attribute of activity has three states; data base query, data base input and the reporting of working hours. Using combinations of these attributes as moderators reveals the most preferred context for the utilization of the mobile police application.

Based on these three different concepts, the research model for this study was developed by integrating the concepts into one model. This model was then used in a user domain, where the importance of mobile information technology is supposed to play a vital role, namely a law enforcement agency - more specifically the Finnish Police.

The research model was used in this research to determine factors that lend support to the hypothesis presented in the research and to better understand the behaviour of users in the context of mobile technology acceptance.

1.6 Theoretical Foundations

Current research studies mobile information system technology acceptance (in the law enforcement context) from several scientific perspectives. Traditionally, the adaption and usage of technology has been an important theme for research in information systems (IS). The literature of technology acceptance is broad and covers for example: developing and presenting new theories and methods (Venkatesh & Davis 2000, Venkatesh et al. 2003, Davis 2004, Fishbein & Ajzen 1975, Ajzen 1985, DeSanctis & Poole 1994, Rogers 1995, Goodhue & Thompson 1995, Davis, Bagozzi & Warshaw 1989, Venkatesh & Bala 2008, Sharp 2007, King & He 2006, Sun & Zhang 2006a); the use and further development, evaluation and review of such methods in the context of IS (King & He 2006, Sun & Zhang 2006a, Moore & Benbasat 1991, Legris 2003, Premkumar & Bhattacherjee 2008, Kijsanayotin, Pannarunothai & Speedie 2009, Gao, Moe & Krogstie 2010, Tang & Chen 2011). Moreover, it has been recognized that the context where the system is used has effects on the determinants of user acceptance (Bouwman & van de Wijngaert 2009, Bouwman, van de Wijngaert & de Vos 2008, Chesney 2008, van de Wijngaert & Bouwman 2009). The literature covers both the utilitarian and recreational contexts of technology use. The utilitarian context is defined by Chesney "as the degree to which the user has a reason for use which is external to the interaction itself" (Chesney 2008). Recreational use is defined as "the degree to which the user is using the system solely for the interaction itself" (Chesney 2008). In other words, in the recreational context the user gets for example a positive feeling from using the system and nothing else, whereas in the utilitarian context, the user gets something tangible instead of only the feeling of using it (Chesney 2008). Most of the research work in the technology acceptance of IS has been undertaken in a utilitarian context. However, the two contexts of utilitarian and recreational, are not exclusionary, as users may find their usage to be sometimes purely recreational but in other situations to be totally utilitarian.

The usage of the IS system can also be classified based on the voluntariness of use and the use of the system can be either mandatory or volitional. These two classifications of the type of use are not the same (Chesney 2008) - mandatory use is for example a professional use of the IS system when the user has no options to select a system, other than that which is stipulated by the agency or a company where the user works. Examples of mandatory IS systems are enterprise systems and public sector systems such as those used in law enforcement. The use of an IS system is volitional when the user has a genuine option either to use it or not. This is the case for example in consumer oriented systems and services. The technology adoption and acceptance in law enforcement which is a good example of mandatory use, is studied in this research.

The most common theory used as a foundation in technology acceptance is in all likelihood the diffusion of innovations (DoI) theory by Rogers (Rogers 1995). It proposes several concepts used to describe the diffusion of innovations.

Relative advantage, observability, trialbility, complexity (ease of use) and compatibility are elementary considerations in the theory of innovation diffusion. Those concepts proposed by Rogers have subsequently been used in many other studies, following the introduction of DoI. The elements of DoI form the basis for other concepts concerning technology adoption models and theories. The Diffusion of Innovation postulates that information spreads out within society using communication networks and channels. In this study, in addition to considering the intention to use technology, the context of the work activities where this decision making occurs, plays on important role. This specific context however is not in the focus of DoI (van de Wijngaert & Bouwman 2009), albeit that it refers to people's favourable or unfavourable decisions in adopting new technology. Moreover, according to them, the future use of technologies cannot be analyzed based on DoI concepts (van de Wijngaert & Bouwman 2009).

An overall model for understanding people's behaviour in general is the Theory of Reasoned Action (TRA), commonly used in social psychology by. It is also a very largely used theory in technology acceptance (Fishbein & Ajzen 1975). According to TRA, behavioural intention is a main factor in predicting behaviour. Fishbein and Ajzen posit that humans make rational choices and utilize the information which is available, for their decision making. In other words, people weigh up the consequences of their actions when carrying a certain behaviour into effect (Ibid.).

Based on the constructs from TRA, Davis proposed his theory on the technology acceptance model (TAM) in the domain of information technology (Davis 1989). TAM identifies perceived usefulness and perceived ease of use as dominant determinants of the intention to use technology. The main aim of TAM is to provide a foundation for chasing up the impacts of external variables on internal beliefs, attitudes and intentions (Legris 2003). The original TAM model also included *attitude* as a mediator of usefulness and *ease of use* as a mediator of the intention to use. The study for the original TAM development was performed among 120 employees of IBM, using their electronic mail system and general editor. Following the study and after the investigations based on TRA and TAM had been completed, attitude was removed from the model, as "their confluence led to the identification of a more parsimonious causal structure that is powerful for predicting and explaining user behaviour based on only three theoretical constructs: behavioural intention (BI), perceived usefulness (U) and perceived ease of use (EOU)" (Davis, Bagozzi & Warshaw 1989). This later study of Davis et al. was done with 107 MBA-students using a word processing application.

TAM has been expanded to form an enhanced version of the model, the Technology Acceptance Model 2 (TAM2) (Venkatesh & Davis 2000). Subjective norm, voluntariness and image are used as items of a social influence process construct; job relevance, output quality and result demonstrability as items of a cognitive instrumental process construct; and experience is used as a moderator are additional to the original TAM constructs in the TAM2 version.

The Technical Acceptance Model 3 (TAM3) is an integrated model of the determinants of perceived usefulness and ease of use (Venkatesh & Bala 2008). The model combines TAM2 with the anchoring and adjustment determinants of perceived ease of use.

The Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003) is a model aiming to explain the relationships between usage and intention. There are four core variables in the model; performance expectancy, effort expectancy, social influence and facilitating conditions. According to Turner (Turner et al. 2010), UTAUT is a behavioural model which aims to explain people's behaviour in organizational settings when they use information technology.

When looking at technology acceptance in the professional context however, there are findings in the literature which suggest that technology acceptance among professional users might not be exactly the same as in the individual context among common users. Chau and Hu state that professional users are more pragmatic and focus on the usefulness of the technology instead of ease of use (Chau & Hu 2002). Their results show that the perceived usefulness might be the only significant determinant on technology acceptance in this context. Based on the results of a study of 400 physicians regarding technology acceptance in telemedicine, Chau and Hu conclude that the compatibility between technology and practice is an issue of concern. Additionally, according to them, professional users appear to put a limited amount of weight on opinions from their peers (Ibid.).

In the professional context and especially in the context of law enforcement, these findings may offer good opportunities for research. Team work and working closely in pairs in a patrol is a prevailing work method in Finnish law enforcement. One might expect the social influence of peers to be a factor of influence on technology acceptance at the individual level. The power of social networks in technology acceptance has been demonstrated by Sykes et al. (Sykes, Venkatesh & Gosain 2009). In their study they have been able to capture the characteristics of user's social networks, in order to propose a new research model – a model of acceptance with peer support (MAPS). This has constructs to predict the use of an ICT system in the early phase. Related to this, emotions in a professional context have been proved to be important drivers of the behaviours in ICT use (Beaudry & Pinsonneault 2010). According to Beaudry and Pinsonneault, emotions that users felt early in the implementation phase of a new ICT system, have important effects on ICT use. Excitement was indirectly but positively affected the use via task adaption, supporting priori evidence in psychology that excitement boosts flexibility in problem solving and performing specific tasks (Beaudry & Pinsonneault 2010).

The intention to use of IT systems (especially mobile devices), may differ depending on the user's purpose in utilizing mobile technology and there are findings in literature to support this. Wakefield at al. have compared the utilitarian and hedonic (or pleasure-based) use of the mobile devices (Wakefield & Whitten 2006). Their findings suggest that there are differences in the impacts of beliefs depending on the user's purpose in utilizing the technology. They propose that usefulness is not an important criteria when users have an aim to have fun with their mobile devices. In that context, playfulness and enjoyment are important determinants of use. Additionally, van der Heijden states that the nature of the IT system is an important boundary stipulation to the validity for the model that is used in technology acceptance research (van der Heijden 2004). If the system itself is hedonic and not professional or utilitarian by nature, then perceived usefulness loses its value as a determinant for use, to the credit of enjoyment and ease of use. Moreover, in work related settings, enjoyment has been found to be the weakest belief in predicting technology acceptance (Venkatesh & Davis 2000, Taylor & Todd 1995). However, usefulness and enjoyment have been found to be mediating factors in the workplace context through studying the intentions to use computers (Davis, Bagozzi & Warshaw 1992). These results suggest that an increased enjoyment would increase the acceptance of useful systems and would have a smaller effect on other systems.

Technology acceptance in law enforcement is a special case in the professional context. In the law enforcement domain the use of a certain technology is not volitional to the user but obligated by the agency. Venkatesh reminds us that the volitional use of technology is one of the boundary stipulations of the utilization of TAM in technology acceptance (Venkatesh 2000). This was the starting point for a study by Brown et al. , who commenced by asking whether these findings relying on behaviour-based models hold true when the use of the technology is mandatory (Brown et al. 2002). They concluded that there was a different pattern of relationships in the technology acceptance models for IT technology in a mandatory setting, when compared with those in a voluntarily setting. These findings set new exigencies for such research in a law enforcement context where the user must perform certain behaviours because they are bound to do so (Brown et al. 2002) . Similarly, these considerations form the basic principles for the research in hand.

The use of mobile technology in law enforcement is a new area in technology acceptance research and only a few studies exist (Hu et al. 2011). However, the use of mobile technology in law enforcement has been seen as important and beneficial for the officers involved to improve the results of their work. Easton concludes that the use of wireless systems among other things, improves productivity, neighbourhood safety and cost reduction (Easton 2002). However, as stated before, those results are contradictory to the results of Garicano et al. that suggest large investments in ICT within law enforcement are not directly linked into an increase in productivity. Because of this, more research in the law enforcement context is needed (Garicano & Heaton 2010).

New research models based on TPB, TAM and UTAUT together with new determinants specific for law enforcement have been proposed. Hu et al. introduce a model where the factors indicating the influence of efficiency gain, facilitating conditions and social influence are integrated into the TAM-based model. This takes into account the anticipated needs of the target users (Hu et al. 2011). In like manner, Bouwman and van de Lidwien underline the context related factors. The context where the communication happens is dominant. They see that the TAM based factors in the research of the use of police mobile technology are not sufficient (Bouwman & van de Wijngaert 2009). In their research the theories of media choice and task-technology fit are integrated into one model. They suggest that TAM based models are too generic to explain fully the factors of the users' intentions in mobile technology use in a law enforcement context. They propose that new research is needed for contextual and task related factors in this area.

This research aims to provide a response to the demands for more research work by the community. In this research, one of the interests is the effects of the working contexts on the acceptance model. The contexts are presented with four attributes; weather, scene, urgency and activity. All these are attributes for mobile contexts outside the normal office environment.

In regard to the Finnish Police: measured in man-years, the agency had 10679 man years personnel in 2010, with the amount of police officers being 7826 (National Police Board of Finland 2011). During 2001-2007 there were approximately 620 citizens for every police officer (Tiainen 2009). The police in Finland are obliged to operate in a number of different working circumstances. The country is geographically large having a lot of sparsely populated rural areas in addition to urban areas. The police have to offer services to all people , regardless of their home area. Balancing these two different areas of operations is one of the main challenges to be faced by the police in the future (National Police Board of Finland 2011). This view reflects the geographical origins of the issue and offers this research the first two contexts of work which are quintessential for police work in Finland; firstly, working in differential climatic conditions and secondly, working in or outside a vehicle. In the first context, the weather conditions may change from harsh frost in the winter to hot weather in the summer. In this study, this context is believed to have an effect on the technology acceptance of mobile technology.

The second context regarding the working scene considers the situation if police work is carried out inside or outside a vehicle. Typically a police team patrols in a police vehicle which is equipped with relevant communication, navigation, and surveillance equipment (for example radio communication requisites for speech and data communication), a satellite based maps application, radar, precision alcometers, etc. When the team reaches the target, the patrol members leave the police car and start using the portable communication tools. Some of the actions such as preliminary questioning of the parties of the case and data base queries are done inside the vehicle using dedicated tools. Some actions, such as voice communication, can take place outside the vehicle. For the future, the idea is to change the working methods of the police to utilize mobile technology as much as possible, so as to transfer the work from the office setting to the field. The intention is to minimize the travelling of police patrols between the scene and police station so that all the paperwork associated with their operations is done in the vehicle environment.

The third context of work is based on the urgency of the assignment. There are actions inside assignments which need to be carried out immediately, such as data base queries regarding the information of vehicles involved in an accident, queries to the weapons register or criminal records or requesting information concerning the identity of the suspect. On the other hand, actions like reading internal notices or feeding in working hour allocations to the follow up system can be classified as non-urgent actions.

The fourth context relates to the assignment itself, in other words, the specific activity which is needed for the assignment in question. In this study three types of activities are considered; data base query, data base input and reporting working hours.

As a summary, these four contexts are based on four attributes; weather, scene, urgency and activity, and are used as moderators for the technology acceptance research model of this study. A more detailed description of the theories, research models and concepts pertinent to the current research is provided in Chapter 2.

1.7 Organization of the Study

The organization of the current study follows the general rules of dissertations. Moreover, it is adapted from several studies and instructions (Niemelä-Nyrhinen 2009, Yalcinkaya 2007, Metsämuuronen 2009, Hirsjärvi, Remes & Sajavaara 2010). The study is organized in the following manner: In Chapter 1 the research is introduced, and the background and relevance of the research is presented. The target group of the research, the Finnish Police is introduced. Following this, a statement of the research problem is offered and the research objectives and theoretical framework are clarified. The literature review that forms the theoretical foundations of the research is presented in Chapter 1. The different research methods employed for researching technology acceptances are outlined, as well as the research model and the hypotheses of the study. Chapter 3 forms the introduction of the methodology and the research domain. The questionnaire, operationalization of constructs and data collection methods are presented. Chapter 4 contains the results of the study including descriptive results, estimations of the measurement and structural equation models, reliability and validity assessments and the results of the multi-group analysis. A summary of these results concludes the chapter. In chapter 5 the concluding discussion of the results and main findings is presented, along with the contributions and limitations of the study and ideas for future work. A summary of the study closes chapter 5.

1.8 Summary

This chapter contained the introduction, backgrounds and relevance of the topic of the current research. It was found that more research is needed in the area of technology acceptance in law enforcement. The research objectives, conceptual framework and theoretical foundations were presented. The main purpose of the current research was defined to analyze and evaluate parameters which affect technology acceptance in the law enforcement context. The research framework was formed combining three elements; using pre-prototypes in predicting users' intentions, using the technology acceptance model TAM with new external variables as a central concept in the framework and using moderators to determine the moderating effects between constructs. The structure of the study was also introduced.

The following chapter includes the literature review of technology acceptance in non-volitional use. The research model and hypotheses of the study are also introduced.

2 LITERATURE REVIEW ON THE RESEARCH OF ACCEPTANCE OF NEW TECHNOLOGY IN NON-VOLITIONAL USE

Technology acceptance research in law enforcement is a special case in the context of non-volitional user research, more specifically among the studies regarding the professional users of information technology. The need for this research has become apparent since the use of information technology has become a prevailing working method in the everyday activities of law enforcement. Typical forms of usage are data base queries, typing in crime fighting related information, utilizing location based GPS information and even more sophisticated services utilizing semantic and data mining technologies for data storing and processing. There is a paucity of research in the law enforcement context. Most of the research in technology acceptance and adoption has been accomplished in a utilitarian context and mainly in workplace settings (Chesney 2008). Target users have been mandated to use enterprise systems like an enterprise management system (EMS), company intranet and e-mail. Those systems have been then used in studies as a target apparatus of the intentions of users. Use in this context can be interpreted to be non-volitional (Rawstorne, Jayasuriya & Caputi 2000) in the professional context, however, in the context law enforcement (especially in the police organizations), the intentions to use information technology are little studied. Hu et al. state that law enforcement officers advocate noteworthy users who have specialized work tasks and are required to constantly improve their job performance. For this reason they also have slightly different criteria, when compared to the business users of information technology (Hu et al. 2011).

2.1 Technology Acceptance in a Non-volitional Context

The use of information technology in different contexts can be classified in many ways. One way is to make this division by examining the reasons for use. Chesney proposes two categories for these reasons; utilitarian and recreational

(Chesney 2008). In utilitarian use, the user of the system expects to achieve some tangible outputs by interacting with the system. Examples of this type of output may be documents from data bases or e-mail attachments from the company e-mail system. The utilitarian reasons are external to the interaction. In contrast, in recreational use, the reasons for use are internal to the interaction. The user does not expect to get anything else other than for example a positive feeling from the system. Examples of this type of system are online games and online movies. However, these two types of use are not mutually exclusive, as a system can be both useful and fun at the same time. This is called the dual context (Chesney 2008). To gain the optimal user experience in utilitarian use, systems can be also designed to be recreational for the user - in other words in dual context. Good examples of these combined systems are online shopping and learning systems. The classification of these contexts is illustrated in FIGURE 2.

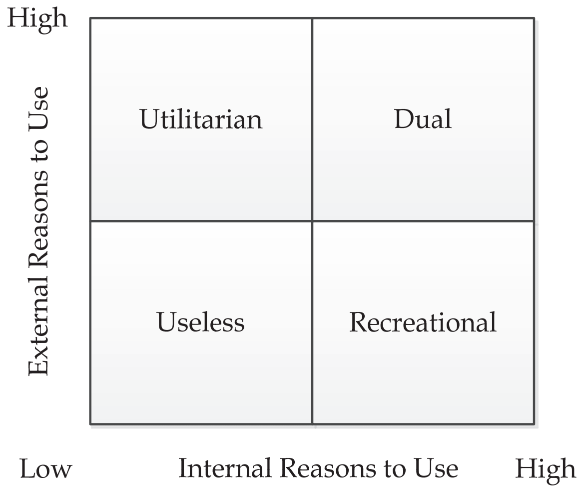

FIGURE 2 Contexts of use (Chesney 2008)

The research in this area has mostly concentrated on the utilitarian settings. However, the current trend seems to be that the research in technology acceptance is moving from the studies in workplace settings towards recreational use (Chesney 2008). Research in both the utilitarian and recreational use of technology looks to find, explain and confirm the different factors affecting a user and making him or her to adapt a certain technology in practice. In this type of research for example, a user's intentions to perform certain behaviour are measured and interpreted.

The classification of technology use can also be undertaken based on the voluntariness to use a system. A system use can be volitional or mandatory (Brown et al. 2002). In mandatory use, the user is obliged to use a certain technology by the organization (Venkatesh & Davis 2000), so the user cannot freely make choices between different solutions. These types of systems are normally enterprise information systems for employers and management to run and control the business of a company, or systems inside the public organizations like government agencies such as law enforcement or hospitals. In these systems which are classified as volitional, a user has a free choice to use the system or not. The volitional use of technology is the most popular research area in technology acceptance. The majority of the research methods are based on the theory of reasoned actions (TRA) (Fishbein & Ajzen 1975) and technology acceptance model (TAM) (Davis, Bagozzi & Warshaw 1989) - a model which has its origins in TRA. These models both share the common principle of a capability to predict an individual's behaviour, based on their intention to perform that behaviour, when enough time and knowledge is provided (Rawstorne, Jayasuriya & Caputi 2000). According to Fishbein and Ajzen, this requires that a user's behaviour is under his or her volitional control, which can be achieved when the user is reasonably able to express their will. This can be measured by measuring the individuals intention to perform that action (Fishbein & Ajzen 1975).

Research of the adaption and use of new information technology is one of the most developed and popular research areas in the information technology field (Jasperson, Carter & Zmud 2005). At the same time, user acceptance, (in other words, the pre-adoption of systems in a mandatory context) is gaining popularity. There are several explanations to this trend. The pressure to get users to fully utilize the investments which being made in information systems (especially in public organizations) is growing. The productivity demands of public organizations have been foregrounded in the regression of the world wide economy. The same phenomena can be seen in the private sector as well, where companies try to get better economical results, even during periods of recession. In order to do more with less, companies invest for example in enterprise resource planning (ERP) systems to manage their core processes and resources. However, only one half of ERP investments enjoy the benefits of the new IT system in practice (Shanks, Seddon & Willcocks 2003). Scholars therefore propose that user acceptance as an elementary part of the overall acceptance of the information system rollout, should therefore be a dominant practice in industry. To understand the factors affecting the end-user acceptance is one motivator for the current research.

2.2 Using Pre-prototype Testing in Technology Acceptance Testing

The traditional methods in information systems research of measuring a user's behaviour in technology acceptance processes are based on the belief that there must be an existing system in operational use to be used by the user and the survey questions are presented to users, after they have used that system. The use of a pre-prototype to assess user's perceptions of an information system long before the system is in operational use, offers a trustworthy way to get an insight into the system and as to the functionality of it. This method, introduced by Davis, challenges the traditional methods which posit that hands-on usage is a premise for measuring the user acceptance attributes of information systems (Davis 2004). He has shown that combined with TAM, pre-prototype testing gives a good approximation for the user's perceptions of the information system. While using a pre-prototype which imitates the system in its early development stage there is no need for a real working system. This in turn offers possibilities for types of studies which normally would require the user's interactions with a working system in a real environment. The idea of using pre-prototypes is depicted in FIGURE 3.

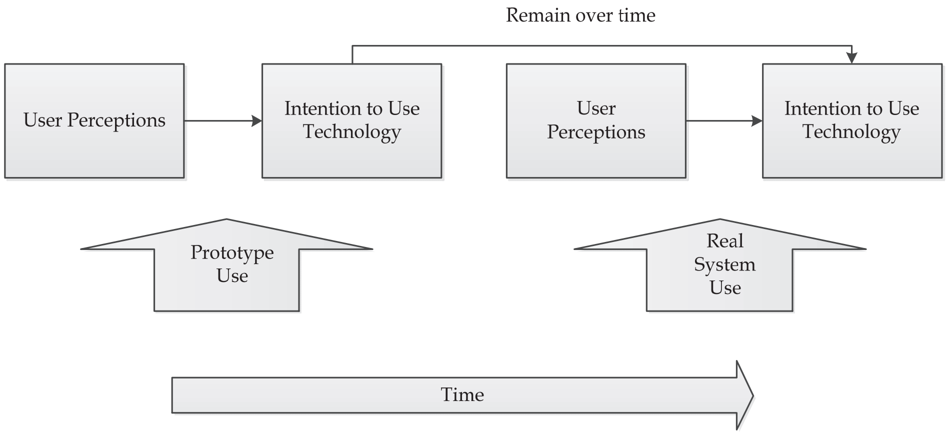

FIGURE 3 Using pre-prototypes in measuring user perceptions (Davis 2004)

Davis has found out that the behavioural intention and perceived usefulness (both being constructs of TAM, and being measured with the pre-prototype of an information system), highly correlate with measurements which were undertaken after some months usage of a real information system (Davis 2004). This finding demonstrates that it is possible to predict users' intentions in advance without a real working system using a non-working mock up.

What are the attributes in technology acceptance testing which could be measured using a pre-prototype? In TAM (Davis 1989) the best predictor of user behaviour for the actual technology is a user's intention. This use of intention is based on the intention model theory from psychology (Fishbein & Ajzen 1975). In meta-analyses, according to and covering several domains, the correlation between intention and behaviour has been reported to have a mean of 0.47 (Ajzen & Fishbein 2005). According to the intention model theory (Fishbein & Ajzen 1975, Fishbein & Ajzen 1975, Ajzen 1985) each behaviour that a human performs, is related to a corresponding intention to perform that behaviour. Using this theory, the dependency between the intention to use and real use has been proved to be significant also in the context of information systems (Davis, Bagozzi & Warshaw 1989). The TAM has two beliefs - perceived usefulness (PU) and perceived ease of use (PEOU), which are both determinants of the behavioural intention to use technology. Davis demonstrates that the perceived usefulness is a stronger determinant of the behavioural intention of these two (Davis 1989). Supporting this finding, Venkatesh et al. go further, concluding that perceived usefulness is the only determinant of intention (Venkatesh et al. 2003). This conclusion is based on the discovery that when users become more experienced with the system use through hands-on utilization, the effect of perceived ease of use is reduced. This is based on the premises that firstly; the perceived usefulness will be stable over time and will not change, even though the users will gain more experience while using the information system, and secondly; as perceived usefulness being the strongest determinant of behavioural intention - the behavioural intention will stay stable over the course of time. This hypothesis has been validated and confirmed in field studies (Davis 2004). Hence, behavioural intention having perceived usefulness and perceived ease of use as its determinants with their respective antecedents of social influence and compatibility, is supposed to be measured reliably using a pre-prototype to approximate the user's perception.

2.3 Theory of Reasoned Action (TRA)

The theory of reasoned action (TRA) is a model in social psychology aimed at explaining the psychological factors which can be used to predict behavioural intentions or behaviour (Fishbein & Ajzen 1975). This model is widely used in modern research, as it was originally targeted to try to understand the beliefs and attitudes of human beings which affect their behaviour in general. Fishbein and Ajzen define behavioural intention as a "person's intentions to perform various behaviours" linking it directly to a person's probability to perform to some action (Fishbein & Ajzen 1975). TRA assumes that human beings behave rationally, making choices between different actions before performing those behaviours. Information about the consequences of different actions is used in the decision making process in deciding whether to perform a certain behaviour or not. According to TRA, the immediate determinant of behaviour is person's behavioural intention. FIGURE 4 presents the model of TRA.

The model reveals that the antecedents are classified into conceptually two categories; behavioural and normative. The attitude indicates if a person feels that performing that behaviour is good or bad for him or her. The subjective norm of a person indicates whether a person believes that other people want that a person would perform the behaviour (Hartwick & Barki 1994). During the decision making process, attitude and subjective norm are weighted to reflect their corresponding importance. The importance is different for different people, for situations where the behaviours are performed, and for the behaviours themselves.

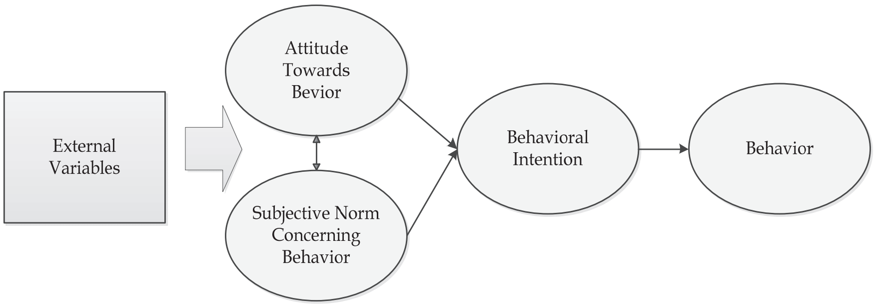

FIGURE 4 The model of theory of reasoned action (TRA) (Fishbein 1984)

Thus, the external variables are assumed to affect the behavioural intentions only through attitudes and subjective norms (Madden, Ellen & Ajzen 1992). From the point of view of the present study, in TRA there is a boundary condition which affects the intensity of the relation between intentions and behaviour; by assumption, carrying out the intention must be under the volitional control of the individual.

2.4 Theory of Planned Behaviour (TPB)

The theory of planned behaviour (TPB) is an expansion of the theory of reasoned action. The expansion is a new exogenous variable, perceived behavioural control, which has both a direct and indirect effect on behaviour (Ajzen 1985). This is based on the interpretation of behavioural intention. It is an intention to try to perform a certain behaviour. By using this definition of behavioural intention, in other words - in trying to do, an individual can be understood to intend to perform a behaviour even if the factors which are not under his or her control may prevent the execution of that behaviour after the assessment. Thus, the insertion of perceived behavioural control on the top of TRA allows the theory of reasoned action to be utilized in the non-volitional context as well as the volitional. The model of TPB is presented in FIGURE 5. The direct path which goes from perceived behavioural control to behaviour denotes the actual control which an individual has over their action when performing the behaviour. It is significant when the behaviour happens in a non-volitional context and when the perception of the control is accurate (Madden, Ellen & Ajzen 1992). The indirect path from the perceived behavioural control via behavioural intention, to behaviour itself is grounded on the premise that perceived behavioural control has motivational implications for behavioural intentions (Madden, Ellen & Ajzen 1992).

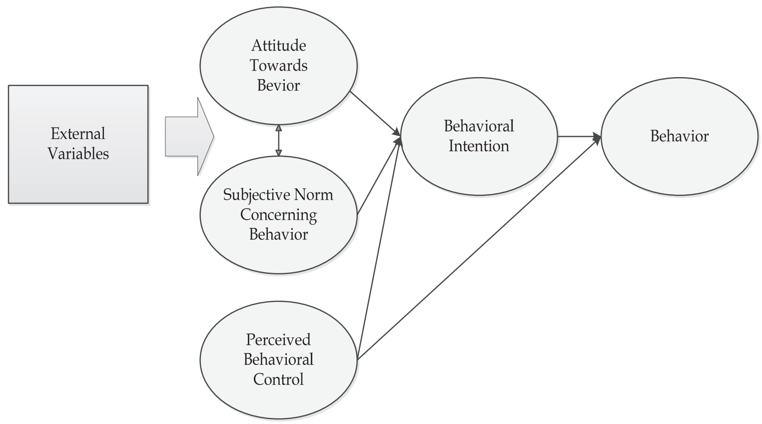

FIGURE 5 The model of the theory of planned behaviour (TPB)

Ajzen makes the TPB more general by defining that according to TPB, an individual will try to perform a behaviour if he or she believes that the advantages of success are bigger than the disadvantages of failure, and if he or she believes that the those people who are close to him or her think that a behaviour should be performed (Ajzen 1985). This attempt is successful if an individual has sufficient control over the internal and external factors which have an effect on the intention.

The subjective norm as a determinant of behavioural intention and its role in the domain of information technology use is suggested to change as a function of the phase of implementation. The subjective norm has been found to be more important in the early stages of or prior to an implementation (Hartwick & Barki 1994) . They explain this with the statement that the users in the early stage of an implementation have limited experience from which to develop attitudes towards the systems use.

2.5 Innovation Diffusion Theory (IDT)

According to Innovation Diffusion Theory (IDT), diffusion is "the process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers 1995 p. 5). The four main elements in the diffusion are innovation, communication channel, time and social system. The innovation, according to Rogers is an idea, object, or practice that can be seen new by a person or other relevant adopter. Communication channels are the means by which the information related to the innovation is passed from one person to another. The time dimension in the process of innovation diffusion is one of its strengths as the adoption of the technology occurs in sequences of time ordered steps through knowledge, persuasion, decision, implementation and confirmation. The social system covers all the units that are involved in collective problem solving to reach a common goal. The members of these units may be constructed of individuals, organizations, informal teams or subsystems (Rogers 1995).

In IDT, the perceived characteristics of an innovation from the individual's point of view are relative advantage, compatibility, complexity, trialability and observability. The relative advantage is the degree to which an innovation is perceived as better than the preceding idea, object or practice. What matters is the degree of advantageousness as perceived by an individual, not the objective advantageousness itself. Compatibility takes account of the parameters related to the consistency of an innovation with the existing values, past experience and needs of a user. An innovation which is compatible with the values and norms of the social systems is accepted faster than an innovation which is not compatible with such values and norms. Complexity is defined as the degree to which an innovation is perceived as difficult to use and understand. Trialability is the extent to which an innovation can be experimented with before the real use. Observability is the extent to which an innovation is visible to other people. Using these perceived characteristics of innovations, Rogers suggests that those innovations which have a greater relative advantage, compatibility, trialability, observability and less complexity will be adopted more rapidly than other innovations (Rogers 1995). The method of how the adoption of innovations develops as a function of time is depicted in FIGURE 6. It presents the presumption that most innovations have an adoption rate that is s-shaped. Some of the innovations diffuse very rapidly having a steep s-curve whereas some others are adopted more slowly ending up with a gradual s-curve. This difference in adoption rates between different innovations creates new research questions for science and is one of the motivators for the present study as well.

The compatibility aspect of IDT has been used later in other research models, such as decomposed TPB model by Chau & Hu (2001). This model decomposes attitude and uses perceived usefulness and perceived ease of use as mediating variables and uses compatibility as a determinant for both of them. The significance of the compatibility has been recognised. It has been suggested to be a determinant for user intentions also by Tornatzky & Klein (1982), Taylor & Todd (1995), and Moore & Benbasat (1991).

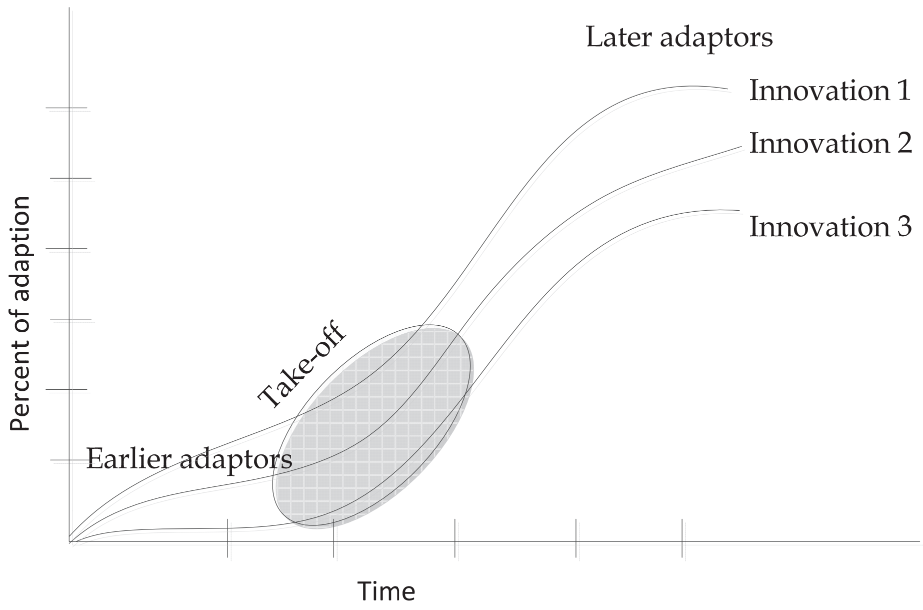

FIGURE 6 Diffusion of innovations as a function of time (Rogers 1995)

2.6 Technology Acceptance Model (TAM)

According to the original Technology Acceptance Model (TAM) two particular beliefs, perceived usefulness (PU) and perceived ease of use (PEOU) are the main factors in explaining user attitude, intention and their actual use of computers (Davis, Bagozzi & Warshaw 1989, Davis 1989). Perceived usefulness in TAM is defined as "the prospective user's subjective probability that using a specific application system will increase his or her job performance within the organizational context" (Davis 1989) {{35 Davis, Fred D. 1989}}(Davis 1989). Perceived ease of use in TAM is defined as "the degree to which the prospective user expects the target system to be free of effort" (Davis 1989). TAM uses the Theory of Reasoned Actions (TRA) as a theoretical framework to explain the causal linkages between the two main beliefs, usefulness and ease of use, and behaviour and its antecedent attitude. TRA is presented in Chapter 2.3 of the present study. TAM is designed specifically to explain computer user behaviour but as it contains a large amount of cumulated findings in information technology research, it is suggested that TAM can be used in modelling computer acceptance as well (Davis, Bagozzi & Warshaw 1989). The original model of TAM is depicted in FIGURE 7.

