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**Measuring Performance Impacts of Mobile Business  
Services from the Customer Perspective**



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## **Measuring Performance Impacts of Mobile Business Services from the Customer Perspective**

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In loving memory of my dad, Leo

# ABSTRACT

**Vuolle, Maiju, 2011.** *“Measuring performance impacts of mobile business services from the customer perspective”* Department of Business Information Management and Logistics, Tampere University of Technology, Tampere, Finland.

**Keywords:** performance impacts, business performance measurement, productivity, intangible impacts, technology evaluation, measurement design process, mobile business services

Mobile technology and services are increasingly used to support workers in various industries. The goal of deploying mobile business services is to achieve various business benefits, such as cost savings, improved productivity, reachability, communication and customer satisfaction. However, research capturing the measurement of these performance impacts in mobile business service context is scarce. Therefore, the achieved impacts remain uncertain and there are no tools for measuring the impacts. In addition, there is a need to understand the contextual factors that influence the measurement of these impacts and whether the impacts can be achieved or not. This research aims to answer three research questions: 1) Which contextual factors should be taken into account when measuring the performance impacts of mobile business services? 2) Which business performance impacts should be measured? and 3) How to measure the performance impacts of mobile business services in practice?

Background theories include technology and services research as well as business performance measurement that are combined and applied in the mobile business service context. This study approaches performance impacts as benefits from the customer's point of view, including the customer organization and their employees using the services. This empirical research was conducted as action oriented case studies on three types of mobile business services in different industries and as a part of the measurement tool development process in Finland. Data was collected using interviews, observations, workshops and questionnaire. In addition, three pilot tests were conducted during measurement tool development process. The results of this research emerge by combining two parts of the dissertation: the literature discussed in the first part and the findings from five research articles included in the second part.

The key findings of this research are summarized as a performance measurement design process in the mobile business context including three phases: analyzing contextual factors, identifying performance impacts and defining measures. Contextual factors are related to mobile service specific factors and more general business factors. Tangible and intangible performance impacts of mobile business services can be identified and structured into employee, structural, relational, and monetary impacts. Performance measures can be defined using direct and indirect approaches capturing objective and subjective data. This research operationalizes some of the performance impacts and applies subjective productivity measurement in practice at the employee level. The findings of this research contribute to the discussion on the measurement of services and, in particular, to measuring customer impacts of services.

# TIIVISTELMÄ

**Vuolle, Maiju, 2011.** “Yritysten mobiilipalveluiden vaikutusten mittaaminen asiakkaan näkökulmasta” Tiedonhallinnan ja logistiikan laitos, Tampereen teknillinen yliopisto, Tampere, Suomi.

**Avainsanat:** suorituskykyvaikutus, liiketoiminnan suorituskyvyn mittaaminen, tuottavuus, aineettomat vaikutukset, teknologian arviointi, mittaamisen suunnitteluprosessi, mobiili yrityspalvelu

Mobiiliteknologiaa ja -palveluita käytetään yhä enemmän työntekijöiden tukemisessa eri toimialoilla. Yritysten mobiilipalvelujen käyttöönoton tavoitteena on saavuttaa monenlaisia liiketoiminnallisia hyötyjä, kuten kustannussäästöjä sekä tuottavuuden, tavoitettavuuden, kommunikaation tai asiakastyytyväisyyden paranemista. Näiden liiketoiminnan suorituskykyyn liittyvien vaikutusten mittaamiseen liittyvä tutkimus on ollut kuitenkin vähäistä mobiili kontekstissa. Tämän vuoksi ei ole selkeää kuvaa mitä vaikutuksia palveluilla saadaan aikaan eikä vaikutusten mittaamiseen ole työkaluja. Vaikutusten mittaamiseen ja toteutumiseen vaikuttaa monet kontekstiin liittyvät tekijät joita tulisi ymmärtää paremmin. Tämän tutkimuksen tavoitteena on vastata kolmeen tutkimuskysymykseen: 1) Mitä kontekstitekijöitä tulisi huomioida mitattaessa mobiilipalvelujen vaikutuksia? 2) Mitä liiketoiminnan suorituskykyvaikutuksia tulisi mitata? 3) Kuinka vaikutustekijöiden mittaaminen voidaan toteuttaa?

Tutkimuksen taustateorioihin kuuluvat teknologia- ja palvelututkimus sekä liiketoiminnan suorituskyvyn mittaaminen. Näitä taustateorioita sovelletaan yritysten mobiilipalveluissa ja palvelujen vaikutuksia lähestytään asiakashyödyn näkökulmasta. Empiirinen tutkimus toteutettiin kolmena toiminta-analyyttisenä tapaustutkimuksena joissa tarkasteltiin mobiilipalveluja eri toimialoilla sekä mittarien kehitysprosessina. Data kerättiin haastattelemalla, havainnoimalla, työpajojen avulla sekä kyselyllä. Lisäksi toteutettiin kolme pilottitestiä osana mittarien kehitysprosessissa. Tutkimuksen tulokset syntyvät yhdistämällä väitöskirjan kaksi osaa: ensimmäisessä osassa esitetty kirjallisuus sekä toiseen osaan liitetyt tutkimuspaperit.

Tutkimuksen keskeiset tulokset tiivistetään mobiilipalveluiden suorituskykyvaikutusten mittaamisen suunnitteluprosessiksi joka koostuu kolmesta vaiheesta: kontekstitekijöiden analysoiminen, suorituskykyvaikutusten tunnistaminen ja mittarien määrittäminen. Kontekstitekijät liittyvät sekä liiketoimintakontekstin vaatimukseen että palvelukohtaiseen mobiilikontekstiin. Tunnistetut aineelliset ja aineettomat vaikutukset jäsennetään neljään osatekijään: työntekijä, rakenne, suhde sekä rahalliset vaikutukset. Suorituskykymittarit voidaan määrittellä käyttäen suoraa ja epäsuoraa lähestymistapaa objektiivista sekä subjektiivista data keräten. Tässä tutkimuksessa myös operationalisoidaan osa vaikutuksista ja sovelletaan subjektiivista tuottavuuden mittaamista työntekijätasolla. Tutkimuksen tulokset tuovat uutta tietoa erityisesti palveluiden asiakasvaikutusten mittaamiseen.

# ACKNOWLEDGEMENTS

Writing a doctoral dissertation is often a story in itself. My journey was no exception. It started in 2006 and now few years later, on the last mile of the journey, I begin to see that I have all a good story needs to finish it: I have a beginning, I have an ending, I have had lows and highs and all the interesting plot twists in-between. During this research I've married, had my first child, lived two years in the Southern Hemisphere, mourned great losses, and what have you. Throughout that time I kept on learning, seeking, writing, rewriting, and again writing this dissertation – the topic never ceased to interest me. The end result is something I am (as a Finnish person, humbly) proud of. Something I genuinely want to build on in the future. There are many people I have to thank for this.

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Tampere, 20.11.2011

Maiju Vuolle



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- II **Vuolle, M.** (2011) Intangible benefits of mobile business services, *International Journal of Learning and Intellectual Capital*, Vol. 8, No. 1, pp. 50-62.
- III **Vuolle, M.**, Aula, A., Kulju, M., Vainio, T. & Wigelius, H. (2008) Identifying usability and productivity dimensions for measuring success of mobile business services, *Journal of Advances in Human-Computer Interaction*, Vol. 2008, doi:10.1155/2008/680159, 9 p.
- IV **Vuolle, M.**, Kallio, T., Kulju, M., Tiainen, M., Vainio, T. & Wigelius, H. (2008) Developing a questionnaire for evaluating mobile business service experience, *The proceedings of the 10th International Conference on Human Computer Interaction with Mobile Devices and Services (MobileHCI 2008)*, September 2-5, 2008. Amsterdam, the Netherlands, pp. 53-62.
- V **Vuolle, M.** (2010) Productivity impacts of mobile office service, *International Journal of Services Technology and Management*, Vol. 14, No. 4, pp. 326-342.

The author's maiden name was **Markova**. See the contribution of the author in each paper in Table 9, page 46.



## **PART I: INTRODUCTORY ESSAY**

# 1 INTRODUCTION

## 1.1 Background

Mobile technology and services are increasingly used in the work context and may benefit the users and companies in several industries. Mobile services for business use include both business-to-employee and business-to-business applications that are used to enhance the mobility and accessibility of employees and the efficiency of business processes (Chen & Nath, 2004; Liang et al., 2007). The goal of deploying these services is to achieve business performance impacts, including cost savings, increased productivity and various intangible impacts, such as employee and customer satisfaction, creation and use of knowledge assets and image of a company (Alanen & Autio, 2003; Evans, 2002; Gebauer & Shaw, 2004; Rangone & Renga, 2006; Sheng et al., 2005). However, the measurement of these impacts has been difficult as companies do not usually have a comprehensive way to assess the overall impacts of these services (Chen & Nath, 2008). The identification and measurement of intangible and other non-financial performance impacts have repeatedly been reported to be complicated and thus, often neglected (Irani, 2002; Gunasekaran et al., 2006). There is usually an underlying assumption that more utilization of a technology means more benefits, but this is often false in practice (Goodhue, 2007). For a technology to positively affect performance, it must be utilized and it must be appropriate for the task (Goodhue, 2007) and more broadly for the mobile and organizational contexts in which it is used.

Using mobile technologies in the work environment is still at the adoption and learning phase in many companies and the impacts have been little studied from the performance measurement perspective. The large sum of money spent on information technology (IT) and information system (IS) projects in general and the high degree of uncertainty associated with the adoption of new technology (benefits, risks, and costs) implies that the measurement of IT/IS should assume great importance (Irani et al., 2002; Gunasekaran et al., 2006). Although the importance of measuring success in the mobile work context has also been acknowledged, many organizations do not have comprehensive ways to measure success, or it may not be a priority at this point (Chen & Nath, 2008). In fact, IT investments in general have often been based on beliefs in the benefits rather than on any sound attempts to measure such benefits (Fitzgerald, 1998). The lack of understanding and measuring the holistic implications of adopting new technology may lead decision-makers to invest in unproductive technology and at the same time to refuse to implement a technology that could be beneficial to their long-term competitiveness (Irani et al., 2002; Gunasekaran et al., 2006). Seddon et al. (2000) report that the main difficulty in evaluating IT projects has been the identification and measurement of benefits, and particularly intangible benefits. In addition, the special characteristics of mobile work necessitate considering many new issues in order to understand the performance impacts of mobile services. Therefore, there seems to be a need to consider new approaches to identifying and measuring the business performance impacts of mobile business services and to have empirical evidence of how the measurement could be conducted in practice.

The research related to mobile technology and services has focused on the technical perspective and consumer markets although many attempts have also recently been made in the enterprise context (Basole, 2008; Sørensen et al., 2008; Gebauer et al., 2010; Yuan et al., 2010). Consumer studies usually focus more on hedonic voluntary use than on goal-oriented, utilitarian use and consumers are using mobile services for personal purposes. Various information and entertainment services, such as news, music and games are examples of content services that are mainly driven by consumer markets (Steinbock, 2005). These services aim at bringing consumers pleasure, fun and enjoyment (e.g., Lee et al., 2005; Kim et al., 2007). Mobile banking (Wessels & Drennan, 2010), payments and ticketing (Mallat, 2007; Mallat et al., 2009) are examples of more utilitarian use of consumer services. Depending on the user's goals, mobile services need to provide utility, communication or fun (Kaasinen, 2008). The perceived value of mobile services has also been categorized into context-related (incl. conditional, and epistemic value) and content-related (incl. emotional, social, convenience, and monetary value) value (Pihlström, 2008). Although these value dimensions can be useful in business use as well, there is still a need to understand the business value of mobile services. As Paavilainen (2001) argues, consumer services and enterprise services cannot be measured in the same way as the value analysis of corporate services is based on business expectations and requirements rather than individual goals.

In the context of mobile business services, recent studies have focused on different aspects than performance impacts, for example, usage intentions and fit between task and technology (Bouwman & van de Wijngaert, 2009; Gebauer et al., 2010; Yuan et al., 2010). The impacts of technology use are usually ignored or evaluated narrowly, for example, by combining all the impacts under one dimension and assessing performance with one or two statements (Vuolle & Käpylä, 2010). Some studies have identified the business value of mobile services (Picoto et al., 2010) and classified the benefits (Basole, 2007) but they have not provided information on how to operationalize the impacts, how the impacts may be related to different types of mobile services or how to carry out the measurement in practice.