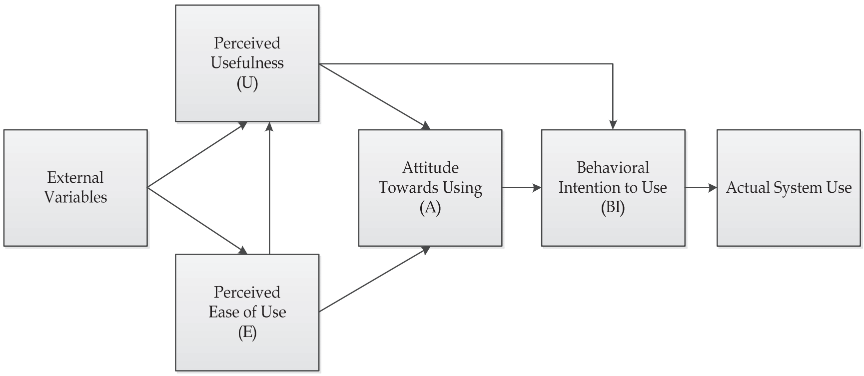

FIGURE 7 Original Technology Acceptance Model (TAM) (Davis 1989)

The TAM posits that external variables affect the attitude toward using and the intention to use technology, only via a user's beliefs. Those two beliefs and the determinants of attitude and intention are perceived as usefulness and perceived ease of use. Especially, perceived usefulness has been shown to be a strong determinant of usage intentions. Additionally, perceived usefulness is a mediator for perceived ease of use. This gives an explanation to a belief that the easier an information system is to use, the more useful it can be (Venkatesh & Davis 2000). Attitude then sequentially affects upon the behavioural intention to use technology which is the sole determinant for the actual use of the system. After the introduction of TAM, attitude has been removed from the original TAM. Venkatesh and Davis found that attitude has little impact in mediating the perceptions of usefulness and ease of use, to behavioural intention (Venkatesh & Davis 2000). However, attitude is still used today in the variants of TAM within information research. The summary of the results of a meta-analysis shows that out of 28 studies based on TAM measurements between the years 1980 and 2001, 7 studies reported significant relations between attitude and intention, 4 reported non-significant results and 17 did not test the relationship (Legris 2003, Polančič, Heričko & Rozman 2010). The modified TAM where attitude is removed is depicted in FIGURE 8.

Generally TAM has been reported in several studies to explain approximately 40 percent of the variance in behavioural intentions and behaviour (Tang & Chen 2011). They present the results of their comparative study of four different models. TAM explains 45 to 61 percent of the variance in intention and between 30 to 74 percent of the variance in behaviour. Venkatesh and Davis state that TAM explains typically 40 percent of the variance in user's intentions and behaviour (Venkatesh & Davis 2000). Partly due to these reasons, TAM has been used widely in empirical tests in predicting users' information technology usage intentions (Premkumar & Bhattacherjee 2008).

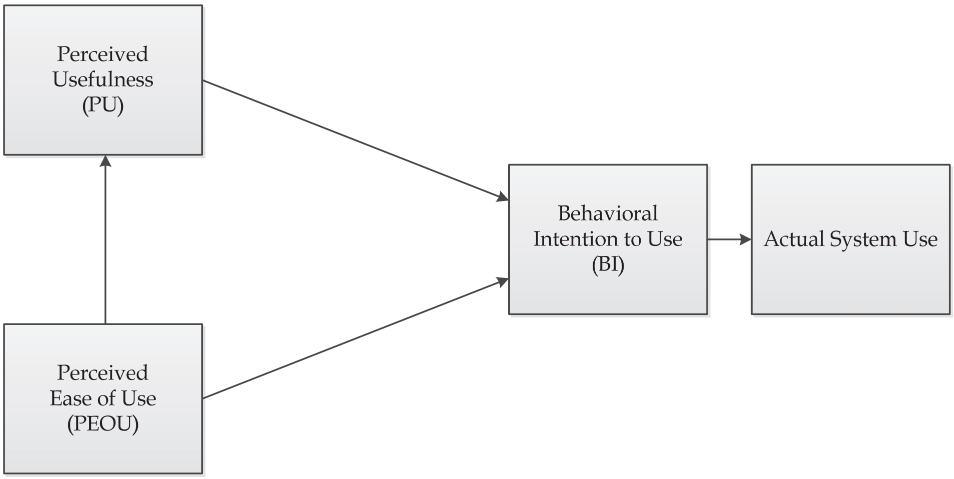

FIGURE 8 Technology Acceptance Model (TAM) (Venkatesh 2000)

TAM has not survived without criticism. Legris states that although the results of the studies based on the use of TAM are convergent, some are conflicting (Legris 2003). He sees that when TAM is used in organizational studies, it should be integrated into a broader model to increase the predictive characters of the model and should be made more versatile with organizational and social factors. Perceived usefulness has been found to be a strong determinant of intention. The effect of ease of use will diminish over time when the users gain more experience of using the system (Venkatesh et al. 2003). It has been proposed that based on the comparative studies of several acceptance models - that ease of use, not only in TAM, but in all models which were studied, is an instable factor because the correlation coefficient varied between 0.01 to 0.20 and therefore its determinants should be renewed (Tang & Chen 2011).

2.7 Technology Acceptance Model 2 (TAM2)

The Technology Acceptance Model (TAM) has two main determinants for the user's intentions; perceived usefulness and perceived ease of use. Perceived usefulness has been a strong determinant of usage intentions. In order to understand better such an important construct in TAM, additional determinants for perceived usefulness were added into the model. Subjective norm, voluntariness and image, as items of a social influence process construct; job relevance, output quality and result demonstrability, as items of a cognitive instrumental process construct; and experience as a moderator are additional to the TAM constructs in the enhanced version of it, Technology Acceptance Model 2 (TAM2) (Venkatesh & Davis 2000). The model of TAM2 is depicted in FIGURE 9.

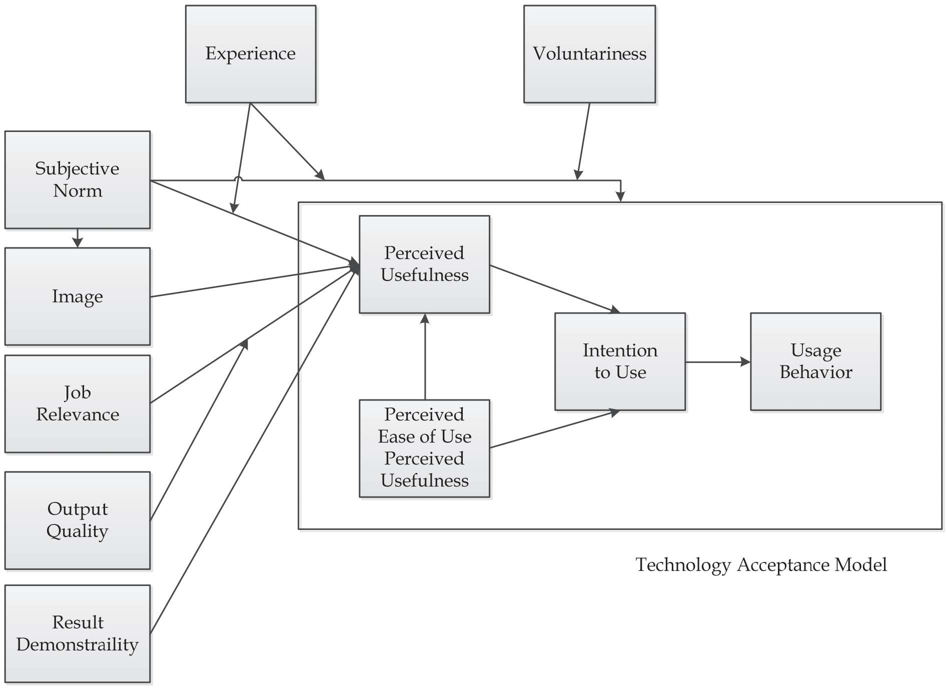

FIGURE 9 Technology Acceptance Model 2 (TAM2) (Venkatesh 2000)

TAM2 has been demonstrated to explain up to 60 per cent of the variance in perceived usefulness. In this sense, it has more explaining power than TAM for user intentions. Further, in addition to perceived usefulness and perceived ease of use, subjective norm has a significant direct influence on usage intentions in TAM2 in mandatory settings but not in voluntary settings (Venkatesh & Davis 2000). Subjective norm also has indirect effects on intentions, namely via perceived usefulness using internationalization and identification. The effect via internationalization happens when users let social influences have an effect on their perceptions. The effect via identification happens when users use the system in order to have more status and visibility in their working environment and to improve their own work performance.

Experience and voluntariness are moderators of the effects of subjective norm on perceived usefulness and intention to use. The experience has been proved to have a moderating effect on the intention to use technology in mandatory settings in the early stages of the systems use. When users get more experience of the systems in the course of time, they start to rely less on social influence, but continue to rely on usefulness. This is explained by the conclusion that people believe they gain status benefits when using the system (Venkatesh & Davis 2000). TAM2 contains the interactive effect between the job relevance and output quality in determining the perceived usefulness. User perceptions of results, demonstrability and ease of use are significant determinants of the usefulness in TAM2. This reveals that the system user acceptance can be increased by empirical demonstrations of the system.

2.8 Technology Acceptance Model 3 (TAM3)

The Technical Acceptance Model 3 (TAM3) is an integrated model of the determinants of perceived usefulness and ease of use (Venkatesh & Bala 2008). The model combines TAM2 (which is presented in chapter 2.7 of the present study), with the anchoring and adjustment determinants of perceived ease of use. The anchoring determinants of ease of use are computer self-efficacy, computer anxiety, computer playfulness and the perception of external control (Venkatesh 2000). The adjustment determinants of ease of use are perceived as enjoyment and objective usability. The comprehensive nomological network of TAM3 is depicted in FIGURE 10.

TAM3 has its background in existing and validated models. In addition to these relationships, TAM 3 posits three new relationships which were not measured earlier; firstly the moderation effect of experience to the relationship between computer anxiety and perceived ease of use, secondly the moderation effect of experience to the relationship between perceived ease of use and perceived usefulness and thirdly, the moderation effect of experience to the relationship between perceived ease of use and behavioural intention. Venkatesh and Bala have demonstrated that regarding the first new relationship of TAM3, the moderation effect of experience to the relationship between computer anxiety and perceived ease of use; experience moderates the effect of computer anxiety on perceived ease of use in such a way the power of computer anxiety diminishes when the experience of the system use increases (Venkatesh & Bala 2008). Similarly, they have demonstrated that regarding the second new relationship in TAM3, the moderation effect of experience to the relationship between perceived ease of use and perceived usefulness; experience moderates the effect of the perceived ease of use to perceived usefulness in such a way that when experience grows, the effect becomes stronger. Furthermore, regarding the third new relationship, the moderation effect of experience to the relationship between perceived ease of use and behavioural intention; experience moderates the effect of the perceived ease of use to intention to use in such a way that with increasing experience the effect becomes weaker. Venkatesh and Bala report that TAM3 can explain between 40-53 percent of the variance in behavioural intention, supporting the suggestion that behavioural intention is a significant predictor of use.

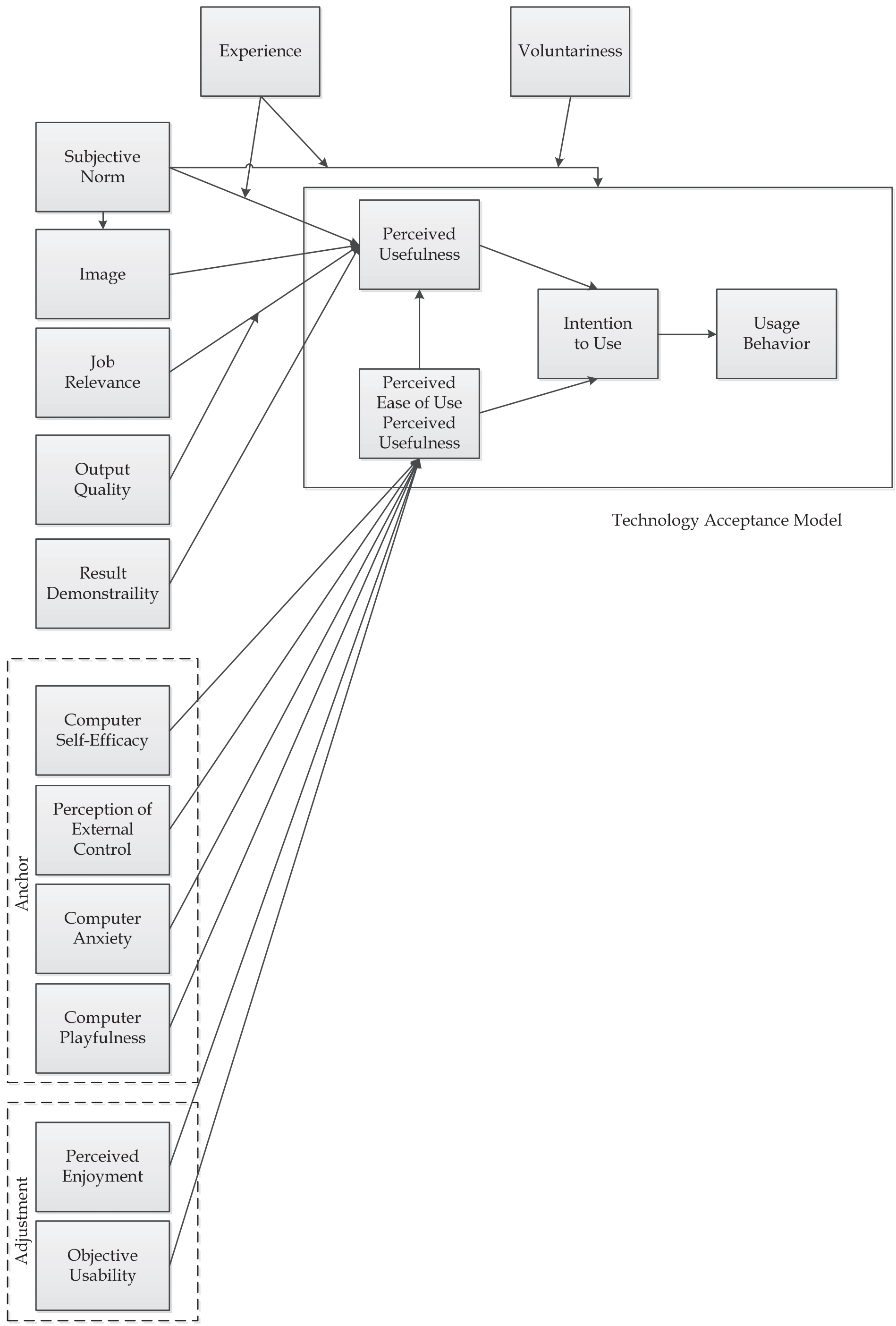

FIGURE 10 Technology Acceptance Model 3 (TAM3) (Venkatesh 2008)

2.9 Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) is a model aiming at explaining the relationships between usage and intention (Venkatesh et al. 2003). There are four core variables in the model; performance expectancy, effort expectancy, social influence and facilitating conditions. The first three variables; performance expectancy, effort expectancy, and social influence are direct determinants of the intention which in turn is a direct determinant of usage behaviour. The fourth factor; facilitating conditions, is a direct determinant of usage behaviour. There are four more factors in the UTAUT model; gender, age, experience and voluntariness, which work as moderators for all relationships. The model of UTAUT is depicted in FIGURE 11. The development of UTAUT is based on the identification of eight existing theoretical technology acceptance models; the theory of reasoned actions (TRA), the technology acceptance model (TAM), the motivational model, the theory of planned behaviour (TPB), the model of PC utilization, the innovation diffusion theory, and the social cognitive theory. The four determinants of intention and usage are performance expectancy, effort expectance, social influence and facilitating conditions. According to Turner, UTAUT is a behavioural model which aims to explain people’s behaviour in organizational settings when they use information technology (Turner et al. 2010).

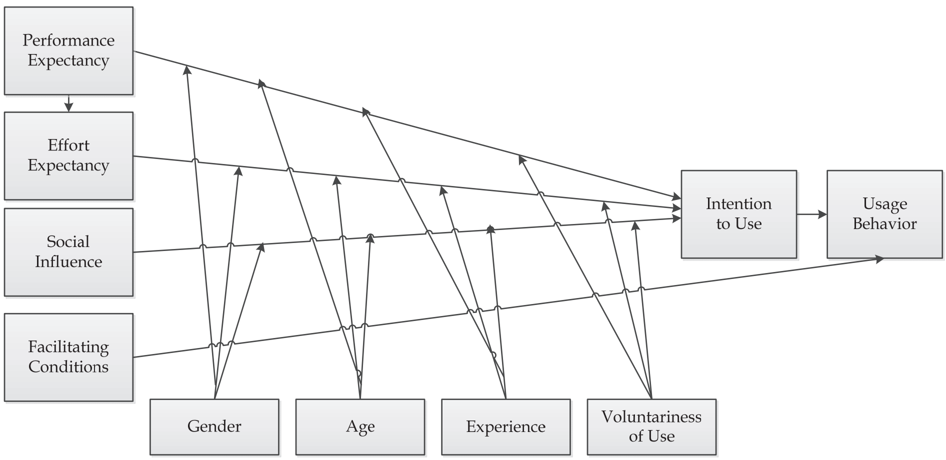

FIGURE 11 Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh 2003)

The results vary in studies using UTAUT to explain the variance of intention to use. It has been suggested that 54 percent of the variance of the intention to use health technology can be explained with the modified UTAUT (Kijsanayotin, Pannarunothai & Speedie 2009). However, other results suggest that as much as 70 percent of the variance of the intention to use technology in an organizational setting can be explained using the UTAUT model (Venkatesh et al. 2003). Therefore, Venkatesh at al. propose that this figure is getting close to the practical limit in explaining individual technology acceptance and usage decisions in organizational settings.

2.10 Task Technology Fit (TTF)

Task Technology Fit (TTF) is defined as a situation where technology is capable of providing such features and support which fit the requirements of the work in question (Goodhue & Thompson 1995). TTF has been used as a conceptual basis for a user evaluation instrument in the context of assessing information systems and services for managerial use in decision making (Goodhue 1998). Results of a good fit between user needs and technology are for example a positive effect in the performance of the users (Goodhue & Thompson 1995).

The key factor of the task-technology fit model is an assertion that information systems give value to users as those systems are of help in those tasks which users have to accomplish. Users reflect this value when they evaluate information systems.

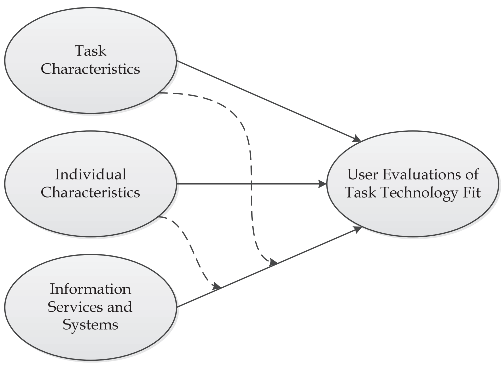

FIGURE 12 Task Technology Fit (TTF) (Goodhue 1998)

Hence, the strongest connection between the information system and performance effect is caused by the conformity of the needs of tasks and system functionality (Goodhue 1998). As a consequence of this, when the task needs change, the most appropriate systems will change accordingly. Using the TTF, it has been suggested that the productivity of police officers would not improve a field officers' productivity (Ioimo & Aronson 2004). On the contrary, they suggest that in-field computing decreases the productivity of field officers while it increases productivity in other departments. The basic model of task-technology fit is depicted in FIGURE 12.

2.11 Adaptive Structuration Theory (AST)

The Adaptive Structuration Theory (AST) is a theory which emphasizes the interplay between technology, social structures and human interactions (DeSanctis & Poole 1994). It is a framework for studies of variations in organizational changes caused by the technology used in the organization. AST has its foundations in Gidden's structuration theory (Giddens 1979). The structuration theory is a general theory of social organization which posits that the social structure is a continuous process of everyday practices. It highlights the process type of interaction between individuals and society instead of static properties or patterns (Jones & Karsten 2008). Moreover, it is not specifically related to information systems but rather a high level abstraction of social phenomena.

According to AST, users of an information system create and maintain their social systems applying the rules and resources from the information system they use. This is based on the other cornerstone of AST, the appropriation of technology. Appropriations of technology are defined as "immediate, visible actions that evidence deeper structuration processes" (DeSanctis & Poole 1994). Those actions are instantiated by the users via appropriation moves, such as a direct use of technology structures, making judgments about them and displaying various types of attitudes towards them. At the same time when performing their actions, they interplay continuously with other members of the organization. In this way, both the technology and actions are iteratively shaping each other.

AST illustrates the versatility of different outcomes resulting from the same technology implementations. This is based on the argument of AST that advanced technology can trigger adaptive structurational processes which in the long run may lead to changes in the organizational rules and resources which are used by the organization in question. The model of the AST is depicted in FIGURE 13.

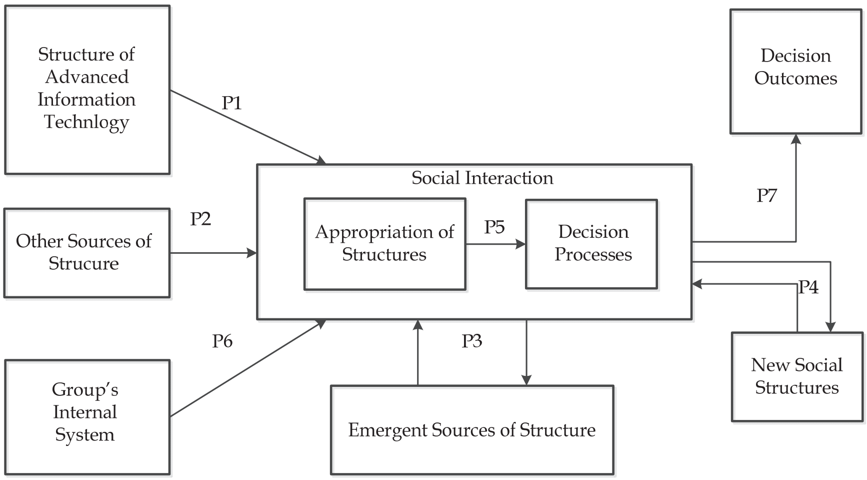

FIGURE 13 Adaptive Structuration Theory (AST) (DeSanctis 1994, Jones & Karsten 2008)

2.12 Over and above TAM – Compatibility and Social Influence of the Team Work

The importance of compatibility in technology acceptance models has only recently been recognized. Unfortunately, the attempts to include compatibility into the models that explain technology adoption have not had a favourable outcome. This is partly due to the difficulties in making a clear distinction between the beliefs of perceived usefulness and compatibility (Karahanna, Agarwal & Angst 2006, Taylor & Todd 1995). The inability to discriminate between these two beliefs has resulted in failings in various empirical tests. Compatibility is defined early in the history of innovation adoption by Rogers (Rogers 1962), as the degree to which an innovation is understood to be compatible with existing socio-cultural beliefs and values, earlier and current experiences and the needs of likely adopters. It has later been broadened to cover two types of compatibility: normative compatibility which refers to the compatibility with users' feelings and thoughts about the innovation, and practical compatibility which refers to what users do with it (Tornatzky & Klein 1982). Later, more dimensions are suggested to be included in the definition of compatibility. This is due to the fact that the majority of the definitions tend to concentrate on two dimensions: compatibility with the preferred work style and compatibility with the current situation. Karahanna et al. suggest that there are four dimensions in compatibility (Karahanna, Agarwal & Angst 2006). Firstly, compatibility with existing work practices; secondly, compatibility with preferred work style; thirdly, compatibility with prior experience; and fourthly, compatibility with values. They leave out the compatibility with needs from their constructs, to avoid possible confusion with the constructs of perceived usefulness. In a professional context, compatibility has been disserted to have strong direct and indirect effects on the behavioural intention to use new technology (Wu, Wang & Lin 2007). For this reason compatibility is included within the current study as well.

The social influence on technology acceptance has been recognized. According to Venkatesh and Bala, social influence is a determinant of perceived ease of use and perceived usefulness and is able to capture a great deal of those processes and mechanisms which conduct the user to build their impressions of a certain information system (Venkatesh & Bala 2008). Subjective norm and image, presenting the social influence process, are two determinants of perceived ease of use and perceived usefulness in TAM 2. However, it is missing from the TAM model. In the domain of the current study, the Finnish Police, the social influence of a team member in a police patrol can easily be anticipated to have an effect on the other member of the team. Team work is vitally important in field operations and the team of two police officers works in close cooperation for a twelve hours shift. During this time, the effect of the team member may happen via internalization, in other words they change their own belief about the usefulness of the new technology system. The positive impression is suggested to be passed from a team worker to another (Venkatesh & Davis 2000) and this is the reason to include social influence, especially the social influence of a team member of a police patrol into the constructs of the current study.

2.13 Research Model

This section presents the theoretical model that was used in this research. The model is based on the requirements of the research problems, the research questions, and the prior literature presented earlier in this chapter. The nomological network is depicted in FIGURE 14.

To be able to test the research questions using the research model, it was supposed to have elements that were suited firstly, for analyzing and evaluating the main parameters affecting the technology acceptance. Secondly, it had to have elements to measure the compatibility parameters related to the research questions. Thirdly, it required elements to measure the social influence of peers. Fourthly, it had to have a means for measuring the moderating effects of age, length of career, location of the police department and context of work.

Based on the four requirements indicated above, the research model had three main components. Firstly, a technology acceptance model component based on TAM, which measures the impacts of perceived usefulness and perceived ease of use on the intention to use the technology. Secondly, a compatibility component which measures the effects of the compatibility components on perceived usefulness and perceived ease of use, and thirdly, a social influence component which measures the social influence of a team member in a police patrol on perceived usefulness, perceived ease of use, and on behavioural intention. Additionally, there are moderators in the model, namely age, length of career, location of the police department, and context of work.

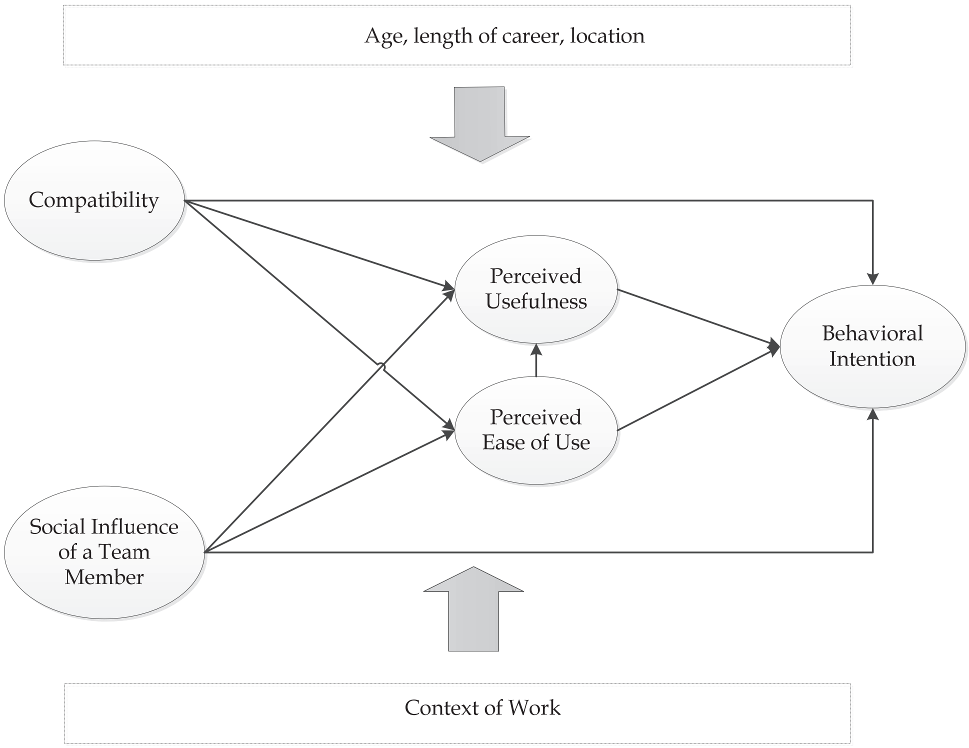

FIGURE 14 Research model

The selection of TAM as the core for the research model was decided based on the literature review presented in the previous chapter. TAM was selected for inclusion into the model as a core component for the following reasons: Firstly, TAM is a widely employed and accepted method in information technology acceptance. Secondly, the constructs of TAM have been tested and used in various studies and have been found reliable and valid. Thirdly, the original TAM was developed for testing work-related technology acceptance. Fourthly, TAM is a predictive method used to explain a user's intentions to use technology, which suits the context of the current research very well. Fifthly, TAM is parsimonious enough to be used in moderator contexts. Using a more complex model may have resulted in unstable parameter estimates.

At the centre of the model there is the technology acceptance model TAM (Davis 1989). TAM posits that usage can be predicted by the intention to use. Likewise, the intention to use certain technology is impacted by the beliefs of the user about the technology in question. Moreover, even the newest version of TAM, TAM3, supports the strong role of intention to use as a mediator to user behaviour (Tang & Chen 2011). However, some studies suggest (Turner et al. 2010), (Straub, Limayem & Karahanna-Evaristo 1995) that special attention is needed when TAM is used outside the contexts against which it has been validated as the relationships of the constructs are not necessarily as straightforward as TAM is its original form suggests (Turner et al. 2010, Straub, Limayem & Karahanna-Evaristo 1995).

Two determinants as external variables are added to the research model in addition to the TAM constructs. These two variables are compatibility and social influence. Additionally, four parameters, namely length of career, age, location of the police department, and context of work are used to examine the moderating effects of those parameters. In addition to behavioural intention there are two beliefs from the original TAM in the model, perceived usefulness (PU) and perceived ease of use (PEU). TAM has been suggested to provide a robust model to explain about 40 % of the variance of use (Legris 2003). The original TAM disserts that the perceived usefulness has direct influence to the intention. Davis defined perceived usefulness as "the degree to which a person beliefs that using a particular would enhance his or her job performance" (Davis 1989 p.320). In voluntary settings it has been shown to be an important determinant of the intention to use (Hu et al. 2011). In the mandatory use of technology it can be expected that perceived usefulness could be an important determinant predicting the intention to use. There is evidence in the literature supporting this expectation (Hu, Lin & Chen 2005, Colvin & Goh 2005). It has been suggested that usefulness is the single most important factor for technology acceptance and has a direct effect on behavioural intention among law enforcement officers (Davis, Bagozzi & Warshaw 1989). For this reason perceived usefulness has been included into the research model of the current research as the study assumes that the Finnish Police users see the mobile application as beneficial and useful for their work.

Hence, the following hypothesis is proposed:

H1: Perceived usefulness has a direct positive effect on the intention to use mobile technology in police field operations.

Ease of use is another determinant of the intention to use in TAM. It is also a determinant to perceived usefulness in TAM. Davis defines ease of use as "the degree to which an individual believes that using a particular system is free of effort" (Davis 1989 p. 320). In TAM, TAM 2, and in TAM 3, ease of use has a direct effect on intention to use and an indirect effect on intention via perceived usefulness. However, some studies suggest that in mandatory settings, especially among law enforcement officers, ease of use has an insignificant effect on usefulness and the intention to use (Hu, Lin & Chen 2005, Hu et al. 2011). This is partly in line with the findings in other research amongst the same type of users in law enforcement suggesting that ease of use together with usefulness in the two factor model in TAM does not fit well with data (Colvin & Goh 2005). In the research with consumers in voluntary settings there is a good fit with the model and data (Wu & Wang 2005). In the light of these inconsistencies in the results of prior research, in the current study ease of use is an elementary factor in defining determinants both for the intention to use mobile technology and for usefulness in a mandatory usage setting, as it is in the original TAM. Based on the preceding discussion, the following hypotheses are proposed:

> **H2**: Perceived ease of use has a direct positive effect on the intention to use mobile technology in police field operations.

> **H3**: Perceived ease of use has a direct positive effect on perceived usefulness of using mobile technology in police field operations.

It has been proposed, that even though TAM had proven to be a useful theoretical model, in order to improve the predictive capacity of TAM, new constructs should be integrated into the research models in addition to TAM (Legris 2003). Hence, in this research those new constructs are compatibility and social influence as exogenous effects and a users age, length of career, context of work and the location of police department are used as moderators.

Compatibility is an important and repetitive belief in the research of the adoption of information systems (Karahanna, Agarwal & Angst 2006). The definition for the compatibility has been offered in its traditional form by Rogers (Rogers 1995). He defined the concept of compatibility as “the degree to which using an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters”. The discrepancy between the innovation and the cultural values of the potential adopters will prevent the adoption process of the potential adopter to accept new innovations and technology (Bunker & Thanh 2007). Tornatzky and Klein suggest that instead of a broad definition, it is appropriate to make a distinction between value compatibility and practical compatibility (Tornatzky & Klein 1982). Value compatibility refers to compatibility with what adopters feel or think about the innovation, and practical compatibility refers to what adopters do (Karahanna, Agarwal & Angst 2006). The literature suggest that compatibility could be a sub-dimension of perceived usefulness (PU) as there have been indications of possible problems with discriminant validity between the constructs of PU and compatibility, especially regarding the compatibility with the preferred work style. For this reason, the loadings in factor analysis may load on both compatibility and PU. As such, in some studies the constructs measuring compatibility with preferred work style have been removed (Karahanna, Agarwal & Angst 2006, Moore & Benbasat 1991). As stated by Karahanna et al., compatibility assesses the magnitude of correspondence between the technology and many aspects of the individual and the context where the new technology is employed (Karahanna, Agarwal & Angst 2006). This offers a way to examine the effect of compatibility in a mandatory setting. However, the construct for compatibility is missing from the original TAM, from TAM 2 and from TAM 3. For this reason the construct of it is included in the research model of the current study. Based on the preceding discussion, the following hypotheses are proposed:

> **H4**: Compatibility has a direct positive effect on the intention to use mobile technology in police field operations.

> **H5**: Compatibility has a direct positive effect on the perceived usefulness of using mobile technology in police field operations.

> **H6**: Compatibility has a direct positive effect on the perceived ease of use of using mobile technology in police field operations.

The social influence in this research model is seen as a vehicle to accomplish pre-implementation interventions. Pre-implementation interventions are the assortment of activities of an organization which are aimed to lead to a better acceptance of a system (Venkatesh & Bala 2008). The aim of these interventions is to minimize the resistance of an organization towards the new system. As Venkatesh and Bala state, the employees may believe that a new system may threaten their current working methods and routines, change the characters of their jobs and change their social relations and status in their organization (Venkatesh & Bala 2008). Equally important, is that employees may fear that the new system may create both a physical and mental excess work load due to the complexity of the new system (Ahuja & Thatcher 2005). These fears may be due to misinterpreted system features and user's beliefs that the new system will not fulfil the user's expectations of the benefits and real features of the system (Davis 2004).

Social influence, according to Venkatesh and Bala, as a determinant of the perceived ease of use and perceived usefulness, is able to capture a great deal of those processes and mechanisms which conduct the user to build impressions of a certain information system (Venkatesh & Bala 2008). Subjective norm and image, and presenting the social influence process, are two determinants of perceived ease of use and perceived usefulness of TAM 2 (Venkatesh & Davis 2000). Accordingly, Venkatesh and Davis suggest, that to understand the social influence in TAM 2, three social influence mechanisms exist in the model: internalization, identification and compliance (Venkatesh & Davis 2000). These three processes present three different ways of accepting an influence and induce the behaviour from one individual to another. Moreover, these processes can also be understood as different levels. With the same resulting behaviour an individual may adopt different processes (Kelman 1958). According to him, identification happens when an individual, by accepting the influence, wants to create a gratifying relationship to a person or to a group. Compliance occurs when an individual expects to obtain rewards or approvals and to avoid punishments when accepting influence from another person. Internalization occurs when an individual accepts behaviour when he or she feels that it is intrinsically rewarding. This indicates that the induced behaviour is consistent with his or her value system (Kelman 1958). TAM 2 posits that subjective norm and image have a positive influence on perceived usefulness through the process of internalization and identification. According to TAM 2, these are disserted to be attenuating factors over time as the users become more experienced with the system use (Venkatesh & Davis 2000).

In the law enforcement context, especially in the Finnish Police, this process of how an individual captures new beliefs offers a captivating premise to the current study. The Finnish Police, when they work outside the office environment, work in teams of two patrol partners. The team of two persons have a great deal in common. Team members share a common team identity, which is used for example in radio communication. Moreover, they work in close cooperation for the whole 12 hour shift. The teams may be work in the same pairs for a number of years. The influence of the team members on each other during that time, offers a good possibility to see the effect of a team member towards new technology as one probable vehicle in reviewing mobile technology acceptance.

However, in professional settings it has been suggested that the social influence of peers does not have a significant direct effect on the technology acceptance of professionals (Hu et al. 2011, Chau & Hu 2002) and this effect happens through usefulness (Yang & Yoo 2004). They suggest that the cognitive attitude is a mediator between the influence of perceived usefulness and perceived ease of use and the use of technology by an individual. In the current study, this individual is an intimate team member in a police patrol and it is anticipated that the attitude of a team member may have an effect on another team member via the construct of social influence. It has been stated that in the working community, if co-workers are affirmative toward a new system, then the social influence attends to forming an affirmative impression toward a new system (Venkatesh & Davis 2000). In the context of the current study, and similar to Hu et al. (Hu et al. 2011), the police officer in the field may think that he or she should internalize, in other words to change his or her belief about the usefulness of the system. Via identification as a member of a group, an individual police officer may want to achieve acceptance in the group. Social influence is added in to the research model because close team work is an important element in the ways that the police work in Finland and this effect on technology adoption needs to be studied closer. Hence, the following hypotheses are proposed:

H7: Social influence has a direct effect on the intention to use mobile technology in police field operations.

H8: Social influence has a direct effect on the perceived usefulness of using mobile technology in police field operations.

H9: Social influence has a direct positive effect on the ease of use of using mobile technology in police field operations.

H10: Social influence has a different influence on the intention to use in different contexts of work.

H11: Social influence has a different influence on perceived usefulness in different contexts of work.

H12: Social influence has a different influence on the ease of use in different contexts of work.

The effect of the context of work in law enforcement technology adoption is a notable matter. It has been suggested, that instead of TAM, a context oriented method to examine the adoption of new technology (specifically in the law enforcement environment) explains the variances in the users' behaviour more conclusively (Bouwman & van de Wijngaert 2009). They conclude that the police tasks take place in a wide range of different contexts, each having unique characteristics. It is these contexts which determine the criteria that users consider when they decide on the type of technology to be utilized in each context. In some cases those technologies are mutually exclusive. Especially regarding the use of the mobile technology in police use, the analysis of mobile devices should not be undertaken separately from the work context as they link the usage of the mobile device to the tasking environment (Pica, Sorensen & Allen 2004). This is also supported in another study (Sorensen & Pica 2005). They suggest that the communication of the police has certain variations by introducing the concept of the rhythms of interaction. This presents that there are alternations in the intensity of the communication depending on the situation types of the normal police work. In this study, the contexts are created using four attributes which define the type of assignment for each specific context. The attributes are weather, scene, urgency, and the activity in the assignment. The weather in this study can have two levels; hot summer or cold winter. The scene of the assignment can have two levels as well; in or outside of the vehicle. The urgency attribute can have two levels; urgent or non-urgent. Finally, the activity attribute can have three levels; data base query, data base input, and the reporting of working hours to the information system. Hence, the following hypothesis is proposed:

H13: Context of work is a moderating factor in the adoption of mobile technology.

In this research, the effects of experience (in other words the length of service in the police force) and the age of the law enforcement officer on technology acceptance are factors which are aimed to be studied. For this reason, length of career and age are anticipated to be moderators. Hence the following hypotheses are proposed:

H14: Length of career of the law enforcement officer is a moderating factor in the adoption of mobile technology.

H15: The age of the law enforcement officer is a moderating factor in the adoption of mobile technology.

Finland is a large country. It offers a versatile and demanding operational environment for the police force to operate in. There are both urban and rural areas in the country and operational circumstances differ widely between different areas. There is large, hilly, sometimes sparsely inhabited countryside between densely inhabited towns, cities and villages. Hence, the type and amount of police assignments varies largely depending on the location of the police department. Additionally, the broadband commercial mobile communication radio network coverage may vary widely between locations as well. In cities and populated areas the radio coverage is normally good. In sparsely populated areas it is not necessarily so extensive (Telia Sonera 2012, Elisa 2012). Even though the police in Finland currently use their own radio network for voice and data communication and these have a good countrywide coverage, commercial networks are used as a part of their communications. Experiences of both the police's own radio communication networks and commercial cellular networks may have an effect on the intention to use future mobile police systems. Additionally, the working procedures may vary between the police departments, even though as a rule those are supposed to be identical. Similarly, personal preferred working styles may be different. Hence, in the light of these presumptions, the following hypothesis is presented:

H16: Geographical location of the local police department is a moderating factor in the adoption of mobile technology.

2.14 Summary

In Chapter 2, the literature review on various technology acceptance models was presented. It was found that the research of technology acceptance in the law enforcement context is quite infrequent and more research is needed. The two external variables, compatibility and social influence were introduced and were included into the research model of the current research. The research model, including both the technology acceptance model TAM and the two external variables were presented. At the end, 16 hypotheses were introduced.

The following chapter introduces the methodology of the research, data collection and sampling, an introduction of the orthogonal design and conjoint analysis for the operationalization of contexts of work, the operationalization of all constructs, and finally, an introduction to Structural Equation Modelling (SEM) and multi-group analysis.

3 RESEARCH METHODOLOGY AND DATA COLLECTION

The methodology in the current research is a self administered survey design. The questionnaire was delivered to the participants using e-mail. They accomplished the survey independently according to the written instructions. The survey consisted of watching a 12 minutes video presenting the future police mobile ICT system. Following this they filled in an electronic questionnaire. This research is a confirmatory case study in nature. It is made more to understand, rather than predict, the behavioural intention to use the mobile police ICT system. This research is one of the first researches to be made in the Finnish Police force regarding mobile technology acceptance. The empirical part of the current research is quantitative. The aim of the empirical part is to test the fit of the research model with received data. The research model was introduced in the previous chapter. In this chapter the research domain - the Finnish Police - is first introduced. Next, the questionnaire and the operationalization of the constructs are described. The validity of the measurement is assessed and data sampling and the collection procedure are described. Finally, the methods of analysis are introduced. The analysis of data and the results are presented in the following chapter.

3.1 Mobile Use of the Future Police Information System

The Finnish Police operates under the guidance and supervisory of the Ministry of the Interior. The Finnish Government governs the police through its governmental program and resolutions. The set-up of the organization is two-tier; The National Police Board and directly under it are the local police departments and national units, the Police Technical Centre, and The Police College of Finland. The local police departments are organized in 24 departments (plus Ålands polismyndighet which was not included into this research), each of them having one main police station and a number of other police stations and service points. There were circa 7800 police officers in Finland in the year 2011 (Poliisi 2012).

The Finnish Police started in 2009 to update their information systems to fulfil the modern requirements of an electronic society. It is also a response to the growing economic demands on the productivity of the Finnish police organization. The new information system will intensify the use of working hours by supporting the new processes to be used by the organization. One main goal of the new information system is mobility. During field operations, by using mobile end-user devices police officers would be able to make most of their duties using PC-based working stations installed in police vehicles and utilizing personal carry-on smart phones and tablets. All police vehicles are supposed to be used as mobile offices. Hence, excess driving between the scene of the assignment and office would be abated. The use of mobile end-user devices for example to make queries to various data bases directly from the mobile devices instead of using the control points in emergency centres would reduce the workload of the emergency centres. The central idea in the new process utilizing the mobile information system is the team work in police patrols. The police work in field operations in teams of two police officers. This team works either as a whole team or separated into two distributed individuals who still would work in close contact with each other using mobile end-user devices. The new information system would mean the integration of currently diverse separate systems into one. This is also expected to bring new methods and possibilities to crime investigation (Ministry of the Interior 2011).

3.2 The Questionnaire and Operationalization of the Constructs

In this chapter the operationalization of the measurement of latent constructs is introduced. As theoretical latent constructs, for example beliefs, cannot be measured directly, they were measured indirectly using observable indicators which are presumed to be reliable representatives of those constructs. For this reason, the measurement scales of the constructs were adapted from the prior literature of technology acceptance and information systems research. The items were translated carefully into the Finnish language by the author. They were then cross-checked with native Finnish research colleagues. After that the questions of scales were reviewed together with the target police staff. The team of police reviewers consisted of four policemen; one female and three male police officers operating in field operations on a daily basis.

The intention to use a future mobile application was tested using the findings of Davis (2004). According to these findings pre-prototype testing can be used in predicting the user acceptance in IT systems instead of a real IT system. In the current study the subjects were shown a 12 minutes video which presented the features and functionality of the future mobile IT system. The system that was shown in the video was created by the Finnish police as a part of the definition work of the end user requirements creation in the year 2010. The users who appeared in the video were real police officers from one police department.

In the questionnaire a seven point Likert scale was used. The scale was built in such a way that the lower item value on the scale represented agreement with the negative statement, whilst the higher value represented agreement with the positive statement. The questionnaire was implemented electronically using Webropol analysis and questionnaire software (Webropol 2012). The questionnaire was delivered to subjects using an e-mail containing an introduction to the research, instructions how to complete the survey and two web-links; one to the video to be watched first and another link to the questionnaire.

3.2.1 Operationalization of the Constructs of TAM

Perceived Usefulness and Perceived Ease of Use

Operationalization of the constructs for perceived usefulness and perceived ease of use in the technology acceptance model (TAM) was adopted from Wu, Wang & Lin (2007) and Venkatesh & Bala (2008). They originate from the original TAM constructs (Davis, Bagozzi & Warshaw 1989, Davis 1989). Consistent with Venkatesh and Bala, the scales in the current study for both constructs consisted of four items of the six original items of the scales (Venkatesh & Bala 2008). Four usefulness items were related to the effectiveness and productivity objectives of using the mobile system as those two objectives were likely to be related to the professional and non-volitional usage of technology. Two items measuring the easiness and quickness aspects of the scale were left out. Moreover, the wording of the items was adjusted to fit the usage of the future mobile system.

TABLE 1 Measurement scales for perceived usefulness (PU) and perceived ease of use (PEOU)

Perceived usefulness (PU)	
PU1	Using the system would improve my performance in my job.
PU2	Using the system in my job would increase my productivity.
PU3	Using the system would enhance my effectiveness in my job.
PU4	I would find the system to be useful in my job.
Perceived Ease of Use (PEOU)	
PEOU1	My interaction with the system would be clear and understandable.
PEOU2	Interacting with the system would not require a lot of my mental effort.
PEOU3	I would find the system to be easy to use.
PEOU4	I would find it easy to get the system to do what I want it to do.

The four items for perceived ease of use were consistent with Venkatesh and Bala (2008) and Davis (2004). They suggest that based on the existing theoretical and empirical evidence that measuring user perceptions regarding perceived ease of use before the actual use of a system should be anchored on more general beliefs about computer use rather than beliefs requiring experience of the actual use of computers. Even though Davis suggests that unlike usefulness, perceived ease of use would not be strong predictor of actual use based on the prototype usage, in the current study ease of use was chosen as a determinant for the behavioural intention to use as suggested in TAM (Davis 2004). The measurement scales of perceived usefulness and ease of use are presented in TABLE 1.

Behavioural Intention

The operationalization of behavioural intention was adopted from Wu, Wang & Lin (2007). They used the scale in the professional, non-volitional use. It originates from original TAM scales (Davis, Bagozzi & Warshaw 1989, Davis 1989) and contained three items. The measurement scale for behavioural intention is presented in TABLE 2.

TABLE 2 Measurement scale for behavioural intention (BI)

Behavioural Intention (BI)	
BI1	I would intend to use the system in my daily work as often as needed.
BI2	Whenever possible, I would intend to use the system in my daily job.
BI3	I would estimate that my chances of using the system in my daily job are frequent.

3.2.2 Operationalization of the other constructs

Compatibility

The operationalization of the compatibility construct was adopted from Wu, Wang & Lin (2007). They used the scale in non-volitional, professional use. It contained three items. The three item scale for compatibility is presented in TABLE 3.

TABLE 3 Measurement scale for compatibility (COMP)

Compatibility (COMP)	
COMP1	Using the system would be compatible with most aspects of my work.
COMP2	Using the system would fits well with the way I like to work.
COMP3	Using the system would fit into my work style.

Social influence

The operationalization of the construct of social influence was adopted from Hu et al. (2011) who used it in the context of mobile system usage in the law enforcement environment. For this reason it was selected for the current research. The measurement scale is presented in TABLE 4.

TABLE 4 Measurement scale for social influence (SI)

Social Influence (SI)	
SI1	I believe that my patrol team thinks that I should use the system.
SI2	I believe that my patrol team member thinks that I should not use the system.
SI3	The senior management of this business would be helpful in the use of the system.
SI4	Generally, the organization would support the use of the system.

3.2.3 Operationalization of the Contexts of Work

Operationalization of the measurement of the contexts of work is based on the use of conjoint measurement, conjoint analysis and orthogonal design of the attributes. Conjoint analysis is one of the techniques which can be used to manage situations in which a decision maker has to handle several options which simultaneously may vary across two or more attributes of these situations (Green, Krieger & Wind 2001, Green & Srinivasan 1978, Green & Wind 1975). For example a decision maker is presented with the options A, B and C and all these options have attributes x, y and z. The task is to make the best choice between these options. A decision maker has to make tradeoffs between A, B and C taking all the possible variations of the attributes x, y and z into account as these attributes may be conflicting. This means that a choice A might be the best solution taking into account attributes x and z, but a choice C or B would be better from the viewpoint of attributes y and z.

Conjoint analysis is used and evolved widely after its introduction by Luce and Tukey in 1964 in the Journal of Mathematical Psychology (Luce & Tukey 1964). Especially in marketing research, it is one of the most popular methods when consumers' preferences and tradeoffs are being researched (Helm et al. 2008, Green, Krieger & Wind 2001). In marketing research, surveys are conducted by asking a consumer to make a preferred selection - for example between different brands of products having different attributes. The purpose of using conjoint analysis in this type of survey is to get metric-scale data, in other words numeric values from the response data which are measured using ranking scales. In this way the tradeoffs between different choices can be measured (Green & Wind 1975). As a stimulus, consumer is presented for example an illustrated card of every product which has a table of attributes, each attribute having a number of levels. In the context of marketing research these attributes can be for example price, colour, feature set and brand name. The levels indicate the character of an attribute, for example for price levels - prices in euros; for colour levels blue, yellow, and green, and so on. A consumer then evaluates those cards, giving his or her preference for each card presenting an individual combination of the attributes on varying levels. Based on these evaluations, utility functions are estimated typically using regression models. As a result, utility scores, which are called part-worth utilities, are available separately for each attribute. These part-worth utilities indicate the preference of an attribute of the respondents. Part-worth utilities are interval data which allow simple mathematical operations like addition and subtraction between them. Hence, the preference for any combination of the attributes in a product can be calculated by summing the part-worth utilities and a constant of those attributes, to get the total individual utility for each combination (Green & Wind 1975, Gustafsson, Herrmann & Huber 2003).

The amount of attributes and levels may play an important role in conjoint measurement. If all the attributes with all possible levels are supposed to be included in the analysis it will be a full factorial design or complete design (Gustafsson, Herrmann & Huber 2003). In full factorial design of conjoint analysis the amount of permutations may rise significantly. In full factorial design all attributes will be assigned all possible values of the levels. If, for example, there are 8 attributes, each having 4 levels, the total amount of possible choices to be presented to the consumer in the survey is 4 x 4 x 4 x 4 x 4 x 4 x 4 x 4 = 65 536 different cards. To reduce the number the combinations to be presented to the respondent, several different methods have been proposed in literature. There are basically two ways to reduce the number of combinations in conjoint analysis. In practice both these mean fractionating the full factorial design. The simplest and easiest way is to select randomly the options to be presented to the subjects. In this method, random sampling is used to select as many options of the full factorial design as needed, in order to fulfil the requirements of the research scope (Gustafsson, Herrmann & Huber 2003). Another way is to systematically reduce the amount of options, maintaining the independence - in other words orthogonality of the attributes. Orthogonal design is an example of fractional factory design where only a small fraction of all combinations of the options are shown to the respondent. Orthogonal design is possible when attributes are uncorrelated. This means that any combination of the levels of an attribute is possible, independent of the other combinations of the levels of the other attributes - hence, they do not interact (Green, Krieger & Wind 2001). Depending on whether the amount of levels of the attributes is equal or not, symmetrical and unsymmetrical design types may be recognized among the attributes. Orthogonal design can be done using the main-effect design arrays which allow the picking up of a representative fractional sample from the whole full factory design. There are several methods in the literature to form the main-effects design array plans. Addelman presents plans known as Addelman plans (Addelman 1962) and Plackett and Burman present plans known as Plackett-Burman plans (Plackett & Burman 1946).

In the current study, the orthogonal design was constructed using PASW Statistics 18 software utilizing the incorporated orthogonal design feature (PASW Statistics 18 2012). This software is capable of utilizing both Addelman and Plackett-Burman plans. There were four attributes in the current study for the contexts. Those attributes were weather, scene, urgency and activity. The full factorial design would have meant 24 (= 2x2x2x3) different variations. By using orthogonal design the amount of variation could be reduced. Because three of the four attributes, weather, scene and urgency had two levels and one attribute, activity, had three levels, the selection algorithm in PASW Statistics

18 software was to select the smallest, in other words for N=8 , the two-level Plackett-Burman plan. This created ten different contexts – two holdouts were added by the software - out of 24 different full factorial design variations. Those are depicted in TABLE 5.

TABLE 5 Profiles generated in orthogonal design to build context scenarios

Context number	Card ID	Weather	Scene	Urgency	Activity
1	1	hot summer	outside vehicle	urgent	reporting working hours
2	2	hot summer	in vehicle	urgent	data base query
3	3	cold winter	in vehicle	urgent	data base query
4	4	cold winter	in vehicle	non-urgent	reporting working hours
5	5	cold winter	outside vehicle	non-urgent	data base query
6	6	cold winter	outside vehicle	urgent	input to data base
7	7	hot summer	in vehicle	non-urgent	input to data base
8	8	hot summer	outside vehicle	non-urgent	data base query
9[a]	9	cold winter	outside vehicle	urgent	data base query
10[a]	10	cold winter	in vehicle	non-urgent	data base query

[a] holdout created for validity check

The following ten context profiles were created, based on the orthogonal design:

1. It is hot summer and you have to make an urgent report of your working hours into the system outside your vehicle.
2. It is hot summer and you have to make an urgent Vitja data base query in your vehicle.
3. It is cold winter and you have to make an urgent Vitja data base query in your vehicle.
4. It is cold winter and you have to make a non-urgent report of your working hours into the system in your vehicle.
5. It is cold winter and you have to make a non-urgent Vitja data base query outside your vehicle.
6. It is cold winter and you have to make an urgent input to Vitja data base outside your vehicle.
7. It is hot summer and you have to make a non-urgent input to Vitja data base in your vehicle.
8. It is hot summer and you have to make a non-urgent query to Vitja data base outside your vehicle.
9. It is cold winter and you have to make an urgent query to Vitja data base outside your vehicle.
10. It is cold winter and you have to make a non-urgent query to Vitja data base in your vehicle.

The Vitja system mentioned in the context profiles was a project name of the new police ICT system which was under development during the research period and was known to the subjects at least by name. The Vitja system was also planned to include a mobile application for field operations running in a smart phone and for this reason it was selected to act as an example of the future application for data base queries and inputs.

The ten profiles were used as different contexts in the current study to see what the rank of the preferred contexts for the subjects is. Every context will get a total utility as a sum of the part-worth utility scores of the factors of each variable. Profiles 9) and 10) are holdout cases and they were created in the orthogonal design by the PASW Statistics 18 software to guarantee the validity of the estimated utilities. They were made using a different random plan. They were judged by the subjects but they were not used in the calculation of the estimates of the utilities by the software. However, these were used in the study to find out preferred contexts similar to normal contexts.

3.2.4 Background Information

Over and above the theoretical constructs, the questionnaire included the questions concerning the background information of the subjects. This information comprised gender, age, experience in the police force, rank, education before joining the Police College, and the location of their current police station. Because the location of the police department was one of the hypothesized moderating factors in the research model of the current study, the locations were selected as being widely representative of Finnish Police departments. These included both urban and sparsely populated rural areas and departments of different size, totalling 15 police departments and one nationwide traffic police unit. In this way the samples would present the population as reliably as possible.

3.3 Sampling and Data Collection

Data were collected electronically using Webropol analysis and questionnaire software (Webropol 2012). The collection of data started in mid-February 2012 and ended mid-April 2012. The survey was open to all target subjects in participating police departments during the whole two month period. Before actual use in the questionnaire, all items of the measurement scales underwent pilot testing. These tests are described in detail in Chapter 3.4.

To ensure the anonymity of the subjects, a network of contact persons was created amongst the selected 16 police departments by the author. The responsibility of those contact persons was to receive the request from the author by e-mail to take part in the research and then to forward the same e-mail to the subjects of his or her own police department. The e-mail comprised an introduction to the survey, a link to the video to be watched before filling in the questionnaire and another link to the electronic questionnaire itself. The e-mail also included the contact information of the author. The contact person in the police department was in most cases the inspector who was responsible for managing the police patrol activities in his or her own geographical area. In this way the subjects received the request from an authorized and known sender and the probability of them opening the e-mail and responding was supposed to be greater than if the sender would be unknown to the subjects. Moreover, both the video and the questionnaire were implemented by the national police IT department inside the firewalls of the police information infrastructure, making the sending of the request from outside impossible. The response to the questionnaire was totally voluntary for the subjects and the questionnaire was completed anonymously. There was no compensation for participating and the subjects were allowed to fill in the questionnaire during their working hours in the office environment.

After the enquiry was closed, the data was analyzed using Mplus (Muthen & Muthen 2012b) and PASW Statistics 18 statistical software (PASW Statistics 18 2012). 302 responses were received from the 16 selected police departments. The request was sent to approximately 3000 police officers who were supposed to be included in the target group of the current study. However, the responses also included 35 answers from high rank inspectors and those were removed from the data as the interest in the current study was in those officers working in field operations only. This method is proposed in several prior studies amongst mandatory users in order to prevent the extraneous responses of such participants who are not mandated to use the information system under study in the actual practice (Moore & Benbasat 1991, Rawstorne, Jayasuriya & Caputi 2000, Hartwick & Barki 1994). After the removal of the responses of high rank officers the data comprised 267 valid responses from the target ranks including the ranks of police cadet, constable, senior constable and sergeant. The removed data of 35 high rank officers was decided to be conserved for future research. The summary of the demographic characteristics of the respondents is presented in TABLE 6.

TABLE 6 Demographic characteristics of respondents

	N				
	Valid	**Missing**	**Mean**	**Median**	**Std.deviation**
Age	267	0	40.85	40.0	9.365
Length of Career	261	6	16.88	14.0	10.465

The share between the sexes among the respondents was 91.4 percent male and 8.6 percent female. Based on these figures, men can be suspected to be over-represented. In Finland, 13.4 percent of the Finnish Police in 2010 were female (Finnish National Police Board 2011). Of the uniformed police officers, 11.7 per cent were women in 2007 (Finnish National Police Board 2009). The frequencies and percentages of the gender of respondents are presented in TABLE 7.

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TABLE 7 Frequencies and percentages of gender of respondents

Gender	Frequency	Percentage	Valid percentage
Male	243	91.4	91.4
Female	23	8.6	8.6
Total	266	99.6	100.0
Missing	1	0.04	

The age of the respondents ranged from 22 years to 58 years. The mean of age was 40.9 years and median was 40 years. The frequencies and percentages of the age of respondents are presented in TABLE 9.

Of the respondents, 61.8 percent (N=165) were senior constables. The rank of sergeant and constable had a share of 36.0 (N=96) and 2.2 (N=6) percent accordingly. There were no police cadets among respondents. The frequencies and percentages of the ranks of respondents are presented in TABLE 8.

TABLE 8 Frequencies and percentages of the rank of respondents

Rank	Frequency	Percentage	Valid Percentage
Police cadet	0	0	0
Constable	6	2.2	2.2
Senior constable	165	61.8	61.8
Sergeant	96	36.0	36.0
Total	267	100.0	100.0
Missing	0	0	

TABLE 9 Frequencies and percentages of age of respondents

Age	Frequency	Percentage	Valid Percentage
22	1	0.4	0.4
23	2	0.7	0.7
25	2	0.7	0.7
26	5	1.9	1.9
27	10	3.7	3.7
28	10	3.7	3.7
29	3	1.1	1.1
30	7	2.6	2.6
31	13	4.9	4.9
32	8	3.0	3.0
33	8	3.0	3.0
34	12	4.5	4.5
35	11	4.1	4.1
36	13	4.9	4.9
37	7	2.6	2.6
38	11	4.1	4.1
39	6	2.2	2.2
40	10	3.7	3.7
41	3	1.1	1.1
42	5	1.9	1.9
43	8	3.0	3.0
44	7	2.6	2.6
45	12	4.5	4.5
46	7	2.6	2.6
47	11	4.1	4.1
48	7	2.6	2.6
49	5	1.9	1.9
50	6	2.2	2.2
51	11	4.1	4.1
52	9	3.4	3.4
53	5	1.9	1.9
54	5	1.9	1.9
55	12	4.5	4.5
56	9	3.4	3.4
57	4	1.5	1.5
58	2	0.7	0.7
Total	267	100.0	100.0
Missing	0	0	

The mean of the length of career was 16.9 years and the median was 14 years. The frequencies and percentages of the length of career of the respondents are presented in TABLE 10.

TABLE 10 Frequencies and percentages of length of career of respondents

Length of career	Frequency	Percentage	Valid Percentage
0	1	0.4	0.4
1	4	1.5	1.5
2	3	1.1	1.1
3	1	0.4	0.4
3	8	3.0	3.1
4	17	6.4	6.5
5	10	3.7	3.8
6	7	2.6	2.7
7	7	2.6	2.7
8	13	4.9	5.0
9	7	2.6	2.7
10	14	5.2	5.4
11	7	2.6	2.7
12	24	9.0	9.2
13	7	2.6	2.7
14	3	1.1	1.1
15	7	2.6	2.7
16	6	2.2	2.3
17	3	1.1	1.1
18	2	0.7	0.8
19	1	0.4	0.4
20	5	1.9	1.9
21	9	3.4	3.4
22	6	2.2	2.3
23	4	1.5	1.5
24	8	3.0	3.1
25	4	1.5	1.5
26	10	3.7	3.8
27	3	1.1	1.1
28	7	2.6	2.7
29	8	3.0	3.1
30	7	2.6	2.7
31	8	3.0	3.1
32	6	2.2	2.3
33	8	3.0	3.1
34	7	2.6	2.7
35	4	1.5	1.5
36	3	1.1	1.1
37	1	0.4	0.4
38	1	0.4	0.4
Total	261	97.8	100.0
Missing	6	2.2	

Most of the respondents, 57 per cent had a high school level education before starting the studies in the Police College. 27 per cents had a vocational level education and 8.7 per cent had a polytechnic level education. Secondary school was an education level among 4.2 per cent of the respondents and upper polytechnic and master's degree among 0.8 and 2.3 percent of the respondents accordingly. The frequencies and percentages of the education of respondents are presented in TABLE 11.

TABLE 11 Frequencies and percentages of education of respondents

Education	**Frequency**	**Percentage**	**Valid Percentage**
Secondary school	11	4.1	4.2
High school	151	56.6	57.0
Vocational school	72	27.0	27.2
Polytechnics	23	8.6	8.7
Upper polytechnics	2	0.7	0.8
Master's degree	6	2.2	2.3
Total	265	99.3	100.0
Missing	2	0.7	

Of the respondents, 18.8 per cent were from the National Traffic Police (Liikkuva Poliisi). 13.3 per cent were from Varsinais-Suomen poliisilaitos. Pirkanmaan poliisilaitos had a share of 11.3 per cent. The next biggest portions, 9.4 percent and 8.4 percent, fell for Helsingin poliisilaitos and Lapin poliisilaitos respectively. The frequencies and percentages of the location of the respondents are presented in TABLE 12.

TABLE 12 Frequencies and percentages of location of respondents

Location			
Helsingin poliisilaitos	25	9.4	9.4
Länsi-Uudenmaan poliisilaitos	9	3.4	3.4
Itä-Uudenmaan poliisilaitos	9	3.4	3.4
Keski-Uudenmaan poliisilaitos	14	5.2	5.3
Etelä-Karjalan poliisilaitos	7	2.6	2.6
Varsinais-Suomen poliisilaitos	36	13.5	13.5
Satakunnan poliisilaitos	11	4.1	4.1
Pirkanmaan poliisilaitos	30	11.2	11.3
Keski-Suomen poliisilaitos	16	6.0	6.0
Pohjanmaan poliisilaitos	9	3.4	3.4
Pohjois-Karjalan poliisilaitos	7	2.6	2.6
Oulun poliisilaitos	8	3.0	3.0
Kainuun poliisilaitos	6	2.2	2.3
Koillismaan poliisilaitos	6	2.2	2.3
Lapin poliisilaitos	23	8.6	8.6
Liikkuva Poliisi	50	18.7	18.8
Total	266	99.6	100.0
Missing	1	0.4	

3.4 Validity Assessment of the Measurement Scales

In order to ensure the validity of the measurements using the scales which were used in this study, an assessment of validity of the scales was undertaken. The measurement models contained 25 items which described seven latent constructs: behavioural intention, perceived usefulness, perceived ease of use, compatibility, social influence, perceived enjoyment and computer anxiety. Perceived enjoyment and computer anxiety were not used in this study but the scales were included in the questionnaire. Validity describes the extent to which the results of the study are true, in other words, what is the truth-value of the results of the study (Seale 2004). According to Seale, validity can be divided into three components; measurement, and internal and external validity (Seale 2004). The measurement validity is defined as the degree to which the items in the questionnaire describe the concept which is to be measured. Internal validity implies the extent to which causal linkages can be supported by the study. Accordingly, the external validity implies the extent to which the generalization of the results of the study can be relied upon.

One of the most frequently used methods to improve measurement validity is by using face validity, in which the items of the questionnaire are put under evaluation to assess whether the questions really measure the concept concerned (Seale 2004). In the current study, face validity was guaranteed in several ways. Firstly, the development of the scales was made through a series of steps. In the first step all items measuring the constructs were taken from previously validated instruments. The selection of the items was based on the principle that all scales for the measurement model must have been validated in some domain, although not necessarily the police domain. Hence, all items in the models were validated previously in professional non-volitional domains. The selection of the items was based on the knowledge of the research questions, the hypotheses of this research and on the knowledge of the domain of the research target population. The tense of the scales was changed to the future tense to imply the use of the future mobile system.

Secondly, once the scales were developed they were carefully translated by the author into the Finnish language from their original English versions. These Finnish versions were cross-checked with native Finnish colleagues having a research background and familiarity with both languages in the context concerned. Following that, the questions of the scales were reviewed with the target police staff. The team of police reviewers consisted of four policemen, one female and three male police officers operating in field operations on a daily basis. The aim of the police review was to ensure that the questions would be understood by the police and the phrasing of the questions was consistent with police vocabulary. Some modifications and word changes were made following the police review.

Thirdly, the questions of the scales underwent a sorting procedure. The aim of the sorting procedure was to measure the degree of the sorting agreement between the raters, in other words how well sorters are able to sort the questions of the model into their correct constructs. Sorting was performed in two rounds. In round one, ten sorters sorted the questions. The sorters were colleagues in the research area having no previous knowledge or information of the sorting method or of the content of the measurement scales. The methods by which the sorting agreement were analyzed included item placement scores (Moore & Benbasat 1991) and Fleiss' kappa calulation (Fleiss 1971). The item placement score is an indicator of how many items are placed in the targeted category (in this case on the construct of the model), by the raters. This method has been used in prior research, for example by Taylor and Todd, and Chau & Hu (Taylor & Todd 1995, Chau & Hu 2001). In order for the items placement scores to be calculated, the raters were given all 25 questions of the measurement model, printed in random order on three pages of A4-size paper. All questions were randomly numbered as well. Together with the questions, the raters were given a separate form with all seven construct names printed on it in the form of an empty table. The constructs were: perceived usefulness (PU), perceived ease of use (PEOU), social influence (SI), behavioural intention (BI), compatibility (COM), perceived enjoyment (PE) and computer anxiety (CANX). The task for the sorter was to sort the 25 questions under the construct names by writing the corresponding number of the question of the scale into the table on the form, under the construct name where he or she thought it should belong. The raters included nine male and one female researcher in the first round. The raters were individually given verbal instructions before the task. They were encouraged to ask any questions related to the understandability of the questions, about the task itself or the instructions to discharge the rating. After the raters returned the forms following round one, the results were manually moved to the summary table which is shown in TABLE 13. The table shows the theoretical versus actual matrix of item placements.

TABLE 13 Item placement scores of the constructs after the first sorting round

				Actual				
Construct	PU	PEOU	SI	BI	COM	PE	CANX	total	hit- %
PU	<u>39</u>			1				40	97.5
PEOU	2	<u>36</u>				1	1	40	90.0
SI	1		<u>34</u>	1	2		2	40	85.0
BI	8			<u>22</u>				30	73.3
COM	1	3	1	1	<u>19</u>	5		30	63.3
PE		3				<u>27</u>		30	90.0
CANX						3	<u>37</u>	40	92.5

item placements: 25 items x 10 raters = 250
hits: 39+36+34+22+19+27+37 = 214
overall hit ratio: 100*214/250 = 85.6 %

In the first round there were ten raters and twenty five questions. The total amount of placements for each of the constructs can be seen in the column labelled "total" in TABLE 13. This amount is not the same for all constructs as it can be calculated separately for each construct using the formula: amount of raters multiplied by amount of questions for that construct. In this study this amount varied between 30 and 40 as there were either 3 or 4 questions for each construct and ten raters. As each rater can place any question in any construct, the theoretical total for item placements is 250 (=10 multiplied by 25). The diagonal of the matrix in TABLE 13 tells the amount of the "hits" made by the raters to the targeted construct. Those values are underlined. The sum of the diagonal is 214 which reveals the amount of total hits made by the raters. As the theoretical total for item placements is 250, the total hit ratio is 85.6 % (= 100 x 214/250). A more precise analysis of the hits of questions to the target constructs was done by looking at the rows of the table. Those rows reveal not only the hits to target constructs but the placements of items to incorrect constructs as well. As seen with compatibility (COM), it achieved the lowest score, with a hit percentage of 63.3 % - 19 placements out of 30 were placed into the correct compatibility construct. This was considered as rather low. For this reason some modifications were made to the wording of the items of compatibility. Perceived usefulness (PU) having the highest placement score, had a 73.3 hit percentage value and had 39 placements out of 40 in the right construct. Other rows had a hit percentage value ranging from 73.3 % to 92.5 %. All these were deemed to be acceptable.

The second sorting round was similar to the first. In round two, six sorters sorted questions which had been modified based on the results of the analysis of round one. In the second round five male and one female researcher sorted the questions. They were a subgroup of the sorters of the round one. The results of the second sorting round are presented in TABLE 14.

TABLE 14 Item placement scores of the constructs after the second sorting round

					Actual				
Construct	PU	PEOU	SI	BI	COM	PE	CANX	total	hit- %
PU	<u>24</u>							24	100.0
PEOU	5	<u>17</u>		1			1	24	70.8
SI			<u>24</u>					24	100.0
BI	4	2		<u>11</u>		1		18	61.1
COM	1	2		1	<u>14</u>			18	77.8
PE		1		1		<u>16</u>		18	88.9
CANX				1		2	<u>21</u>	24	87.5

item placements: 25 items x 6 raters = 150
hits: 24 + 17 + 24 + 11 + 14 +16 +21 = 127
overall hit ratio: 100*127/150 = 84.7 %

As seen in the table, the row of compatibility (COM) achieved a better hit percentage (77.8 %) than in the first round (63.3%). Thus, the modification helped to achieve a better hit ratio. The same occurred with perceived usefulness (100%) and social influence (100%) even though the items were not modified. However, perceived ease of use (PEOU) and behavioural intention (BI) achieved smaller hit ratios than in the first round. The overall hit ratio was also lower after the second round and was 84.7%. The constructs of perceived enjoyment (PE) and computer anxiety (CANX) also achieved lower values in the second round. Because the second round did not improve the overall hit ratio, it was decided that the items which were used in the first sorting round would be used in the questionnaire.

Because the two-phased sorting procedure did not improve the overall hit ratio, another method was used to evaluate the agreement of the sorters. The Fleiss kappa–value, based on the ratings after the first round was calculated. Fleiss kappa is a statistical value that is used to assess the reliability of the agreement between any number of raters when they classify a fixed number of items into categories (Fleiss 1971). In this study the items were questions of the scale and categories were constructs. Fleiss kappa measures the overall agreement between the sorters and is an expression of a consistency which exists between the amount of the agreed sorted items and the amount of items if the raters were to make the ratings fully in random.