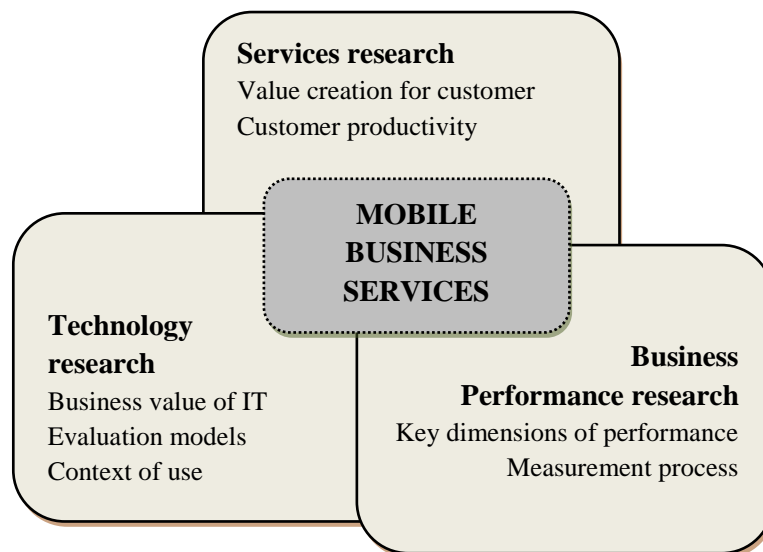
This research studies the measurement of the performance impacts of mobile business-to-employee services, such as mobile office and mobile operations services (Alanen & Autio, 2003). The performance impacts are studied especially from the customer perspective, including the impacts at various levels, such as employees using the mobile services, processes in which the services are deployed, and at customer company level. In order to have measurement information for managerial purposes, this dissertation identifies the various business performance impacts of using mobile services at work and develops measures for these impacts. The research focusing on mobile business services is conducted in various research fields, thus conceptual development and theoretical approaches have been scattered. This dissertation aims at bringing together these approaches by structuring the performance impacts and including the contextual characteristics and demands of mobility and business use in the measurement process of impacts. The empirical research is carried out as three case studies and a measurement tool development study in Finland.

This dissertation contains an introductory part and five individual research papers. The introductory part includes four chapters: *1. Introduction* provides background and motivation for the study, introduces the theoretical approaches of the study, defines the key concepts and introduces earlier studies related to the business value and benefits of mobile business services. *2. Research design*

first identifies the gaps in existing research and poses research questions to fill these gaps and also determines the scope and limitations of the research. Next the research strategy is presented including the methodological approaches of this study, the research process and empirical context. Finally, summaries of the research papers are provided. 3. *Results* describes and summarizes the key findings in relation to each research question. In 4. *Conclusions*, the contribution and implications for theory and practice are summarized, likewise the limitations and suggestions for future research.

## 1.2 Theoretical background of the study

This dissertation combines ideas and concepts from three research discourses that are distinct but also partly overlapping: services, technology and business performance research (Figure 1). These theoretical perspectives are applied in the mobile business service context that provides a novel and interesting phenomenon with no long research traditions as constraints. Thus new knowledge can emerge when taking a multidisciplinary view within this context. Studies conducted under mobile business or enterprise mobility research are reviewed in more detail in Chapter 1.4.



**Figure 1 Theoretical approaches of the study.**

Services have traditionally been studied in various fields such as service marketing (Edvardsson et al., 2005; Grönroos, 2007; Lovelock & Gummesson, 2004; Vargo & Lusch, 2004; Zeithaml et al., 2009) and service operations management (Roth & Menor, 2004; Johnston & Clark, 2008). Service science is an emerging cross-disciplinary field that “focuses on fundamental science, models, theories and applications to drive innovation, competition, and quality of life through service(s)” (Bitner et al., 2008, p. 228). The contribution and role of the customer is emphasized in the service literature (see, e.g., Bitner et al., 2007). As Edvardsson et al. (2005) suggest, service can be seen as a perspective on value creation where the focus is on value in use in the eyes of the customer. Sampson and Froehle (2006) argue that the presence of customer inputs (customer self-inputs:

physical presence or mind, tangible belongings, or customer-provided information) is a necessary and sufficient condition to define a production process as a service process. Services research also provides perspectives related to the nature of services (e.g., quality aspects, intangibility) (Grönroos, 2009; Lovelock, 1983) and defines the concepts of service productivity and customer productivity (Grönroos & Ojasalo, 2004; Johnston & Jones, 2004; Parasuraman, 2002; Anitsal & Schuman, 2007; Vuorinen et al., 1998) for understanding the impacts from the customers' point of view. Results and outcomes of services from the customer perspective are emphasized in this study.

Technology research is used in this dissertation as a broad concept including information technology (IT) and information systems (IS) evaluation studies, technology adoption and use research and human-computer interaction (HCI) studies. The first field studies the business value of using IT in companies and the justification of IT investments (Fitzgerald, 1998; Farbey et al., 1999; Irani, 2002; Melville et al., 2004, Tallon et al., 2000; Gunasekaran et al., 2006). The second field provides theoretical models that are used when evaluating the adoption, use intentions and impacts of technology in organizations (Davis, 1989; Venkatesh & Davis, 2000; Goodhue & Thompson, 1995; DeLone & McLean, 1992, 2003). HCI studies provide concepts of user experience (Forlizzi & Ford, 2000; Hassenzahl & Tractinsky, 2006) and context of use that are important factors when exploring mobile use (York & Pendharkar, 2004; Dix et al., 2000; Turel, 2006; Jumisko-Pyykkö & Vainio, 2010).

Studies related to business performance include the measurement of various key dimensions of performance such as productivity (Tangen, 2005; Misterek et al., 1992) and intangible factors (Lev, 2001; Marr et al., 2004; Lönnqvist, 2004; Schiuma & Lerro, 2008) as well as the performance measurement process (Kaplan & Norton, 1996; Neely et al., 2002; Bourne et al., 2000). These research fields provide approaches to understand the different types of performance impacts (financial, non-financial, tangible, intangible) at various levels from the managerial perspective and to develop measures for these impacts. There are various recommendations for performance measures (Neely et al., 1997; Hudson et al., 2001; Tangen, 2004), structural frameworks (e.g., Kaplan & Norton, 1996; Neely et al., 2001; 2002) and measurement system design processes (Bourne et al., 2000; Neely et al., 2000; Medori & Steeple, 2000) that can be used as guides when measuring the performance impacts of mobile business services. In addition, various contingency and contextual factors that influence performance measurement have been emphasized in recent studies (Garengo & Bititci, 2007, Chiesa et al., 2008). Performance and intellectual capital measurement are usually used when evaluating the performance of a company or a department. It seems worthwhile to adapt these perspectives for measuring the performance impacts of mobile business service use as the measurement is done for managerial purposes and these approaches are familiar in business context. These approaches also give a more balanced view of the impacts – both tangible and intangible impacts can be taken into account as well as various levels of analysis. To the best of the author's knowledge, these approaches have not previously been used as such within mobile business studies.

By combining these three approaches within the mobile business service context, a comprehensive view is applied for understanding the contextual factors that influence the performance impacts of mobile business services and the measurement of these impacts. The service perspective brings the customer focus into consideration, the technology perspective adds the business value of technology



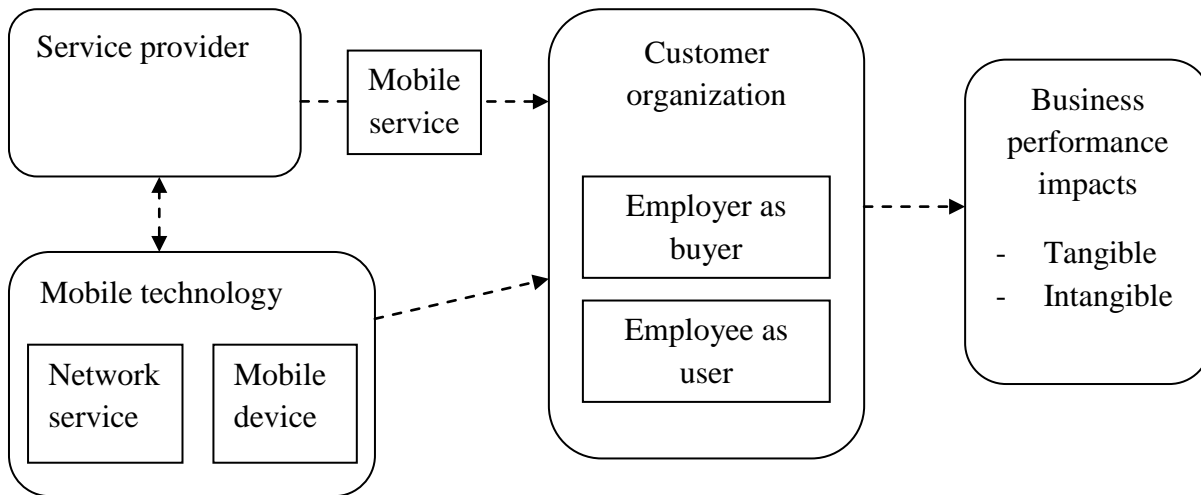
and context of use to this research, and performance measurement guides the process of identifying and measuring the performance impacts of technology-based services.

## 1.3 Key concepts

### 1.3.1 Mobile business services

**Mobile services** differ from other technology-based services due to the ability to provide service offerings independent of time and location (Heinonen & Pura, 2006). The purpose of using mobile services is to provide value above other methods through ubiquitous access, time, convenience and mobility (see e.g., Ancar & D’Incau, 2002). Mobile services can be characterized many ways, for example, based on technology (e.g., WAP, SMS), functionality (messaging, infotainment (information and entertainment), enterprise services, commerce etc.), customer needs or the characteristics of the task (Turel, 2006). Mobile services are usually classified based on the target user into business-oriented and consumer-oriented services (Chen et al., 2005), or business-to-consumer (B2C), business-to-business (B2B) and business-to-employees (B2E) services (Leem et al., 2004; Rangone & Renga, 2006).

In this research, service refers to a perspective on creating value-in-use as defined and experienced by customers (Edvardsson et al., 2005). The performance impacts are also studied from the customer perspective at various levels, Therefore, it is important to understand who the customer is. The mobile services discussed in this dissertation are **mobile business services** (more precisely, business-to-employee services) thus the customers of these services are organizations. The aim of a mobile business service is to create value for the customer organization (and employees and other stakeholders of the organization) as distinct from creating value for the individual consumer. The role of the customer is twofold and sometimes customer and user may even refer to different roles of the same person – a customer selects the service provider and which of the services offered to buy, whereas a user selects and uses applications and decides how long and how much they are used (Pohjola & Kilkki, 2007). In the business context, the use may also be mandatory and the user is usually not involved in selecting which services to use. There are several players involved in provisioning mobile services to end-users, for example, network and device vendors, network operators, service providers, content providers and third party software developers (Verkasalo, 2009). In this research, the focus is on the interaction of service provider and their customers (Figure 2). A service provider deals with the customer relationship and designs service portfolio, pricing and marketing (Pohjola & Kilkki, 2007). The end-users of these services are employees whose employer pays for the services. A useful mobile service can improve the efficiency of work and also improve employee satisfaction. However, there may be conflicting needs and expectations for the benefits of mobile services as employees may be forced to use services and their employer expects business benefits.



**Figure 2 Actors in the mobile business service provisioning.**

In addition to the term ‘service’, many other concepts are used in the literature. For example, some authors refer to mobile business applications (Gebauer & Shaw, 2004; Leem et al., 2004; Chen & Nath, 2004; Scornavacca & Barnes, 2008), mobile Internet applications (Rangone & Renga, 2006), mobile workforce solutions (Wang et al., 2005) or mobile work support (Zheng & Yuan, 2007; Yuan et al., 2010). Sometimes more specific terms are used, for example, sales force automation applications (Evans, 2002), mobile office services (Vuolle, 2010) or mobile digital calendars (Sell, 2008), depending on the purpose of the service or the application context. In addition, some authors refer more broadly to mobile technology (Sheng et al., 2005; Gebauer, 2008) or mobile technologies and applications (Bowman & van de Wijngaert, 2009) in order to include devices and network connections in the examination. Moreover, the term ‘enterprise mobility’ is quite often used to refer to the use of mobile technologies and services in companies (Barnes, 2003; Basole, 2008; Sørensen et al., 2008). To differentiate from the technical point of view, the term “service” is used in this dissertation instead of “application”. Application is considered as technical solutions that implement services whereas service is the whole entity seen by end-users (Verkasalo, 2009).

Although various concepts are used, they are rarely properly defined. Some *consumer-oriented definitions*, however, can be found that are useful for this study. For example, a mobile service is defined as “any kind of service that can be retrieved via a mobile device (cellular phone, personal digital assistant (PDA), or other handheld device) and that is delivered in interaction between an organization and a customer” (Pihlström, 2008, p. 4). This definition concentrates on content services, excluding interpersonal communication involving interaction between customers only (e.g., calling and messaging). Organization refers to a service provider and customer to an individual consumer. In addition, based on the definition of electronic (information) services Kar and Verbraeck (2008, p. 29) define mobile information service as “an activity or series of activities of intangible nature that occur when the consumer is mobile and a mobile telecommunications network supports the interaction through an Internet channel between customers and service employees or systems of a service provider. The aim is to provide solutions to customer’s problems and needs, add value, and thus create customer satisfaction.” This definition specifies the mobility

and service characteristics (intangibility), the interaction between consumer and service provider as well as the value creation for individual consumers.

The concept of **mobile business service** has been defined as a service that consists of communication activities or activities related to information recording, processing, delivery and/or use which are done with a mobile device via mobile/wireless networks as part of organizational processes for the benefit of the customer organization (Vuolle & Käpylä, 2010). This definition emphasizes different types of activities that can be supported with service functions and also the organizational context by stating that services are used for the benefit of the customer organization. This new definition is broadened for the purposes of this study by adding the user and use context as well as broadening the benefits to all stakeholders as follows:

*Mobile business service refers to a work-related service that consists of a mobile function or set of functions utilized by employees using mobile technologies in various use contexts for the benefit of stakeholders.*

In this way, various special characteristics of mobile services in business use are taken into account: various functions, user (i.e. employee), mobile technology (device and network connections), context of use (including task, mobility, locations, and time frames) and the outcome (business benefit for various stakeholders). A mobile business service is not only seen as a technical application but as a service that is consumed by a customer (i.e., an employee of a customer organization) and brings value to the customer (including employees, the customer organization, and other stakeholders). A *mobile device* in this dissertation refers to mobile (smart) phones, personal digital assistants (PDAs), and other handheld or fixed computing technologies that are capable of using mobile network access. Although it is here emphasized that the network access is used, some services can be used also in offline mode (Kalkota & Robinson, 2002; Chen et al., 2005). Examples of mobile business services include business data services providing access to the corporate intranet and email and services that enable mobile operations (e.g., sales force and field force).