The formulae to calculate Fleiss kappa are presented in Appendix 4. In the current study, the Fleiss kappa was calculated using formulae implemented in an Excel worksheet (Microsoft 2012). The Fleiss kappa and its standard error were calculated as instructed by the original method (Fleiss 1971), with parameter values N=25 (amount of items) n= 10 (amount of sorters) and k=7 (amount of constructs). The Fleiss kappa (κ) was 0.751 with a standard error (S.E.) of 0.069. The 95 % confidence interval (= 1.96 x S.E.) was calculated. With values of 1.96 x 0.069, a confidence interval value of 0.135 was achieved. Therefore the lower limit of Fleiss kappa's confidence interval was 0.751 – 0.135= 0.616 and the upper limit was 0.751 + 0.069= 0.820. Hence, with 95 % probability, the Fleiss kappa for the item placements into 7 constructs was between the limits of 0.616 and 0.820. The κ/S.E. value is a normal distributed value and in the current study it was 10.884. This suggested that based on Fleiss kappa there was a statistically significantly better agreement between sorters on the 0.001 level than if it were done by chance.

After rating and validity, the scales were subjected to pilot testing. The pilot test included 76 subjects. They were both police cadets and police officers at the Police College of Finland. The questionnaire was presented to the respondents in a classroom environment. The respondents had a working experience of the Finnish Police ranging from 6 months to 15 years. The questionnaire was presented on paper in two sessions - 36 participants in the first session and 39 participants in the second. In both sessions the subjects were first shown the same twelve minute video as in the real survey showing how the future mobile police field system would work. After this, they were instructed to fill in the questionnaire. Items of the constructs were presented on a 7-scale Likert– type scale. All participants returned the questionnaire. The data was analyzed after the pilot test using PASW Statistical 18 software (PASW Statistics 18 2012) to see whether correlations, reliabilities and the loadings of the factors were acceptable. Even though the amount of subjects was small (N=76) it could be seen that both the correlations and loadings of the factors were acceptable. The reliabilities, measured with Cronbach's alpha, ranged from 0.750 for the scale of behavioural intention to 0.995 for the scale of perceived ease of use. Some minor changes were made to the scales. Two items of the scale measuring the behavioural intention (BI) and two items of the scale of social influence were reformulated to make them more understandable and more descriptive.

The operationalization of the contexts was tested in the same pilot test. 25 respondents of 76 completed the context part of the questionnaire fully. The results of the conjoint analysis made with this pilot test data showed a good acceptability and the utility scores for the ten contexts could be calculated.

Based on this pilot testing the scales were then accepted to be used in the questionnaire. The scales of the final questionnaire are included in Appendix 1.

External validity is related to the generalizations of the results of the research. Hence, external validity is tightly related to the sampling of the research data. In the current research, the sampling method was stratified sampling (Metsämuuronen 2009). It means that instead of totally random sampling, the samples were selected from certain Finnish Police departments in order to achieve a balance between urban and rural police departments. By doing this it was confirmed that a necessary amount of respondents are from both urban and rural areas. On the other hand, in the current study (and in common with research concerning people's behaviours), not all the police officers can be studied, so the data which is collected using samples from a whole population, must be capable of being representative of that population. In the current study the population are the Finnish Police officers working in field operations. Hence, the results of this study are able to be generalized to that population. The population in 2010 in its entirety was approximately 5000 and covered patrol officers and traffic police officers (National Police Board of Finland 2011). The questionnaire was sent in February 2011 to approximately 3000 police officers via e-mail and 302 responses were received. These responses included some received from officers having high ranks which were outside the scope of the current study. For this reason they were removed. Hence, the sample finally comprised of 267 answers including responses from police officers having the ranks of police cadet, constable, senior constable and sergeant. This provided a response rate of around nine percent and representative of approximately 5 percent of the whole population. This indicates the sampling fraction of over 5 per cent and presents an acceptable generalization capability of the results to the whole population.

3.5 Structural Equation Modelling (SEM) as a Research Method

Structural equation modelling (SEM) is a comprehensive multivariate statistical methodology which can be used to represent, estimate and test the relationships among observed and latent variables (Gefen, Straub & Boudreau 2000). SEM allows the modelling of such relationships simultaneously. This is the biggest difference between SEM and most of the first generation regression models such as the Analysis of Variance (ANOVA) and the Multivariate Analysis of Variance (MANOVA), which allow only one layer of the relationships to be analyzed at a time.

SEM is suitable for those studies in which a researcher already holds a potential theory of the relationships of the variables in question (Metsämuuronen 2009).

3.5.1 Development of SEM Model

In SEM there are two parts: the measurement part and the structural part. The measurement part is consisted of the loadings of the observed items of the expected latent variables (Gefen, Straub & Boudreau 2000) and is analyzed using a confirmatory factor analysis (CFA). The structural part entails estimating the relationships of the latent constructs, and is the hypothesized causation between the dependent and independent constructs. It shows which latent constructs have a direct or indirect effect on the other latent variables in the model. Using SEM, it is possible to assess the structural model and measurement model within the same analysis. Thus, the combined analysis of the structural model and the measurement model enables the measurement errors of the observed variables to be included in the analysis and also the factor analysis to be combined in one operation. As a result, factor analysis and hypothesis testing is performed in the same analysis. SEM can also be understood as a combination of path analysis and confirmatory factor analysis.

SEM has a growing popularity in behavioural and social sciences and has lent support to information technology research. It can be used not only for research which is confirmatory by nature but also for generating the model. If the hypothesized model does not fit the measurement data, the model can be modified and a new analysis can be performed using SEM. This can be iterated until a plausible model is found which is compliant with the content and the theory requirements of the model. However, SEM is confirmatory in nature and the basic idea of it is lost, if the model is changed radically during the analyzing phase (Metsämuuronen 2009).

In creation of SEM, there five stages can be distinguished (Niemelä-Nyrhinen 2009, Yalcinkaya 2007, Schumacker & Lomax 2010), namely model specification (1), model identification (2), model estimation (3), model testing (4) and model modification (5). In the present study this five step approach is used and is partly adopted from Niemelä-Nyrhinen (Niemelä-Nyrhinen 2009).

1. *Model specification*

The model specification phase forms the foundation for SEM. In this phase, based on the literature and existing theories, a theoretical model is developed. The latent variables are defined and the relationships between them are created. In the current study this phase is included in Chapter 1.

2. *Model identification*

The main concern during this phase is the question whether there is a unique set of parameter estimates for the model. The variance-covariance matrix of the observable variables is transformed into the estimated parameters of the model. There are three levels for model identification: under-identified, just-identified, and over-identified. In the first two levels, the number of parameters is equal or less than the number of data variances and covariances. In these cases the parameters cannot be estimated. In order to perform this estimation, the model must be over-identified. It means that the number of estimated parameters is smaller than the number of available data points. In this case the parameters can be estimated and the model can be tested. Hence, in SEM, the aim is to create an over-identified model.

3. *Model estimation*

In the model estimation phase, the parameters of the model are estimated. The parameter matrix of the model should yield the matrix of parameters calculated from the sample data as closely as possible. When remainder of the elements of those matrices equals zero, then $\chi^2=0$ and there is a perfect fit between the model parameters and the data. Special software tools are used to accomplish the estimation procedures. There are several fitting functions available to minimize the remaining residuals between those two matrices in the software tools. Most of these fitting functions make use of the standard error in determining whether the parameters differ statistically from zero.

4. *Model testing*

The model testing phase is the point where the fit of the observed data to the parameters obtained from the model estimation is tested. In the current study the analyzing software was Mplus v 6.12 (Muthen & Muthen 2012b). This phase is reported in Chapter 1. The Mplus software produces the model fit testing indices as an output. The usage of those fit indices assessing the model fit is described as follows:

The overall goodness-of-fit test using χ^2 (chi-square) is a common method to express whether the data accepts or rejects the model (Byrne 2012). It is an absolute fit index assessing the degree to which the model-implied covariance matrix matches the observed covariance matrix. A small χ^2 value is an indication of a good fit and large value is an indication of a non-acceptable fit. The degrees of freedom (df) which are needed for the χ^2 tests are calculated based on the numbers of parameters to be evaluated and on the parameters which are available. The p-values of the χ^2 test with the existing degrees of freedom results present the fit of the model. When p-values with calculated degrees of freedom are ≥ 0.05, the model has a good fit. This criterion has been used in the study in hand.

For large sample sizes (for example even for $N \geq 250\text{-}300$), an χ^2 test may give an indication that rejects the model fit (Stommel et al. 1992). For this reason there are other parameters which can be used to test the fit of the model if the χ^2

test rejects the fit due to a large sample size. The parameter estimates of the model should be statistically significant. Hence, for a 0.05 significance level |t=value| it should be > 1.96. In the current study this criteria is used.

Root Mean Square Error of Approximation (RMSEA) is an absolute fit index, which describes the fit of a model using the discrepancy function (Browne & Cudeck 1993). It is proposed in (Browne & Cudeck 1993) that the value of RMSEA < 0.05 would express a close fit; 0.05 < RMSEA < 0.08 would express reasonable fit and a model having a value of RMSEA > 0.1 would not be used. If the RMSEA equals zero there is an exact fit. The confidence interval can also be calculated around the value of RMSEA. For the well-fitting model the lower limit of the confidence interval (p=0.05) should be near zero and the upper limit should be less than 0.08 (Hooper, Coughlan & Mullen 2008).

Standardized Root Mean Square Residual (SRMR) is an absolute measure of fit. It denotes the average of the standardized residuals between the observed and predicted values in their corresponding covariance matrices (Chen 2007). When SRMR equals zero it denotes an exact fit of the model with data. SRMR is relatively independent of the sample size. The values SRMR < 0.05 are deemed to express acceptable fit, even though values of up to SRMR < 0.08 are considered as acceptable (Weston & Gore 2006). SRMR will achieve lower values with models having a high number of parameters and if the sample size is large (Hooper, Coughlan & Mullen 2008).

Comparative Fit Index (CFI) is an incremental fit index for model sufficiency, comparing the model to a null model (Chen 2007). The range of CFI is between 0 and 1. The limit for an acceptable value of CFI is 0.9. The value of CFI > 0.95 is an indication of a good fit (Hooper, Coughlan & Mullen 2008).

Tucker-Lewis index (TLI) is an incremental fit index. It is also known as the Non-normed Fit Index (NNFI). It is a result of the comparison of the χ^2 values of the model to the χ^2 values of the null model. The null model is presented as the worst case scenario having a zero fit of the parameters. Values of TLI range from 0 to 1. Values TLI ≥0.95 are considered acceptable (Byrne 2012). TLI prefers simple models and is sensitive to large sample sizes, underestimating sample sizes of less than 200 samples (Hooper, Coughlan & Mullen 2008).

Normed Fix Index (NFI) can be used to test the model fit if the rejection of the model fit is caused by a large sample size. If the χ^2 test rejects the model and the value of NFI is ≥0.95, then it can be assumed that the rejection is caused by a large sample size (Hooper, Coughlan & Mullen 2008).

Cronbach's Alpha is a common index used to assess scale reliability (Cronbach 1951). It can be used to assess the scale reliability via internal consistency. Internal consistency measures the extent to which the items of the scale are measuring the same scale and it should be determined before the scale is used for testing. Cronbach's alpha can achieve values between 0 and 1. There are several suggestions of an acceptable alpha value. The alpha value for the scale should be > 0.6 (Metsämuuronen 2009) or > 0.7 (Gefen, Straub & Boudreau 2000, Tavakol & Dennick 2011) . However, a high value of Cronbach's alpha does not necessarily mean a high reliability because the length of a scale also affects its coefficient alpha value. With short scales it may achieve values that are too low. High values of Cronbach's alpha may indicate a redundancy of the items, i.e. that several items are measuring the same question. In the current study Cronbach alpha was computed using PASW Statistics 18 software.

The χ^2 distribution table for the given probability levels is presented in Appendix 2. The formulae to calculate RMSEA, SRMR, CFI, TLI, NFI, and Cronbach alpha values are presented in Appendix 3.

5. *Model modification*

In this phase the model can be modified and adjusted, if the parameter estimates of the model do not fit the observed data. The analyzing software tools provide a modification index for each parameter of the model. This index presents how much the χ^2 value could be lowered if that particular modification is applied to the model. This modification must be compatible with the content and theory which is behind the development of the model (Metsämuuronen 2009, Anderson & Gerbing 1988).

3.5.2 Multi-group Confirmatory Factor Analysis

Multi-group analysis is a method especially used in social sciences, for comparing the differences across the groups of subjects utilizing the confirmatory factor analysis framework and SEM (Cheung & Lau 2012). The groups may be defined by age, gender, experience, cultural background, nationality, etc. Before the groups can be tested, there must be certitude that the subjects in different groups have adopted the same meaning for the construct items and have understood the items similarly. This creates the need for the measurement invariance which has to be verified using the created structural model in χ^2 tests of difference. Hence, by combining the structural model developed in the SEM creating procedure, (as described in chapter 3.5.1 of the current study), with a series of successive tests of the constrained nested models, a researcher will have an invariant model, which can then be used to compare the differences in construct means, path coefficients and variances between groups. This method is used in the current study, where the comparison is made between different police officer groups based on age, length of career, location of the police department and a preferred usage context of the mobile system used in the questionnaire and using the model obtained in the SEM creation procedure and χ^2 tests of difference.

The comparison between groups is based on testing the measurement invariance of the structural model in successive χ^2 tests of difference (Cheung & Lau 2012, Dimiter 2006) for the nested models. This is possible because according to the χ^2 distribution principles, if the test statistics themselves are χ^2 distributed, their difference is χ^2 distributed as well and the resulting degrees of freedom are the difference in the degrees of freedom for these two test statistics. The procedure goes from the less constrained model to the more constrained model. In each phase of the test, the parameters of interest in the model are constrained to be equal in groups and the χ^2 test of difference is performed to find any deterioration of the constrained model. If the new constrained model still fits the data and there is no significant deterioration, there is invariance with respect to that constrained parameter in the model. If the test fails, there is non-invariance with respect to the parameter. Next, the resulting modification indices are examined and the model must be made less constrained by relaxing the parameter in question for an overall model fit. These successive χ^2 tests of difference continue until all required parameters are examined and the model can be found to be invariant or partly invariant (Meredith 1993). Following this, a comparison between groups can be made so that possible non-invariant parameters can be taken into account as well.

For comparison of the latent means and path coefficients between groups, the testing of measurement invariance can be accomplished in three phases (Cheung & Lau 2012). Firstly, configural invariance is tested. This reveals whether the subjects in each group have maintained the same meaning for the constructs. This level of invariance is also called form invariance (Dimiter 2006) or weak factorial invariance (Cheung & Lau 2012). To test the configural invariance there are no constraints for the parameters used in the model. The model is estimated separately for each group and a χ^2 test is performed for an overall model fit. The goodness-of-fit indices are examined. These may include χ^2 test values, Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Standardized Root Mean Square Residual (SRMR) as the χ^2 test may reject the model easily with larger sample sizes. If the model fits the data, the hypothesis of the full configural invariance between groups can be accepted and as a result, a baseline model is obtained. If the estimation of the model fails, the model is not adequate and it must be improved upon, based on the information obtained from the modification indices.

Secondly, the metric invariance is tested using the full configural invariance model. In this test, the factor loadings are constrained to be equal between the groups and a χ^2 test of difference is performed. The resulting χ^2 value is compared to that of the full configural invariance model. If the resulting difference in χ^2 test values shows up to be statistically non-significant, it reveals that there is no deterioration in the model, when compared to the full configural model. Also, the differences in other goodness-of –fit indices can be used for evaluation of the model fit. As a result, a full metric invariance model is obtained. This type of invariance is also called strong factorial invariance (Cheung & Lau 2012). If the fit is not acceptable, the modification and fit indices of the χ^2 test are examined and the model must be justified for the partial metric invariance model and the test continues using the partial metric invariance model.

Thirdly, the scalar invariance is tested for the comparison of latent means. In order to test this, the item intercepts are then constrained to be equal between the groups in the model which can be either a full or partial metric invariance model depending on the outcome of the metric invariance test. The item intercept represents the item value for the zero value of the corresponding construct. The resulting $\chi 2$ test of difference results are compared to those of the full metric invariance model, or to the partially metric invariance model respectively. If the difference in the $\chi 2$ test results suggests an acceptable fit then either full or partial scalar invariance is achieved. In this case the latent means across the groups can be compared. The comparison happens by fixing the means of one reference group to zero and allowing them to be freely estimated in the other groups. In this way the difference in estimates indicates the sign and the level of the difference in means.

Additionally, in the current study the path coefficients are also compared between the groups. This is done by constraining the path coefficients equal between groups using the metric invariance model and then estimating the model. The results following the difference test are then compared to those of the metric invariance model. If the results suggest that no significant deterioration has occurred, the path coefficients are qual across groups. If there is a difference in path coefficients between groups, then there is deterioration in the model fit and the modification indices are examined to find out the path coefficients which are causing the difference. If the modification indices cannot indicate any reasonable modifications, the path coefficients are examined one by one in successive χ^2 tests of difference as proposed by Im et al (Im, Hong & Kang 2011). The invariance of variances between the groups is not needed to be assessed as any measurement errors are accounted for when the SEM model is estimated. Additionally, the factor variances and covariances are not postulated to be equal when testing latent means.

In practical research it is not uncommon that the full measurement invariance fails (Cheung & Lau 2012). In those cases, the successive χ^2 tests have to be done using partially metric and scalar invariance models. In such cases a researcher has to identify the parameters which cause the fail in invariance and explore the cause of that fail.

In the current study, the estimation of the models and running the χ^2 tests was achieved using Mplus software utilizing the MLM-estimator (Muthen & Muthen 2012b). For this reason the successive χ^2 tests of difference had to be performed using the Satorra-Bentler scaling correction factor (Satorra & Bentler 2001) as proposed in the Mplus-software instructions (Muthen & Muthen 2012a).

3.6 Summary

In this chapter the research domain (the Finnish Police) was introduced. The questionnaire and the operationalization of the constructs were described. The data sampling and collection procedure were described and the validity of the measurement was assessed. Finally, the methods of analysis, structural equation modelling and multi group confirmatory factor analysis, were introduced. The results of the analysis of data are presented in the following chapter.

4 RESULTS

This chapter firstly introduces the descriptive results of the data. Means, standard deviations and medians are presented for all items of the constructs. The preferred contexts of work as assessed by the respondents are introduced and measurement models are estimated for the latent variables. The SEM model is estimated and multi-group analysis is performed for moderator effects.

4.1 Responses from subjects

The original data included responses from 302 subjects. Those subjects included police officers having a rank of police constable, senior constable, sergeant inspector and chief inspector. Because the target group of the current study was those police officers working in field operations, replies from the two highest ranks of inspector and chief inspector were removed from data, as those ranks do not normally attend to operations in the field. Hence, 35 replies were removed. This left 267 valid responses from the ranks of police constable, senior constable and sergeant who operated in the field in their daily police operations. The responses of the negative item SI2 were re-coded into the same variable to be equivalent with the others which all were positive items.

Data from respondents had very few missing values. The amount of missing values per item varied from 0 (COMP2, BI2) to 11 (SI2) and 12 (SI1). Because SI1 and SI2 (social influence) were deemed to be important items for the study as they measured the trait of a team member of a subject regarding system use, it was decided that the missing values would be imputed into the data. The multiple imputation was done for all items with PASW Statistics 18 software (PASW Statistics 18 2012) using the fully conditional specification with a linear regression method with 5 imputation rounds. All measured items were used as matching variables in the imputing process. This process provided data with 276 valid replies with no missing values, to be used in further analysis. However, the descriptive results of data are based on the same data with its missing values.

4.2 Descriptive Results

The descriptive results are presented in this chapter. The survey was undertaken for the subjects in order to collect their understanding on utilizing the future police mobile information system. After watching the introductory video, the perceptions of the subjects were assessed regarding perceived usefulness, perceived ease of use and their intention to use the system which they had seen in the video. Additionally, respondents gave their assessments on two external variables, namely compatibility and social influence. The responses were given by subjects using a 7point Likert scale having the following steps: 1: *strongly agree,* 2: *moderately agree,* 3: *somewhat agree,* 4: *neutral* (neither disagree nor agree), 5: *somewhat disagree,* 6: *moderately disagree and* 7: *strongly disagree.* The lowest number indicated the strongest level of conformity with the positive claim in question. The number 8 was for reserved for the possibility to answer "*I cannot or I do not want to answer* "which was treated as a missing value. The means, medians and standard deviations of the measured items (behavioural intention, perceived ease of use, perceived usefulness, compatibility and social influence) are presented in TABLE 15.

TABLE 15 Means, medians and standard deviations for measured items

	N				
Item	Valid	Missing	Mean	Median	Standard deviation
BI1	264	3	2.70	2	1.5
BI2	263	4	3.05	3	1.7
BI3	267	0	2.67	2	1.6
PEOU1	263	4	3.47	3	1.5
PEOU2	265	2	3.12	3	1.6
PEOU3	264	3	3.20	3	1.6
PEOU4	262	5	3.39	3	1.6
PU1	264	3	4.03	3.5	1.8
PU2	261	6	4.03	4	1.9
PU3	261	6	4.07	4	1.7
PU4	264	3	3.20	3	1.7
COMP1	266	1	3.34	3	1.6
COMP2	267	0	3.25	3	1.7
COMP3	264	3	3.33	3	1.7
SI1	255	12	3.10	3	1.6
SI2	256	11	2.88	2	1.7
SI3	262	5	2.46	2	1.4
SI4	262	5	3.16	3	1.5

Generally, the results indicate that on average the subjects gave very positive responses as most of the responses were under 4 (neutral value) on the scale of 7 points. This may be an indication of the existence of some bias in the responses when a Likert- scale is used and may result a bias in the results as well. Nevertheless, the results indicate that the respondents intend to use the system if it were made available. The mean of all items measuring behavioural intention was 2.83 (SD=1.6). The respondents felt that the system would be easy to use as the mean of all items measuring it was 3.31 (SD=1.6). The mean of items of perceived usefulness was 3.84 (SD=1.8) which indicates that the respondents were almost neutral in regard to the usefulness of using the system. Three items of four measuring perceived usefulness are scored just above 4 indicating a neutral opinion. Item PU4 of perceived usefulness which was measuring directly the usefulness aspect of the system, indicates that respondents would to a certain extent agree that using the system would be beneficial. Compatibility items had a mean of 3.31 (SD=1.7) indicating that respondents would (slightly) see that the system as compatible with most of the aspects related to their current work. Social impact has a mean of 2.92 (SD=1.6) proposing that the subjects tend to see that both the social influence of team partner and the management of the department might have an influence on their opinions on using the new technology.

The preferred context of work in which the mobile system would be at its best was assessed by the subjects after they had seen the video and filled in the survey questionnaire. Respondents were asked to rank the presented ten different working contexts in their preferred order, based on their own view. Based on the rankings made by respondents the part-worths were calculated for all factor levels of the context variables using PASW Statistics 18 software. The calculated part-worth estimates and their standard errors (S.E.) are presented in TABLE 16. A higher part-worth value indicates a higher preference for each factor.

TABLE 16 Part-worths of context factors

Variable	Factor	Part-worth estimate	S.E.
Weather	Hot summer	-0.185	0.136
	Cold winter	-0.371	0.273
Scene	In vehicle	-0.118	0.136
	Outside vehicle	-0.236	0.273
Urgency	Urgent	-0.916	0.136
	Non-urgent	-1.831	0.273
Activity	Data base query	-0.575	0.082
	Data base input	-1.150	0.165
	Reporting working hours	-1.725	0.247
Constant		7.319	0.389

Discharging a non-urgent task using a mobile system had the lowest part-worth value -1.831 (S.E.= 0.273) This indicates that respondents rank using the mobile system in non-urgent assignments as very low. Reporting working hours and data base input also have low values, being -1.725 (S.E.= 0.247) and -1.150 (S.E. = 0.165) respectively. These figures indicate that the respondents saw that the mobile system in the field would not be at its best in those operations which are both normally done in the office. The highest part-worths indicating high preferences fall on in-vehicle operations (-0.118, S.E. = 0.136) and using the system in the summer (0.185, S.E.= 0.136). The importance of the factors in ranking the contexts in preferred order can be assessed by calculating the importance score for each factor. It is calculated by taking the part-worth of each factor individually and dividing it by the sum of all part-worths for all factors for all subjects and then averaged over all subjects. Hence, the importance score represents the relative importance of each factor in the conjoint analysis (PASW Statistics 18 2012). The importance scores for the factors used in the ranking of contexts by the respondents are presented in TABLE 17.

TABLE 17 Importance scores for weather, scene, urgency and activity

Factor	Importance factor
Weather	7.825
Scene	4.980
Urgency	38.651
Activity	48.545

The importance scores reveal that an activity (importance score=48.5 %) plays a major role when respondents ranked the contexts of work. Urgency (importance score = 38.7 %) has a slightly smaller weight on evaluations of the contexts of work by the respondents. This can be interpreted that weather and scene have no or limited role in using a smart phone application. This discovery was used later in the multi-group analysis when the different contexts of work were utilized.

The part-worths which were calculated above can be used to find the most preferred contexts of work, by adding the individual part-worth of each factor together with the constant (7.319) for each context. Hence, the contexts can be ranked in preference order. The operationalization of them was presented in paragraph 3.2.3. The following ten context profiles were used in the survey:

1. It is hot summer and you have to make an urgent report of your working hours into the system outside your vehicle.
2. It is hot summer and you have to make an urgent Vitja data base query in your vehicle.
3. It is cold winter and you have to make an urgent Vitja data base query in your vehicle.
4. It is cold winter and you have to make a non-urgent report of your working hours into the system in your vehicle.
5. It is cold winter and you have to make a non-urgent Vitja data base query outside your vehicle.
6. It is cold winter and you have to make an urgent input to Vitja data base outside your vehicle.
7. It is hot summer and you have to make a non-urgent input to Vitja data base in your vehicle.

8. It is hot summer and you have to make a non-urgent query to Vitja data base outside your vehicle.
9. It is cold winter and you have to make an urgent query to Vitja data base outside your vehicle.
10. It is cold winter and you have to make a non-urgent query to Vitja data base in your vehicle.

The ten contexts of work showing their part-worths, rankings by respondents and the number of respondents who preferred that context as their most preferred context are presented in TABLE 18.

TABLE 18 Contexts of work and their part-worths and ranked preferences

No	Part worth calculation	Part worth	Ranking	N of #1 ranks
1	7.319 - 0.185 - 0.236 - 0.916 - 1.725	4.257	9	31
2	7.319 - 0.185 - 0.118 - 0.916 - 0.575	5.525	1	30
3	7.319 - 0.371 – 0.118 – 0.916 – 0.575	5.339	2	27
4	7.319 – 0.371 – 0.118 – 1.831 – 1.725	3.274	10	17
5	7.391 – 0.371 – 0.236 – 1.831 – 0.575	4.306	8	10
6	7.319 – 0.371 – 0.236 – 0.916 – 1.150	4.646	4	37
7	7.319 – 0.185 – 0.118 – 1.831 – 0.575	4.610	5	11
8	7.319 – 0.185 – 0.236 – 1.831 – 0.575	4.492	6	16
9[a]	7.319 – 0.371 – 0.236 – 0.916 – 0.575	5.221	3	74
10[a]	7.319 – 0.371 – 0.118 – 1.831 – 0.575	4.424	7	13

[a] holdout

The calculation of the part-worths of the contexts of work indicate that the respondents ranked context number 2 to be the most preferred context where the mobile system would be at its best. Context 2 is: "*It is hot summer and you have to make an urgent Vitja data base query in your vehicle*". This suggests that the respondents would prefer to use the future mobile system in the same way as the PC based data system installed in vehicles are used today. The number of respondents who deemed context no 2 as their most preferred was 30, which was 11.2 per cent of the valid respondents. The smallest part-worth falls on context number 4. Context 4 is "*It is cold winter and you have to make a non-urgent report of your working hours into the system in your vehicle*". This indicates that the users do not see the reporting of their working hours in the winter to be as so urgent that they prefer using the new mobile system for that task. The number of respondents who esteemed context no 4 the least preferred one was 71.

In order to have a view on the data for the normality of observed variables, the kurtosis and skewness of the data was checked. Kurtosis indicates the peakedness of the probability distribution of the data. Skewness indicates the symmetry of the probability distribution of the data (Byrne 2012). The SEM analysis postulates that data is multivariate normal. Possible kurtosis in data of the SEM analysis affects seriously on the tests of variances and covariances, whereas skewness affects on tests of means (DeCarlo 1997). Logically, as the

SEM analysis is based on the use of covariance structures, any existence of kurtosis in data is a concern. The non-normality indicators of skewness and kurtosis with responding standard errors for the observed variables are presented in TABLE 19. The formulae of how kurtosis and skewness are calculated are presented in Appendix 5.

TABLE 19 Skewness and kurtosis with their standard errors of observed variables

Item	Skewness	Std. error	Kurtosis	Std. error
BI1	1.116	0.150	0.748	0.299
BI2	0.834	0.150	-0.087	0.299
BI3	1.163	0.149	0.673	0.297
PEOU1	0.484	0.150	-0.421	0.299
PEOU2	0.698	0.150	-0.300	0.298
PEOU3	0.694	0.150	-0.261	0.299
PEOU4	0.571	0.150	-0.486	0.300
PU1	0.185	0.150	-1.074	0.299
PU2	0.116	0.151	-1.182	0.300
PU3	0.135	0.151	-1.029	0.300
PU4	0.779	0.150	-0.208	0.299
COMP1	0.633	0.149	-0.617	0.298
COMP2	0.767	0.149	-0.432	0.297
COMP3	0.569	0.150	-0.675	0.299
SI1	0.671	0.153	-0.192	0.304
SI2	0.713	0.152	-0.298	0.303
SI3	1.263	0.150	1.503	0.300
SI4	0.484	0.150	-0.421	0.299

The analysis for skewness reveals that all variables except PU1, PU2 and PU3 show statistically significant values of positive skewness. Furthermore, the analysis of data reveals that almost all variables show kurtosis. Kurtosis is a measure of a difference between a certain distribution and normal distribution (DeCarlo, 1997). Kurtosis can be either positive which is called leptokurtosis, or negative which is called platykurtosis. Leptokurtic distribution has fat tails and a higher peak whereas platykurtic distribution is flatter and has lighter tails. Variables BI1, BI3 and SI3 show statistically significant values for leptokurtosis. Variables PU1, PU2, PU3, COMP1 and COMP3 show statistically significant values for platykurtosis. In order to prevent the effects of kurtosis and skewness in estimations of the parameters in the SEM analysis, a Satorra & Bentler scaling correction method for the χ^2 tests was used (Satorra & Bentler 2001). This method was available in the Mplus software when the robust MLM estimator was selected as an estimator. The computation of the scaling correction value takes into account both the kurtosis of data, the model itself and the MLM- estimator. In this way the values are valid in spite of the non-normality of data (Byrne 2012). Moreover, the values of the scaling corrections are reported together with the corresponding goodness-of-fit values in the estimations of the measurement models which are presented next.

4.3 Measurement Model

The research in hand is confirmatory in nature. The developed research model based on the existing literature is aimed to measure the relationships between the latent variables and their observed items. The adequacy of the measurement model was tested using the confirmatory factor analysis (CFA) before running the structural equation modelling as suggested by Byrne (2012). The measurement model which is depicted in FIGURE 14 was estimated using the MLM robust estimator in the CFA framework of the Mplus software. The χ^2 test rejected the model fit (χ^2 (125) = 327.738, scaling correction value = 1.363, p-value = 0.000). The goodness-of-fit did not support the fit either (RMSEA = 0.078, CFI = 0.947, TLI = 0.936, SRMR = 0.052). All factor loadings were significant, however there were several modification indices which stood out. The four largest modification indices suggested that PU4 would be an item either for the construct of behavioural intention (BI) (MI = 69.866), or for the construct of compatibility (COMP) (MI = 61.281), or for the construct of perceived ease of use (MI = 51.396), and for the construct of social influence (SI) (MI = 30.480). Similarly, modification indices proposed similar deviant changes related to items PEOU2, PEOU 4 and BI3.

These large values of modification indices alluded to an inadequate discriminant validity between constructs. For this reason it was decided that each scale of the measurement model will be estimated separately on the confirmatory factor analysis framework for a proper evaluation of the reliability and validity of the scales.

4.3.1 Individual Measurement Models

The testing of overall model fit for each measurement model was done based on the use of the χ^2 test supported with goodness-of-fit indices RMSEA, CFI, TLI and SRMR. The reliability of the scales was evaluated using Cronbach's alpha and the internal consistency using composite reliability. As stated earlier, the values of Cronbach's alpha should be above 0.7 (Gefen, Straub & Boudreau 2000, Tavakol & Dennick 2011), or above 0.6 (Metsämuuronen 2009). The composite reliability value should be above 0.7 with each item having reliability above 0.5 (Fornell & Larcker 1981). The item reliabilities were evaluated using squared multiple correlations (R^2). These values should be over 0.7 (Gefen, Straub & Boudreau 2000). The construct validity evaluation was based on the method proposed by Fornell and Larcker (Fornell & Larcker 1981). In that method, the convergent validity is assessed by examining the average variance extracted (AVE), which should be more than 0.5. Further, the discriminant validity was assessed by examining the square root of the AVE of every construct which resultantly should be more than the correlation of that construct with other constructs.

The measurement model for behavioural intention (BI) was estimated first. The model was just-identified, and even though the model fit could not be tested, the parameters could be estimated. The standardized factor loadings were significant and high, ranging from 0.896 to 0.919. Item reliabilities were high as the squared multiple correlations (R^2) were significant and for BI1, BI2 and BI3 they were 0.844, 0.836 and 0.802 accordingly. Cronbach's alpha of 0.934 indicated good scale reliability supported by a good composite reliability of 0.935 indicating good internal consistency. The average variance extracted value (AVE = 0.827) indicated a good convergent validity. There were no modification indices proposing modifications to the model. The model of behavioural intention is illustrated in FIGURE 15.

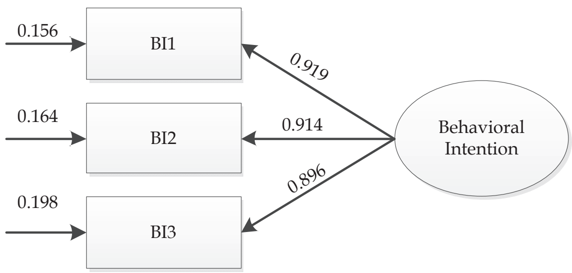

FIGURE 15 Estimated measurement model for behavioural intention (standardized values)

The model of perceived ease of use (PEOU) was estimated. The χ^2 test rejected the model fit (χ^2 (2) = 17.187, scaling correction value = 2.246, p-value = 0.000). The supporting goodness-of-fit also did not support the fit (RMSEA = 0.169, CFI = 0.967, TLI = 0.901, SRMR = 0.038). All factor loadings were significant. The modification indices suggested that by releasing the covariances of the measurement errors between the items PEOU2 and PEOU3 (MI = 18. 331) and items PEOU1 and PEOU4 (MI = 18.332), the model could be better. Compared to other correlations between the items of PEOU, the relatively low correlation of PEOU2 with PEOU4 (0.560) and with PEOU1 (0.603) indicated that the reliability of PEOU2 might not be acceptable. Due to this it was decided that item PEOU2 would be removed from the model.

The new model of PEOU without the item PEOU2 was next estimated. The model was just-identified, and even though the model fit could not be tested, the parameters could be estimated. The standardized factor loadings were significant and high, ranging from 0.775 to 0.926. Item reliabilities were acceptable as the squared multiple correlations (R^2) were significant and for PEOU1, PEOU3 and PEOU4 they were 0.857, 0.600 and 0.708 respectively. Cronbach's alpha of 0.882 indicated good scale reliability supported by a good composite reliability of 0.886 which indicated good internal consistency. The average variance extracted value (AVE = 0.722) indicated acceptable convergent validity. The model of perceived ease of use is outlined in FIGURE 16.

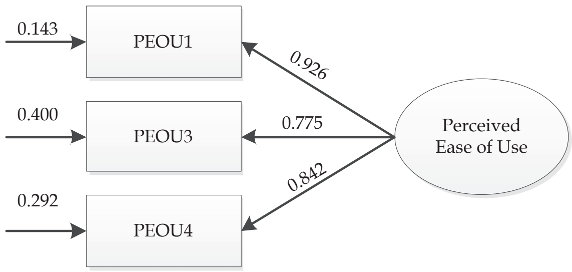

FIGURE 16 Estimated measurement model for perceived ease of use (standardized values)

The model for perceived usability (PU) was estimated. The measurement model was accepted in terms of exact fit (χ^2 (2) = 0.128, scaling correction value = 1.610, p-value = 0.9380). The goodness-of-fit indices supported the fit (RMSEA = 0.000, CFI = 1.000, TLI = 1.005, SRMR = 0.001). All factor loadings were significant and were 0.955, 0.937, 0.961 and 0.805 for PU1, PU2, PU3 and PU4 respectively. The squared multiple correlations (R^2) for PU1, PU2, PU3 and PU4 were 0.912, 0.878, 0.924 and 0.648 respectively. However, with all its favourable goodness-of-fit indices it was suspected the there was something wrong with the item PU4 as the factor loading and thus the squared multiple correlation was rather poor (0.648). It was much lower than the squared multiple correlations of the other items of the scale. This was also an issue initially when the entire measurement model was estimated. The suspicion was also supported by the notably different mean of item PU4 in the construct score compared to those of other means of the construct. After calculating the Cronbach's alpha it was seen that the removing of item PU4 would raise Cronbach's alpha from the high value of 0.953 to an even better 0.966. Due to these suspicions it was decided to remove the item PU4 from the construct of perceived usefulness.

Hence, the model for perceived usefulness (without the item PU4) was estimated. The model was just-identified. The model fit could not be tested but the parameters could be estimated. The standardized factor loadings were significant and high, ranging from 0.938 to 0.961. Item reliabilities were acceptable as squared multiple correlations (R^2) were significant and for PU1, PU2 and PU3 they were 0.911, 0.880 and 0.924 respectively. Cronbach's alpha of 0.966 indicated good scale reliability and was supported by good composite reliability of 0.966 for a good internal consistency. The average variance extracted value (AVE = 0.905) indicated good convergent validity. The model of perceived usefulness is depicted in FIGURE 17.

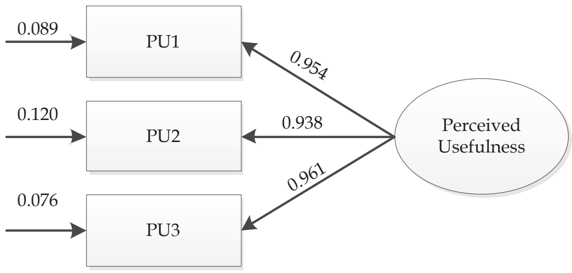

FIGURE 17 Estimated measurement model for perceived usefulness (standardized values)

The measurement model for compatibility was estimated. The model was just-identified, hence the model fit could not be tested but the parameters could be estimated. The standardized factor loadings were significant and high, ranging from 0.881 to 0.932. Item reliabilities were acceptable as squared multiple correlations (R^2) were significant. For COMP1, COMP2 and COMP3 they were 0.776, 0.869 and 0.823 respectively. Cronbach's alpha of 0.932 indicated good scale reliability supported by a good composite reliability of 0.933. The average variance extracted value (AVE = 0.823) indicated good convergent validity. The model of perceived compatibility is presented in FIGURE 18.

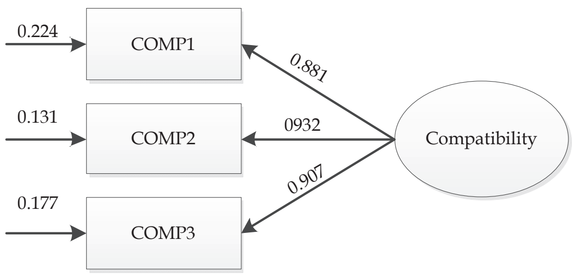

FIGURE 18 Estimated measurement model for compatibility (standardized values)

The measurement model for social influence was estimated next. The $\chi 2$ test rejected the fit of the model (c, scaling correction factor = 2.114, p= 0.0001). The supporting goodness-of-fit did not support the fit either - (RMSEA = 0.172, CFI = 0.933, TLI = 0.800, SRMR = 0.054). All factor loadings were significant. The two large modification indices suggested that releasing the covariances of the measurement errors between the items SI1 and SI2 (MI = 18.357) and between SI3 and SI4 (MI = 18.361) would ameliorate the model. The loadings of the items on the construct were not very good. They were 0.887, 0.691, 0.633 and 0.700 for the items SI1, SI2, SI3 and SI4 respectively. These four items of the constructs were such that they could be split into two parts; items SI1 and SI2 were measuring the social influence of the team member of the respondent and items SI3 and SI4 were measuring the social influence of the management to the respondent. Hence, there was full reason to assume that there were two separate factors; one indicating the social influence of the team member and the other demonstrating the social influence of the management.

Based on the assumption of two factors - the factor of the social impact of the team member and the factor of the social impact of the management, the model of social influence was estimated with two factors. The measurement model was accepted in terms of exact fit. (χ^2 (1) = 0.674, scaling correction value = 2.427, p-value = 0.4116). The goodness-of-fit indices supported the fit (RMSEA = 0.000, CFI = 1.000, TLI = 1.008, SRMR = 0.010). All factor loadings were significant and were 0.976 (SI1) and 0.671 (SI2) for the factor of the social influence of the team member, and 0.737 (SI3) and 0.819 (SI4) for the factor of the social influence of the management. The squared multiple correlations (R^2) were 0.952 (SI1) and 0.451 SI2) for the social influence of the team member and 0.542 (SI3) and 0.670 (SI4) for the social influence of the management.

Cronbach's alphas of 0.791 and 0.753 indicated reasonable scale reliability for both scales. It was supported by good composite reliability of 0.820 for the social influence of the team member and by low composite reliability of 0.754 for the social influence of the management. Average variance extracted values (AVE = 0.701 and AVE= 0.606) indicated adequate convergent validity even though they were low. The correlation between these factors was 0.749 (t-value 11.956) indicating the existence of two separate but closely associated factors. The Akaike Information Criterion (AIC) index difference (Hooper, Coughlan & Mullen 2008) also suggested that the two model is better as the value of the index (AIC= 3580.414) was smaller than the index for the one factor model (AIC=3614.542). The two factor model of social influence is depicted in FIGURE 19.

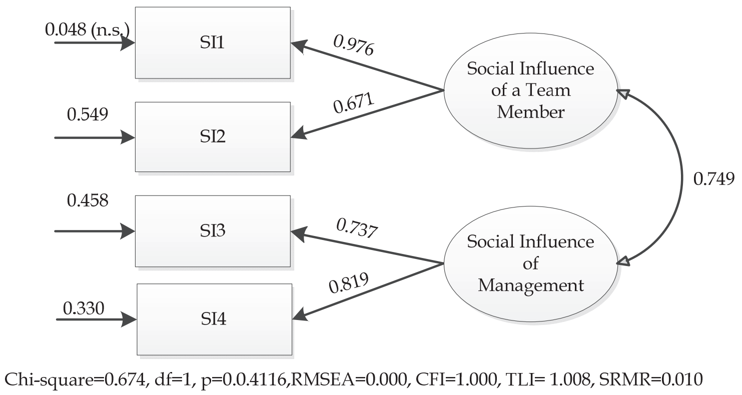

FIGURE 19 Estimated measurement model for the social influence of team member and management (standardized values)

The residuals of the items SI3 and SI4 measuring the social influence of the management were explicated as high. This raised doubts whether the model is appropriate. For this reason the factor score coefficients of the model were examined. For the factor of the social influence of the team member they were 0.885 (SI1), 0.053 (SI2), 0.025 (SI3) and 0.037 (SI3). For the factor of the social influence of management they were 0.180 (SI1), 0.011 (SI2), 0.221 (SI3) and 0.327 (SI4). Based on these score coefficients a scale reliability of a factor score Rel(S_2) was computed as proposed in Niemelä-Nyrhinen (2009). Rel(S_2) was 1.0 for the factor of social influence of the team member, and 0.546 for the factor of social influence of management. The latter Rel(S_2)-value was discovered to be low suggesting inadequate reliability for the corresponding factor score. For this reason it was decided that the segment that was measuring the social influence of the management with items SI3 and SI4 would be a separate factor in the research model that would be estimated. Hence, the items for the construct of the social influence of the team member were SI1 and SI2. It was decided that this would be used further in the current study because one of the goals was to explore the effect of the team member. The construct was named as the social influence of the team member. Even though there were doubts about inadequate reliability and if items SI3 and SI3 formed the construct for the influence of the management this new discovered construct would be estimated as a part of the research model as well.

The standardized factor loadings, standard errors, item reliabilities (R^2) for observed variables, and Cronbach's alphas and composite reliabilities for latent factors are presented in TABLE 20.

TABLE 20 Standardized factor loadings, standard errors, item reliabilities for observed variables and Cronbach's alphas and composite reliabilities for latent factors

Factor	**Item**	**Factor loading**	**Std. error**	**Item reliability (R^2)**	**Cronbach's alpha**	**Composite reliability**
Behavioural intention	BI1	0.919	0.019	0.844	0.935	0.935
	BI2	0.914	0.021	0.836		
	BI3	0.896	0.031	0.802		
Perceived ease of use	PEOU1	0.926	0.022	0.857	0.882	0.886
	PEOU3	0.775	0.053	0.600		
	PEOU4	0.842	0.028	0.708		
Perceived usefulness	PU1	0.954	0.010	0.911	0.966	0.966
	PU2	0.938	0.012	0.880		
	PU3	0.961	0.010	0.924		
Compatibility	COMP1	0.881	0.022	0.776	0.932	0.933
	COMP2	0.932	0.014	0.869		
	COMP3	0.907	0.026	0.823		
Social influence of	SI1	0.976	0.048	0.952	0.791	0.820
team member	SI2	0.671	0.065	0.451		
Social influence of	SI3	0.737	0.060	0.542	0.753	0.754
management	SI4	0.819	0.052	0.670		

When the results of the estimations of the individual measurement models are examined closer, it can found that in general the factor loadings and item reliabilities are high except the items PEOU3 and SI2. The possible explanation for the low values of PEOU3 might be in the question that was used to measure PEOU3. The item was *"I would find the system to be easy to use"*. In a questionnaire based on the real use of the systems under study, this question is supposed to measure a real experience after the user has actually used the system. However, in the current study the subjects did not use any system but simply saw a video presenting the capabilities of the future system. Hence, they had no real experience of the easiness of using the system. They had to create their view only by the vision they formed when they saw someone else operate with the system. This may effect on the perceived experience which then reflected as a low factor loading because the item may be loaded to another maybe unknown latent factor. However, it was decided to include item PEOU3 in the construct of perceived ease of use.

Another observation is related to the low values of item SI2, which was used to measure the social influence of the team member. It had low values in factor loading and item reliability. This may be caused by the fact that item was a negative item. It was the same as SI1 but turned to be negative. This may have caused either confusion or misunderstanding among the subjects which can then be detected in low measurement values of the item. Item SI1 which is the positive form (the same as item SI2) has both good factor loading and item reliability. However, it was decided to keep both items SI1 and SI2 in the construct measuring the social influence of the team member in the current study.

4.3.2 Reliability and Validity of Constructs and Conjoint analysis

The reliability of the items of the constructs and the constructs themselves were validated alike. For evaluation of the reliability of the items, the composite reliability values were examined at the same time with the estimation of the individual models above. The results indicate a good reliability of the items. The reliability of the constructs was evaluated by examining the Cronbach's alpha and composite reliability. The values of both indicated good reliability of the constructs.

The convergent validity and discriminant validity evaluation were based on the method proposed by Fornell and Larcker (Fornell & Larcker 1981). In this method, the convergent validity is assessed by examining the average variance extracted (AVE) which should be more than 0.5. Based on the AVE values, all constructs showed good convergent validity.

Further, the discriminant validity was assessed using the same process described by Fornell and Larcker (Fornell & Larcker 1981), by examining the square root of AVE of every construct which should be more than the correlation of that construct with other constructs. The AVEs, square roots of AVEs and correlations of the constructs are presented in TABLE 21 below. Square roots of AVEs are bolded on the diagonal.

TABLE 21 AVEs, square roots of AVEs and correlations of the constructs.

Construct	AVE	BI	PEOU	PU	COMP	SI-TM	SI-M
BI	0.827	**0.909**					
PEOU	0.722	0.888	**0.850**				
PU	0.905	0.766	0.812	**0.951**			
COMP	0.823	0.946	0.853	0.799	**0.907**		
SI_TM	0.701	0.862	0.784	0.701	0.803	**0.837**	
SI_M	0.606	0.720	0.689	0.684	0.657	0.754	**0.778**

The correlations between the latent factors were high. The square roots of AVEs of the constructs of behavioural intention, perceived ease of use, compatibility and social influence of team member were smaller than their corresponding correlations with some factors. This was seen as an indication of questionable discriminant validity and the presence of multicollinearity. Discriminant validity and multicollinearity are related (Grewal, Cote & Baumgartner 2004). If the correlations between the constructs are high, it may be a sign of a lack in discriminant validity. However, it was decided that the issue with the possible discriminant validity would be examined in more detail when the full measurement model would be estimated before testing the structural correlations. This is presented in Chapter 4.3.4 of the current study.

The validity of the results of conjoint analysis was done based on the use of correlation parameters Pearson's R and Kendall's tau which were calculated by the analysing software when the part-worths were estimated for the context factors. These parameters indicate the correlation between the observed and estimated preferences (PASW Statistics 18 2012). Both Pearson's R and Kendall's tau indicated good validity by their values 0.985 and 0.929 respectively. Both values were significant. Kendall's tau for the two holdout cases was 1.000 indicating perfect match between the observed and estimated values. This in turn indicated good validity of the conjoint analysis. The correlations are presented in TABLE 22.

TABLE 22 Correlations between the observed and estimated part-worths

	Value	Significance
Pearson's R	0.985	0.000
Kendall's tau	0.929	0.001
Kendall's tau for holdouts	1.000	-

4.3.3 Testing the Existence of the Common Method Variance

Existence of Common Method Variance (CMV) refers to that part of the total variance is caused for example by the data collection method rather than with the variance derived from the constructs as had been planned (Malhotra, Kim & Patil 2006). It has been suspected to be very common in self-reported surveys in which respondents fill out the questionnaire at the same point in time. The consequences of CMV may be harmful to research because of bias. In order to test whether there was common method variance in data, Harman's single factor test was performed in the CFA framework using the method as suggested by Malhotra, Kim & Patil (2006). The test results indicated that the single factor model did not fit the data ((χ^2 (104) = 677.259, scaling correction value = 1.363, p-value = 0.000). The supporting goodness-of-fit did not support the fit either (RMSEA = 0.144, CFI = 0.833, TLI = 0.807, SRMR = 0.055). Even though the Harman's single factor test has its limitations in detecting small or medium size CMV effects, these results gave suggestive support to reject the possible assumptions of substantial bias in the data caused by the common method variance.

4.3.4 Measurement Model Estimation

When the individual constructs of behavioural intention, perceived usefulness, perceived ease of use, compatibility and social influence (including both the influence of a team member and management) were estimated, they were used to estimate the measurement model as a whole. The Mplus-software with the MLM robust estimator was used. The χ^2 -test rejected the model fit (χ^2 (89) = 133.355, scaling correction value = 1.350, p-value = 0.0016). However, the supporting goodness-of-fit indices indicated good fit (RMSEA = 0.043, CFI = 0.987, TLI = 0.983, SRMR = 0.042). The 90 %confidence interval of RMSEA (0.027; 0.058) and the probability of RMSEA to be less than 0.05 (p= 0.764) supported the good fit of the model with data. The modification indices did not suggest any reasonable improvements to the model. The correlations between the latent factors were high and are presented in TABLE 23.

TABLE 23 Correlations between the latent factors PU, PEOU, BI, SI_T, SI_M and COMP

	PU	PEOU	BI	SI_T	SI_M	COMP
PU	1					
PEOU	0.812	1				
BI	0.766	0.888	1			
SI_T	0.701	0.784	0.862	1		
SI_M	0.684	0.689	0.720	0.754	1	
COMP	0.799	0.853	0.946	0.803	0.657	1

In order to review the discriminant validity issue which was raised earlier (in Chapter 4.3.2 above), the χ^2 test (Wald test) was performed pair-wise between the factors. This test was performed in order to see whether the factors are discriminant, forming factors of their own or are they somehow combined or mixed. In the test the correlation of the two factors under test are set to 1, meaning a full correlation between them in another model and the correlation can be freely estimated in another model. The significance of the difference between these two models is then tested with the χ^2 test. The results of the χ^2 tests are presented in TABLE 24.

TABLE 24 Discriminant validity χ^2 test results

Factor pair	χ^2	Degrees of freedom	p-value
PU – PEOU	26.433	1	0.000
PU – BI	19.315	1	0.000
PU – COMP	29.172	1	0.000
PU – SI_T	22.144	1	0.000
PU – SI_M	1.355	1	0.244
PEOU –BI	14.273	1	0.000
PEOU – COMP	15.394	1	0.000
PEOU – SI_T	15.028	1	0.000
PEOU – SI_M	0.000	1	0.991
COMP – SI_T	18.519	1	0.000
COMP – SIM_M	0.019	1	0.889
BI – COMP	19.900	1	0.000
BI – SI_T	17.468	1	0.000
BI – SI_M	0.045	1	0.831
SI_T – SI_M	1.414	1	0.235

The χ^2 test results indicate that the constructs have discriminant validity except that construct measuring the social influence of the management (SI_M). The SI_M construct was found as a result of the estimations of the individual measurement models of the social influence and was not originally in the scope of this study. For this reason it was decided to leave to leave it out from the measurement model and decision could be easily justified. The influence of the management was also found to be a good candidate for further studies.

The full measurement model without the factor of the social impact of the management (SI_M) was estimated next. The χ^2 test rejected the model fit (χ^2 (67) = 93.113, scaling correction value = 1.417, p-value = 0.0192). However, the supporting goodness-of-fit indices indicated an excellent fit (RMSEA = 0.038, CFI = 0.992, TLI = 0.989, SRMR = 0.022). The 90 % confidence interval of RMSEA (0.016; 0.056) and the probability of RMSEA to be less than 0.05 (p= 0.856) supported the excellent fit of the model with the data. The NFI index value (NFI= 0.971) indicated the the χ^2 test rejection may be caused by a sample size. The largest modification index (MI = 21.911) suggested that the model could be improved if item BI3 were loaded on the construct of compatibility. This indicated that the discriminant validity of the constructs of compatibility and behavioural intention could be questionable. To test the discriminant validity between the constructs after the factor of the social influence of the management was removed from the model, a series of Wald tests were performed pair-wise between the constructs. The results showed no deteriorations in the results compared to those which were presented earlier and are presented in TABLE 24. Based on this test, the model possessed adequate discriminant validity.

The modification index in the estimation suggested that the model could be improved if the loading of item BI3 would be on the construct of compatibility. In SEM, the factor loadings cannot be both on endogenous and on exogenous variables (Weston & Gore 2006). One method is to remove the item from the construct. In order the test the implications of the possible removal of item BI3 from the construct of behavioural intention of the model, a full measurement model without item BI3 was estimated as well. The χ^2 test accepted the model (χ^2 (55) = 54.468, scaling correction value = 1.308, p-value = 0.4949). The supporting goodness-of-fit indices supported an excellent fit (RMSEA = 0.000, CFI = 1.000, TLI = 1.000, SRMR = 0.019). The 90 % confidence interval of RMSEA (0.000; 0.038) and the probability of RMSEA to be less than 0.05 (p= 0.996) supported the excellent fit of the model with data. To test the discriminant validity between the constructs after the item BI3 in the construct of behavioural intention was removed from the model, a series of Wald tests were performed pair-wise between the constructs. The results showed no deteriorations on the results, when compared to those which were presented earlier and are presented in TABLE 24. Based on this test the model would possess discriminant validity as well.

The item BI3 in the survey was *"If the system was available, I would use it"*. The item was deemed to be so important for the construct of behavioural intention that it was decided not to leave it out from the model as its removal could not easily be justified. Hence, the model having TAM with the constructs for perceived usefulness (measured with items PU1, PU2 and PU3) , perceived ease of use (measured with items PEOU1, PEOU3 and PEOU4), behavioural intention (measured with items BI1, BI2 and BI3) added with external variables compatibility (measured with items COMP1, COM2 and COMP3) and social influence of the team member (measured with items SI and SI2) was decided to be used as the full model for evaluation of the structural relationships of the model. The estimates of the factor loadings on their corresponding constructs, their standard errors (S.E.), t-values and p-values based on the confirmatory factor analysis are presented in TABLE 25. They all are statistically significant.

TABLE 25 Standardized factor loading estimates, standard errors (S.E.), t-values and p-values

Construct	**Item**	**Estimate**	**S.E.**	**t-value**	**p-value**
Perceived Ease of Use	PEOU1	0.910	0.016	55.156	0.000
	PEOU3	0.780	0.047	16.671	0.000
	PEOU4	0.855	0.022	39.394	0.000
Perceived Usefulness	PU1	0.956	0.009	112.442	0.000
	PU2	0.937	0.010	93.349	0.000
	PU3	0.960	0.009	101.204	0.000
Compatibility	COMP1	0.877	0.018	47.867	0.000
	COMP2	0.926	0.012	75.128	0.000
	COMP3	0.917	0.015	62.662	0.000
Social influence of a Team Member	SI1	0.957	0.024	40.577	0.000
	SI2	0.685	0.060	11.364	0.000
Behavioural intention	BI1	0.901	0.017	51.993	0.000
	BI2	0.919	0.014	65.501	0.000
	BI3	0.908	0,.013	70.089	0.000

The correlations of the items of all constructs are presented in TABLE 26.

The correlations between the items had correct sign and their degrees indicated correct relationships between the items. The only remarkable and conspicuous correlation was between items SI1 and SI2. It was only 0.655 which can be evaluated as being low for two items measuring the same construct. One possible explanation could be that the item SI2 is the same as SI1 but turned into a negative form of it. This was already an issue earlier with the low factor loading and item reliability in the estimation of the individual measurement models in Chapter 4.3.1.

TABLE 26 Correlations of the items of all constructs

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PEOU1	1													
PEOU3	0.717	1												
PEOU4	0.779	0.652	1											
PU1	0.691	0.571	0.723	1										
PU2	0.657	0.569	0.689	0.895	1									
PU3	0.696	0.567	0.727	0.917	0.902	1								
BI1	0.740	0.661	0.671	0.679	0.631	0.660	1							
BI2	0.772	0.675	0.711	0.694	0.677	0.688	0.840	1						
BI3	0.708	0.601	0.626	0.644	0.623	0.651	0.823	0.819	1					
SI1	0.679	0.63	0.623	0.647	0.637	0.631	0.768	0.770	0.728	1				
SI2	0.511	0.463	0.480	0.490	0.521	0.502	0.551	0.537	0.495	0.655	1			
COMP1	0.689	0.611	0.644	0.682	0.668	0.664	0.702	0.745	0.791	0.664	0.449	1		
COMP2	0.720	0.603	0.658	0.722	0.709	0.709	0.748	0.789	0.837	0.711	0.513	0.821	1	
COMP3	0.724	0.641	0.634	0.697	0.661	0.692	0.777	0.793	0.826	0.722	0.509	0.799	0.845	1

4.4 Estimating the Structural Relationships of the Model

The estimation of the structural relationships of the full SEM model containing both TAM with the external variables combined with the structural model is described in this chapter. The full SEM model was estimated. The model was rejected in terms of exact fit (χ^2 (67) = 93.113, scaling correction value = 1.417, p-value = 0.0192). However, the supporting goodness-of-fit indices indicated an excellent fit (RMSEA = 0.038, CFI = 0.992, TLI = 0.989, SRMR = 0.022). The 90 % confidence interval of RMSEA (0.016; 0.056) and the probability of RMSEA to be less than 0.05 (p= 0.856) supported the excellent fit of the model with data. The NFI index value (NFI= 0.971) indicated that the χ^2 test rejection may be caused by a sample size. The estimated full SEM model with estimated factor loadings, residual variances, R^2-values, and path coefficients is depicted in FIGURE 20.

The path coefficients were all significant except the path from social influence of a team member to perceived usefulness. Contrary to one salient presumption of the TAM model, the path from perceived usefulness to behavioural intention was negative and significant (standardized γ= - 0.107, t= -2.03). Hence, the hypothesis H1, *Perceived usefulness has a direct positive effect on the intention to use mobile technology in police field operations,* was not supported. As disserted in the TAM model, the path coefficient from perceived ease of use to behavioural intention was strong and significant (γ=0.263, t=3.14). Hence, the hypothesis H2, *Perceived ease of use has a direct positive effect on the intention to use mobile technology in field operations,* was supported. Similarly, the path coefficient from perceived ease of use to perceived usefulness was high and significant (γ=0.464, t=4.58). Hence, the hypothesis H3, *Perceived ease of use has a direct positive effect on perceived usefulness of using mobile technology in police field operations,* was supported.

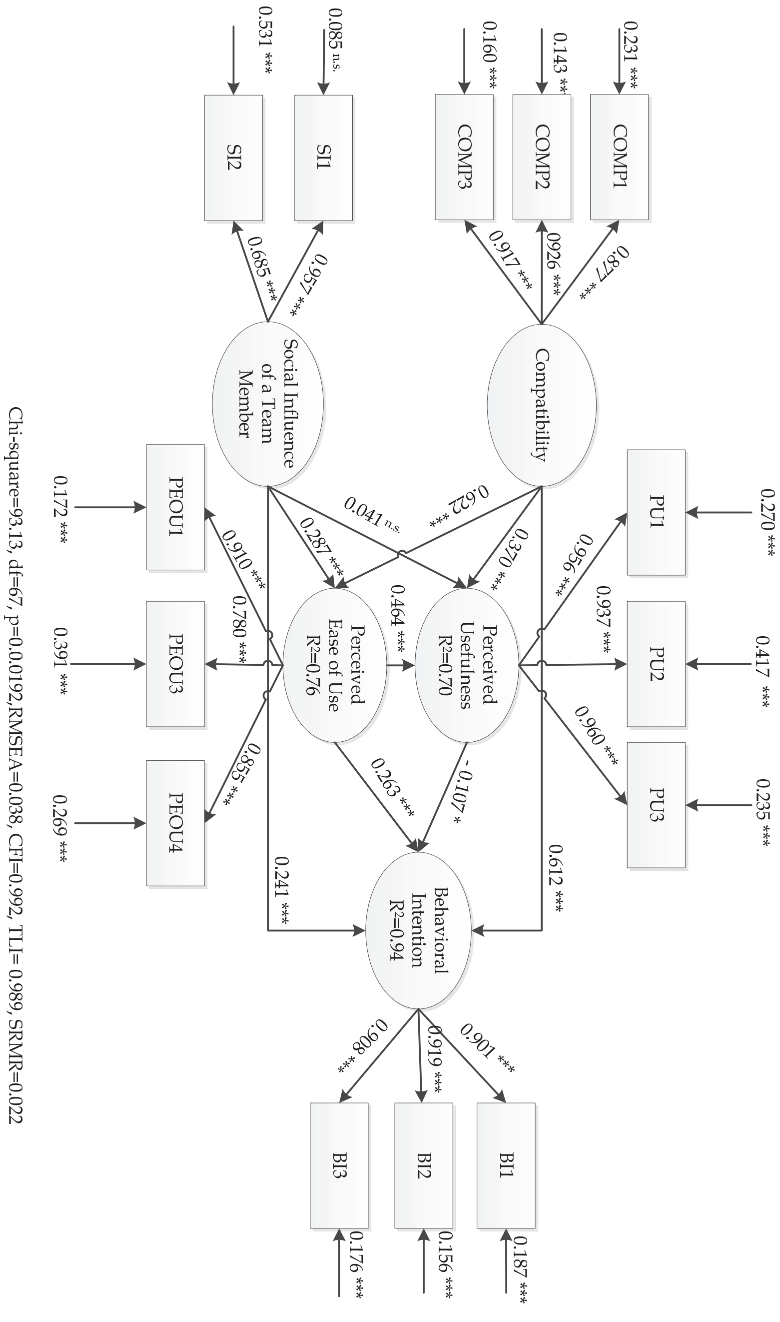

FIGURE 20 Estimated structural relationships of the model

The paths from external variables compatibility and social influence to TAM constructs existed and were significant except the path from social influence of a team member to perceived usefulness (γ=0.041, non-significant). The paths from compatibility to behavioural intention (γ=0.612,t=7.93), to perceived usefulness (γ =0.370, t=3.68), and to perceived ease of use (γ =0.622, t=6.73) were as hypothesized. Thus the hypothesis H4, *Compatibility has a direct positive effect on the intention to use mobile technology in field operations,* hypothesis H5, *Compatibility has a direct positive effect on perceived usefulness of using mobile technology in police field operations,* and hypothesis H6, *Compatibility has a direct positive effect on perceived ease of use of using mobile technology in police field operations,* were supported accordingly. The paths from the social influence of a team member to behavioural intention (γ =0.241,t=2.58) and to perceived ease of use (γ =0.287,t=3.07) were significant and were as hypothesized. Hence, the hypotheses H7, *Social influence has a direct effect on the intention to use mobile technology in field operations,* and H9, *Social influence has a direct positive effect on ease of use of using mobile technology in police field operations,* were supported. The path from social influence of a team member to perceived usefulness, as stated earlier, was 0.041 and was non-significant. Hence, hypothesis H8, *Social influence has a direct effect on perceived usefulness of using mobile technology in police field operations,* was not supported.

Social influence of a team member and compatibility appeared to explain 76 per cent of the variance in ease of use (squared multiple correlation, R^2 = 0.76). Ease of use, compatibility and the social influence of a team member seemed to explain 70 per cent of the variance in perceived ease of use (R^2 = 0.70). Perceived usefulness, perceived ease of use, compatibility and the social influence of a team member appeared to explain 94 per cent of the variance in behavioural intention (R^2 =0.94). The sum of the standardized indirect effects of both compatibility and social influence of a team member on behavioural intention mediated by perceived usefulness were both insignificant. Similarly, the sum of standardized indirect effects of social influence of a team member on behavioural intention mediated by perceived ease of use and perceived usefulness was insignificant. However, the sum of indirect standardized effects of compatibility mediated by perceived ease of use was 0.160 and significant (t=2.916). Similarly, the sum of the standardized effects of social influence of a team member on behavioural intention mediated by perceived ease of use was 0.07 and significant (t=2.135). The sum of the standardized effects of social influence of a team member on perceived usefulness was 0.133 and significant (t= 2.665).

In the current study the hypothesized direct positive effect of perceived usefulness on behavioural intention to use the future system in field operations was found to be negative. This was in line with some prior research in non-volitional mobile use (Gao, Moe & Krogstie 2010, Robinson Jr., Marshall & Stamps 2005). Both Gao et al. and Robinson et al. have found out that usefulness is not a primary determinant for the intention to use mobile services. In the current study the results of the estimation of the full research model proposed that the effect of usefulness may be replaced by the effect of compatibility on the behavioural intention. This can be interpreted that compatibility is more important than usefulness regarding the future system use. The subjects may see the future system to be replacing the current system and may be worried about its compatibility with their current procedures and personal preferences. On the other hand, usefulness can be understood to be a subjective probability (Robinson Jr., Marshall & Stamps 2005). By utilizing the device which users have believed to be useful, users may possess a belief that they can fulfil their duties in the most efficient and productive way. This was measured by the construct of usefulness. The discovery of the current study that usefulness is not a significant positive determinant of the behavioural intention may suggest that users do not see the device itself an important factor but see the general compatibility of the system as a whole more important instead. This may be an indication of their worry of the functionality of their working practices with the new system. Additionally, this may further increase the pressure on the development of processes and working practices in field operations.

A summary of the results of the estimations of the effects of compatibility, social effect of a team member, perceived usefulness and perceived ease of use on behavioural intention and on each other are presented in TABLE 27.

TABLE 27 Effects of compatibility, social effect of a team member, perceived usefulness and perceived ease of use on PU, PEOU and BI

	On Perceived Usefulness	**On Perceived Ease Of Use**	**On Behavioural Intention**
COMP	0.370 (t=3.68)	0.622 (t=6.73)	0.612 (t=7.93)
SI_T	n.s.	0.287 (t=3.07)	0.241 (t=2.58)
PU	N/A	N/A	-0.107 (t=-2.03)
PEOU	0.464 (t=4.58)	N/A	0.263 (t=3.14)

4.5 Multi-group Comparisons

In this chapter the moderator effects of the length of career, age of respondent, location of the police department and context of the work on the construct means and the regression coefficients are described. These effects were studied using a multi-group comparison method in a structural equation modelling framework. In this method, the groups are studied utilizing the testing of the measurement invariance of the structural model in successive χ^2 tests of difference. The differences in means of the constructs, indicating the effect size are compared along with the regression coefficients. The multi-group analysis using invariance testing of the model also helps to disinter and understand the group differences at the level of structure items (Sass 2011). The procedure used in the current study is described in detail in section 3.5.2.

4.5.1 Moderating Effects of the Length of Career

The mean of the length of career was 16.9 years. This was used as a cut-off point in dividing the respondents into two groups and formulate two groups of; those *less experienced* having a length of career less than the mean, and those *experts* having a length of experience above the mean. The sizes of the groups were 146 and 115 respondents accordingly. 6 values were missing as a list-wise deletion of the responses had to be used in the MLM estimation and these missing values were not imputed into the research data. In a multi-group comparison in SEM, the size of the groups should be as close to each other as possible to guarantee comparability. The size of the groups should also be adequate.

First the mean values of the standard errors of each item of the constructs were compared for both groups separately and together. The significance of the difference of the means of the items was tested with the independent samples t-test (2-tailed). The results are presented in TABLE 28.

TABLE 28 Comparison of the basic statistics across groups

Construct	Item	Less Experienced (N=146)		Experts (N= 115)		All together (N=261)		Significance between groups
		Mean	S.E.	Mean	S.E.	Mean	S.E.	
Perceived	PU1	4.05	0.146	3.98	0.170	4.02	0.109	n.s.
Usefulness	PU2	4.05	0.153	4.04	0.176	4.05	0.114	n.s
	PU3	4.04	0.144	4.14	0.163	4.08	0.106	n.s
Perceived	PEOU1	3.50	0.125	3.48	0.152	3.49	0.095	n.s
Ease of Use	PEOU3	3.27	0.136	3.12	0.151	3.21	0.099	n.s
	PEOU4	3.04	0.124	3.40	0.162	3.40	0.097	n.s
Social influence	SI1	3.21	0.136	3.05	0.153	3.14	0.100	n.s
of Team Member	SI2	2.87	0.135	2.91	0.160	2.88	0.102	n.s
Compatibility	COMP1	3.40	0.135	3.25	0.158	3.34	0.101	n.s
	COMP2	3.21	0.135	3.29	0.165	3.25	0.103	n.s
	COMP3	3.21	0.140	3.35	0.173	3.34	0.107	n.s
Behavioural	BI1	2.67	0.126	2.78	0.151	2.72	0.095	n.s
Intention	BI2	3.09	0.133	3.06	0.163	3.09	0.102	n.s
	BI3	2.64	0.130	2.70	0.159	2.67	0.099	n.s

n.s. = not signficant

The statistics reveal that the responses of all items were evenly distributed between the groups. The responses were measured on a Likert- scale of one to seven. The low value on scale indicated high positive agreement with the question and vice versa. No clear distinction could be drawn as to which of the groups had generally higher or lower responses. However, the responses inside both groups reveal that perceived usefulness achieved lower responses compared to the other constructs. Behavioural intention achieved higher responses.

The differences of the items between groups were not statistically significant and there was no difference whether equal variances between the groups were assumed or not.