In order to emphasize business use, some other definitions should be introduced. **Mobile work** refers to the flexible use of time and place using mobile information and communication technology for work and collaboration from multiple places (Vartiainen & Hyrkkänen, 2010). Main job categories of mobile workers include field work, sales work, executives/managers, transportation/delivery, health care, emergency service workers, journalism and mobile professionals (e.g., Corso et al., 2006; York & Pendharkar, 2004; Yuan et al., 2010). **Mobile task** characteristics include mobility, location dependency (variety, specificity and flexibility) and time criticality (time window, urgency) (Yuan et al., 2010) as well as task structure (routine to non-routine) and interdependence of other tasks and organizational units (Gebauer et al., 2010). **Mobility** can refer to any situation where a user is away from his or her standard office environment, for example, *wandering* (local mobility) in a building or local area, *visiting* customers and different places or *travelling* (either driving the vehicle or being a passenger) (Kristoffersen & Ljungberg, 1999; Gebauer, 2008; Yuan et al., 2010). It refers to the extent of using mobile services at different geographic locations and while the user is in transit between the locations (Gebauer et al., 2010). Location can vary from always at the same locations to different locations, be limited to

a specific location or task that can be done at any place and there may be differences in freedom of choosing a place (Yuan et al., 2010). Similarly, the task can be independent of time or need to be done at a particular time (Wiberg & Ljunberg, 2001). In addition to various physical environments that an employee uses for working (i.e., home, the main workplace, moving places, customer's or own company's other premises, hotels and cafes etc. ("third workplaces")), there are also virtual and social/mental spaces that constitute the multiple workplaces of mobile employees (Vartiainen, 2007; Vartiainen & Hyrkkänen, 2010). Virtual space refers to virtual workspace consisting of various tools and media for individual employees, groups and the whole organization that are used in physical workplaces (Vartiainen & Hyrkkänen, 2010). Mobile workers can be supported with various types of services that include *functionalities*, such as notifications, communication, information access, data processing (Gebauer et al., 2010), transactions, location tracking, navigation and online job dispatching (Yuan et al., 2010).

**User experience** is an important aspect of mobile technologies (Gebauer et al., 2010) and refers to a person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service (ISO 9241-210, 2010). User experience is affected by the user, the system and the context in which the interaction between user and system takes place (Forlizzi & Ford, 2000; Hassenzahl & Tractinsky, 2006). **Context of use** is the main differentiator of mobile and non-mobile services and systems and is studied a lot within HCI research. Context of use includes user characteristics, task, as well as technical, physical, and social environment (ISO standard 13407, 1999). In a recent review, context of use is separated from user, mobile system and the interactions between them and various external context related factors are identified, including physical, temporal, task, social, and technical and information contexts (Jumisko-Pyykkö & Vainio, 2010). Previously presented aspects related to mobile task characteristics are actually similar to different components of use context as defined in HCI studies. For example, in mobile work studies time, location, and mobility are included in mobile task characteristics (Yuan et al., 2010) or mobile use context (Gebauer, 2010) but they are also part of temporal and physical contexts (Jumisko-Pyykkö & Vainio, 2010). Social context has also been found to be important for mobile workers (Vartiainen & Hyrkkänen, 2010, Wigelius & Vääätäjä, 2009). It can also be broadened to include organizational factors that are important in business use.

Table 1 provides a summary of different contextual factors related to mobile work based on the combination of mobile work (Gebauer et al., 2010; Yuan et al., 2010) and HCI studies (Jumisko-Pyykkö & Vainio, 2010, p. 9). Technical context together with various mobile functionalities constitute the virtual workspace as defined by Vartiainen and Hyrkkänen (2010).

**Table 1 Context related factors in mobile work**

| <b>Component of use context</b>          | <b>Examples of Subcomponents</b>  |
|--|---|
| <b>Physical context</b>                  | <ul style="list-style-type: none"><li>- Location</li><li>- Movements and mobility</li><li>- Sensed environmental attributes</li></ul>                       |
| <b>Temporal context</b>                  | <ul style="list-style-type: none"><li>- Time criticality</li><li>- Duration</li><li>- Time of day/week/year</li></ul>                                       |
| <b>Task context</b>                      | <ul style="list-style-type: none"><li>- Task structure</li><li>- Interdependence</li><li>- Multitasking</li><li>- Interruptions</li></ul>                   |
| <b>Social context</b>                    | <ul style="list-style-type: none"><li>- Persons present</li><li>- Interpersonal actions</li><li>- Organizational culture</li></ul>                          |
| <b>Technical and information context</b> | <ul style="list-style-type: none"><li>- Other systems and services</li><li>- Portability/device</li><li>- Network connectivity</li><li>- Maturity</li></ul> |

### **1.3.2 Business performance impacts**

From the practical and measurement-oriented view, **performance** can be defined as “the measurement object’s ability to achieve results in relation to goals” (Lönnqvist, 2004). Performance is usually used as an umbrella concept for various **success factors** of a company, including efficiency, effectiveness, quality, productivity, profitability, etc. (Sink, 1983). Success factors are key aspects where targets must be reached in order to succeed in business objectives and strategies (Hannula & Lönnqvist, 2002). By using the term **business performance**, it is emphasized in this dissertation that the goals are usually the company’s goals and the analysis is related to companies rather than organizations (Franco-Santos et al., 2007) as this dissertation does not address the challenges related to non-profit and public organizations (see Jääskeläinen, 2010).

**Productivity** is one example of success factors that affect the overall performance of a company. It is closely related to performance, which it is easily confused and considered to be interchangeable, along with terms such as efficiency, effectiveness and profitability (see Tangen, 2005). Thus, they are important concepts to define. Traditionally, *productivity* has been defined as output divided by the input used to generate the output. Input consists of resources such as materials, labor, capital, and energy, and output consists of products, services or information. (Sink, 1983; Misterek et al., 1992; Tangen, 2005). *Efficiency* is related to the internal performance whereas *effectiveness* can be related more to the external performance of a process (Hannula, 1999).

*Profitability* is related to the relationship between revenue and costs and is affected by productivity and price recovery (i.e. changes in costs and prices) (Loggerenberg & Cucchiaro, 1981; Hannula, 1999). Performance, on the other hand, is a broader term that includes both overall economic and operational aspects.

The meaning of the multidimensional concept of productivity may vary depending on the context in which it is used. (Tangen, 2005). In the service context, productivity is seen broadly, also including the customer perspective. *Service productivity* can be seen as a relationship between service provider's operational productivity and customer productivity (Johnston & Jones, 2004). *Customer productivity* refers to the ratio of the service output experienced by a customer (e.g., satisfaction) to the inputs (e.g., time, effort, emotional energy) provided by that customer as a participant in service production (Parasuraman, 2002). According to Johnston and Jones (2004), customer outputs include experience, outcome, and value, whereas customer inputs include time, effort and cost. Bitner et al. (1997) note that in many services, the customers themselves have vital roles to play in creating service outcomes, and ultimately enhancing or detracting from their own satisfaction and the value received.

**Performance impacts** refer to benefits and changes in relation to performance that are achieved after some specific intervention, such as the deployment of new technology. The performance impacts of information technology are also included in the concept of IT business value (Tallon et al., 2000; Melville et al., 2004; Basole, 2007). Melville et al. (2004) define IT business value as “the organizational performance impacts of information technology at both the intermediate process level and the organization-wide level, and comprising both efficiency impacts and competitive impacts” (Melville et al., 2004). The business value of mobile ICT is defined as an overarching measure of different types of benefits to the organization, which combines strategic benefits, informational benefits, transactional benefits and enterprise transformation benefits (Basole, 2007). These definitions both indicate the fact that various levels need to be taken into account when analyzing the impacts. In their model of IT business value, Melville et al. (2004) divide performance into business process performance and organizational performance. Business process performance refers to the operational efficiency of specific business processes, measures of which include customer service, flexibility, information sharing, and inventory management. Organizational performance refers to overall firm performance, including productivity, efficiency, profitability, market value, competitive advantage, etc.

Intangible factors may account for the majority of the benefits resulting from investments in mobile business services, and thus they are included in this dissertation as one critical aspect of business performance. Including intangible benefits provides a more comprehensive and realistic view of returns as a result of the investment (Murphy & Simons, 2002). In addition, it is assumed that intangible impacts eventually lead to tangible outcomes, such as improved productivity and organizational performance (Marr et al., 2004; Carlucci & Schiuma, 2006). In this dissertation, the **intellectual capital** approach is utilized. According to Stewart (1997), intellectual capital (IC) refers to “intellectual material – knowledge, information, intellectual property, experience – that can be put to use to create wealth”. In addition, Marr and Moustaghfir (2005) define IC as “any valuable intangible resources gained through experiences and learning that can be used in the production of future wealth” (p. 1116).

Intellectual capital is usually divided into different components, for example, human capital, structural capital and customer capital (Edvinsson and Malone, 1997). On the other hand, Sveiby (1997) uses the concept of intangible assets and divides it into employee competence (education, experience), internal structure (management, patents, systems and organizational culture) and external structure (brands, customer and supplier relations). The three frequently used components of IC include various intangible resources: *human capital* consists of resources such as knowledge, competence, and education, *structural capital* includes the values and culture of an organization, likewise processes and systems, documented information, and immaterial properties (e.g., patents, copyrights, trade secrets), and finally *relational capital* consists of relationships with customers and other stakeholders, an organization's image and brands (Kujansivu, 2008). These components are applied in this dissertation to structure the business performance impacts of mobile business services together with financial and other tangible aspects.

Based on the approaches and definitions discussed in this chapter, the following definition is used in this dissertation:

*Business performance impacts refers to both tangible and intangible effects of using mobile business services in companies.*

### 1.3.3 Measurement as a managerial tool

The concepts of measurement, evaluation, appraisal and assessment are used in different research fields and usually refer to the same process of making a measurement object explicit. For example, according to Neely et al. (1995), performance measurement is the process of quantifying the efficiency and effectiveness of action or the results of that action. According to Farbey et al. (1999, p. 190), IT evaluation is “a process, or group of parallel processes, which take place at different points in time or continuously, for searching and for making explicit, quantitatively or qualitatively, all the impacts of an IT project and the programme and strategy of which it is a part.” Usually evaluation refers to post-implementation review of achieved benefits whereas appraisal refers to deciding whether the project should go ahead (Farbey et al., 1999). In this dissertation, the term ‘measurement’ is used in order to avoid inconsistency and following definitions are used:

- **Performance measurement** is a process used to determine the status of an attribute or attributes of the measurement object.
- **A performance measure** can be defined as the means for determining the status of an attribute or attributes of a measurement object.
- **Performance measurement system** is a set of measures which are used to determine the status of attributes of the measurement objects. (Lönqvist, 2004)

The evolution of balanced performance measurement started from the notion that traditional financial measures were too internal, short-term and historically-based with a narrow focus (Neely et al., 2000; Bourne et al., 2000; Nudurupati et al., 2011). Since then the literature in the field has been focusing on designing performance measurement system (PMS), with few studies illustrating

the issues in implementing and using PMS (Nudurupati et al., 2011). According to Folan and Browne (2005a), the evolution can be described in four phases: 1) recommendations, 2) structural and procedural frameworks, 3) performance measurement systems and 4) inter-organizational performance measurement. Various recommendations state that performance measures should be derived from strategy, clearly defined/explicit purpose, simple to understand and use, provide fast, accurate feedback, link operations to strategic goals and stimulate continuous improvement (Hudson et al., 2001). Inter-organizational performance measurement studies include the measurement within supply-chains (Gunasekaran et al., 2001), extended enterprises (Folan & Browne, 2005a; 2005b) and networks (Kulmala & Lönnqvist, 2006).

Several structural measurement frameworks have been presented in the literature that specify a typology for performance measures and thus provide the basis for identifying and choosing the success factors to be measured (Folan & Browne, 2005a; Neely et al., 2000; Pun & White, 2005; Nudurudati et al., 2001; Tangen, 2004). For example, the Balanced Scorecard framework consists of four perspectives on performance: financial, customer, internal business process, and learning and growth (Kaplan & Norton, 1996). The Performance Prism framework, on the other hand, includes five perspectives: stakeholder satisfaction, strategies, processes, capabilities and stakeholder contribution (Neely et al., 2001; 2002). The Intangible Assets Monitor focuses on measuring only intangible assets classified into employees' competencies, internal structure and external structure (Sveiby, 1997). The Navigator measurement framework, on the other hand, provides five perspectives including different components of intellectual capital and financial capital: financial, customer, human, process and renewal and development focus (Edvinsson & Malone, 1997).

Procedural framework refers to a step-by-step process for developing performance measures from strategy (Folan & Browne, 2005a). In addition to strategy, operative goals can also be used as a starting point (Franco-Santos et al., 2007) or stakeholders' wants and needs (Neely et al., 2001). There are several frameworks with different numbers of phases available in the literature (Neely et al., 2002; Bourne et al., 2003). In this dissertation, performance measurement is seen as a process with three main phases: the design of performance measures, the implementation of performance measures, and the use of performance measures (Bourne et al., 2000). First, key objectives need to be identified and then a performance measure for each objective needs to be designed. After that, measures are implemented, used, and reflected. In this dissertation, the focus is on the design phase of the measurement as the purpose is first to identify and structure the various performance impacts and then to develop proper measures for selected impacts.

Performance measurement systems combine both structural and procedural frameworks (Folan & Browne, 2005a). Kaplan and Norton (1996) provide a procedural framework that can be used together with the Balanced Scorecard and includes four stages: translating vision, communicating and linking, business planning and feedback and learning. Medori and Steeple (2000) provide an integrated performance measurement framework that works as a system consisting of six phases: company success factors (i.e., defining a company's strategy), performance measurement grid (including quality, cost, flexibility, time, delivery and future growth), selection of measures using spectrum/checklist, audit (a company's existing performance measurement system), implementation of measures and periodic maintenance.



### ***Purpose of measurement***

Performance impacts of mobile business services can be measured for various purposes. The role of performance measurement in general is to measure performance, for strategy management, decision-making, planning and forecasting, control, guidance, internal and external communication, influence behavior or education, learning and improvement (Simons, 2000; Franco-Santos et al., 2007). On the other hand, the benefits of performance measurement for employees include clear responsibilities and objectives, seeing accomplishments and receiving recognition, and more empowerment (Kaydos, 1999). Similarly, Marr et al. (2003) report that companies measure their intellectual capital due to implementing and validating their strategy, influencing employees' behavior and reporting externally. The purpose of technology evaluation models is usually to measure users' intentions to use and user satisfaction. Although these models do not emphasize performance impacts, they may give some new ideas on potential impacts. The results are usually used for the design and development of the technology. Analysis of benefits is one part of the overall IT/IS evaluation process (Fitzgerald, 1998). IT/IS investments are usually measured in order to compare different projects, rank projects in terms of organizational priorities, justify investment requests by management, control expenditure, benefits, risk, development and implementation of projects, provide a framework that facilitates organizational learning, and facilitate mechanisms to decide whether to fund, postpone or reject investment requests (Irani & Love, 2002).

In this dissertation, performance measurement puts emphasis on measuring the results and benefits of mobile business service use for managerial purposes. In this context, two factors pose challenges that need to be taken into account. First, the impacts should be considered in the context of the customer firm's goals for mobile services. Contradictory business goals needs to be understood when measuring work-related services, that is, success means different things for different stakeholders. In addition, needs and constraints related to measurement in the business context should be taken into account when developing measures, for example, in terms of the ease and speed of conducting the measurement and interpreting the results (see also Neely et al., 1997; Hudson et al., 2006). The other factor is related to understanding mobility and the mobile use context. Different types of mobile services contain various functions/features that yield several benefits. However, not all business users need every type of services and the goals cannot be satisfied without the fit between the mobile task and the service in a specific use context. It is also important to understand the nature of mobile services - They can be complementary services, only a small part in bigger process or the main way of working.

Managerial use of measurement implies pragmatic use instead of scientifically formed and validated measures. This dissertation focuses on understanding the business performance impacts in order to develop a practical mobile service measurement tool that can be used for different purposes: For example, a service provider could utilize measurement for supporting service development and marketing. In addition, they would benefit from having an easy way to monitor customer satisfaction. On the other hand, a customer company could set the targets for mobile service deployment and assess whether the goals are achieved or not. They could compare the level of impacts and develop actions and work practices with the help of technology. In addition, the

purpose is to give support and justification for investing in mobile technology based on evaluating the benefits instead of beliefs in the benefits.

### ***Measurement approaches***

In the literature, the factors measured are often called success factors (Kaplan and Norton, 1996; Toivanen, 2001) or measurement objects (Lönnqvist, 2004). Performance can be evaluated by measuring one success factor (for example productivity or cost savings) at the time or using balanced or multidimensional measurement frameworks. A balanced set of measures usually focuses not only on financial aspects but also on non-financial, external and forward looking performance measures (Bourne et al, 2000). In this dissertation, a balanced view is used. For example, even when considering only productivity impacts, productivity is measured from multiple perspectives and including direct and indirect measures.

In general, business performance can be measured in many ways with objective and subjective measures either directly or indirectly focusing on financial and non-financial, tangible and intangible factors (e.g., Kaydos, 1999; Simons, 2000; Lönnqvist, 2004). For example, objective productivity measures include total productivity measures (i.e. comparing all outputs with all inputs), partial productivity measures (dividing the total output by one input or some portion of inputs) and indirect productivity measures (factors which are closely related to problems in productivity) (Mistereck et al., 1992; Uusi-Rauva, 1996; Hannula, 1999). In practice, the measurement of total productivity is difficult as different types of outputs and inputs cannot be summed up and compared directly. Labor productivity is a most common example of partial productivity measure and is usually used when measuring the impacts of IT investments. Labor productivity is the ratio calculated by dividing the total output (e.g., number of products) by labor input (e.g., man-hour). Indirect productivity measures can be used when the data needed for partial productivity measures is not available. They include, for example, high defect rates, machine defects, unused capacity, high material scrap, unnecessary transports, poor atmosphere, and long waiting times. (e.g., Sink, 1985; Uusi-Rauva, 1996) Indirect measures can be used to explain the reasons behind the changes in productivity.

The problem with the traditional productivity measures is that they do not take into account changes in the quality of the inputs or outputs (Mistereck et al., 1992). In addition, they are related to a service provider's productivity and do not capture the customer perspective, which is important in the service context. In service business, quality and productivity cannot be dealt with separately (Sahay, 2005). For example, in knowledge and service work, inputs and outputs are usually intangible and the quality may vary a lot. In these cases, *subjective measurement* is one possible method to collect the needed information about the level of or problems in productivity or performance (see, e.g., Antikainen et al., 2008; Kujansivu & Oksanen, 2010; Torkzadeh & Doll, 1999). Subjective measures are based on personnel's subjective assessments and data is usually collected using surveys or interviews (Lynch & Riedel, 2001). In this study, subjective measures related to productivity impacts of mobile services are examined.

### ***Measurement challenges related to performance impacts***

A typical measurement challenge of performance impacts includes the timing of the realization as there is often a time lag before the impacts are achieved (Davern & Kauffman, 2002; Love & Irani, 2004): some of the impacts may occur immediately, soon or only after long period of time, for example, due to learning. The impact may also be negative right after the investment. For example, Jones et al. (2011) studied the impacts of adopting an enterprise resource planning system in a retail chain and found that performance initially dropped by 7% and then recovered in 6-12 months. In addition, some may not achieve any impacts. According to Devaraj and Kohli (2003), no connection between technology and productivity may be due to the aggregated unit of analysis at organizational level making it difficult to isolate the impact of any individual technology. Their review shows that the results of impacts are mixed: ranging from negative impact on the economy level to positive or no significant advantage at the industry level and positive or no impact at firm level. Overall, the more detailed the level of analysis, the better the chance to detect the impact, if any, of a given technology. For example, Torkzadeh and Doll (1999) argue that the success of IT can be measured through its impact on work at the individual user level. As there are several aspects that may influence performance in addition to mobile business services, it may be difficult to determine which factors cause alteration in the performance level. Antikainen et al. (2008) suggest using subjective measures and also measuring surrogate factors as the impacts can be relatively small in the short term.

In addition to challenges related to time lag and determining the impact of a given technology in relation to other factors at different levels, differences in measurement contexts may pose another problem for measurement as some methods cannot be applied in every context and there may be difficulties when comparing the results between different situations, for example, between jobs (Antikainen et al., 2008). The importance of contextual factors related to performance measurement has emerged in various research contexts, for example, when discussing the applicability of output- and throughput focused approaches in the not-for-profit sector (Jansen, 2004), the role of performance measurement systems in supporting organizational development in Scottish small and medium sized enterprises (Garengo & Bititci, 2007) and measuring the impacts of an IC development service in Russia (Kujansivu & Lönnqvist, 2009). Tilemma (2005), for example, argues that the appropriateness of using accounting instruments depends on the circumstances in which these instruments are used. In addition, Li and Tang (2009) point out that achieving the impacts depends upon the goal of implementing the new system and the existence of contextual factors of the specific business environment should be taken into account. Thus, in order to measure the performance impacts of mobile business services, it should be understood that this context is heavily dependent on various contingency factors, which means that various situational factors influence performance measurement and management practices in companies and there is no single, best way to manage or organize (Zeithaml et al., 1988; Garengo & Bititci, 2007).

The relationship between deploying new technology and its various impacts is complex. First, it is difficult to differentiate which of the impacts are due to the technology investment and which are affected by some other factor. In addition, the impacts are also connected to each other in various ways and there may be several correlations or cause and effect chains between the impacts. For

example, technology investments may produce intangible impacts that have effects on productivity and ultimately, on the profitability of a company. Performance impacts may include both performance drivers and outcomes that form a chain of cause and effect in which lower-level outcomes may be the drivers of higher-level results (Olve et al., 2000). There are some visualization tools available in the literature that presents the assumed relationships between the critical success factors and the objectives of an organization (Kaplan & Norton, 2004) or between intellectual capital and business performance (Marr et al., 2004; Carlucci et al., 2004; Carlucci & Schiuma, 2006). However, these relationships are not within the scope of this research as the performance impacts of mobile business services need to be identified first in order to identify relationships between the impacts.

## **1.4 Earlier studies on the performance impacts of mobile technology and services in the business context**

### **1.4.1 Technology evaluation models - focusing on mobility and business use**

Various technology evaluation models have been used for measuring the adoption and usage intentions of mobile technologies and performance impacts have also been analyzed and measured at some level. These models include the *Technology Acceptance Model (TAM)*, the *Task-Technology Fit (TTF) model* and the *Information Systems (IS) Success Model* and their extension as summarized in Table 2.

**Table 2 Examples of technology evaluation models used in mobile work context**

| <b>Model(s) used</b>  | <b>Mobile/business extensions</b>   | <b>Application area</b>                                      | <b>Author (year)</b>                    |
|---|---|--|---|
| <b>TAM</b>  | Perceived cost savings,<br>Company's willingness to pay   | Smartphone use<br>by employees                               | Kim (2008)                              |
| <b>Technology<br/>Satisfaction Model<br/>(based on TAM)</b> | Perceived loss of control<br>Perceived market performance   | Sales force  | Lee & Park (2008)                       |
| <b>TAM, TTF</b>   | Task: User mobility, time<br>criticality, interdependence, non-<br>routineness<br>Technology: Maturity, portability   | Mobile e-mail,<br>mobile devices,                            | Gebauer (2008)                          |
| <b>TAM, TTF, Media<br/>choice</b>                           | Perceived usefulness: Productivity,<br>resource advantage<br>Media fit: Solve problems,<br>information exchange   | Police   | Bouwman & van<br>de Wijngaert<br>(2009) |
| <b>TTF</b>  | Task: Structure, frequency, user<br>mobility, need for emergency<br>handling<br>Technology: Functionality,<br>portability, system performance and<br>user support<br>Impacts: Efficiency, effectiveness | Mobile electronic<br>procurement<br>application              | Gebauer & Shawn<br>(2004)               |
| <b>Fit-viability model<br/>(based on TTF)</b>               | Viability: economic feasibility,<br>technical infrastructure, social<br>readiness   | Seven mobile<br>applications in<br>four areas of<br>business | Liang et al. (2007)                     |
| <b>Mobile task model<br/>(based on TTF)</b>                 | Mobile task characteristics,<br>Functions of Mobile Work Support  | Mobile work  | Yuan et al. (2010)                      |
| <b>IS Success Model</b>                                     | Portability,<br>Nature of work (task structure,<br>extent of mobility)  | Health care  | Chatterjee et al.<br>(2009)             |

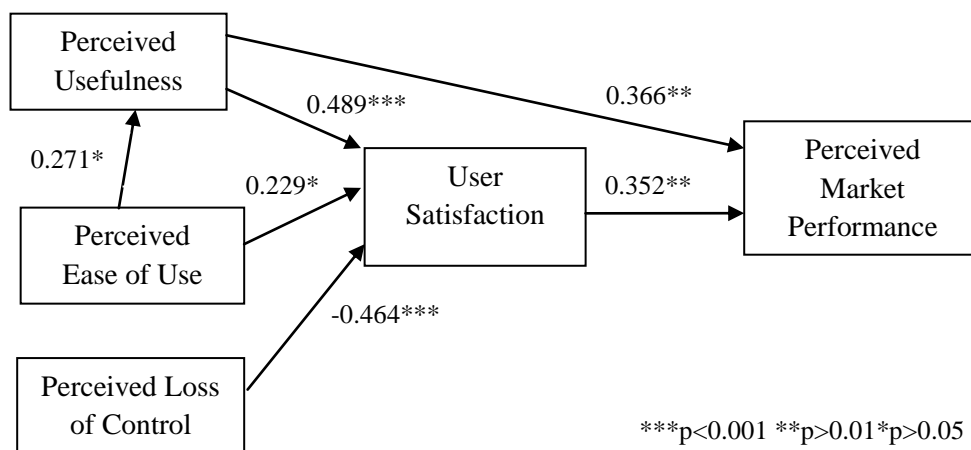
**The Technology Acceptance Model (TAM)**<sup>1</sup> predicts *user intentions* through *perceived usefulness* and *ease of use* (Davis, 1989). Usefulness is conceptually related to performance and productivity (Gebauer, 2008; Bouwman & van de Wijngaert, 2009). Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance". Perceived usefulness is measured using five statements concerning how using technology in job would enable worker to accomplish tasks more quickly, improve job performance, enhance effectiveness on the job, make it easier to do the job and how the worker

<sup>1</sup> Later, Venkatesh and Davis (2000) extended TAM to include additional key determinants of perceived usefulness and usage intention. This new model, TAM2, includes the constructs of subjective norm, voluntariness, (experience), image, job relevance, output quality and result demonstrability as determinants of user acceptance. Mobile extensions are, however, usually related to original TAM.

would find technology useful in his/her job. Although usefulness measures intentions (would), the statements have also been used for measuring actual impacts by changing grammatical tense.