Following general scrutiny of the statistics, the SEM model was estimated separately for the less experienced group and for the experts' group without any constraints between groups. This model was estimated and described earlier and is depicted in FIGURE 20. The resulting full configural invariance model fitted the data well. The χ^2 test rejected the model (χ^2 (134) = 178.305, scaling correction value = 1.307, p-value = 0.0063). However, the supporting goodness-of-fit indices indicated a good fit of the model with the data (RMSEA = 0.050, CFI = 0.987, TLI = 0.982, SRMR = 0.028). The 90 % confidence interval of RMSEA (0.028; 0.069) and the probability of RMSEA to be less than 0.05 (p= 0.474) supported the good fit of the model with the data. Hence, the configural invariance between the groups was confirmed. This model is also called the baseline model in the current research.

Following the test of full configural invariance with the baseline model, the metric invariance was tested. A model having the factor loadings constrained equal on both groups was estimated. The χ^2 test rejected the model (χ^2 (143) = 201.540, scaling correction value = 1.288, p-value = 0.0009). However, the supporting goodness-of-fit indices indicated good fit of the model with the data (RMSEA = 0.056, CFI = 0.983, TLI = 0.978, SRMR = 0.066). The 90 % confidence interval of RMSEA (0.037; 0.073) and the probability of RMSEA to be less than 0.05 (p= 0.283) supported the good fit of the model with the data. The deterioration of the model was examined from the results of these two successive χ^2 tests by comparing the results of the baseline model and the estimated full metric invariance model. The resulting difference in the tests suggested a substantial deterioration in the model (Δ χ^2 (9)=26.404, p < 0.01). Hence, the hypothesis of full metric invariance between the models was rejected. The large modification index (MI = 13.078) proposed that relaxing the constraint of the loading of PEOU3 on the perceived ease of use in the experts' group would make the model fit better with the data. This was supported by the lower standardized loading of the item PEOU3 on perceived ease of use (0.758, t=14.867) in the experts' group, compared to the loading of it (0.843, t= 30.378) in the group of less experienced police officers. It was decided to relax the equality constraint of the loading of PEOU3 in the experts' group in the model. The resulting partial metric invariant model where item PEOU3 was non-invariant across the groups was estimated. The χ^2 test rejected the model (χ^2 (142) = 188.709, scaling correction value = 1.284, p-value = 0.0053). However, the supporting goodness-of-fit indices indicated a good fit of the model with the data (RMSEA = 0.050, CFI = 0.986, TLI = 0.982, SRMR = 0.042). The 90 % confidence interval of RMSEA (0.028; 0.068) and the probability of RMSEA to be less than 0.05 (p= 0.478) supported the good fit of the model with the data. The modification indices proposed no sensible changes in the model. The deterioration of the model was examined from the results of these two successive χ^2 tests by comparing the results of the baseline model and the estimated partial metric invariance model.

The resulting difference in the tests suggested no significant deterioration in the model fit ($\Delta\ \chi^2$ (8)=10.301, p > 0.05). Hence, the hypothesis of partial metric invariance between the models was accepted. This suggested that the two groups differ in terms of factor loadings of PEOU3 indicating differences in factor scores between the groups regarding this specific item.

Scalar invariance was tested using the partial metric invariant model by having also the item intercepts constrained equal between the groups. The χ^2 test rejected the model (χ^2 (151) = 199.998, scaling correction value = 1.267, p-value = 0.0047). However, the supporting goodness-of-fit indices indicated an acceptable fit of the model with the data (RMSEA = 0.050, CFI = 0.985, TLI = 0.982, SRMR = 0.044). The 90 % confidence interval of RMSEA (0.029; 0.068) and the probability of RMSEA to be less than 0.05 (p= 0.490) supported the acceptable fit of the model with the data. The deterioration of the model was examined from the results of these last two successive χ^2 tests by comparing the results of the partial metric invariance model and the results of the estimated model. The resulting difference in the tests suggested no deterioration in the model ($\Delta\ \chi^2$ (9)= 11.109, p > 0.05). Hence, the partial scalar invariance between the models was confirmed.

In the last phase, the invariance of the regression coefficients was also tested. The regression coefficients between the constructs of the model were constrained to be equal between the groups. The resulting model was estimated. The χ^2 test rejected the model (χ^2 (161) = 213.823, scaling correction value = 1.265, p-value = 0.0034). However, the supporting goodness-of-fit indices indicated a good fit of the model with the data (RMSEA = 0.050, CFI = 0.984, TLI = 0.982, SRMR = 0.053). The 90 % confidence interval of RMSEA (0.030; 0.067) and the probability of RMSEA to be less than 0.05 (p= 0.481) supported the good fit of the model with the data. The deterioration of the model was examined from the results of these last two successive χ^2 tests by comparing the results of the partial scalar invariance model and the estimated model. The resulting difference in the tests suggested no deterioration in the model ($\Delta\ \chi^2$ (10)= 13.839, p > 0.05). Hence, the full invariance of the regression coefficients between the groups was confirmed.

The unstandardized loading of item PEOU3 on the construct of perceived ease of use was 1.088 (t=19.675) in the less experienced group and 0.688 (t=5.940) in the expert's group, estimated using the regression invariant model. The summary of the measurement invariance test results is presented in TABLE 29.

The differences in the means were observed from the estimation results of the partial scalar invariance model. In the estimation, the group of less experienced police officers was set as a reference group and the means of it were set to zero. Therefore, the means of the expert's group expressed the sign and the difference between the two groups. The differences in means were all small and statistically non significant. The unstandardized difference in perceived usefulness was 0.051 (t= 0.240), in perceived ease of use 0.009 (t=0.049), in behavioural intention 0.070 (t=0.389), in compatibility 0.041 (t=0.228) and in social influence of a team member -0.114 (t= -0.583).

TABLE 29 Test results of measurement invariance between less experienced and experts groups

Model	χ2	df	Scaling corr. factor	RMSEA	CFI	TLI	SRMR	Δχ2	Δdf	p
Full configural invariance (Baseline model)	178.305	134	1.307	0.050	0.987	0.982	0.028	-	-	-
Full metric invariance	201.540	143	1.288	0.056	0.983	0.978	0.066	26.404	9	< 0.01
Partial metric invariance	188.709	142	1.284	0.050	0.986	0.982	0.042	10.301	8	>0.05
Partial scalar invariance	199.998	151	1.267	0.050	0.985	0.982	0.044	11.109	9	>0.05
Regression invariance	213.823	161	1.265	0.050	0.984	0.982	0.053	13.839	10	> 0.05

As suggested above, the regression coefficients of the constructs were equal across the groups. This was also identified from the non-standardized results of the estimation of the partial regression invariance model. The regression of perceived usefulness on perceived ease of use was 0.606 (t=7.075) and 0.425 (t= 5.037) on compatibility. The regression of perceived ease of use on compatibility was 0.619 (t=7.870) and on social influence of a team member 0.249 (t= 3.407). The regression of behavioural intention on perceived usefulness was -0.077 (t=-2.000), on perceived ease of use was 0.251 (t= 3.555), on compatibility 0.534 (t= 7.861) and on social influence of a team member 0.273 (t= 3.883).

There was difference in factor loadings leading to the use of a partially metric invariance model between the groups. The comparison of the means and path coefficients can also be undertaken using the partially metric invariant models (Steenkamp & Baumgartner 1998). Based on the comparison, there was no difference in the means of the constructs, and no difference in the path coefficients between the groups. Hence, the hypothesis H14, *Length of career of the law enforcement officer is a moderating factor in the adoption of mobile technology,* was not supported.

This discovery suggests that the length of career is not a moderating factor in technology acceptance.

TABLE 30 Results of the comparisons of means (α) and regression coefficients (β) and coefficient of determination (R^2)

	Group	
	Less experienced	Experts
λ_{PEOU3}	1.088 ***	0.688 ***
α_{PU}	0.000 [a]	0.051 [n.s.]
α_{PEOU}	0.000 [a]	0.009 [n.s.]
α_{BI}	0.000 [a]	0.070 [n.s.]
α_{COMP}	0.000 [a]	0.041 [n.s.]
α_{SI_T}	0.000 [a]	-0.114 [n.s.]
$\beta_{PU,PEOU}$	0.606 ***	
$\beta_{PU,COMP}$	0.425 ***	
$\beta_{PEOU,COMP}$	0.619 ***	
β_{PEOU,SI_T}	0.249 ***	
$\beta_{BI, PU}$	-0.077 *	
$\beta_{BI, PEOU}$	0.251 ***	
$\beta_{BI,COMP}$	0.534 ***	
β_{BI,SI_T}	0.273 ***	
R^2	91 %	95 %

[a] = set to zero
[n.s.] = not significant
* = p<0.05
**=p<0.01
***=p<0.001

The model explained 68.6 per cent of the variance of perceived usefulness and 83.3 percent of the variance in perceived ease of use amongst the less experienced police officers. Similarly, the model explained 71.8 per percent of the variance in perceived usefulness and 68.9 per cent of the variance among the experts' group. On the whole, the model explained 90.8 percent of the total variance of intention among the less experienced police officers, and 95.4 per cent of the total variance of intention among the expert's group. The summary of the results (non-invariant loadings of PEOU3 (λ), means (α) and regression coefficients (β), the coefficient of determination (R^2) for the behavioural intention and for both groups) are presented in TABLE 30.

4.5.2 Moderating Effects of Age of the Police Officer

The median of the age of respondents was 40 years. That was used as a cut-off point in the division of the respondents into two groups. This yielded to formulate two groups; the *young* group having an age less than the median, and the *old* group having an age above the median. The size of the groups was 139 and 128 respondents accordingly. No values were missing. The size of both groups fulfilled the requirement of equal sizes in multi-group comparison in SEM.

TABLE 31 Comparison of the basic statistics across groups

Construct	Item	Young (N=139)		Old (N= 128)		All together (N=261)		Significance between groups
		Mean	S.E.	Mean	S.E.	Mean	S.E.	
Perceived	PU1	4.03	0.147	4.01	0.162	4.02	0.109	n.s.
Usefulness	PU2	4.06	0.154	4.03	0.168	4.05	0.114	n.s
	PU3	4.02	0.146	4.15	0.154	4.08	0.106	n.s
Perceived	PEOU1	3.47	0.125	3.51	0.144	3.49	0.095	n.s
Ease f Use	PEOU3	3.21	0.136	3.21	0.145	3.21	0.099	n.s
	PEOU4	3.37	0.127	3.44	0.150	3.40	0.097	n.s
Social influence	SI1	3.18	0.138	3.10	0.147	3.14	0.100	n.s
Of Team Member	SI2	2.85	0.139	2.91	0.150	2.88	0.102	n.s
Compati-bility	COMP1	3.37	0.134	3.30	0.150	3.34	0.101	n.s
	COMP2	3.17	0.135	3.34	0.158	3.25	0.103	n.s
	COMP3	3.26	0.140	3.43	0.164	3.34	0.107	n.s
Behav-ioural	BI1	2.60	0.122	2.86	0.147	2.72	0.095	n.s
Intention	BI2	3.06	0.135	3.11	0.154	3.09	0.102	n.s
	BI3	2.59	0.127	2.77	0.154	2.67	0.099	n.s

n.s. = not significant

Using the same procedure as above in the multi-group comparison exploring the effects of the length of career on means and on regression coefficients of the constructs, the effect of age of respondent on the same elements was studied. Firstly, the mean values the standard errors of each item of the constructs were compared for both groups separately and as one. The significance of the difference of the means of the items was tested with the independent samples t-test (2-tailed). The results are presented in TABLE 31.

The statistics reveal that the responses of all items were almost equal to the responses of those groups when the effect of experience was tested in the previous chapter. The responses were measured on a Likert scale of one to seven. The low value on scale indicated a high positive agreement with the question and vice versa. The responses were evenly distributed between the groups. No clear distinction could be drawn as to which of the groups had generally higher or lower responses, however, the responses inside both groups reveal that perceived usefulness achieved lower responses when compared to other constructs. Behavioural intention achieved higher responses respectively. The differences of the items between the groups were not statistically significant and there was no difference in significance whether equal variances between the groups were assumed or not.

Firstly, the model was estimated separately for the young group and for the older group without any constraints between the groups. The resulting full configural invariance model fitted the data very well. The χ^2 test rejected the model (χ^2 (134) = 175.902, scaling correction value = 1.323, p-value = 0.0088). However, the supporting goodness-of-fit indices indicated a good fit of the model with the data (RMSEA = 0.048, CFI = 0.988, TLI = 0.983, SRMR = 0.028). The 90 % confidence interval of RMSEA (0.025; 0.067) and the probability of RMSEA to be less than 0.05 (p= 0.538) supported the good fit of the model with the data. Hence, the configural invariance between the groups was confirmed. This model is also called the baseline model in the current research.

Following the test of full configural invariance with the baseline model, metric invariance was tested. The model having the factor loadings constrained equal on both groups was estimated. The χ^2 test rejected the model (χ^2 (143) = 195.789, scaling correction value = 1.301, p-value = 0.0022). However, the supporting goodness-of-fit indices indicated a good fit of the model with the data (RMSEA = 0.053, CFI = 0.984, TLI = 0.980, SRMR = 0.060). The 90 % confidence interval of RMSEA (0.032; 0.070) and the probability of RMSEA to be less than 0.05 (p= 0.395) supported the good fit of the model with the data. The deterioration of the model was examined from the results of these two successive χ^2 tests by comparing the results of the baseline model and the estimated full metric invariance model. The resulting difference in the tests suggested a small deterioration in the model ($\Delta\ \chi^2$ (9)=18.508, $p < 0.05$). Modification indices suggested no sensible changes in the model. The supported goodness-of-fit indices suggested a good model fit. Moreover, the test result was very close to the acceptance limit ($\Delta\ \chi^2$(9)=16.919). Based on these the hypothesis of full metric invariance between the models was accepted.

The scalar invariance was tested using the full metric invariant model by having also the item intercepts constrained as equal between the groups. The χ^2 test rejected the model (χ^2 (152) = 208.238, scaling correction value = 1.283, p-value = 0.0017). However, the supporting goodness-of-fit indices indicated a good fit of the model with the data (RMSEA = 0.053, CFI = 0.983, TLI = 0.980, SRMR = 0.061). The 90 % confidence interval of RMSEA (0.033; 0.070) and the probability of RMSEA to be less than 0.05 (p= 0.391) supported the good fit of the model with the data. The deterioration of the model was examined from the results of these last two successive χ^2 tests by comparing the results of the full metric invariance model and the results of the estimated model. The resulting difference in the tests suggested no deterioration in the model ($\Delta\ \chi^2$ (9)= 12.485, $p > 0.05$). Hence, the full scalar invariance between the models was confirmed.

In the final phase, the invariance of the regression coefficients was tested. The regression coefficients between the constructs of the model were constrained to be equal between the groups. The resulting model was estimated. The χ^2 test rejected the model (χ^2 (161) = 220.848, scaling correction value = 1.281, p-value = 0.0015). However, the supporting goodness-of-fit indices indicated good fit with the data (RMSEA = 0.052, CFI = 0.983, TLI = 0.980, SRMR = 0.070). The 90 % confidence interval of RMSEA (0.033; 0.069) and the probability of RMSEA to be less than 0.05 (p= 0.406) supported the good fit of the model with the data. The deterioration of the model was examined from the results of these last two successive χ^2 tests by comparing the results of the full scalar invariance model and the estimated model. The resulting difference in the tests suggested no deterioration in the model ($\Delta\ \chi^2(10)= 12.584$, $p > 0.05$). Hence, the full invariance of the regression coefficients between the groups was confirmed. The summary of the measurement invariance test results is presented in TABLE 32.

TABLE 32 Test results of measurement invariance between young and old

Model	χ2	df	Scaling correction factor	RMSEA	CFI	TLI	SRMR	Δχ2	Δdf	p
Full configural invariance (Baseline model)	175.902	134	1.323	0.048	0.988	0.983	0.028	-	-	-
Full metric invariance	195.789	143	1.301	0.053	0.984	0.980	0.060	18.508	9	<0.05
Full scalar invariance	208.238	152	1.283	0.053	0.983	0.980	0.061	12.485	9	>0.05
Regression invariance	220.848	162	1.281	0.052	0.983	0.980	0.070	12.584	10	>0.05

The differences in the means of the constructs were observed from the estimation results of the full scalar invariance model. In the estimation, the group of young police officers was set as a reference group and the means of it were set to zero. Therefore, the means of the older group expressed the sign and the difference between the two groups. The differences in means were all small and statistically non-significant. The unstandardized difference in perceived usefulness was 0.040 (t= 0.190), in perceived ease of use 0.041 (t=0.229), in behavioural intention 0.150 (t=0.845), in compatibility 0.104 (t=0.577) and in social influence of a team member -0.069 (t= -0.353).

Similarly, as suggested above, the regression coefficients of the constructs were equal across the groups. This was verified from the untandardized results of the estimation of the full regression invariance model. The regression of perceived usefulness on perceived ease of use was 0.613 (t=7.138) and 0.425 (t= 4.958) on compatibility. The regression of perceived ease of use on compatibility was 0.610 (t=7.736) and on the social influence of a team member 0.261 (t= 3.727). The regression of behavioural intention on perceived usefulness was -0.083 (t= -2.154), on perceived ease of use 0.271 (t= 3.858), on compatibility 0.525 (t= 8.118) and on the social influence of a team member 0.266 (t= 3.799). Therefore, because there was no difference in the means of the constructs between the groups and no difference in the path coefficients between the same groups, the hypothesis H15, *Age of the law enforcement officer is a moderating factor in the adoption of mobile technology,* was not supported.

This discovery means that there are no hypothesized differences between these two age groups regarding mobile technology acceptance. Both the group of young officers and the group of older ones, which in the current research meant police officers over 40 years old, showed the determinants and also the relationships between them, affecting their behavioural intention statistically similarly.

TABLE 33 Results of comparisons of means (α) and regression coefficients (β) and coefficient of determination (R^2)

	Group	
	Young	Old
α_{PU}	0.000a	0.040 n.s.
α_{PEOU}	0.000 a	0.041 n.s.
α_{BI}	0.000 a	0.150 n.s.
α_{COMP}	0.000 a	0.104 n.s.
α_{SI_T}	0.000 a	-0.069 n.s.
$\beta_{PU,PEOU}$	0.613 ***	
$\beta_{PU,COMP}$	0.425 ***	
$\beta_{PEOU,COMP}$	0.610 ***	
β_{PEOU,SI_T}	0.261 ***	
$\beta_{BI, PU}$	-0.083 *	
$\beta_{BI, PEOU}$	0.271 ***	
$\beta_{BI,COMP}$	0.525 ***	
β_{BI,SI_T}	0.266 ***	
R2	92 %	95 %

a =set to zero
n.s. = not significant
*= p<0.05
**= p<0.01
***=p<0.001

The model explained 67.8 percent of the variance of the perceived usefulness and 81.6 percent of the variance in perceived ease of use among the young police officers. Similarly, the model explained 73.3 per percent of the variance in perceived usefulness and 71.6 per cent of the variance among older police officers. On the whole, the model explained 91.8 percent of the total variance of intention among the young police officers and 95.1 per cent of the total variance of intention among the older police officers. These both were considered very high presenting very high explanatory power.

The results of the comparisons of means (α) and regression coefficients (β) and the coefficient of determination (R^2) for the behavioural intention for both groups are presented in TABLE 33.

4.5.3 Moderating Effects of the Geographical Location of the Police Department

The effect of the location of the police department was studied in a multi-group comparison of different types of departments. The departments were categorized into two groups; *urban* and *rural* groups. The research was implemented in Finland in 15 local police departments and in one national police unit (National Traffic Police - Liikkuva Poliisi). The selection of the police departments out of the total of 24 departments in the country was made in a way that there would be different types of departments included in terms of whether their main operations took place in rural or urban environments. The number of respondents was 134 in the urban group and 132 in the rural group. The group of urban police departments included the following local police departments:

	N
Helsingin poliisilaitos	25
Länsi-Uudenmaan poliisilaitos	9
Itä-Uudenmaan poliisilaitos	9
Keski-Uudenmaan poliisilaitos	14
Varsinais-Suomen poliisilaitos	36
Satakunnan poliisilaitos	11
Pirkanmaan poliisilaitos	30
Total	134

The group of rural departments included the following police departments:

	N
Liikkuva poliisi	50
Kainuun poliisilaitos	6
Koillismaan poliisilaitos	6
Lapin poliisilaitos	23
Oulun poliisilaitos	8
Pohjois-Karjalan poliisilaitos	7
Etelä-Karjalan poliisilaitos	7
Keski-Suomen poliisilaitos	16
Pohjanmaan poliisilaitos	9
Total	132

First the mean values and the standard errors of each item of the constructs were compared for both groups both separately and as one. The significance of the difference of the means of the items was tested with the independent samples t-test (2-tailed). The results are presented in TABLE 34.

The statistics reveal that there are significant differences in responses for the items between the urban and rural groups. Items measuring perceived usefulness (PU2), perceived ease of use (PEOU3), social influence of a team member (SI1), compatibility (COMP2, COMP3) and behavioural intention (BI2) were significantly different between the groups. The responses were measured on a Likert scale of one to seven. The low value on scale indicated a high positive agreement with the question and vice versa. Hence, all values measuring perceived usefulness, perceived ease of use, social influence of a team member, compatibility and behavioural intention were lower in the urban group than in the rural group.

TABLE 34 Comparison of the basic statistics across groups

Construct	Item	Urban query (N=134)		Rural (N= 132)		All together (N=266)		Significance between groups
		Mean	S.E.	Mean	S.E.	Mean	S.E.	
Perceived Usefulness	PU1	4.15	0.151	3.90	0.158	4.02	0.109	n.s.
	PU2	4.33	0.157	3.77	0.163	4.05	0.114	*
	PU3	4.24	0.147	3.93	0.153	4.08	0.106	n.s
Perceived Ease of Use	PEOU1	3.62	0.137	3.37	0.131	3.49	0.095	n.s
	PEOU3	3.49	0.144	2.93	0.133	3.21	0.099	**
	PEOU4	3.44	0.136	3.37	0.141	3.40	0.097	n.s
Social influence	SI1	3.35	0.150	2.93	0.132	3.14	0.100	*
of Team Member	SI2	3.06	0.149	2.71	0.138	2.88	0.102	n.s
Compatibility	COMP1	3.49	0.142	3.18	0.143	3.34	0.101	n.s
	COMP2	3.49	0.147	3.02	0.144	3.25	0.103	*
	COMP3	3.64	0.152	3.05	0.148	3.34	0.107	**
Behavioural Intention	BI1	2.87	0.137	2.58	0.132	2.72	0.095	n.s
	BI2	3.33	0.145	2.84	0.142	3.09	0.102	*
	BI3	2.84	0.140	2.51	0.140	2.67	0.099	n.s

n.s. = not signficant
*= p<0.05
**=p<0.01
***=p<0.001

Firstly, the model was estimated separately for the urban and rural groups without any constraints between groups. The resulting full configural invariance model fitted the data very well. The χ^2 test rejected the model (χ^2 (134) = 183.994, scaling correction value = 1.303, p-value = 0.0027). However, the supporting goodness-of-fit indices indicated a good fit of the model with the data (RMSEA = 0.053, CFI = 0.985, TLI = 0.980, SRMR = 0.032). The 90 % confidence interval of RMSEA (0.032; 0.071) and the probability of RMSEA to be less than 0.05 (p= 0.385) supported the good fit of the model with the data. Hence, the configural invariance between the groups was confirmed. This model is also called the baseline model in the current research.

Following the test of full configural invariance with the baseline model, metric invariance was tested. The model having the factor loadings constrained as equal on both groups was estimated. The χ^2 test rejected the model (χ^2 (143) = 193.979, scaling correction value = 1.285, p-value = 0.0029). However, the supporting goodness-of-fit indices indicated a good fit of the model with the data (RMSEA = 0.052, CFI = 0.985, TLI = 0.981, SRMR = 0.048). The 90 % confidence interval of RMSEA (0.031; 0.069) and the probability of RMSEA to be less than 0.05 (p= 0.423) supported the fit of the model with the data. The deterioration of the model was examined from the results of these two successive χ^2 tests by comparing the results of the baseline model and the estimated full metric invariance model. The resulting difference in the tests indicated no deterioration in the model ($\Delta\ \chi^2$ (9)=9.360, p > 0.05). Hence, the full metric invariance between the groups was confirmed.

The scalar invariance was tested using the full metric invariant model by also having the item intercepts constrained as equal between the groups. The χ^2 test rejected the model (χ^2 (152) = 216.503, scaling correction value = 1.268, p-value = 0.0017), however the supporting goodness-of-fit indices indicated a good fit of the model with the data (RMSEA = 0.056, CFI = 0.981, TLI = 0.977, SRMR = 0.051). The 90 % confidence interval of RMSEA (0.038; 0.073) and the probability of RMSEA to be less than 0.05 (p= 0.260) supported the good fit of the model with the data. The deterioration of the model was examined from the results of these last two successive χ^2 tests by comparing the results of the full metric invariance model and the results of the estimated model. The resulting difference in the tests suggested a deterioration in the model ($\Delta\ \chi^2$ (9)= 25.316, p < 0.01). Hence, the existence of full scalar invariance between the models was rejected.

The modification indices suggested an invariance of the items PU2 (MI = 6.679) and PEOU3 (MI = 6.560). It was decided to release the constraint of the intercept of the item PU 2 in the rural group. The model having the equality constraint of the intercept of item PU2 released was estimated. The χ^2 test rejected the model (χ^2 (151) = 209.467, scaling correction value = 1.269, p-value = 0.0012). However, the supporting goodness-of-fit indices indicated a good fit of the model with the data (RMSEA = 0.054, CFI = 0.983, TLI = 0.979, SRMR = 0.050). The 90 % confidence interval of RMSEA (0.035; 0.071) and the probability of RMSEA to be less than 0.05 (p= 0.345) supported the fit of the model with the data. The deterioration of the model was examined from the results of these two successive χ^2 tests by comparing the results of the full metric invariance model and the estimated partial scalar invariance model. The resulting difference in the tests indicated a deterioration in the model ($\Delta\ \chi^2$ (8)=16.837, p < 0.05). The modification indices suggested the invariance of the intercept of item PEOU3 (MI =6.552). Even though the χ^2 test result was close to the acceptance limit ($\chi^2_{0.05}$ (8)=15.507), it was decided to release also the intercept of item PEOU3 in the rural group. Hence, the resulting partial scalar invariance model was estimated. The χ^2 test rejected the model (χ^2 (150) = 202.470, scaling correction value = 1.271, p-value = 0.0028), however the supporting goodness-of-fit indices indicated a good fit of the model with the data (RMSEA = 0.051, CFI = 0.985, TLI = 0.981, SRMR = 0.049). The 90 % confidence interval of RMSEA (0.031; 0.069) and the probability of RMSEA to be less than 0.05 (p= 0.440) supported the fit of the model with the data. The deterioration of the model was examined from the results of these two successive χ^2 tests by comparing the results of the full metric invariance model and the estimated partial scalar invariance model. The resulting difference in the tests indicated no deterioration in the model ($\Delta\ \chi^2$ (7)= 8.199, p > 0.05). The partial scalar invariance between the groups was then confirmed. Finally, the invariance of the regression coefficients was tested. The regression coefficients between the constructs of the model were constrained to be equal between the groups. The resulting model was estimated. The χ^2 test rejected the model (χ^2 (160) = 219.436, scaling correction value = 1.268, p-value = 0.0013). However, the supporting goodness-of-fit indices indicated a good fit with the data (RMSEA = 0.053, CFI = 0.982, TLI = 0.980, SRMR = 0.049). The 90 % confidence interval of RMSEA (0.034; 0.069) and the probability of RMSEA to be less than 0.05 (p= 0.381) supported the good fit of the model with the data. The deterioration of the model was examined from the results of these two successive χ^2 tests by comparing the results of the partial scalar invariance model and the estimated model. The resulting difference in the tests indicated no deterioration in the model ($\Delta\ \chi^2$ (10)= 17.094, p > 0.05). Hence, the equality of the path coefficients across the groups was confirmed. The summary of the measurement invariance test results is presented in TABLE 35. In the model the intercepts of items PU2 (4.328, t=28.272) and PEOU3 (3.493, t= 24.632) for the urban group and (4.063, t= 25.441) and (3.096, t= 20.005) for the rural group respectively were non-invariant between the two groups.

TABLE 35 Test results of measurement invariance between urban and rural groups

Model	χ2	df	Scaling correction factor	RMSEA	CFI	TLI	SRMR	Δχ2	Δdf	p
Full configural invariance (Baseline model)	183.994	134	1.303	0.053	0.985	0.985	0.028	-	-	-
Full metric invariance	193.979	143	1.285	0.052	0.985	0.981	0.048	9.360	9	> 0.05
Full scalar invariance	216.503	152	1.268	0.056	0.981	0.977	0.051	25.316	9	< 0.01
Partial scalar invariance 1	209.467	151	1.269	0.054	0.983	0.979	0.050	16.837	8	< 0.05
Partial scalar invariance 2	202.470	150	1.271	0.051	0.985	0.981	0.049	8.199	7	> 0.05
Regression invariance	219.436	160	1.268	0.053	0.982	0.980	0.049	17.094	10	> 0.05

The differences in the means were observed from the estimation results of the partial scalar invariance model. In the estimation, the group of urban police officers was set as a reference group and the means of it were set to zero. Therefore, the means of the rural group expressed the sign and the difference between the two groups. The results revealed that there were statistically both significant and insignificant differences in the means of the constructs between the groups. The unstandardized differences in perceived usefulness (-0.286, t=-1.361) and in perceived ease of use (-0.185,t= -1.017) were insignificant. The differences in behavioural intention -0.361 (t= -2.049), in compatibility -0.443 (t= -2.446), and in the social influence of a team member -0.431 (t= -2.175) were all statistically significant.

As suggested above, the regression coefficients of the constructs were equal across the groups. This was also identified from the unstandardized results of the estimation of the full regression invariance model. The regression of perceived usefulness on perceived ease of use was 0.553 (t=5.076) and 0.486 (t= 4.526) on compatibility. The regression of perceived ease of use on compatibility was 0.603 (t=7.738) and on the social influence of a team member 0.265 (t= 3.688). The regression of behavioural intention on perceived usefulness was - 0.087, t= -2-355), on perceived ease of use was 0.259 (t= 3.426), on compatibility 0.600 (t= 8.529) and on the social influence of a team member 0.206 (t= 2.756). Therefore, because there was difference noted in the means of the constructs between the groups and no difference in the path coefficients between the same groups, the hypothesis H16, Geographical location of the local police department is a moderating factor in the adoption of mobile technology, was partly supported.

The results of the comparisons of means (α) and regression coefficients (β) and the coefficient of determination (R^2) for the behavioural intention and the non-invariant intercepts of PU2 and PEOU2 (ν) for both groups are presented in TABLE 36.

The results suggest that the rural police officers value the opinion of their team member more than was indicated by their urban colleagues (α_{SI_T} = - 0.443, $p<0.05$). Moreover, the results indicate that the intention to use the system is stronger among the rural police officers than among urban police officers (α_{BI} = - 0.361, $p<0.05$). Exactly the same applies regarding compatibility; the rural police officer seems to regard the system as more compatible with their existing working practices and their preferred individual working procedures (α_{COMP} = - 0.431, $p<0.05$). Regarding the perceived usefulness and perceived ease of use there seems to be no difference between urban and rural police officers. The path coefficients between factors indicate the internal relationships between the latent variables. There seems to be no difference between the police officers in rural and in urban police departments regarding the path coefficients. This indicates that both groups experience the effects between latent factors in the same way.

The model explained 67.8 percent of the variance of the perceived usefulness and 81.6 percent of the variance in perceived ease of use among the young police officers. Similarly, the model explained 73.3 per percent of the variance in perceived usefulness and 71.6 per cent of the variance among the older police officers. On the whole, the model explained 91.8 percent of the total variance of intention among the urban police officers and 95.1 per cent of the total variance of intention among the rural police officers. All these figures were considered very good.

TABLE 36 Results of non-invariant intercepts (ν), comparisons of means (α) and regression coefficients (β) and coefficient of determination (R^2)

	Group		
	Urban		Rural
ν_{PU2}	4.328 ***		4.063 ***
ν_{PEOU3}	3.493 ***		3.096 ***
α_{PU}	0.000[a]		-0.286 [n.s.]
α_{PEOU}	0.000 [a]		-0.185 [n.s.]
α_{BI}	0.000 [a]		-0.361 *
α_{COMP}	0.000 [a]		-0.431 *
α_{SI_T}	0.000 [a]		-0.443 *
$\beta_{PU,PEOU}$		0.553 ***	
$\beta_{PU,COMP}$		0.486 ***	
$\beta_{PEOU,COMP}$		0.603 ***	
β_{PEOU,SI_T}		0.265 ***	
$\beta_{BI, PU}$		-0.087 *	
$\beta_{BI, PEOU}$		0.259 ***	
$\beta_{BI,COMP}$		0.600 ***	
β_{BI,SI_T}		0.206 ***	
R^2	92 %		95 %

[a] =set to zero
[n.s.] = not significant
*= p<0.05
**=p<0.01
***=p<0.001

4.5.4 Moderating Effects of the Context of Work

The effect of the context of work on technology acceptance was studied using the multi-group comparison between two different groups of respondents. Those two groups were formed based on the results of the conjoint analysis on the contexts of work which was part of the survey. In that part of the survey, the subjects were asked to rank ten different contexts of work into priority order based on their own preference of using the future mobile police information system that was shown to them ahead of the questionnaire. Using conjoint analysis, part-worths were calculated for each factor level of the contexts. By summarizing the part-worths for each context of work, the contexts could be listed in preference order, based on their part-worth values. The detailed conjoint analysis and the part-worth calculations are presented in Chapter 4.2 of the current study. The three highest ranked contexts were context numbers 2, 3 and 9. The number of respondents who had ranked these as number one was 30, 27 and 74 accordingly. The common factor for these three high ranked contexts was urgent data query. They all had *urgent* as the preferred attribute for urgency (instead of *non-urgent*), and *data base query* as their most preferred content for the attribute of activity. It does not appear in any other combination of activities contained elsewhere in the conjoint analysis. Hence, it presented the most preferred work context for 131 respondents. These subjects formed the first group, called the *urgent query* group, for the multi-group comparison for the analysis of the effect of the context of work on the technology acceptance. The second group was formed from the rest of subjects, totalling 135 respondents. Their preferences were largely distributed across the rest of the contexts. This group was called the *others* group. One reply was missing as a list-wise deletion of the responses had to be used in the MLM estimation and these missing values were not imputed into the research data.

Firstly, the mean values and the standard errors of each item of the constructs were compared for both groups separately and as one. The significance of the difference of the means of the items was tested with the independent samples t-test (2-tailed). The results are presented in TABLE 37.

TABLE 37 Comparison of basic statistics across groups

Construct	Item	Urgent query (N=131)		Others (N= 135)		All together (N=266)		Significance between groups
		Mean	S.E.	Mean	S.E.	Mean	S.E.	
Perceived	PU1	3.98	0.155	4.08	0.155	4.02	0.109	n.s.
Usefulness	PU2	4.00	0.160	4.07	0.163	4.05	0.114	n.s
	PU3	3.97	0.145	4.20	0.155	4.08	0.106	n.s
Perceived	PEOU1	3.40	0.125	3.58	0.144	3.49	0.095	n.s
Ease of Use	PEOU3	3.04	0.130	3.36	0.149	3.21	0.099	n.s
	PEOU4	3.35	0.131	3.46	0.146	3.40	0.097	n.s
Social Influence	SI1	2.96	0.132	3.32	0.151	3.14	0.100	n.s
of Team Member	SI2	2.78	0.135	2.97	0.152	2.88	0.102	n.s
Compatibility	COMP1	3.24	0.139	3.40	0.146	3.34	0.101	n.s
	COMP2	3.15	0.140	3.34	0.152	3.25	0.103	n.s
	COMP3	3.18	0.139	3.48	0.162	3.34	0.107	n.s
Behavioural	BI1	2.64	0.120	2.80	0.148	2.72	0.095	n.s
Intention	BI2	2.90	0.137	3.27	0.152	3.09	0.102	n.s
	BI3	2.53	0.133	2.81	0.147	2.67	0.099	n.s

n.s. = not significant

The responses were measured on a Likert scale of one to seven. The low value on scale indicated a high positive agreement with the question and vice versa. The statistics reveal that all responses of all items were higher in the urgent query group. Similarly, they are higher than the means of all responses of all respondents. However, the differences of the items were not statistically significant.