TAM is used also in mobile work research a lot by extending the original model with constructs relevant to mobility and business use (e.g., Wu et al., 2007; Gebauer, 2008; Kim, 2008; Lee & Park, 2008; Bouwman & van de Wijngaert, 2009). Some authors have extended the model towards the financial perspective. For example, Kim (2008) examines employees' intentions to use smart phones by extending TAM with two new constructs: *Perceived cost savings* refers to user's perception on smart phones providing cost-effective communication and information exchange in terms of monetary factors, time and emotional effort. *Company's willingness to pay* is defined as "the degree to which a company believes that funding would enhance an individual's adoption".

Lee and Park (2008) took TAM as a starting point when investigating the mandatory adoption of mobile IT in the business-to-business (sales force) setting. They suggest that *user satisfaction* should be emphasized under mandatory adoption instead of evaluating the actual use or intention to use. In their **Technology Satisfaction Model (TSM)**, user satisfaction is also influenced by *perceived loss of control* (in addition to usefulness and ease of use) (Figure 3). Moreover, *perceived market performance* (profitability and revenues) is included in TMS as an organizational level performance measure. They found that the perceived loss of control has a negative impact on user satisfaction, and that user satisfaction, in turn, is positively related to perceived market performance. In addition, they found a relationship between perceived usefulness and perceived market performance. Therefore, usefulness, loss of control and satisfaction are critical factors when determining the success and organizational performance under mandatory use. This model examines negative impacts that may occur due to mobile business services and also extends the financial perspective to the organizational level.



**Figure 3 Technology Satisfaction Model (Lee and Park, 2008).**

**Task-Technology Fit (TTF)** is another model that is used when examining mobile technologies in the work context (e.g., Gebauer & Shaw, 2004; Ioimo & Aronson, 2004; Lee et al., 2005; Gebauer,

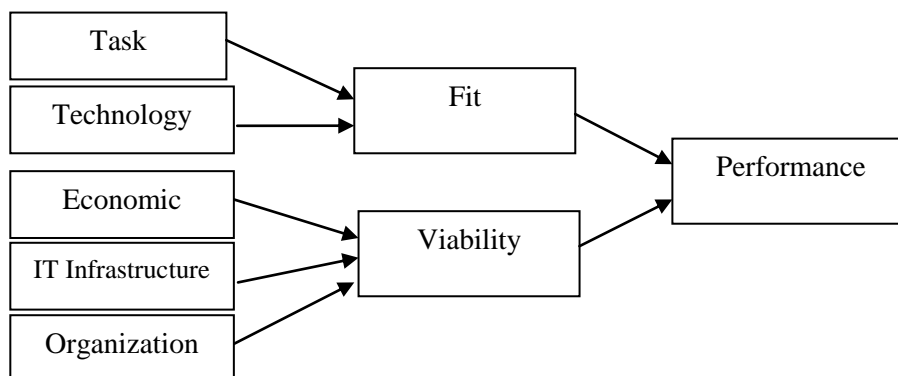
2008). TTF measures how well the technology assists an individual in performing his or her work tasks (Goodhue and Thompson, 1995). In this model, *individual performance impact* is measured using two statements:

- 1) The company computer environment has a large, positive impact on my effectiveness and productivity in my job.
- 2) IS computer systems and services are an important and valuable aid to me in the performance of my job.

These statements do not capture the impacts of one system/service but broader environment and IT portfolio. In addition, the first statement evaluates two impacts (effectiveness and productivity) in same statement, and thus may be difficult to answer.

In order to emphasize the organizational context, some authors have broadened the model. For example, Gebauer and Shaw (2004) extend TTF by addressing the *organizational impacts* of the mobile electronic procurement application. They note that usage can have operational impacts as well as impacts on organizational flexibility and emergency handling. Operational impacts refers to improving employee productivity and operational efficiency. They note that these improvements are due to the ability to process waiting tasks while out of the office and to make better informed decisions by obtaining additional information. According to the study, organizational flexibility results from better information access and sharing, allowing employees to keep in touch with their co-workers while out of office, and also to react quickly to unforeseen situations. They also found that the mobile service not only has effects on the user but indirect effects on the employees interacting with the user of the service.

In their **Fit-viability model**, Liang and Wei (2004) introduce a concept of viability to extend TTF to the organizational context (Figure 4). *Fit* is measured by the match between mobile task requirements (timeliness and mobility) and mobile technology capabilities (portability and the ability of the mobile device to access and provide timely information). *Viability* refers to the organization's readiness to apply mobile technology and is measured by the economic feasibility, the maturity of IT infrastructure and organizational support (Liang et al., 2007). Organizational viability is an important extension when assessing the success of the service. However, it is more like an enabler/prerequisite to the successful implementation and does not provide information on the organizational performance impacts.



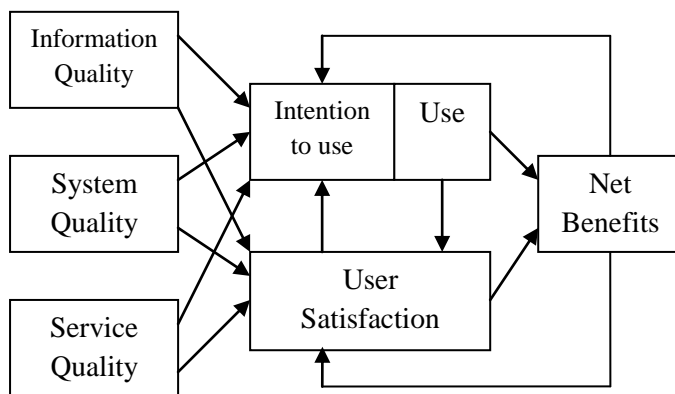
**Figure 4 Fit-viability model (Liang & Wei, 2004; Liang et al., 2007).**

In addition to organizational extension, some authors have focused more on the special characteristics of mobile work and mobile technologies. For example, Yuan et al. (2010) apply TTF to construct a **mobile task model** for identifying the fit between *mobile task characteristics* (mobility, location dependency and time criticality) and *mobile work support functions* (location tracking, navigation, notification and online job dispatching). Gebauer et al. (2010) apply and extend TTF for mobile information systems that are used by managers. Their conceptual model includes the mobile use context (distraction, connectivity, mobility) as a key differentiator between mobile and non-mobile use. The fit is established between *managerial tasks* (non-routineness, task interdependence, time criticality), *mobile IT* (functionality, user interface, adaptability) and the *mobile use context*, assuming that a good fit positively impacts task performance. Both of these previously presented models identify special characteristics of mobility and using mobile technology at work. Performance impacts are not taken into account.

Some authors have combined insights from TAM and TTF and applied them in the mobile context. Gebauer (2008) presents the results of four studies that use TAM and TTF as background theories. She provides a good analysis of how these models are conceptually related and complement each other well by addressing three key elements of success: *task* (mobility, non-routine and supervisory tasks), *technology* (ease of use (usability), technology maturity, portability, availability) and *user behavior*. Bouwman and van de Wijngaert (2009) study police officers using mobile communication tools and information technologies by combining TAM-related characteristics with media choice and TTF theories. They divide perceived usefulness into *productivity* and *resource advantage* and add media fit, which is related *problem-solving* and *information exchange* activities. They found that resource advantage relates to intention to use but there was no correlation between productivity and behavioral intention. Police officers see mobile systems as additional resources that are more suitable for sharing information than for solving problems in urgent situations. These authors conclude that TAM models are too generic to fully explain people's intentions to use mobile technologies and models should take (physical) context and task-related factors into account in order to better understand usefulness and intention to use.

The third popular model is **Information Systems (IS) Success Model** (DeLone & McLean, 1992) providing success factors for both *individual impact* (e.g., information awareness, decision effectiveness, improved individual productivity) and *organizational impact* (e.g., operating cost reduction, staff reductions, overall productivity gains, increased revenues, sales, market share and/or profits, product quality, service effectiveness). The original model has six interrelated dimensions of success that were derived from an extensive literature review: 1) system quality and 2) information quality affect both 3) use and 4) user satisfaction, which lead to 5) individual impact, and this should eventually have some 6) organizational impact. In addition, the amount of use can have a positive or negative effect on the degree of user satisfaction and vice versa. In the **updated IS Success Model**, the dimensions of individual and organizational impact are combined into one new dimension, named *net benefits*, to broaden the impacts of IS to groups, industries and nations, depending on the context (DeLone & McLean, 2003). In addition, service quality (e.g., IS support) and intention to use was added into the updated model based on the findings and suggestions from the literature (Figure 5).





**Figure 5 The updated IS Success Model (DeLone & McLean, 2003).**

Although the IS Success Model provides a quite comprehensive list of success factors, it does not provide ready-to-use measures and is therefore not much used that in mobile research. In addition, the comparison between the results is difficult due to the lack of measures/statements. However, as the impacts are case-specific, this may be justifiable. The IS success model has been used for examining mobile work in healthcare (Chatterjee et al., 2009). In their study the key success factors that can influence use, satisfaction and realization of the net benefits are portability, task structure, spatial mobility, and service quality (i.e. system reliability and support). Net benefits were defined as the extent to which there is a reduction in the delay of healthcare service provided to patients, increase in the accuracy and efficiency of healthcare service, reduction in errors in medical reports, improved security of medical records, increase in the ability to continuously monitor critical patients, etc.

Table 3 provides examples of various mobility and business factors that are used to extend traditional technology evaluation models. The measurement is usually made subjectively through questionnaires and these represent the opinion of the end-users (except for perceived market performance, which was directed to wholesale managers).

**Table 3 Examples of subjective measures for business and mobility factors**

|  | <b>Subjective measures – Statements</b>   | <b>Author (year)</b>              |
|--|---|-----------------------------------|
| <b>Business factor</b>                           |   |                                   |
| <b>Perceived Loss of Control</b>                 | The use of PDA transaction system is not voluntary.<br>We had no choice but to use PDA transaction system.  | Lee & Park (2008)                 |
| <b>Perceived Market Performance</b>              | PDA transaction system has contributed to increase in revenues over the last 3 years.<br>PDA transaction system has contributed to increase in profit over last 3 years.  | Lee & Park (2008)                 |
| <b>Perceived Cost Savings</b>                    | In my job, I can avoid any unnecessary cost and time by using a smartphone.<br>In my job, the use of smartphone saves costs related to time and effort.<br>A smartphone is more cost effective than other technologies in my job.   | Kim (2008)                        |
| <b>Company's willingness to fund</b>             | In my job, funding from my company is crucial for me because with new technology, I too often risk paying a lot of money for something that is not worth much.<br>In my job, if a company pays for any cost to use a smartphone, I will definitely use it.  | Kim (2008)                        |
| <b>Perceived usefulness (productivity)</b>       | Using mobile systems in my job would enable me to accomplish tasks more quickly.<br>Using mobile systems in my job would increase my productivity.<br>Using mobile systems would make it easier to do my job.   | Bouwman & van de Wijngaert (2009) |
| <b>Perceived usefulness (resource advantage)</b> | I would consider mobile systems useful in my job.<br>Mobile communication systems are a nice supplement to existing systems.<br>Mobile systems have many advantages over other systems.   | Bouwman & van de Wijngaert (2009) |
| <b>Mobile factor</b>                             |   |                                   |
| <b>Mobility</b>                                  | To what extent do you work at various locations?<br>To what extent is your work limited to a specific location?<br>To what extent do you have the freedom of choosing a place to perform your work?   | Yuan et al. (2010)                |
| <b>Location dependency</b>                       | To what extent is performing your work dependent on information about...<br>...your current location?<br>...other people's (such as co-workers or customers) locations?<br>...the location of things or equipments that are related to your work?<br>...travel or navigation guides to the destination? | Yuan et al. (2010)                |
| <b>Time criticality</b>                          | What is the time urgency for you to start or finish your typical task?<br>It is very important for you to start/complete your task on time<br>It is very important for you to start/complete your task as soon as possible  | Yuan et al. (2010)                |

Based on the foregoing discussion and examples, it seems that the performance impacts are not sufficiently emphasized in technology evaluation models as the performance impacts are measured only with a couple of statements, mainly from the user perspective. Some attempts have been made to emphasize the financial perspective of a company in order to extend the impacts to organizational level. As these models have been used and extended to mobile context, they provide good understanding related to the special characteristics of mobility and mobile work, including mobile task, technology and use context. These characteristics are useful for this research when analyzing the contextual factors. In addition, the statements used for measuring user's perceptions of usefulness are applied when developing the measurement tool in this research. However, there is still a missing link between different types of services and their possible due to the special characteristics of those services.

#### **1.4.2 Methods for analyzing mobile business value and benefits**

Many studies have identified various benefits of using mobile technologies and services in companies. Commonly observed benefits include higher levels of end-user convenience, efficiency, productivity, decision-speed and process improvement (Basole, 2008). Measures currently used for measuring the success of mobile work include return on investment (ROI), cost of operation, customer satisfaction and employee retention (Chen & Nath, 2008). In this chapter, various methods for analyzing performance impacts of using mobile business technologies and services are discussed (Table 4).

**Table 4 Approaches used for analyzing business performance impacts of mobile technology**

| <b>Approach</b>                                       | <b>Description</b>   | <b>Author (year)</b>   |
|---|--|--|
| <b>Financial calculations</b>                         | Calculating cost savings and ROI   | Evans (2002), Kornak et al. (2004)   |
| <b>Process level analysis</b>                         | Process measures, business process modeling  | Kadyte (2004), Rossi et al. (2007), van der Heijden and Valiente (2002), Gruhn et al. (2007) |
| <b>Business value classification</b>                  | Strategic, informational and transactional benefits, enterprise transformations  | Basole (2007)  |
| <b>Classification based on Value-Focused thinking</b> | Means-end objective network  | Sheng et al. (2005), Nah et al. (2005)   |
| <b>Mobile Enterprise Model (MEM)</b>                  | Mobility, process, market value proposition  | Barnes (2003)  |
| <b>Impact/Value framework</b>                         | Impact: Time, mobility, relationships, location<br>Value: efficiency, effectiveness, innovation                              | Chen & Nath (2004)   |
| <b>Mobility-M framework</b>                           | Technology, mobile added values (or cost analysis), informational added values (or benefit analysis), process classification | Gumpp & Pousttchi (2005), Pousttchi et al. (2009)  |
| <b>Model for M-business value</b>                     | Impact on downstream, internal and upstream dimension  | Picoto et al. (2010)   |

At the beginning of mobile business studies, it seems that measuring one success factor at a time was prevalent and the emphasis was initially on financial measures and tangible benefits at first. For example, cost reduction and productivity improvements are usually said to be the main drivers for companies deploying mobile business services (Alahuhta et al., 2005). Table 5 provides some examples of calculating cost savings and ROI when using mobile services in order entry process and for field work (Evans, 2002). The calculations are based on time savings that are achieved when using mobile services and average salaries and number of workers. Similarly, Kornak et al. (2004, p. 37) measured the cost savings of field work based on time saved by inputting info onsite, average cost per hour per field worker and the number of orders per day. Moreover, they also included time saved in administrative tasks per day. They calculated revenue generation by extra service calls per week and average revenue per service call.

**Table 5 Examples of estimating cost savings and measuring ROI (Evans, 2002)**

| <i>Sales (Order entry process)</i> |  |
|------------------------------------|--|
| Cost savings =                     | Time savings per order (hrs) *<br># orders per salesperson *<br># of salespersons *<br>(avg. salary/#of hrs worked per year) |
| Cost savings =                     | % productivity increase * # of salespersons * avg. Salary  |
| Revenue increase =                 | % productivity increase * Productivity Factor * # of orders<br>per salesperson * # of salespersons * avg. price per order    |
| <i>Field</i>                       |  |
| Cost savings =                     | Time savings (hrs/wk) * 52 * avg. salary * # of field<br>workers   |
| ROI =                              | Total benefits (cost savings) / Total costs<br>= (Labor cost savings + other cost savings) / Total costs                     |
| where Labor cost savings =         | (# of reps) * (salary + benefits) * (% time savings) *<br>(productivity rating)  |

Even though there are extensive calculations available (such as cost savings and ROI), these techniques do not capture the entire value of investment in mobile business services as they do not take into account intangible factors such as quality, timeliness, flexibility, user satisfaction and security (Duyshart et al., 2003). As it is argued that much of its value comes from intangible benefits (Seddon et al., 2002), the disappointment may be great if the success of technology is measured only with traditional economic measures. In order to measure the value of mobile business service investment, the total benefits and impacts on business performance should first be identified. This means that both the tangible as well as intangible benefits created by mobile service investment should be estimated. For example, Basole (2007) argues that business value should be considered as a combination of both tangible and intangible metrics.

Some of the studies have identified the benefits of mobile business services at **process level** (Gumpp & Pousttchi, 2005; Kadyte, 2004; Rossi et al., 2007). For example, van der Heijden and Valiente (2002) identify the value of mobile technology for *business process performance* in vehicle dispatching and mobile parking by modeling the business processes. They conclude that the benefits from mobile technologies arise when coordination is required between business process actors who are (temporarily) difficult to locate. In addition, the benefits are related to the costs of not being able to coordinate during the time when the actors are difficult to reach and also to the costs of available substitutes for mobile technology in a business process. Gruhn et al. (2007) present a method for organizing business processes more efficiently through mobile technologies in order to realize cost savings. They analyze the initial process together with different alternatives and calculate the *process costs* based on the average execution time for single process steps.

There are also some **classifications of the impacts and value** of mobile technology in the literature. For example, Alanen and Autio (2003) divide impacts into productivity gains (savings related benefits) and competitive edge (profit related benefits). Basole (2007) argues that organizations can gain four kinds of benefits: 1) *strategic benefits* include aspects related to

competitive advantage, organizational goals, new products and services and customer relationships, 2) *informational benefits* include faster and easier access to internal and external information, more useful, accurate and reliable information, and increased flexibility for manipulation of content and format of information, 3) *transactional benefits* include operational and cost savings, supply chain management savings, staff cost savings, and improved business efficiency of employees, business processes, and financial resources and 4) *enterprise transformation* include improved skill levels, new business plan and business models, expanded capabilities, and improved structure and processes. The business value is measured by the extent with which decision-makers agree that these benefits will be achieved by utilizing mobile technology.

Another type of classification is provided by Sheng et al. (2005) and Nah et al. (2005) who examined the strategic implications of mobile technology for sales personnel in a publishing company and in utility company using *value-focused thinking*. They constructed the means-end objective network to identify how company strategies (fundamental objectives) can be achieved by using mobile technology (means objectives). This helps companies to identify the main strategic implications of mobile technology, such as improve the work process by enabling activities to be carried out in real-time and eliminating redundant procedures, increase internal communication and knowledge sharing through the new channel and enhance sales and marketing effectiveness (Sheng et al., 2005). Fundamental objectives can include factors such as maximizing customer service, maximizing company image, maximizing employee satisfaction, maximizing efficiency, maximizing effectiveness and minimizing cost (Sheng et al., 2005).

In addition to these benefit classifications, some authors have provided mobile specific **models and frameworks** in order to capture the potential of mobile business services. For example, Barnes (2003) describes a conceptual **Mobile Enterprise Model (MEM)** that consists of three axes and each having three possible positions: *mobility*, *process* and *market value proposition*. Mobility refers to the level of geographical independence of employees (*transient*, *mobile* or *remote*). Process describes the change in the nature of work tasks and processes due to the mobile service adoption and may be *automation*, *decision support/information* or *transformation*. Market value proposition indicates how much products, services and relationships with customers, partners and suppliers are changed. The three levels include *mobile channel access (for mobile employees)*, *mobile service value* and *mobile service creation*. This model provides an analysis tool for understanding different levels of enterprise transformation and how enterprises can be transformed by utilizing mobile technology. It does not, however, examine practical and measurable impacts and benefits but is more like a strategic tool for understanding employee mobility, structural and relational changes. Scornavacca and Barnes (2008) applied the MEM when analyzing the strategic value of mobility among companies in New Zealand. They found that most of the business benefits were related to employee integration and individual performance improvement instead of product, service or organizational improvement. In addition, they found that there is little indication that the applications had any impact on the market value proposition.

Moreover, Chen and Nath (2004) provide an **impact/value framework** for mobile business applications based on the framework developed by Hammer and Mangurian (1987). The purpose of the framework is to help managers systematically identify the opportunities of mobile services from the perspective of the organization's goals and objectives. The framework suggests that the four

impacts of mobile business applications include *time, mobility, relationships, and location*. These mobile specific impacts can bring value into three perspectives: *efficiency* in operations, *effectiveness* in decision-making and *innovation* in business processes to generate competitive advantage. For example, the impact of a mobile business application on mobility can result in efficiency by capturing information electronically anytime-anywhere, produce effectiveness through accessing critical information anytime-anywhere and create competitive advantage through enhanced service quality.

Gumpp and Pousttchi (2005) provide a structural **Mobility-M framework** for understanding the potential organizational impacts of mobile technologies by analyzing mobile technology, business processes and the link between them. *Business processes* include customer relationship management, administration, operations and business intelligence. *Mobile technology* refers to mobile devices, mobile communication techniques and mobile infrastructure. The impacts on business processes are categorized based on *eight informational added values* and these impacts are induced by particular qualities of mobile technology (*mobile added values*), such as ubiquity, context-sensitivity and functions. This framework is proposed for application to mobile business process re-engineering and evaluating the use of mobile technologies according to their potential benefits. However, the framework does not provide any methods or actual measures for measuring the benefits, and the impacts are only linked to informational added value. Pousttchi et al. (2009) used the Mobility-M framework for structured analysis and comparison of six mobile enterprise solutions in Europe and Japan. They took a broader view on the benefits resulting from mobile technology and differentiated two groups: *monetary benefits* (cost savings) and *effectiveness* (e.g., customer or employee satisfaction, data quality, new market opportunities). They found that European mobile enterprise solutions aim at generating monetary benefits due to more efficient business processes whereas Japanese companies typically focus on entering new markets, increasing customer service and improving convenience.

In order to provide an improved third quadrant to the Mobility-M framework, Habermann & Pousttchi (2009) identify six requirements on appropriate measures for the business value of mobile-integrated business processes (MIBP) based on the specific characteristics of MIBP investments. They conclude that MIBP business value measures 1) should be defined in relation to the business objectives for which the technology is deployed, 2) should consider the time horizon of the expected realization, 3) should be defined at the internal organizational level, assessing the complete business effect of the MIBP, 4) should assess the outcomes separately for different stakeholders in the process, 5) should be agreed with all stakeholders prior to the invest to ensure later acceptance and 6) should regard the degree of intended innovation and consider the corresponding realization risks especially when the MIBP has a transformational character. These requirements help the development of a suitable measurement framework for mobile business process reengineering.

Picoto et al. (2010) provide a **conceptual model for m-business value**. This model can be used for investigating how mobile business creates value for firms through the impact on three major groups of activities in the value chain: the *downstream* dimension (sales, customer, product and service innovation), *internal* operations (efficiency, productivity, flexibility) and the *upstream* dimension (inventory management, communication with suppliers). The value is based on the unique features

of mobile technologies, such as flexibility, convenience and ubiquity. Picoto et al. (2010) found evidence from interviews that mobile business has impacts on the organizational downstream and internal dimensions but its impacts upstream were not clear. Downstream impacts included increased sales, widened sales area, improved product and service innovation, increased customer satisfaction, increased convenience to customers and enhanced communication with customers. Internal impacts included more efficient internal operations (e.g., speed up processing, reduce bottlenecks, reduce errors, notification), increased staff productivity, facilitated communication among employees, increased compression of business process, improved organizational flexibility, reduced administrative workload by elimination of manual routines, increased control, enhanced decision-making and improved staff motivation.

The positive aspects in these classifications and frameworks are that they all provide a more balanced view of the impacts by introducing also intangible benefits, multiple levels of analysis and they are meant for managerial use. In addition, they link different mobile dimensions to these impacts and provide an understanding of how the impacts can be achieved via mobile technologies. These results are linked to the empirical findings of this research and used to analyze various performance impacts of mobile business services. Moreover, mobile dimensions provide a better understanding of the contextual factors of this research. However, most of these studies are only conceptual and do not provide any measures for performance impacts. Some have used empirical studies when identifying the impacts but concrete examples of how the measurement could be carried out in practical context are still missing.



## 2 RESEARCH DESIGN

### 2.1 Research problem and questions

In the early phases of mobile technology adoption, the expected benefits were rarely achieved due to fairly immature technology and companies lacking the readiness to deploy these technologies. Now the number of companies using mobile technologies and services is increasing as the underlying technology has improved significantly and value-added mobile applications are rapidly emerging. Therefore, it is essential to have a better understanding of the value and impacts of using mobile services in the work context. (Basole, 2008)

Technology evaluation models and questionnaires were originally developed for desktop environments and many of the applications of these models focus on mobile consumer use (e.g., Kaasinen, 2008; Kim et al., 2007; Lopez-Nicolas et al., 2008), for example mobile banking (Lee & Chung, 2009) or mobile ticketing (Mallat et al., 2009). Among mobile consumer services, Pihlström (2008) has divided customer perceived value into six dimensions: conditional, epistemic, emotional, social, convenience and monetary value. In the case of business services, however, value is also created for the organization and its stakeholders in addition to individual users. Therefore, there is still a need to explore customer value and impacts more broadly in the work context and from the business perspective.