In order to evaluate the measurement invariance, firstly the model was estimated separately for the urgent query group and others group, without any constraints between groups. The resulting full configural invariance model fitted the data very well. The χ^2 test accepted the model (χ^2 (134) = 158.541, scaling correction value = 1.311, p-value = 0.0726). The supporting goodness-of-fit indices indicated the good fit of the model with the data (RMSEA = 0.037, CFI =

0.993, TLI = 0.990, SRMR = 0.028). The 90 % confidence interval of RMSEA (0.000; 0.058) and the probability of RMSEA to be less than 0.05 ($p = 0.82$) supported the good fit of the model with the data. Hence, the hypothesis on configural invariance between the groups was accepted. This model is also called the baseline model in the current research.

Then using the baseline model, the metric invariance was tested. The model having the factor loadings constrained as equal on both groups was estimated. The χ^2 test accepted the model (χ^2 (143) = 165.890, scaling correction value = 1.291, p-value = 0.0924). Also the supporting goodness-of-fit indices indicated a good fit of the model with the data (RMSEA = 0.035, CFI = 0.993, TLI = 0.991, SRMR = 0.033). The 90 % confidence interval of RMSEA (0.000; 0.056) and the probability of RMSEA to be less than 0.05 ($p = 0.874$) supported the good fit of the model with the data. The deterioration of the model was examined from the results of these two successive χ^2 tests by comparing the results of the baseline model and the estimated full metric invariance model. The resulting difference in the tests indicated no deterioration in the model ($\Delta\ \chi^2$ (9)=6.360, $p > 0.05$). Hence, the full metric invariance between the groups was confirmed.

The scalar invariance was tested using the full metric invariant model by also having the item intercepts constrained as equal between the groups. The χ^2 test accepted the model (χ^2 (152) = 175.419, scaling correction value = 1.273, p-value = 0.0938). The supporting goodness-of-fit indices indicated a good fit of the model with the data (RMSEA = 0.034, CFI = 0.993, TLI = 0.992, SRMR = 0.034). The 90 % confidence interval of RMSEA (0.000; 0.055) and the probability of RMSEA to be less than 0.05 ($p = 0.890$) supported the good fit of the model with the data. The deterioration of the model was examined from the results of these last two successive χ^2 tests by comparing the results of the full metric invariance model and the results of the estimated model. The resulting difference in the tests suggested no deterioration in the model ($\Delta\ \chi^2$ (9)= 9.265, $p > 0.05$). Hence, the full scalar invariance between the models was confirmed.

As a final test, the invariance of the regression coefficients was tested. The regression coefficients between the constructs of the model were constrained to be equal between the groups. The resulting model was estimated. The χ^2 test rejected the model (χ^2 (162) = 196.757, scaling correction value = 1.265, p-value = 0.0326). However, the supporting goodness-of-fit indices indicated a good fit with the data (RMSEA = 0.040, CFI = 0.990, TLI = 0.988, SRMR = 0.051). The 90 % confidence interval of RMSEA (0.013; 0.059) and the probability of RMSEA to be less than 0.05 ($p = 0.792$) supported the good fit of the model with the data. The deterioration of the model was examined from the results of these two successive χ^2 tests by comparing the results of the full scalar invariance model and the estimated model. The resulting difference in the tests indicated a deterioration in the model ($\Delta\ \chi^2$ (10) = 22.380, $p < 0.02$). Hence, the test assumption on the equality of the path coefficients across the groups was rejected. The modification indices suggested no reasonable ways to make the model fit better. For this reason it was decided, as proposed by Im et al. that the paths would be constrained one by one and the χ^2 difference test of equality would be performed separately for each path coefficient (Im, Hong & Kang 2011).

Following the procedure offered by Im at al. (Im, Hong & Kang 2011), the path from perceived ease of use to perceived usefulness was constrained first to be equal between the groups. The χ^2 difference test suggested significant deterioration between the models ($\Delta\ \chi^2(1)= 6.078$, $p < 0.02$). This implied that a moderation effect existed between the groups regarding the path from perceived ease of use to perceived usefulness.

Secondly, the path from the social influence of a team member to perceived usefulness was constrained. In the SEM estimation this path was found to be insignificant. The χ^2 difference test suggested significant deterioration between the models ($\Delta\ \chi^2(1) = 8.943$, $p < 0.01$). This implied that a moderation effect existed between the groups regarding the path from the social influence of a team member to perceived usefulness.

Thirdly, the path from the social influence of a team member to perceived ease of use was constrained. The χ^2 difference test suggested a significant deterioration between the models ($\Delta\ \chi^2(1)= 4.389$, $p < 0.02$). This implied that a moderation effect existed between the groups regarding the path from the social influence of a team member to perceived ease of use.

Fourthly, the path from compatibility to perceived usefulness was constrained. The χ^2 difference test suggested no deterioration between the models ($\Delta\ \chi^2(1) = 0.047$, $p > 0.8$). This implied that there was no moderation effect between the groups regarding the path from compatibility to perceived usefulness.

Fifthly, the path from compatibility to perceived ease of use was constrained. The χ^2 difference test suggested no deterioration between the models ($\Delta\ \chi^2(1) = 2.655$, $p > 0.10$). This implied that there was no moderation effect between the groups regarding the path from compatibility to perceived ease of use.

Sixthly, the path from perceived usefulness to behavioural intention was constrained. The χ^2 difference test suggested no deterioration between the models ($\Delta\ \chi^2(1) = 0.011$, $p > 0.90$). This implied that there was no moderation effect between the groups regarding the path from perceived usefulness to behavioural intention.

Seventhly, the path from perceived ease of use to behavioural intention was constrained. The χ^2 difference test suggested no deterioration between the models ($\Delta\ \chi^2(1) = 1.223$, $p > 0.20$). This implied that there was no moderation effect between the groups regarding the path from perceived ease of use to behavioural intention.

Eighthly, the path from compatibility to behavioural intention was constrained. The χ^2 difference test suggested no deterioration between the models ($\Delta\ \chi^2(1) = 3.344$, $p > 0.05$). This implied that there was no moderation effect between the groups regarding the path from compatibility to behavioural intention.

Lastly, the path from the social influence of a team member to behavioural intention was constrained. The χ^2 difference test suggested no deterioration between the models ($\Delta\ \chi^2$ (1) = 0.791, p > 0.30). This implied that there was no moderation effect between the groups regarding the path from social influence of a team member to behavioural intention.

Finally the model in which the paths which were found to be invariant was constrained as equal between the groups, and the non-invariant paths were left free. This was then estimated. The χ^2 test accepted the model (χ^2 (158) = 181.887, scaling correction value = 1.273, p-value = 0.0937). Also, the supporting goodness-of-fit indices indicated a good fit with the data (RMSEA = 0.034, CFI = 0.993, TLI = 0.992, SRMR = 0.038). The 90 % confidence interval of RMSEA (0.000; 0.054) and the probability of RMSEA to be less than 0.05 (p= 0.898) supported the good fit of the model with the data. The χ^2 difference test suggested no deterioration between the models ($\Delta\ \chi^2$ (6) = 6.468, p > 0.30). The estimated regression paths were identified from the unstandardized values of the regression coefficients. These estimations were consistent with the results of the χ^2 tests of difference above.

For the urgent query group, the regression of perceived usefulness on perceived ease of use was 0.920 (t= 6.112), on social influence of a team member -0.194 (non significant, t= -1.178), and on compatibility 0.444 (t= 4.083). The regression of perceived ease of use on the social influence of a team member was 0.176 (t= 2.065), and on compatibility 0.609 (t= 7.242). The regression of behavioural intention on perceived usefulness was -0.092 (t= -2.299), on perceived ease of use 0.249 (t= 3.533), on compatibility 0.616 (t= 9.708), and on the social influence of a team member 0.201 (t= 3.152).

For the others group, respectively, the regression of perceived usefulness on perceived ease of use was 0.249 (t= 1.957) and on the social influence of a team member was 0.288 (t= 3.037). The regression of perceived ease of use on the social influence of a team member was 0.315 (4.056) suggesting significant difference when compared to the urgent query group. The rest of the regressions were equal to those the urgent query group being the regression of perceived usefulness on compatibility 0.609 (t= 7.242), the regression of behavioural intention on perceived usefulness -0.092 (t= -2.299), on perceived ease of use 0.249 (t= 3.533), on compatibility 0.616 (t= 9.708), and on the social influence of a team member 0.201 (t= 3.152).The results of the tests of the moderating effects on the path coefficients are presented in TABLE 38.

The results revealed that the differences in means were all statistical insignificant. Hence, the hypothesis of the equal means between the groups was accepted. The results indicate the there are differences in the path coefficients between these two groups. The path from perceived ease of use to perceived usefulness ($\beta_{PU,\ PEOU}$) was strong and significant in both groups. However, in the urgent query group which preferred the use of the system for urgent data base queries, the effect was stronger and more significant (0.920, p<0.001) than in the others group (0.249 , p< 0.05).

TABLE 38 Results of tests of moderating effects of context of work on path coefficients

Model	χ2	df	Scaling corr. factor	RMSEA	CFI	TLI	SRMR	Δχ2	Δdf	p
Full scalar invariance model	175.419	152	1.273	0.034	0.993	0.992	0.034	-	-	-
Perceived ease of use - Perceived usefulness	181.497	153	1.271	0.037	0.992	0.990	0.037	6.078	1	< 0.02
Social influence of a team member - Perceived usefulness	180.633	153	1.269	0.037	0.992	0.990	0.035	8.943	1	< 0.01
Social influence of a team member - Perceived ease of use	180.194	153	1.274	0.037	0.992	0.990	0.036	4.389	1	< 0.02
Compatibility - Perceived usefulness	175.598	153	1.272	0.033	0.993	0.992	0.034	0.047	1	> 0.80
Compatibility- Perceived ease of use	178.074	153	1.273	0.035	0.993	0.991	0.036	2.655	1	> 0.10
Perceived usefulness - Behavioural intention	175.687	153	1.271	0.033	0.993	0.992	0.034	0.011	1	> 0.90
Perceived ease of use - Behavioural intention	176.650	153	1.274	0.034	0.992	0.992	0.034	1.223	1	> 0.20
compatibility - behavioural intention	178.239	153	1.271	0.035	0.993	0.991	0.035	3.344	1	> 0.05
social influence of a team member - behavioural intention	176.080	153	1.276	0.034	0.993	0.992	0.035	0.791	1	> 0.30

The social effect of a team member on perceived usefulness ($\beta_{PU, PEOU}$) was insignificant in the urgent query group but strong and significant in the others group. This indicates that in those situations where the system really is considered as important to be used, the social effect and opinion of the team member does not matter, but in other situations it does. The social influence of the team member on perceived ease of used was significant in both groups but was stronger - more than double in others group than in urgent query group. This can be interpreted that in the context of use which is not so critical or important, the influence of the team member may effect on the belief of perceived ease of use. All other path coefficients were significant and equal between the two groups. The summary of the invariance tests is presented in TABLE 39.

TABLE 39 Test results of measurement invariance tests between the urgent query group and others group

Model	χ2	df	Scaling corr. factor	RMSEA	CFI	TLI	SRMR	Δχ2	Δdf	p
Full configural invariance (Baseline model)	158.541	134	1.311	0.037	0.993	0.990	0.028	-	-	-
Full metric invariance	165.890	143	1.291	0.035	0.993	0.991	0.033	6.360	9	>0.05
Full scalar invariance	175.419	152	1.273	0.034	0.993	0.992	0.034	9.265	9	>0.05
Full Regression invariance	196.757	162	1.265	0.040	0.990	0.988	0.051	22.380	10	< 0.02
Partial Regression invariance	181.887	158	1.273	0.034	0.993	0.992	0.038	6.468	6	>0.30

The model explained 76.7 percent of the variance of perceived usefulness and 71.9 percent of the variance in the perceived ease of use in the urgent query group. Similarly, the model explained 69.1 per percent of the variance in perceived usefulness and 79.1 per cent of the variance among the others group. On the whole, the model explained 89.2 percent of the total variance of intention in the urgent query group, and 99.1 per cent of the total variance of intention in the others group. The values were considered as very good. The differences in the means were observed from the estimation results of the full scalar invariance model. In the estimation, the urgent query group was set as a reference group and the means of it were set to zero. Therefore, the means of the others group expressed the sign and the difference between the two groups.

Based on the results of the comparison of the path coefficients, the differences in them were moderated by the context of work. In proportion, the means of the constructs did not differ significantly. Based on these results, the hypothesis H10, *Social influence has a different influence on intention to use in different contexts of work,* was not supported. The hypotheses H11, *Social influence has a different influence on perceived usefulness in different contexts of work,* and H12, *Social influence has a different influence on ease of use in different contexts of work* , were fully supported. Therefore, as a whole, the hypothesis H13, *Context of work is a moderating factor in the adoption of mobile technology* , was supported.

The results of the comparisons of means (α) and regression coefficients (β) and the coefficient of determination (R^2) for the behavioural intention for both groups are presented in TABLE 40.

TABLE 40 Results of comparisons of means (α) and regression coefficients (β) and coefficient of determination (R^2)

	Group		
	Urgent query		Others
α_{PU}	0.000[a]		0.149 [n.s.]
α_{PEOU}	0.000 [a]		0.191 [n.s.]
α_{BI}	0.000 [a]		0.255 [n.s.]
α_{COMP}	0.000 [a]		0.209 [n.s.]
α_{SI_T}	0.000 [a]		0.340 [n.s.]
$\beta_{PU,PEOU}$	0.920 ***		0.249 *
β_{PU,SI_T}	-0.194 [n.s.]		0.288 ***
$\beta_{PU,COMP}$		0.444 ***	
$\beta_{PEOU,COMP}$		0.609 ***	
β_{PEOU,SI_T}	0.176 ***		0.315 ***
$\beta_{BI, PU}$		-0.092 *	
$\beta_{BI, PEOU}$		0.249 ***	
$\beta_{BI,COMP}$		0.616 ***	
β_{BI,SI_T}		0.201 ***	
R^2	89 %		99 %

[a] =set to zero
[n.s.] = not significant
*= p<0.05
**=p<0.01
***=p<0.001

4.6 Review of the Results

The survey was sent to approximately 3000 police officers in 16 different police departments in Finland in February 2012. A total of 302 respondents returned the questionnaire. In all, 267 of them were deemed to be valid for the analysis of the results. There were very little missing values in the responses, however those missing values were imputed into the data using a multiple imputation method. Most of the respondents were male (91 percent). Only 9 percent were female. Most of the respondents (57 percent) had a high school level education before they joined the Police College. 27 percent had vocational level, almost 9 percent polytechnic level and about 5 percent a secondary school level education degree. Around 1 percent had an upper polytechnic level education and 2 per cent had a master's level education. The majority of the respondents were senior constables (62 percent), 36 percent were sergeants and 2 percent were constables. All the instruments used to measure the constructs employed in the measurement model of the current study were selected from existent literature and had been demonstrated in a variety of studies. Regardless of this however, all the items were re-tested using both sorting procedure and pilot testing with 76 respondents. This was due to the fact that the items were originally in the English language and they were translated into the Finnish language which was used in the questionnaire. The reliability and validity of the constructs were verified with several tests indicating that the responses were both consistent and reliable. Both Cronbach's alpha and composite reliability values were used to assess the reliability of the constructs. Convergent validity was tested using the average variance extracted values (AVE) and discriminant validity was assessed using χ^2 tests. These indicated an acceptable validity of the constructs. The skewness and kurtosis of the data was detected from the responses resulting from the selection of the MLM-estimator in the estimation of the model. The χ^2 test for common model variance (CMV) did not prove the existence of CMV in the data.

The measurement model was estimated. The model indicated a good fit with the data. The structural model was also estimated. The model explained 94 four percent of the total variance of the behavioural intention. All path coefficients were significant. Opposite to the basic presumptions of the TAM model, the path from perceived usefulness to behavioural intention was found to be negative. Both the external variables to TAM, compatibility and the social influence of the team member were found to be strong and significant.

The moderating effects of the length of the career, age of the respondents, the location of the police department and the context of work were studied using the multi-groups analysis in structural equation modelling (SEM) framework. The results revealed that neither the length of the career or age had a moderating effect on technology acceptance. The results suggested that the location of the police department and the context of work would have a moderating effect on the technology adaption, as measured with the SEM model of the current research. As a summary: 11 of the 16 hypotheses postulated were either fully or partly supported, and 5 of the original hypotheses were not supported.

4.7 Summary

This chapter contained the results of the analysis of data collected in the survey of the current research. First, the descriptive results of data were presented. The results indicated that the respondents intended to use the system to a certain extent if it was available. The part-worths and importance scores for the contexts of work were calculated. It was found that weather and the scene of the assignment do not play an important role in the use of the future system but the assignment itself and the urgency of it do. Individual measurement models were estimated and found to be valid for use in the research model. The reliability and validity of the constructs were assessed. The constructs were found to have acceptable levels of reliability and validity. Then the full measurement model (including the individual measurement models for the constructs) was estimated as a whole. It was accepted for use in the analysis of structural relationships as a whole.

The structural relationships of the full model were estimated. The SEM-model was found to have an acceptable fit with data based on the use of various goodness-of-fit indices. One of the discoveries was that usefulness is not a determinant of the intention to use the future ICT-system. This was deviant to the findings of prior research utilizing the technology acceptance model (TAM), but was in-line with some prior studies in mandatory settings. Both of the new external variables in the research model, compatibility and social influence of the team member, were found to be strong and significant. The moderator effects of the various variables were studied using the multi-group comparison. The length of career and the age of the respondent were not found to be moderating factors in technology acceptance among police officers in field operations, although the location of the police department and the context of work where the mobile ICT system is used were found to be moderating factors. Finally, a summary of the results was presented.

In the following chapter a discussion of the main findings and results is presented followed by an assessment of the contribution of the research. Also, the limitations and ideas future work are presented. The summary of the results closes the chapter.

5 CONCLUDING DISCUSSION

This research was a confirmatory case study in nature. It was one of the first comprehensive studies related to mobile technology acceptance studies among the Finnish Police forces. It explored the factors affecting mobile technology acceptance in non-volitional use among the police officers working in field operations in Finland. Additionally, analyzing the moderating effects of the length of a career, age, location of the police department and the context of work was included in the research. The aim of this research was to seek ways to better understand rather than to predict the technology acceptance by end-users, by seeking those factors which have an effect on technology acceptance on a personal level in the mobile ICT environment. For the current research, a research framework was developed. It had three main components; first, a pre-prototype testing environment to present the future mobile ICT-system; secondly, a technology acceptance model (TAM) with two added external variables for compatibility and social influence to test user intentions; and thirdly, the use of moderating variables to study the moderating effects on the model.

The current study had two main parts, the development of theory and confirmation. The theory development examined prior research in the areas of technology acceptance, especially in the light of law enforcement. New variables for police technology acceptance were studied and a research model was formulated to be used in the research.

The confirmatory part was quantitative and the aim of it was to test the fit of the model with collected data. This part included the testing of the research model with data from respondents to find answers to the research questions:

1. How well do the traditional variables combined with additional variables explain technology acceptance among the Finnish Police?
2. To what extent does the length of career of police officers affect mobile technology acceptance?
3. To what extent does the age of police officers affect mobile technology acceptance?
4. How does mobile technology acceptance differ in terms of geographical differences between local police departments?
5. What is the relationship between the context of work activity and intention to use mobile technology in police field operations?

Structural equation modelling was used to estimate the model which was developed. The multi-group comparison in a confirmatory factor analysis framework utilizing constrained nested models was used in studying the moderator effects.

This chapter includes the discussions and conclusions regarding the main results of the study. In the beginning the main findings are summarized and discussed, giving answers to the research questions and to the hypotheses testing. Then the theoretical contributions, implications and limitations are addressed and discussed. Finally, a summary and proposals for future work are presented.

5.1 Discussion on Main Findings

The analysis of data was done in three main stages; the estimation of the measurement model including the individual constructs estimations, the estimation of the structural relationships, and a multi-group comparison using measurement invariance testing. Finally, the results of the analyses were compared to the hypotheses which were posited at the beginning of this research.

Under the results of the current research, the answer to the first research question "How well do the traditional variables for technology acceptance combined with additional external variables explain the technology acceptance among the Finnish Police" is "very well". The dependent variable of the current research, the behavioural intention to use future police mobile ICT system accounted for 94 four percent of the total variances and indicates a very good explanatory power. As the model fit measured with several goodness-of-fit indices indicated a good fit of the model with research data, it suggested a high probability in explaining police officer's behavioural intentions related to mobile technology use. The measurement model was proved to retain high reliability and validity. The model accounted for 70 percent of the variance of perceived usefulness. For perceived ease of use the number was 76 percent respectively.

The most important direct determinants for behavioural intention were compatibility and the social influence of a team member. Compatibility was found to have a very strong, positive and significant direct effect both on behavioural intention and on perceived ease of use. The effect of compatibility on perceived usefulness was only half of that seen with behavioural intention and perceived ease of use. These are all as hypothesized. The direct effects of compatibility on perceived usefulness and on perceived ease of use are in line with prior research results. The indirect effects of compatibility on behavioural intention via perceived usefulness and on perceived ease of use are consistent with the previous studies as well. The effects of compatibility on behavioural intention and on perceived ease of use were not dissimilar. The effect of compatibility on behavioural intention happens both directly and indirectly via perceived ease of use. The direct effect of compatibility on behavioural intention is supportive of the main hypotheses (H4, H5 and H6) of the current research. Finding this empirical support for a direct positive link between compatibility and behavioural intention proposes that professional users value the new mobile system through their own working procedures, preferred working styles, and a compatibility with the relevant aspects of their work.

The salient belief in TAM - perceived ease of use, had a strong, positive and significant direct effect on behavioural intention. This is as hypothesized and is fully in line with prior studies. Ease of use in the context of hectic professional use (especially in law enforcement) can easily be understood to play an important role in adopting new technology. New mobile devices, such as multimedia phones, tablets, and portable laptops are generally becoming more popular and will be every-day tools among the police users as well.

According to the current study, another prominent construct in TAM, perceived usefulness, had only a small, but significant negative impact on the behavioural intention. The direction of the effect was opposite than that hypothesized. This discovery was in line with some prior studies among non-volitional use (Gao, Moe & Krogstie 2010, Robinson Jr., Marshall & Stamps 2005).This was a deviating finding as perceived usefulness has been found to be the most important determinant for the intention to use technology in a voluntary context. However, in the professional context where the use is mandatory and the user cannot affect the selection of the technology and has no choice, the role of perceived usefulness in predicting behavioural intention has also been found to be smaller but still significant than that seen in totally voluntarily use (Brown et al. 2002).

The results of Brown et al. show different patterns in the relationships of TAM in a mandatory context. As a matter fact, Venkatesh states that volitional use is one of the boundary conditions in the TAM model and encourages researchers to examine mandatory use in order to test this condition (Venkatesh 2000). The suggestion regarding the infinitesimal role of perceived usefulness of the current research supports similar findings in prior studies. The result can be interpreted that in lieu of perceived usefulness being a mediator for the effect of compatibility belief on behavioural intention, compatibility itself is a clear determinant of the behavioural intention to use new technology as stated above. Finding the support for these hypotheses regarding compatibility was one of the main goals of the current study. For this reason the construct of compatibility also included a measure for the preferred work style. In earlier studies, attempts have been made to find support for the existence of a link between compatibility and usage (Karahanna, Agarwal & Angst 2006, Moore & Benbasat 1991). However, there have been issues for example with the discriminant validity between the constructs of compatibility and perceived usefulness. After having taken a conservative research approach and due to these discriminant validity issues, the compatibility with the preferred work style has been removed from those earlier analyses. In the current study there were issues with the discriminant validity as well. However, the issue was not between the constructs of perceived usefulness and compatibility. After an exhaustive analysis, the issues regarding the discriminant validity were eliminated. Hence, there is a full reason to believe that the empirical results of the current study are supportive of the finding of the minimal role of perceived usefulness in determining the behavioural intention in the context of mandatory use.

There was a difference in the effect of perceived ease of use on perceived usefulness when the context of work is added as a moderating factor. The effect of perceived ease of use on perceived usefulness was very high and significant among those police officers who considered the system to be most suitable for urgent data queries. The same effect was weaker (about one third), yet strong and significant among the others. The explanation for this could be that in urgent situations the role of perceived ease of use becomes very important and is almost as important a factor as compatibility when accomplishing duties.

The effect of the social influence of a team member was found to be an equal and significant direct determinant for both perceived ease of use and behavioural intention. However, the effect of it on perceived usefulness was found to be insignificant. Hence, this finding is only partly supporting of the hypotheses of the research. It was hypothesized that the team member would internalize, in other words, would change his or her belief about the usefulness of the system based on the opinion of the closest team member. This was not supported. Social influence was added into the research model because close team work is an important element in the way in which police work in Finland. The finding of a strong social influence of a team member on behavioural intention was opposite to the findings in previous studies (Hu et al. 2011, Chau & Hu 2002) which proposed that instead of a direct influence on behavioural intentions, the effect of social influence happens via perceived usefulness. According to the current research, the effect of the social influence of a team member on behavioural intention happens both directly and via the perceived ease of use giving part-support to the hypotheses.

In the results of multi-group comparisons there was a difference in the social influence of a team member and the moderating factor was the context of work. Those police officers who preferred the system most to be used for urgent data base queries did not see social influence as having an effect on perceived usefulness as the effect was insignificant. However, the *others* group who thought that the system would be suitable for all other activities, saw the social influence of a team member as strong and significant. This can interpreted that in those contexts where there is a hurry and a need for more information from the system, the team member is not having an effect on the use of technology because the task has to be accomplished anyway. In other situations when there is not necessarily any sense of urgency, the team member may however influence another team member.

As the effect of perceived usefulness on behavioural intention was negative, whilst significant, several questions may be raised regarding the suitability of TAM in the mandatory context in terms of predicting technology acceptance. How would the users intend to use the future system when they do not see it as being useful? Is compatibility more important than perceived usefulness? This raises the need for further studies regarding usefulness as a determinant in the non-volitional context. However, one can envision that perceived usefulness would be tempered by compatibility as a determinant of behavioural intention in mandatory use. This phenomenon was also detected in the multi-group analysis and there were no differences in any groups regarding the effect of perceived usefulness on behavioural intention. However, enriched with the significant factors of compatibility and the social influence of team member, the TAM model can reliably be used to explain the technology acceptance among the Finnish Police.

The second research question "*To what extent does the length of career of police officers affect the mobile technology acceptance?*" can be answered by "Length of career has no effect on technology acceptance". The hypothesized difference between groups having a different length of career was not found to be supported. The subjects were split up into two groups; under and above the mean length of the career of 16.9 years to find answers to this question. The moderator effect of the length of career was not found. There was a significant difference in one item (PEOU3) measuring the perceived ease of use. This item was "I would find using the system easy". The discovery led to the use of partially metric and scalar invariant models in the comparison of these two groups. However, there was no difference in the means of the constructs, and no difference in the path coefficients between the groups. Hence, the hypothesis H14 was not supported. The model explained 91 percent of the total variance of behavioural intention among the less experienced police officers, and 95 per cent of the total variance of behavioural intention among the experienced police officers.

The third research question "*To what extent does the age of police officers affect the mobile technology acceptance*" can be answered by "Age has no effect on technology acceptance". In order to seek an answer to this question the respondents were separated into two groups based on their age; under and above the median age of 40 years. The results were almost equal with the results of the comparison of the groups based on the length of career. This is understandable as age and the length of career evolve with the same velocity. On the whole, the model explained 92 per cent of the total variance of behavioural intention among the young police officers and 95 per cent of the total variance of behavioural intention among the old police officers.

The fourth research question "*How does the mobile technology acceptance differ in terms of geographical differences between the local police departments?*" can be answered by "The location of the police department has a slight effect on technology acceptance". Two groups: urban police departments and rural police departments were formed based on the location of the police department in order to be able to answer this research question. The two groups were significantly different in terms of three constructs out of five measuring the factors in the technology acceptance. The biggest difference was in the social influence of team member. The respondents in rural police departments seemed to value the opinion of the team member more than respondents in urban police departments. This may indicate that a rural police officer tends to think stronger than urban police officer that his or her team member believes that he or she should use the new mobile system. The effect was weaker in urban police departments. The same phenomenon could be seen regarding the compatibility. The rural police officers appeared to value the new mobile system more when it would be compatible with their own preferred working style. Especially, the difference in the variable measuring the compatibility with their preferred work style was very significant. This may point to conclusions of the possible reasons behind this. Rural police officers may have their own preferred working styles which may be caused for example by the working environment in rural milieu where the traffic, structure of community, geography, etc. can be totally different than in urban milieu. To effectuate working assignments in a personally preferred way is not necessarily possible today using the current systems, but would be possible using the new mobile system. In urban police departments this desire was not so notable.

Overall, the behavioural intention to use the future mobile system was slightly but significantly greater among rural police officers than among the urban officers. This gives an indication of the possible benefits of the future mobile systems which would allow officers to accomplish all the paperwork of the police operations in their police vehicles instead of driving back to the police station after assignments. In the rural environment where the distances are longer than in an urban environment, this would release police officers more rapidly to undertake new assignments. The urban police officers did not see the behavioural intention to use the systems as so distinct. The values measuring the perceived usefulness and the perceived ease of use did not differ significantly between the urban and rural police departments. The effects of the beliefs of each group did not differ significantly either. The effect of perceived usefulness on behavioural intention was slightly negative but significant in the same way as in the overall model where all of the police departments were included. On the whole, the model explained 92 percent of the total variance of behavioural intention among the urban police officers and 95 per cent of the total variance of behavioural intention among the rural police officers.

The fifth research question *"What is the relationship between the context of work activity and the intention to use the mobile technology in police field operations?"* can be answered by "There is a relationship between the context of work and technology acceptance". In the current study the responses were divided into two groups of nearly the same size, based on the preferred context of work where the subjects believed that the mobile system would be at its best. The most preferred context of work, based on a conjoint analysis of the responses, was making an urgent data base query using the mobile system. All responses which preferred this context of work formed one group and the rest of the respondents formed the other group. The groups did not differ in terms of their behavioural intention to use the mobile system. All other differences between their beliefs were insignificant as well. However, the groups differed in terms of the effects of their beliefs on each other. The effect of perceived ease of use on perceived usefulness was very strong and significant in the group that preferred the urgent data base query. The same effect was clear and significant in the other group as well, but was only one third in strength. The finding supports the strong role of perceived ease of use as a determinant of perceived usefulness. This is in accordance with the TAM assumptions.

The effect of the social influence of a team member turned out to be a deviating coefficient. The effect of it on perceived usefulness was insignificant in the group of preferred *urgent data base query* whereas the same effect was strong and very significant in the *others* group. This same effect however, was insignificant for the whole constituency of the research. At the same time, the effect of the social influence of a team member on the perceived ease of use was significant in both groups, but was clearly greater in the *others* group. There were no differences between the groups regarding the effects of the social influence of a team member, compatibility, and perceived ease of use on behavioural intention.

The effect of perceived usefulness in behavioural intention was small and slightly negative but significant in both groups. The results give some guidance of the effect of the context of work, regarding the factors affecting technology acceptance. The effect of the social influence of a team member on perceived ease of use and on perceived usefulness in the context which is not the most preferred for the mobile system showed to be stronger than in the preferred context. This may suggest that the team member's opinion on the suitability of the mobile system on accomplishing the activities of the assignment are listened to and may have an effect on the beliefs of officers. On the other hand, in the situations of the preferred context, the team member's opinion is not listened to. The effect of it on perceived ease of use is smaller than in other situations. Additionally, its effect on perceived usefulness is insignificant because the assignments have to be accomplished regardless of the opinion of the other party. When the context of work is the preferred one (making an urgent data base query), both ease of use and usefulness play a major role and ease of use really has an effect on the perception of usefulness. As a summary,the social influence of a team member on the other team member, however, is complex and remains still partly unexplained within the results of the current study.

The length of career and age were not moderators at all according to the current study. The experienced team members differed in terms of finding the system easy to use significantly from the group of the less experienced. Hence, as the there was a difference in the belief concerning the perceived ease of use and as the influence of a team member happens via internalization (in other words by changing his or her belief about the easiness to use the system), the opinion of an experienced team member may have either an affirmative or negative influence towards the respondents beliefs concerning the ease of use of the new mobile system. The effect of perceived ease of use on perceived usefulness was very strong in the group of officers preferring the context of an urgent data base query. Hence, the effect of a team member on the perceived usefulness is happening only via ease of use in that group, as the direct effect of it to perceived usefulness was insignificant. A belief about the usefulness of the system may then be influenced by a team member via the belief concerning the ease of use.

TABLE 41 Summary of the support for the hypotheses

	Hypothesis	Result
H1	Perceived usefulness has a direct positive effect on the intention to use mobile technology in police field operations	Not supported
H2	Perceived ease of use has a direct positive effect on the intention to use mobile technology in field operations	Supported
H3	Perceived ease of use has a direct positive effect on perceived usefulness of using mobile technology in police field operations	Supported
H4	Compatibility has a direct positive effect on the intention to use mobile technology in field operations	Supported
H5	Compatibility has a direct positive effect on perceived usefulness of using mobile technology in police field operations	Supported
H6	Compatibility has a direct positive effect on perceived ease of use of using mobile technology in police field operations	Supported
H7	Social influence has a direct effect on the intention to use mobile technology in field operations	Supported
H8	Social influence has a direct effect on perceived usefulness of using mobile technology in police field operations	Not supported
H9	Social influence has a direct positive effect on ease of use of using mobile technology in police field operations	Supported
H10	Social influence has a different influence on intention to use in different contexts of work	Not supported
H11	Social influence has a different influence on perceived usefulness in different contexts of work	Supported
H12	Social influence has a different influence on ease of use in different contexts of work.	Supported
H13	Context of work is a moderating factor in the adoption of mobile technology	Supported
H14	Length of career of the law enforcement officer is a moderating factor in the adoption of mobile technology	Not supported
H15	Age of the law enforcement officer is a moderating factor in the adoption of mobile technology	Not supported
H16	Geographical location of the local police department is a moderating factor in the adoption of mobile technology	Partly supported

In the group of *others* (not preferring the context of an urgent data base query), the effect of social influence on perceived usefulness was strong and significant. Logically, the common habit is to build teams for working shifts in a way that a new and inexperienced police officer is accompanied by an officer with more experience. The effect of the experienced police officer on the newcomer is then either positive or negative and may happen either directly or indirectly in regard to their behavioural intentions to use a new system; directly on the beliefs about the perceived usefulness and easiness of use, and indirectly on the systems perceived usefulness via ease of use, and also indirectly on behavioural intentions also via ease of use. However, the indirect effects of social influence on behavioural intention, when mediated by perceived usefulness was insignificant whereas mediated by perceived ease of use it was significant. Based on this the influence of a team member on behavioural intention may happen then only when either directly or partly mediated by a perceived ease of use.

The summary of the support for the hypotheses of the research are presented in TABLE 41.

5.2 Contributions to the Academy

The current study was made more to understand, rather than to predict, the behavioural intention to use the mobile police ICT-system. This research was one of the very first researches made in the Finnish Police force regarding mobile technology acceptance. Hence, this study contributes to the understanding of factors which affect beliefs about the intention and its determinants to adopt mobile information systems based on the modern latest technology in a mandatory context. As a main contribution, the research delivered a research model of mobile technology acceptance for the law enforcement environment in non-voluntary use. The roots of the model are deeply set in the reliable technology acceptance model (TAM) and in external variables measuring the beliefs about compatibility and the social influence of the closest team member. The results suggested that usefulness is not a determinant of the intention to use mobile technology in the mandatory setting. This discovery can also help other researchers to commence further investigations into this linkage between usefulness and intention. Using the structural equation modelling the effects of these beliefs were estimated in a reliable and valid way. Moreover, by using the multi-group comparison method for exploring the differences between various groups in the contingency, the research delivered valuable information about the complex relationships between the beliefs of the respondents. One of the main findings was that there is a connection between those factors affecting mobile technology acceptance and the context of work where the mobile technology is intended to be used. This relationship helps us to understand better the complicated effects of the social influence of a team member on the beliefs surrounding the new technology use. On the other hand, the moderating effect of the geographical location of the police departments makes the internal dependencies of these beliefs more concrete and helps to make future research work in this area apparent. The current research was able to identify quite a plentiful amount of new topics for future research. These include studying the effect of usefulness on behavioural intention in the non-volatile context; studying the influence of management on the intentions to utilize new technology and studying the management of mobile information technology in the context of the current research.