Mobile business services have special characteristics that are related to mobile work use, including task, technology and varying mobile use contexts (Yuan et al., 2010; Gebauer et al., 2010). These aspects are relatively well identified and it is assumed that a good fit between these yields positive performance impacts. However, they have not been linked to business performance impacts in practice. Thus it is important to understand the special nature of these services in business context and how different types of services achieve different types of impacts.

Some attempts have been made to indicate the potential benefits of mobile technologies and services by measuring cost savings and ROI (Evans, 2002; Kornak et al., 2004). These approaches, however, provide quite a narrow view of the impacts as they ignore perspectives other than financial impacts. Technology evaluation models, on the other hand, usually focus on usage intentions and on understanding why technology is (not) used, leaving performance impacts unclear. In addition, these models are usually not used for managerial purposes. Mobile specific classifications and frameworks provide a more balanced view of the impacts of mobile services at work by emphasizing different levels of analysis and also intangible impacts. There is still no consensus on how the impacts should be categorized and how to measure these impacts in practice. In addition, they usually focus solely on planned impacts instead of measuring the actual outcomes of use.

In their study, Chen and Nath (2008) found that none of their sample organizations employed a comprehensive way to measure all the tangible and intangible aspects of mobile work. In this study, a better and more comprehensive understanding is acquired by applying business performance

measurement, including productivity and intellectual capital measurement. As tangible impacts are usually easier to identify and measure, this study puts also emphasis on the intangible benefits of mobile service use. According to Farbey et al. (1999), the difficulty of dealing with intangible benefits, and their frequent omission from business cases is leading to the neglect of important aspects of the investments. Business performance measurement has not been used in the context of mobile business services. Thus the applicability needs to be explored. In addition, there is no link between the different types and characteristics of mobile services and their performance impacts.

As discussed above, there are many research needs related to the topic of measuring the performance impacts of mobile business service use. The first purpose of this study is to structure the various business performance impacts of using mobile services at work and to include the special characteristics and demands of mobility and business use in the practical measurement of these impacts. The other purpose is to provide practical methods for measuring the performance impacts of mobile business services. The three main research questions of this dissertation are:

1. Which contextual factors should be taken into account when measuring the performance impacts of mobile business services?
2. Which business performance impacts should be measured?
3. How to measure the performance impacts of mobile business services in practice?

The research questions are answered utilizing several types of empirical data and theoretical approaches. These questions need to be discussed for two practical reasons: to be better able to measure and manage mobile business services (user company's point of view), and to provide better services and communicate the potential benefits of these services to customers (service provider's point of view). Through these empirical evidences on the performance impacts of mobile business services, more knowledge is acquired for theoretical development.

## **2.2 Scope and limitations of the research**

Mobile services have been studied in various fields. This study takes a multidisciplinary view by combining knowledge from three research perspectives: services, technology and business performance research. The research topic is approached from the management perspective. Mobile services are increasingly used in the work context and may benefit the users and companies in several ways. The main focus of this dissertation is on business services targeted at employees. Its aim is to identify and measure the various performance impacts of different types of services from customer perspective (i.e., customer organizations and their employees (users)). The services can be provided to service provider's internal or external customers. Business performance impacts are considered mainly at micro level, that is, at the operative level and processes in which mobile business services are used instead of the strategic level and macro environment. Although it is conceded that various impact factors are interlinked, the assumed cause and effect relationships of the impacts are not discussed in this research. In order to study and verify various causal relationships, the performance impacts need to be identified first and more measurement data should be gathered related to these impacts over long period of time. Correlations were analyzed

between the perceived productivity impacts in Case C (Paper V) in order to see if there are any linear relationships but they do not show causalities.

There are also some costs and sacrifices that need to be made before potential benefits can be converted into business impacts. This research, however, relies on a benefit-oriented approach from the customer perspective. Business performance impacts are considered as benefits and this study does not explore the trade-off between benefits and sacrifices (cf. Pihlström, 2008 p. 29). There may also be a large set of technological and organizational factors and risks that may inhibit the positive impacts, for example, those related to organizational culture, but these are not included in this study. The benefits are evaluated by focusing on individual mobile business services – not on overall IT investment portfolio or IT department.

The mobile services included in this dissertation are used by using mobile devices, such as mobile smart phones, communicators and fixed in-car devices (as they move with the car and use mobile networks). Laptops were not included in this study although they may be included among mobile devices when used, for example, in a train via mobile networks. A mobile phone can in some situations replace the use of laptops.

Although the case studies of this research were conducted in Finnish organizations with Finnish users, the aim is to keep the research as generalizable as possible. There are differences between countries in how mobile services are produced and how the mobile industry works but these aspects are not addressed in this study nor are legislative issues. The empirical data of this study were gathered at a particular point of time in 2006-2008. Since then, the technological development has been fast and many new mobile technologies and services have been launched on the markets. As the technological evolution of mobile services is not within the scope of this study, the empirical data related to various performance impacts and their measurement is still considered valid and topical. There may be some new ways of working and new impacts achieved with newer technology and services, but the methods of identifying and measuring these impacts remain unchanged.

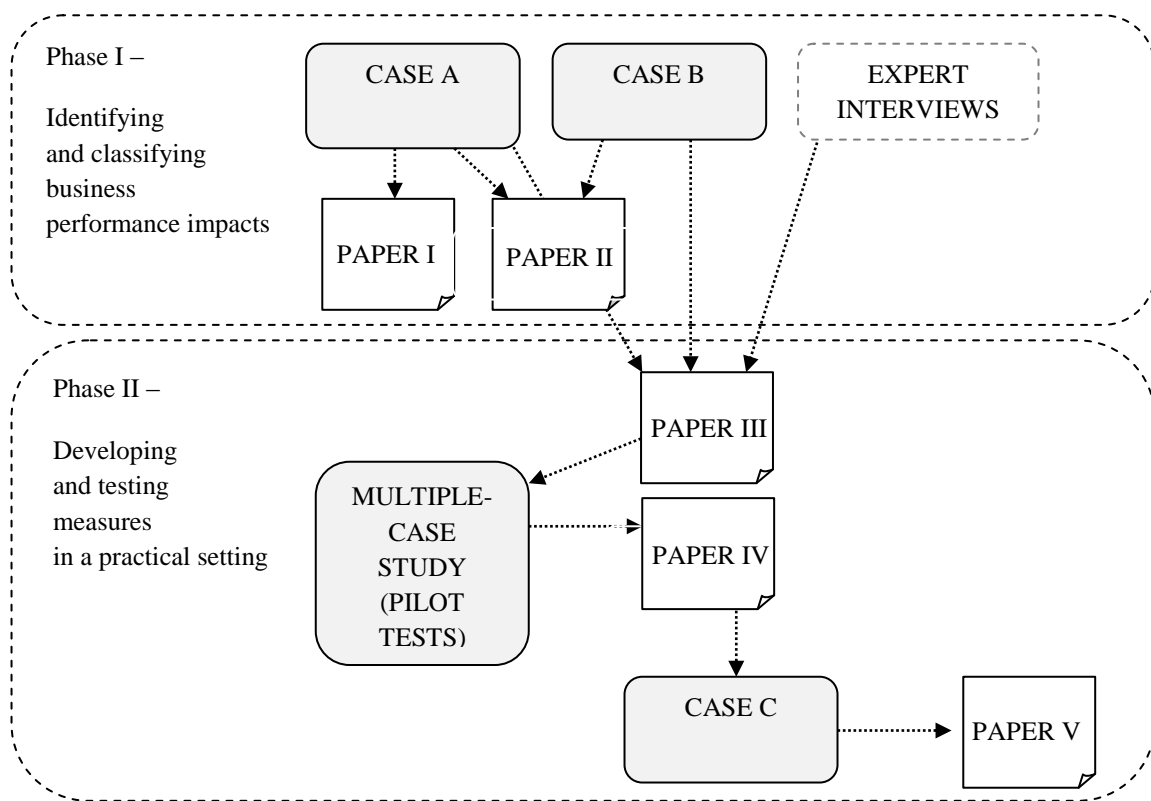
## **2.3 Research strategy**

### **2.3.1 Methodological approach**

Several methodological considerations affect the researcher's choices while conducting research. These choices and their background are described next.

This study explores the business performance impacts of mobile business services on customer organizations and their employees and how to measure these impacts in practice. In order to gain insights into both these aspects, this study consists of two main phases conducted sequentially: first, identifying and classifying the performance impacts of mobile business services, and then developing and testing measures in a practical setting (Figure 6). The starting point and results of this dissertation are practical and the study can therefore be described as applied research. As there

was no strong theoretical base supporting the studies related to mobile business services at the beginning of this study, it was important to have access to real-life context and have close interaction with the participants involved in using mobile business services in their companies. Therefore, this study relies on mainly qualitative empirical action oriented case research. **Action research** is a pragmatic approach that aims to solve current practical problems while learning from outcomes and expanding scientific knowledge and theory (Baskerville & Wood-Harper, 1996; Coughlan & Coughlan, 2002; Baskerville & Myers, 2004). Action researchers are external helpers who act as facilitators of the change and reflection within an organization and simultaneously study the process (Coughlan & Coughlan, 2002; Baskerville & Myers, 2004). Therefore, action research can be viewed as a dual cycle process, including both problem solving interest and research interest, which differentiates it from pure consultancy (McKay & Marshall, 2001).



**Figure 6** The research process of this study.

According to Yin (2009), a **case study** is “an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (p. 18). Cases can be used as the basis from which to develop theory inductively or to confirm existing theories deductively (Eisenhardt, 1989; Eisenhardt & Graebner, 2007; Yin, 2009). In this research, case study is not used in order to test any particular theory or building completely new theory based on empirical findings. Instead, the purpose is to combine theoretical perspectives in order to identify important themes in the mobile business context and reflect those findings iteratively in empirical research. For this purpose, this

study follows the principles of an **abductive case research** by linking empirical findings from case studies to existing frameworks and modifying original frameworks during the process based on real-life observations (Dubois & Gabbe, 2002).

Case study was an appropriate method for this research because new information about mobile services and their impacts in the work context was required. At the beginning of the research, empirical research on the topic was scarce and companies were only beginning to introduce mobile services. In addition, there was a lack of mobile specific theoretical frameworks for measuring the performance impacts. The empirical part of this study was carried out in two research projects<sup>2</sup> in Finland 2006-2008. The projects aimed at developing tools for measuring the success of mobile business services by combining the usability and business performance perspectives. The research for this dissertation was conducted as three individual case studies and a measurement tool development and testing process (including three pilot tests) with the industrial partners and their customers.

A single case study design can be used when the case represents a critical case in testing a well-formulated theory, an extreme or a unique case, a representative or typical case, or where the case serves a revelatory or longitudinal purpose (Yin, 2009, p. 52). Multiple-cases design is usually used when a broader and more robust view of the phenomenon or theory-building is needed (Eisenhardt & Graebner, 2007; Yin, 2009). Multiple-case studies rely on replication logic and the cases either predicts similar results (a literal replication) or contrasting results (a theoretical replication) (Yin, 2009). In order to understand what kinds of business impacts mobile services have on customers' processes and to develop measures for these impacts, multiple case studies were conducted. As the impacts may vary between different types of services, three individual cases were chosen to represent three typical working situations where mobile technologies are utilized, namely, field work, (passenger) transportation and mobile office work (including sales force and managers). Between these cases, it is expected that both similarities and differences can be found in relation to the impacts. The nature of work tasks and use contexts are different in all three cases. In addition to these holistic cases, an embedded case study was conducted where each individual case included testing the measures.

This study as a whole can be described as **mixed-method research** that consists of two main phases that are conducted sequentially one after the other (Figure 6). The first phase of the study focuses on having a broad perspective on both tangible and intangible business performance impacts at various levels using **qualitative methods** for collecting and analyzing the data. The second phase of the study includes both **qualitative and quantitative methods** in order to develop measures through a multiple-case study (three pilot tests) and after that using those measures in a case study. According to Johnson et al. (2007), mixed methods research is a synthesis that includes ideas from qualitative and quantitative research: "Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use

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<sup>2</sup> MOMENTO (Ensuring the success of mobile services for business usage by multidisciplinary measurement tools) and MoBiS (A usability and productivity measurement toolbox to develop successful mobile business services) were conducted at Tampere University of Technology, Finland together with the Unit of Human-Centered Technology and Department of Business Information Management and Logistics at TUT and Media and Mobile usability at VTT Technical Research Center of Finland. The projects were financed by Tekes (the Finnish Funding Agency for Technology and Innovation) and industrial companies.

of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration” (Johnson et al., 2007, p. 123). Similarly, Leech and Onwuegbuzie (2009, p. 267) define mixed methods research as representing “research that involves collecting, analyzing, and interpreting quantitative and qualitative data in a single study or in a series of studies that investigate the same underlying phenomenon”. This research uses **qualitatively dominant** status design. Qualitative dominant mixed methods research is the type of mixed research in which one relies on a qualitative view of the research process, while concurrently recognizing that the addition of quantitative data and approaches is likely to benefit most research projects (Johnson et al., 2007, p. 124). Thus, this research can be described as more **hermeneutic research** in contrast to positivistic as primarily qualitative data are used for understanding and interpretation and the researcher is closely involved with the case studies making subjective observations and co-creating findings (Gummesson, 2000; Guba & Lincoln, 2005).