5.3 Implications for Practitioners

In the current study the use of mobile technology is understood as the use of portable communication devices, such as smart phones, cellular phones, laptops, and tablets amongst other things. For the practitioners in the area of the development of new mobile systems, the results offer a large amount of new opportunities for further research and development work. Based on the results of the current study, the complicated links of customer requirements may be better understood when new mobile systems are developed for law enforcement officers. Knowledge concerning the user's beliefs on usefulness and the effortless of use of mobile information systems can be utilized when designing new functionalities for such systems and user interfaces for end-user devices. For the police force, the results of the study may offer valuable information in understanding the beliefs of staff concerning new technology use. This can be utilized in designing new working practices and procedures. The new possibilities of the modern technology could be utilized in full in the incongruity of economic pressure and an invariably growing demand of premium service capability.

5.4 Limitations of the Study

The study is not without its limitations. Firstly, the system which was used to test the behavioural intention was not a real mobile information system used by the participants but a prototype shown on a video presenting the main functionalities of the system. The use of a real system may have resulted in different results.

Secondly, the results may not be generalizable in a global sense and over all police officers, because the constituency of the study was restricted to police officers working in field operations in Finland. Yet, the study could be directed to clearly limited subjects in the police forces and according to the original goals, at the expense of the generalization of the results.

Third, the sampling of the subjects was not totally coincidental but based on the purposive sampling from different types of police forces in Finland. This was done because the comparison of data drawn from different police department locations was needed. The result of this limitation is that the outcome cannot necessarily be directly interpreted for all members of the Finnish Police force.

Fourth, the sample size was limited due to the low return rate of the questionnaire. For this reason the comparison of different groups was limited to the comparison of two groups only.

Fifth, the gender of the respondents was biased. The share of men was 91 per cent which is more than the share of men generally in the Finnish Police force. Hence, the results may not be generalizable across both sexes in the police force.

Sixth, the research was a single study. In order to have a broader and deeper view of the factors affecting technology acceptance, a longitudinal survey would be needed as proposed by Rawstorne et al. (Rawstorne, Jayasuriya & Caputi 2000).

Seventh, the items of all constructs were translated from the English language into the Finnish language for the survey. In this process, some subtle but important nuances of the original items may have been lost although all measures were taken to transfer the original meanings to the new language.

Eighth, the questionnaire was made using a 7-point Likert scale. This might have had a biasing effect on the responses even though it could not be detected.

Ninth, most of the items of the constructs were positive claims, which also may have had an effect on the inquiry, making the respondents possibly answer the questions more positively than they might have intended.

Tenth, some constructs, like compatibility, got rather low values in the sorting procedure in the testing phase of the questionnaire. This value could not be ameliorated and this may have had an effect on the results even though the construct validity could be shown to be acceptable.

Lastly, the non-normality of the responses which was shown to persist, might have had some effect on the estimations even though a robust estimator that has been developed for non-normal data, was used.

5.5 Future Work

The research was able to provide the community with a measurement model for measuring technology acceptance in a context of mandatory use. Moreover, in using a group comparison, the testing of moderating effects of multiple parameters was performed. However, future work will be needed in order to make clarifications, modifications and enlargements to the model. This especially regards the role of perceived usefulness in explaining user intentions in non-volitional use. To clarify the model, new external variables which were not in the scope of this study could be added instead of, or in addition to compatibility and social influence. Some other model instead of TAM could be used as a basis for a new model and some of these model candidates, such as UTAUT and TAM3, were presented in the literature review of this research.

The current study rejected the responses from high ranking police officers. However, this offers a new possibility to study factors among high rank police officers in regard to new technology. Moreover, researching the management of modern mobile ICT-technology will also offer new openings for future work. The effect of management on the intention to use new mobile technology which was not in the scope of the current research would also provide a new domain for further investigations.

One must not forget the need of further research into technology acceptance, once the real police mobile ICT system would be made available to police officers in Finland. This would offer new opportunities to study the real system's use, not only intentions. Longitudinal research on the continuous use of such a system in police field operations would then be possible as well. Moreover, new moderating factors like gender and prior experience on mobile information system use could be also worthy of future study in a similar research setting.

SUMMARY

In this study, factors affecting the acceptance of new mobile technology among Finnish Police officers were examined. In the study, a research framework was developed and was based on three pre-evaluated concepts. Firstly, the concept of using of a pre-prototype instead of a working system to test the intentions to use was employed. Secondly, the technology acceptance model (TAM) which can be used to measure the intention to use and the determinants of it were combined into the framework. Thirdly, a system to measure the moderator effect of variables on the model was combined within the framework. Based on that framework and on the theories which form the foundation for different technology acceptance models, a measurement model was developed to be used to measure the intention to use technology and latent variables which are determinants of said intention. Various goodness-of-fit indices were used to evaluate the fit of the model with data. Resultantly, the model was found to be statistically reliable and valid to explore the factors affecting on the technology acceptance of the target population.

The electronic survey was performed among the police officers in Finland working in field operations in 15 local police departments and in one national police organization, the National Traffic Police during February-April in the year 2012. The survey was sent by e-mail to approximately 3000 police officers who belonged to the target population. Even though the return rate was low it was acceptable enough to make a statistically reliable analysis with the data obtained. The final amount of valid respondents was 267 from all police units which were then included in the survey. Based on data from the respondents, the measurement model was used to estimate the various parameters for an intention to use new mobile technology and for the determinants of it. The measurement model was found to be reliable and valid having good fit with the data. The results revealed that using the factors in the technology acceptance model (TAM) does not account for all phenomenon, but the external variables for compatibility with existing working procedures, the preferred work style, and the social influence of the team member can account for more of the variance of the intention to use. Compatibility with the existing working procedures and preferred work style were found to be the strongest determinant of the intention to use. The other two strong determinants of intention to use were found to be the perceived ease of use and the social influence of a team member. Those two factors, compatibility with the existing working procedures and preferred work style had both a direct and indirect effect via the perceived ease of use on intention. Perceived usefulness was found to be not a good determinant of intention. The model could account for 94 percent of the total variance of intention which can be considered as extremely good value.

Moreover, the moderator effects of the length of career, age, location of the police department and the context of work on the model results were examined. The moderator effects of length of career and age were found to be insignificant. The effect of gender was not examined because the respondents were mostly

male. The location of the police department was found to have a moderator effect on some mobile technology acceptance. In urban police departments the intention to use was smaller than in rural police departments. Likewise, the determinants of intention to use, compatibility with preferred work style and existing working procedures, and the social influence of a team member were smaller in urban than in rural police departments, however the model could explain both urban and rural locations of police departments equally well.

The moderator effect of the context of work was studied. For the research ten different contexts of work were created based on weather, scene, urgency and the activity of the assignment. These contexts were used to test the moderator effect on the model and its parameters. Urgency and the activity itself were found to have a significant moderating effect on the path coefficients of the constructs of the model. The biggest difference was on the effect on the perceived ease of use on perceived usefulness. The effect of perceived ease of use on perceived usefulness was found to be very high and significant on urgent assignments. The effect of a team member in the same context was found to be insignificant, although it was found to be significant in other assignments. The social influence of a team member on perceived usefulness was significant in all assignments but remarkably weaker in urgent assignments. The perceived usefulness was found to be negative. The results suggested that the context of work had a moderating effect on the intention to use mobile technology.

Based on the data from respondents, eleven hypotheses out of sixteen were supported or partly supported. Only five hypotheses of the sixteen were not supported. One of the rejected hypotheses was the effect of perceived usefulness on behavioural intention which was found to be negative. This finding was found to have support in prior research. Two of those five rejected hypotheses were related to the social influence of a team member. Social influence was hypothesized to be different in different contexts of work, however this was not found to be supported. Similarly, the social influence of a team member was not found to have a direct effect on perceived usefulness. The remaining two rejected hypotheses were the moderating effects of the length of career and age on technology acceptance which were not supported by the results of the current research.

YHTEENVETO (FINNISH SUMMARY)

Tässä tutkimuksessa tutkittiin Suomen poliisin uuden mobiiliteknologian käyttöönottoon vaikuttavia tekijöitä. Työssä kehitettiin tutkimusta varten viitekehys, jossa yhdistettiin kolme jo aiemmin olemassa ollutta tutkimuksen kannalta tärkeää osa-aluetta; ensiksi, prototyypin käyttäminen käyttöaikeiden mittaamisessa ilman valmista tai toimivaa laitteistoa; toiseksi, teknologian hyväksyntämalli, jolla mitataan uuden teknologian käyttöaikeita sekä niiden selittäviä tekijöitä sekä kolmanneksi menetelmä eri tekijöiden muovaavien vaikutusten (moderaattorivaikutusten) mittaamiseen. Tämän viitekehyksen sekä erilaisten teknologian hyväksyntämallien pohjalla olevien teorioiden perusteella kehitettiin mittausmalli, jolla voitiin mitata käyttöaikeisiin ja sitä selittäviin tekijöihin liittyvät latentit muuttujat. Mallin hyvyyttä ja sen riittävyyttä mitattiin erilaisilla hyvyysindekseillä. Tilastollisen mallin todettiin olevan luotettava ja pätevä kohderyhmän mobiiliteknologian käyttöaikeiden tutkimiseen.

Tutkimus tehtiin sähköisenä kyselytutkimuksena Suomessa kenttätyötä tekevälle poliisille 15 poliisilaitoksessa ja Liikkuvassa poliisissa helmi-huhtikuussa 2012. Kysely lähetettiin sähköpostilla noin kolmelletuhannelle kohderyhmään kuuluvalle poliisille. Vaikka vastausprosentti jäi odotettua pienemmäksi, se oli riittävä luotettavan tutkimuksen tekemiseksi. Lopullinen kyselyaineisto kattoi 267 vastaajaa kaikista mukana olleista poliisilaitoksista ja Liikkuvasta poliisista. Vastausten perusteella mittausmallilla laskettiin käyttöaikeisiin ja sitä selittäviin tekijöihin liittyvät tunnusluvut ja tilastolliset luotettavuusrajat. Mittausmalli todettiin luotettavaksi ja sen yhteensopivuus mittausaineiston kanssa oli hyvä. Malli osoitti, että pelkästään aiemmin käytössä olleen ja käytetyn mittausmallin pohjana olleen teknologian hyväksyntämalli TAM:n tekijöillä ei pystytä täysin selittämään kaikkia todettuja ilmiöitä, vaan siihen lisätyt ja malliin mukaan otetut uudet tekijät, yhteensopivuus ja partiokaverin sosiaalisen vaikutus, selittävät paremmin käyttöaietta. Yhteensopivuus nykyisten työtapojen sekä mieluisten työskentelytapojen kanssa löydettiin olevan käyttöaikeen suurin yksittäinen selittävä tekijä. Helppokäyttöisyys ja partiokaverin sosiaalinen vaikutus löydettiin olevan kaksi muuta vaikuttavaa tekijää. Sekä yhteensopivuuden mieluisten työtapojen kanssa että partiokaverin sosiaalisen vaikutuksen todettiin vaikuttavan sekä suoraan että epäsuorasti helppokäyttöisyyden kautta käyttöaikeisiin. Hyödyllisyyden todettiin olevan huono käyttöaikeen selittävä tekijä. Mallilla pystyttiin selittämän 94 % vastausten kokonaishajonnasta, jota voidaan pitää erittäin hyvänä selitysasteena.

Lisäksi tutkittiin poliisin kokemusvuosien, iän, paikkakunnan ja itse työtehtävän vaikutuksia mittausmalliin ja sen antamiin tuloksiin. Kokemusvuosien vaikutus todettiin merkityksettömäksi. Samoin iän vaikutus oli merkityksetön. Sukupuolen vaikutusta ei voitu luotettavasti tilastollisesti todentaa, koska vastaajat olivat pääasiassa miehiä. Poliisilaitoksen sijainnilla todettiin olevan vaikutusta mittausmallin eri tekijöihin. Kaupunkimaisissa poliisilaitoksissa käyttöaie oli pienempi kuin ei-kaupunkimaisissa poliisilaitoksissa. Samoin käyttöaietta selittävät tekijät, yhteensopivuus mieluisten työtapojen kanssa ja partiokaverin sosiaalinen vaikutus olivat merkittävästi pienempiä enimmäkseen kaupunkimaisissa oloissa työskentelevillä kuin maalaismaisissa poliisilaitoksissa työskentelevillä. Malli selitti sijainniltaan kaupunkimaisten ja maaseutumaisten poliisilaitosten käyttöaikeet yhtä hyvin.

Tutkimuksessa tutkittiin myös itse työtehtävän, toisin sanoen sen sisällön, suorituspaikan, sään ja kiireellisyyden muodostavan kokonaisuuden vaikutusta käyttöaikeeseen ja sitä selittäviin tekijöihin. Työtehtävän sisällöllä ja kiireellisyydellä löydettiin olevan merkitsevä vaikutus eri tekijöiden keskinäisiin vaikutuksiin. Suurimmat erot löydettiin helppokäyttöisyyden vaikutuksessa hyödyllisyyteen, joka oli erittäin korkea kiireellisissä työtehtävissä. Sen sijaan partiokaverin vaikutus samassa tilanteessa hyödyllisyyteen todettiin merkityksettömäksi, joka taas muissa tehtävissä oli merkitsevä. Partiokaverin vaikutus helppokäyttöisyyteen oli taas merkitsevä sekä kiireellisissä että muissa tehtävissä, mutta huomattavasti pienempi kiireellisissä tehtävissä. Hyödyllisyyden vaikutus todettiin tässäkin yhteydessä negatiiviseksi. Tulosten perusteella näyttää siltä, että työtehtävän paikan, sisällön, sään ja kiireellisyyden muodostavalla kokonaisuudella olisi vaikutusta itse käyttöaikeeseen sekä sitä selittäviin tekijöihin.

Tutkimuksen kuudestatoista hypoteesista yksitoista todettiin käytetyn aineiston ja menetelmien perusteella oikeiksi tai osittain oikeiksi. Ainoastaan viittä hypoteesia yhteensä kuudestatoista esitetystä ei voitu osoittaa oikeaksi. Yksi hylätyistä hypoteeseista oli hyödyllisyyden vaikutus käyttöaikeeseen. Tämä vaikutus todettiin negatiiviseksi. Löydös oli samansuuntainen aiempien tutkimusten kanssa. Kaksi hylätyistä hypoteeseista liittyi partiokaverin sosiaaliseen vaikutukseen. Sen oletettiin olevan erilainen erilaisissa työtehtävissä. Kuitenkaan tälle olettamukselle ei tässä tutkimuksessa löydetty tukea. Myöskään partiokaverin sosiaalisella vaikutuksella ei löydetty olevan vaikutusta hyödyllisyyteen. Loput kaksi hylättyä hypoteesia olivat tutkittavan työuran pituuden ja iän muovaava vaikutus uuden teknologian hyväksyntään. Näitä ei tämän tutkimuksen perusteella kuitenkaan voitu osoittaa olevan olemassa.

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APPENDIX 1

Perceived Usefulness (PU)	
PU1	Using the system would improve my performance in my job.
PU2	Using the system in my job would increase my productivity.
PU3	Using the system would enhance my effectiveness in my job.
PU4	I would find the system to be useful in my job.
Perceived Ease of Use (PEOU)	
PEOU1	My interaction with the system would be clear and understandable.
PEOU2	Interacting with the system would not require a lot of my mental effort.
PEOU3	I would find the system to be easy to use.
PEOU4	I would find it easy to get the system to do what I want it to do.
Behavioural Intention (BI)	
BI1	I would intend to use the system in my daily work as often as needed.
BI2	Whenever possible, I would intend to use the system in my daily job.
BI3	I would estimate that my chances of using the system in my daily job are frequent.
Compatibility (COMP)	
COMP1	Using the system would be compatible with most aspects of my work.
COMP2	Using the system would fits well with the way I like to work.
COMP3	Using the system would fit into my work style.
Social Influence (SI)	
SI1	I believe that my patrol team thinks that I should use the system.
SI2	I believe that my patrol team member thinks that I should not use the system.
SI3	The senior management of this business would be helpful in the use of the system.
SI4	In general, the organization would support the use of the system.

All items were measured on a 7-point Likert- scale (where 1: *strongly sagree*; 2: *moderately agree*, 3: *somewhat agree*, 4:*neutral* (neither disagree nor agree), 5: *somewhat disagree*, 6: *moderately disagree*, and 7: *strongly disagree*)

Additional items (These were in the questionnaire but were not included in the current study.)

Perceived Enjoyment (PE) (Venkatesh (2000), modified

PE1	I find using the system to be enjoyable.
PE2	The actual process of using the system is pleasant.
PE3	I have fun using the system.

Computer Anxiety (CANX), TAM3 (Venkatesh, Bala 2008)

CANX1	Computers do not scare me at all.
CANX2	Working with a computer makes me nervous.
CANX3	Computers make me feel uncomfortable.
CANX4	Computers make me feel uneasy.

Attitude (Bhattacherjee 2004)

All things considered, using the system will be a

ATT1	bad idea….good idea
ATT2	foolish move…wise move
ATT3	negative step…positive step
ATT4	ineffective idea…effective idea

Attitude was measured using a five-point semantic differential scale consisting of bipolar adjective pairs.

APPENDIX 2

Distribution of χ^2 (Chi square) for given probability levels, df= degrees of freedom

df	Propability													
	0.99	0.98	0.95	0.90	0.80	0.70	0.50	0.30	0.20	0.10	0.05	0.02	0.01	0.001
1	0.000	0.001	0.004	0.016	0.064	0.148	0.455	1.074	1.642	2.706	3.841	5.412	6.635	10.828
2	0.020	0.040	0.103	0.211	0.446	0.713	1.386	2.408	3.219	4.605	5.991	7.824	9.210	13.816
3	0.115	0.185	0.352	0.584	1.005	1.424	2.366	3.665	4.642	6.251	7.815	9.837	11.345	16.266
4	0.297	0.429	0.711	1.064	1.649	2.195	3.357	4.878	5.989	7.779	9.488	11.668	13.277	18.467
5	0.554	0.752	1.145	1.610	2.343	3.000	4.351	6.064	7.289	9.236	11.070	13.388	15.086	20.515
6	0.872	1.134	1.635	2.204	3.070	3.828	5.348	7.231	8.558	10.645	12.592	15.033	16.812	22.458
7	1.239	1.564	2.167	2.833	3.822	4.671	6.346	8.383	9.803	12.017	14.067	16.622	18.475	24.322
8	1.646	2.032	2.733	3.490	4.594	5.527	7.344	9.524	11.030	13.362	15.507	18.168	20.090	26.124
9	2.088	2.532	3.325	4.168	5.380	6.393	8.343	10.656	12.242	14.684	16.919	19.679	21.666	27.877
10	2.558	3.059	3.940	4.865	6.179	7.267	9.342	11.781	13.442	15.987	18.307	21.161	23.209	29.588
11	3.053	3.609	4.575	5.578	6.989	8.148	10.341	12.899	14.631	17.275	19.675	22.618	24.725	31.264
12	3.571	4.178	5.226	6.304	7.807	9.034	11.340	14.011	15.812	18.549	21.026	24.054	26.217	32.909
13	4.107	4.765	5.892	7.042	8.634	9.926	12.340	15.119	16.985	19.812	22.362	25.472	27.688	34.528
14	4.660	5.368	6.571	7.790	9.467	10.821	13.339	16.222	18.151	21.064	23.685	26.873	29.141	36.123
15	5.229	5.985	7.261	8.547	10.307	11.721	14.339	17.322	19.311	22.307	24.996	28.259	30.578	37.697
16	5.812	6.614	7.962	9.312	11.152	12.624	15.338	18.418	20.465	23.542	26.296	29.633	32.000	39.252
17	6.408	7.255	8.672	10.085	12.002	13.531	16.338	19.511	21.615	24.769	27.587	30.995	33.409	40.790
18	7.015	7.906	9.390	10.865	12.857	14.440	17.338	20.601	22.760	25.989	28.869	32.346	34.805	42.312
19	7.633	8.567	10.117	11.651	13.716	15.352	18.338	21.689	23.900	27.204	30.144	33.687	36.191	43.820
20	8.260	9.237	10.851	12.443	14.578	16.266	19.337	22.775	25.038	28.412	31.410	35.020	37.566	45.315
21	8.897	9.915	11.591	13.240	15.445	17.182	20.337	23.858	26.171	29.615	32.671	36.343	38.932	46.797
22	9.542	10.600	12.338	14.041	16.314	18.101	21.337	24.939	27.301	30.813	33.924	37.659	40.289	48.268
23	10.196	11.293	13.091	14.848	17.187	19.021	22.337	26.018	28.429	32.007	35.172	38.968	41.638	49.728
24	10.856	11.992	13.848	15.659	18.062	19.943	23.337	27.096	29.553	33.196	36.415	40.270	42.980	51.179
25	11.524	12.697	14.611	16.473	18.940	20.867	24.337	28.172	30.675	34.382	37.652	41.566	44.314	52.620
26	12.198	13.409	15.379	17.292	19.820	21.792	25.336	29.246	31.795	35.563	38.885	42.856	45.642	54.052
27	12.879	14.125	16.151	18.114	20.703	22.719	26.336	30.319	32.912	36.741	40.113	44.140	46.963	55.476
28	13.565	14.847	16.928	18.939	21.588	23.647	27.336	31.391	34.027	37.916	41.337	45.419	48.278	56.892
29	14.256	15.574	17.708	19.768	22.475	24.577	28.336	32.461	35.139	39.087	42.557	46.693	49.588	58.301
30	14.953	16.306	18.493	20.599	23.364	25.508	29.336	33.530	36.250	40.256	43.773	47.962	50.892	59.703

APPENDIX 3

Formulae for Goodness-of-Fit Indices:

RMSEA

Calculation of Root Mean Square Error of Approximation (RMSEA) (Byrne 2012):

Let δ_H = noncentrality parameter (NCP) = $\frac{\chi^2_H - df_H}{N}$

Where

χ^2_H = χ^2-distribution value for the estimated model

df_H = number of degrees in the estimated model

N = sample size

Then

$$\text{RMSEA} = \sqrt{\frac{\delta_H}{df_H}}$$

Reference values:

RMSEA < 0.05 expresses a close fit

0.05 < RMSEA < 0.08 expresses reasonable fit

RMSEA > 0.1 fit not sufficient

Example: estimation of perceived ease of use (PEOU), page 86.

$$\delta_H = \frac{\chi^2_H - df_H}{N} = \frac{17.187 - 2}{267} = \frac{15.187}{267} = 0.05688$$

$$\text{RMSEA} = \sqrt{\frac{0.05688}{2}} = \sqrt{0.2844}$$

$$= 0.1686416$$

$$= 0.169$$

SRMR

Calculation of Standardized Root Mean Square Residual (SRMR) (Wu, West & Taylor 2009) :

$$\text{SRMR} = \sqrt{\sum_j \sum_k \frac{r^2_{jk}}{p}}$$

Where

j = number of rows of the covariance matrix

k = number of column in the covariance matri

p = number of nonreplicated number of items in the covariance matrix

r_{jk} = standardized residual from covariance matrix with j rows and k colums

Standardized residuals are fitted residuals divided by the standard error of the residual
Fitted residuals are obtained from subtracting the sample covariance matrix from the estimated covariance matrix

Reference values:

SRMR value < 0.05 denotes an acceptable fit

SRMR equals 0 when model fit is perfect

CFI

Calculation of Comparative fit index (CFI) (Byrne 2012):

$$CFI = 1 - \frac{\chi^2_H - df_H}{\chi^2_B - df_B}$$

Where

χ^2_H = χ^2-distribution value for the estimated model
$df_H =$ number of degrees in the estimated model
χ^2_B = χ^2-distribution value for the baseline model
$df_B =$ number of degrees in the baseline model

Reference values:

- CFI > 0.95 indication of a good fit.

Example: estimation of perceived ease of use (PEOU), page 86.

$$CFI = 1 - \frac{\chi^2_H - df_H}{\chi^2_B - df_B}$$

$\chi^2_H = 17.187$
$df_H = 2$
$\chi^2_B = 467.391$ (χ^2-distribution value for the baseline model, not reported)
$df_B = 6$ (number of degrees in the baseline model, not reported)

$$CFI = 1 - \frac{17.187 - 2}{467.391 - 6}$$

$$= 1 - \frac{15.187}{461.391}$$

$$= 1 - 0.0329157$$

$$= 0.967$$

TLI

Calculation of Tucker-Lewis index (TLI) (Byrne 2012):

$$TLI = \frac{\left(\frac{\chi^2_B}{df_B} - \frac{\chi^2_H}{df_H}\right)}{\left(\frac{\chi^2_B}{df_B} - 1\right)}$$

Where

χ^2_H = χ^2-distribution value for the estimated model
$df_H =$ number of degrees in the estimated model
χ^2_B = χ^2-distribution value for the baseline model
$df_B =$ number of degrees in the baseline model

Reference values:

- TLI ≥0. 95 acceptable fit

Example: estimation of perceived ease of use (PEOU), page 86.

$\chi^2_H = 17.187$
$df_H = 2$
$\chi^2_B = 467.391$ (χ^2-distribution value for the baseline model, not reported)
$df_B = 6$ (number of degrees for the baseline model, not reported)

$$TLI = \frac{\left(\frac{467.391}{6} - \frac{17.187}{2}\right)}{\frac{467.391}{6} - 1}$$

$$= \frac{(77.8985 - 8.5935)}{77.8985 - 1}$$

$$= \frac{69.305}{76.8985}$$

$$= 0.901253$$
$$= 0.901$$

NFI
Calculation of Normed Fit Index (NFI) (Wu, West & Taylor 2009):

$$NFI = \frac{\chi^2_B - \chi^2_H}{\chi^2_B}$$

$$= 1 - \frac{\chi^2_H}{\chi^2_B}$$
$$= 1 - \frac{\chi^2_H}{\chi^2_B}$$

Where

$\chi^2_H = \chi^2$-distribution value for the estimated model
$\chi^2_B = \chi^2$-distribution value for the baseline model

Reference values:

- If the $\chi2$ –test rejects the model and the value of NFI is ≥0.95, it can be assumed that the rejection is caused by a large sample size

Example: estimation of perceived ease of use (PEOU), page 86.

$$\text{NFI} = 1 - \frac{\chi^2_H}{\chi^2_B}$$

$$= 1 - \left(\frac{17.187}{467.391}\right)$$

$$= 1 - 0.0367722$$

$$= 0.963$$

Cronbach alpha
Calculation of Cronbach alpha (Gliem & Gliem 2003) :

$$\alpha = \frac{N * \bar{r}}{1+(N-1) * \bar{r}}$$

where N= number of items of a scale
$\bar{r}$ = mean of correlations between items

Example: calculating Cronbach's alpha for the scale of behavioral intention, page 86.

Correlations between items (from page 95)

BI1 - BI2 = 0.840
BI1 - BI3 = 0.823
BI2 - BI3 = 0.819
Mean = 0.827
N = 3

$$\alpha = \frac{3 * 0.827}{1+(3-1) * 0.827}$$

$$= \frac{2.481}{2.654}$$

$$= 0.934$$

APPENDIX 4

Formulae for Fleiss' kappa calculation (Fleiss 1971) :

(a) Fleiss' kappa $\kappa = \frac{\bar{P} - \bar{P_e}}{1 - \bar{P_e}}$

Let
- n_{ij} number of raters who assign the i^th subject to the j^th category
- N number of subjects
- k number of categories
- i index for subjects, i = 1…N
- j index for categories, j = 1…k

To calculate κ, first calculate the proportion of assignments to the j^th category)

(b) $p_j = \frac{1}{Nn} \sum_{i=1}^{N} n_{ij}$

where

- n_{ij} is the number of raters who assign the i^th subject (e.g. COMP1, PU2, SI3) to the j^th category (e.g. COMP, PU, SI)

Then calculate P_i , the amount of rater pairs among n raters out of all possible n(n-1) pairs for the i^th subject

(c) $$P_i = \frac{1}{n(n-1)} \sum_{j=1}^{k} n_{ij}(n_{ij} - 1)$$
$$= \frac{1}{n(n-1)} \sum_{j=1}^{k} (n_{ij}^2 - n_{ij})$$
$$= \frac{1}{n(n-1)} [(\sum_{j=1}^{k} (n_{ij}^2) - n)]$$

Then calculate $\bar{P}$, is the mean of P_i's

(d) $\bar{P} = \frac{1}{N} \sum_{i=1}^{N} P_i$

Then calculate $\bar{P_e}$ which is the sum of squared p_j's from equation (a)

(e) $\bar{P_e} = \sum_{j=1}^{k} p_j^2$

Finally using equation (a)

(f) Fleiss' kappa $\kappa = \frac{\bar{P} - \bar{P_e}}{1 - \bar{P_e}}$

The standard error (S.E.) is calculated by calculating first the variance.

Formula to calculate variance of Fleiss' kappa κ (Fleiss 1971) :

(g) $\mathrm{Var}(\kappa) = \frac{2}{Nn(n-1)} x \frac{\sum_j p_j^2 - (2n-3)(\sum_j p_j^2)^2 + 2(n-2)\sum_j p_j^3}{(1 - \sum_j p_j^2)^2}$

(h) Standard error $= \sqrt{Var}$

Example: calculation Fleiss' kappa for the results after the sorting procedure, page 70. Results are summarized in the table below:

	PU	PEOU	SI	BI	COMP	PE	CANX	P_i
PU1	10							1.000
PU2	10							1.000
PU3	9			1				0.800
PU4	10							1.000
PEOU1		10						1.000
PEOU2	2	8						0.644
PEOU3		10						1.000
PEOU4		8				1	1	0.622
SI1	1		6		2		1	0.356
SI2			10					1.000
SI3			10					1.000
SI4			8	1			1	0.622
BI1				10				1.000
BI2	7			3				0.533
BI3	1			9				0.800
COMP1					10			1.000
COMP2	1	1	1	1	5	1		0.222
COMP3		2			4	4		0.289
PE1		1				9		0.800
PE2		1				9		0.800
PE3		1				9		0.800
CANX1							10	1.000
CANX2						1	9	0.800
CANX3							10	1.000
CANX4						2	8	0.644
total	51	42	35	25	21	36	40	19.733
p_j	0.204	0.168	0.140	0.100	0.084	0.144	0.160	
p_j^2	0.042	0.028	0.020	0.010	0.007	0.021	0.026	$\sum_j p_j^2 = 0.153$
p_j^3	0.0084	0.0047	0.0027	0.0010	0.0006	0.0030	0.0041	$\sum_j p_j^3 = 0.0245$

Fleiss' kappa

$$\kappa = \frac{\bar{P} - \bar{P_e}}{1 - \bar{P_e}}$$

First calulate $p_j = \frac{1}{Nn} \sum_{i=1}^{N} n_{ij}$ starting from from the first column:

$$p_1 = \frac{10+10+9+10+0+2+0+0+1+0+0+0+0+7+1+0+1+0+0+0+0+0+0+0+0}{10\ x\ 25} = \frac{51}{250} = 0.204$$

$$p_2 = \frac{0+0+0+0+10+8+10+8+0+0+0+0+0+0+0+0+1+2+1+1+1+0+0+0+0}{10\ x\ 25} = \frac{42}{250} = 0.168$$

.....

$$p_7 = \frac{0+0+0+0+0+0+0+1+1+0+1+0+0+0+0+0+0+0+0+0+0+10+9+10+8}{10\ x\ 25} = \frac{40}{250} = 0.160$$

Then calculate

$P_i = \frac{1}{n(n-1)} [(\sum_{j=1}^{k}(n_{ij}^2) - n)]$ for each row:

$$P_1 = \frac{1}{10(10-1)} (10^2 + 0^2 + 0^2 + 0^2 + 0^2 + 0^2 + 0^2 - 10) = \frac{100-10}{90} = \frac{90}{90} = 1$$
$$P_2 = \frac{1}{10(10-1)} (10^2 + 0^2 + 0^2 + 0^2 + 0^2 + 0^2 + 0^2 - 10) = \frac{100-10}{90} = \frac{90}{90} = 1$$
$$P_3 = \frac{1}{10(10-1)} (9^2 + 0^2 + 0^2 + 1^2 + 0^2 + 0^2 + 0^2 - 10) = \frac{82-10}{90} = \frac{72}{90} = 0.8$$
$$P_4 = \frac{1}{10(10-1)} (10^2 + 0^2 + 0^2 + 0^2 + 0^2 + 0^2 + 0^2 - 10) = \frac{100-10}{90} = \frac{90}{90} = 1$$
…
$$P_{25} = \frac{1}{10(10-1)} (0^2 + 0^2 + 0^2 + 0^2 + 0^2 + 2^2 + 8^2 - 10) = \frac{68-10}{90} = \frac{58}{90} = 0.644$$

Then calculate $\bar{P}$, which is the mean of P_i 's

$$\bar{P} = \frac{1}{N}\sum_{i=1}^{N} P_i$$

$$\bar{P} = \frac{1 + 1 + 0.8 + 1 + 1 + 0.644 + 1 + \ldots\ldots + 0.8 + 1 + 0.222 + 0.289 + 0.8 + 0.8 + 0.8 + 1 + 0.8 + 1 + 0.644}{25}$$

$$= 0.789$$

Then calculate $\bar{P}_e$ which is the sum of squared p_j ´s from equation (b)

$$\bar{P}_e = \sum_{j=1}^{k} p_j^2$$

$$\bar{P}_e = 0.204^2 + 0.168^2 + \cdots + 0.16^2 = 0.153$$

Finally, using equation (a) calculate Fleiss' kappa

$$\kappa = \frac{\bar{P} - \bar{P}_e}{1 - \bar{P}_e}$$

$$= \frac{0.789 - 0.153}{1 - 0.153}$$

$$= \frac{0.636}{0.847}$$

$$= 0.751$$

Calculation of standard error (S.E.) for Fleiss' kappa (Fleiss 1971) :

Variance of Fleiss' kappa:

$$\text{Var}(\kappa) = \frac{2}{Nn(n-1)} \cdot \frac{\sum_j p_j^2 - (2n-3)(\sum_j p_j^2)^2 + 2(n-2)\sum_j p_j^3}{(1 - \sum_j p_j^2)^2}$$

For this $\sum_j p_j^3$ is needed (sum of p_j ´s 3rd power)

$$\sum_j p_j^3 = 0.204^3 + 0.168^3 + 0.14^3 \ldots + 0.16^3$$

$$= 0.025$$

Then using formula (g) above

$$\text{Var}(\kappa) = \frac{2}{25\cdot 10\cdot(10-1)} \cdot \frac{0.153-(2\cdot 10-3)\cdot 0.153^2+2(10-2)\cdot 0.025}{(1-0.153)^2}$$

$$= \frac{2}{250\cdot 9} \cdot \frac{0.153-17\cdot 0.023+16\cdot 0.025}{0.847^2}$$

$$= \frac{2}{2250} \cdot \frac{0.153-0.391+0.4}{0.717}$$

$$= \frac{2}{2250} \cdot \frac{3.762}{0.717}$$

$$= 0.0047$$

Then finally, using formula(h) above

$$\text{standard error (S.E.)} = \sqrt{Var}$$

$$= \sqrt{0,0047}$$

$$= 0.069$$

and finally

$$\kappa\,/\text{S.E} = \frac{0.751}{0.069}$$

$$= 10.884$$

APPENDIX 5

Calculation of kurtosis and skewness (NIST/SEMATECH 2012) :

Kurtosis $= \frac{\sum_{i=1}^{N}(Y_i - \bar{Y})^4}{(N-1)s^4}$

Where
Y = data point
$\bar{Y}$ = standard mean of data points
s = standard deviation of data points
N = number of data points

Reference values:

- positive values indicate leptokurtic distribution with peak around the mean with fatter tails, negative values indicate platykurtic distribution with wider peak around mean with thinner tails

Skewness $= \frac{\sum(Y_i - \bar{Y})^3}{(N-1)s^3}$

where
Y = data point
$\bar{Y}$ = standard mean of data points
s = standard deviation of data points

Reference values:

- negative values indicate more value below mean, positive values indicate more values above mean, values close to zero indicate symmetric distribution