### **2.3.2 Research process within the empirical context**

The research process and the empirical context including case companies and services are described next. The whole empirical research process was described in Figure 6 in the previous chapter (p. 33). The results of the empirical findings are reported in five research papers that are included in the second part of this dissertation.

The research process started by exploring this emerging phenomenon first by conducting expert interviews and conducting two case studies at the same time. Findings from the expert interviews provided a pre-understanding of the potential impacts of mobile business services and the requirements for measuring business performance impacts in general. The case studies yielded new knowledge about the impacts of two specific mobile services and how to structure these impacts. The purpose was to achieve a broad understanding of both tangible and intangible business performance impacts from various perspectives. This was done by linking empirical findings to previous frameworks as suggested in the abductive approach (Dubois & Gabbe, 2002). The scope of the expert interviews was broad, including the business performance impacts of a service provider and customer (user) organization. This perspective is also used in the first case study (Case A) in Paper I. Later the focus was more on the customer point of view.

**The first case study** (Case A; Papers I, II, III) was conducted during spring 2006 with the (applications service provider) company providing mobile safety measurement services for construction companies using their project management systems/portals. This case study examined a mobile business service used for performing safety measurements on Finnish construction sites. Safety measurements are taken once a week on every construction site in Finland, as required by law. The safety measurement is based on a method called TR-measurement (Laitinen et al., 1999). Safety measurement is carried out by the industrial safety delegate and the site supervisor. The mobile service is used for collecting data when walking around the site and making observations of various safety issues. The observer documents safety items by location, scoring them as “correct” or

“not correct” according to a standard category (e.g., working methods, protection against falls, order and tidiness). In addition, specific problems and the person or organization responsible for correcting the problem are documented by selecting them from a list in the mobile service. The mobile service is connected to the Internet based information management system used for controlling building projects. During the safety measurement process, all data is sent and stored in this information system via the mobile service. Observations were previously documented on paper and entered later in the information system. The mobile service can be used with a portable device, such as mobile phone or PDA. The mobile service was in pilot use and the participants had used the service from five to 12 months.

**The second case study** (Case B; Papers II, III) focused on a taxi order booking and dispatching service used by taxi drivers. This study was conducted together with a service developer and a local area taxi company in Finland during spring 2006. The mobile service is part of a wider booking and order dispatching system that provides data transfer between taxis and the dispatch center. Taxi drivers receive transport requests via the dispatching system. After a customer has contacted the dispatch center, a dispatcher inputs an order to the system and sends it to the taxis. The dispatching system tracks the location of vehicles through satellite positioning and selects the optimal vehicle according to the search chain rules. The optimal taxi may, for example, be the closest taxi that has been free longer than others. The taxi driver accepts the request, sees the location of the customer on the map and then the service navigates the driver from one location to another. In addition to accepting these incoming requests, taxi drivers can use the mobile service for monitoring other drivers and sending messages to taxis, seeing orders in different areas, checking addresses in unfamiliar areas and locating themselves on the map and searching for specific locations. The mobile service can be used with several fixed or portable devices, for example, an in-car system, mobile phone, or PDA. In this study, we focused on the fixed in-car system. At the time of this study, the mobile service had been used for two years.

The research process continued by **developing a measurement tool** (questionnaire) based on the expert interviews and multiple cases. This development process was conducted during the year 2007 and is described in Papers III and IV. A preliminary measurement tool was first constructed (Paper III) and then three pilot tests were conducted during three distinct service development processes (Paper IV). **Pilot tests** (embedded multiple-case study) (Paper IV) for developing and testing the questionnaire were conducted with the users of mobile business services in three companies. The first pilot test was conducted in a local taxi company and involved taxi drivers using a taxi order booking and dispatching service in their work. The second pilot test was conducted with a telecom company providing a mobile office service for their knowledge workers in Finland. The mobile office service includes mobile work e-mail, calendar, and employee directory. The third pilot test, conducted together with a company in the area of mobile service creation, included knowledge workers located all over the world. The mobile office service evaluated was a combination of push email, calendar, contacts, and other mobile services, integrated into one user interface.

After the questionnaire was developed, it was used and further developed by conducting measurements in a practical setting in a case study. This **third case study** (Case C, Paper V) was conducted in 2008 with a medium-sized European teleoperator with a branch in Finland. The case company provides mobile and fixed telecommunications services for the consumer and enterprise markets. The mobile business service examined in this study is a mobile office service in use in the company and also provided to their customers as a service. The mobile office service includes mobile office push mail, calendar and contacts. In the case company, the service is targeted at people working close to customers, that is, workers in sales and support, as well as their managers. These groups represent workers in any knowledge intensive or sales oriented workplace. At the time of the case study, the mobile office service had been in use for one and a half years. It was planned to expand the use of the service to other users. This case study provided insights on how measurement can be conducted in practice and also resulted in the impacts of one specific type of mobile business services.

### 2.3.3 Methods for data collection and analysis

The research methods for collecting and analyzing the data are described in this chapter. A more detailed analysis is provided in each research paper that consists of one or more cases. The research data for this study was collected through individual action research cases using several methods (multiple sources of evidence (Yin, 2009, p. 101)), including interviews, observations, workshops and a questionnaire. The role of the researcher was mainly to act as a participant observer during the case studies and also as a facilitator during the measurement development process (Gummesson, 2000; Guba & Lincoln, 2005). A summary of the research methods and approaches is presented in Table 6.

**Table 6 Summary of the empirical material**

|                                | <b>Case A</b>                           | <b>Case B</b>                              | <b>Multiple-case</b>  | <b>Case C</b>                                   |
|--------------------------------|---|--|---|---|
| <b>Service(s)</b>              | Safety measurement service              | Taxi dispatching service                   | Taxi dispatching service, two mobile office services        | Mobile office service                           |
| <b>Application area(s)</b>     | Construction work (field work)          | Taxi drivers (passenger transportation)    | Taxi drivers, knowledge workers                             | Managers, product specialists and sales workers |
| <b>Year</b>                    | 2006                                    | 2006                                       | 2007  | 2008  |
| <b>Data collection methods</b> | Interviews<br>Observations<br>Workshops | Interviews<br>Observations<br>Focus groups | Expert interviews<br>Pilot tests of using the Questionnaire | Interviews<br>Questionnaire<br>Workshops        |
| <b>Approach</b>                | Abductive<br>Qualitative                | Abductive<br>Qualitative                   | Mixed methods   | Mixed methods                                   |



During the case studies, all data was carefully documented in different phases and a case study database was created. After the data collection and analysis phases of each case study, the researchers had a group discussion in the case companies where the preliminary findings were presented and discussed. Case reports were written and given to the case representatives for comments and corrections. Thus, the findings underwent respondent validation.

## ***Interviews***

Interviewing is a typical way of collecting primary data in case research as it is an efficient way to gather rich empirical data (Eisenhardt & Graebner, 2007; Yin, 2009). There are many different ways of conducting interviews, for example, in surveys through the Internet, by telephone, or in face-to-face interaction. Moreover, interviews can be more or less structured. (Fontana & Frey, 2005) In this dissertation, all interviews were semi-structured face-to-face interviews. Most of the interviews involved only one person but a group discussion and focus group interviews were also conducted with the users of mobile business services. According to Patton (2002), a focus group interview is an interview on a specific topic with a small group of people who share a similar background. The object is to gather high-quality data in a social context where participants can consider their own views and make additional comments as they hear what other people have to say. Focus group interviews have several advantages, for example, data collection is cost-effective as information can be gathered from more people instead of only one, significantly increasing sample size. In addition, interactions among participants enhance data quality. However, the number of questions that can be asked is greatly restricted in the group setting and the available response time for any particular individual is restricted in order to hear from everyone. In addition, those who realize that their viewpoint is a minority perspective may not be inclined to speak up and risk negative reactions. (Patton, 2002)

At the beginning of this research, expert interviews provided a starting point for expected performance impacts and for the practical measurement tool development. Interviewees were selected from various departments in different companies, thus representing the broad view of mobile business services and their impacts. Expert interviews were carried out with managers, service developers, usability specialists and customers (decision-makers) of mobile business services in order to discuss how they would describe the performance impacts of using mobile business services and the current status of as well as the needs and purposes for measuring the impacts. There were altogether 14 participants in the interviews. Questions were related to describing the benefits and drawbacks of using mobile business services, value propositions and sales arguments, the service development process and the needs for measurement information in order to support the development and decision-making.

In Cases A and B, interviews were conducted with the representatives of the service provider as well as decision-makers and users in the customer company in order to gain a holistic view on the impacts from different perspectives. The goal of the interviews with managers was to identify the various performance impacts of a mobile business service in those specific use contexts and to understand what information should be gathered through measures. Users were interviewed in order

to gather experiences of using a particular mobile business service to identify the impacts at employee level. In Case A, three interviews were conducted with the representatives of the service provider, including the CEO, the business field manager, and the product manager. In addition, one group discussion was organized with the representatives of the construction company and the service provider and one interview was conducted with the user of the mobile safety measurement service at the construction site. In Case B, three representatives of the service provider were interviewed, including the business unit director, the product developer and the research and development director. Two interviews were conducted with the decision-makers in the taxi company, including the managing director and the chairman of the board. In addition, four thematic focus group interviews were conducted where a total of nine taxi drivers and four dispatchers were interviewed. The benefits and problems related to using mobile dispatching service were discussed during the focus groups.

In Case C, two managers, three sales people and one product specialist were interviewed. The role of the interviewees was twofold as they represented both the service provider and the user of the mobile office service at the same time. The questions used in these interviews were more focused on the value propositions and benefits for customers, including the impacts at individual and organizational levels. The purpose of these interviews was to improve the content validity of the measurement tool used in this case study by producing service-specific content for the questionnaire.

All the interviewing sessions lasted from one to two hours. Two researchers participated in each interview session. One researcher acted as the main interviewer and the other took notes and posed additional questions when needed. The interviews were recorded with a digital voice recorder and transcribed for further analysis. The interviewees had an opportunity to comment on the transcriptions.

The transcribed interviews were analyzed qualitatively in order to find important themes. Two researchers first analyzed each interview by organizing the contents of the interviews under various themes and summarizing the results. Themes emerged from the data and included business performance related factors, such as satisfaction, customer feedback, efficiency, productivity, image, cost savings, information sharing, processes, stakeholders and working atmosphere as well as also measurement related needs and contextual factors. The results of each interview were then combined during a group discussion where the researchers further analyzed the findings in order to extract a common understanding on the important themes. The emerged empirical themes were then compared with the earlier studies and frameworks and categorized under four main impact dimensions by the author of this dissertation. The researchers also collected other empirical data and combined the findings with the earlier results. In addition, as new theoretical research emerged during the research process, the real-life observations were again compared to the new findings and support for grouping various impacts and naming the categories were sought from these studies. Finally, this resulted in a structural framework of performance impacts that is discussed and presented in Chapter 3.2.

## ***Observations***

In order to collect information on the actual use of mobile business services in the natural setting, direct observations were conducted with the users in two case studies. According to Patton (2002), observations have several advantages. First, through direct observations the inquirer is better able to understand and capture the context within which people interact. Understanding context is essential to a holistic perspective. Second, firsthand experience with a setting and the people in the setting allows an inquirer to be open, discovery oriented and inductive because, by being on-site, the observer has less need to rely on prior conceptualizations. A third strength is that the inquirer has the opportunity to see things that may routinely escape awareness among the people in the setting. Limitations of observations include the possibility that the observer may affect the situation being observed in unknown ways, participants may behave in some atypical fashion when they are being observed, and the selective perception of the observer may distort the data. Observations are also limited in focusing only on external behaviors. (Patton, 2002)

In Case A, three users working with the mobile safety measurement service on two different construction sites were observed in order to understand the process where mobile service was used and to gather information from real users in real use context. Two researchers observed the construction workers for two hours by following them at the construction site during the safety measurement process. The researchers took notes and pictures during the observations. After the observations, the participants were interviewed for background information and to go over the observation notes.

In Case B, the training of approximately 50 trainee taxi drivers was observed during three three-hour training sessions in order to evaluate the taxi dispatching service from the perspective of new users. During these sessions, the candidates used the mobile service to complete typical usage scenarios (such as accepting a customer order, locating an address from the map, and changing the settings of the interface) in a classroom setting. When observing the users, the data was collected by the researchers by taking notes and asking unstructured questions.

The observations were analyzed so that the observed process and the impacts of using mobile service in that particular process was deeply understood: the roles and tasks of the actors involved in the process, how they performed their work tasks by using the mobile business service, what problems occurred during the process and how the process had been changed or improved after deploying the mobile business service. As Patton (2002) points out, observations are often constrained by the limited sample of activities actually observed and therefore, researchers need other data sources to find out the extent to which observed activities are typical or atypical. Thus, the findings from the observations were combined together with the findings from interviews. Observations provide a check on what is reported in interviews: interviews, on the other hand, permit the observer to go beyond external behavior to explore feelings and thoughts (Patton, 2002).

## ***Workshops***

The purpose of the data collection was to identify the performance impacts of using mobile business services and also to develop measures for these impacts for practical purposes. In order to develop measures that are suitable in a specific use situation, workshops were held together with the representatives of service providers during Case A and C. The purpose was to better understand the mobile business services they were providing and to discuss the potential benefits for their customers in order to develop suitable measures for each context. The length of the workshops varied from two to four hours.

In Case A, the representatives of service provider explained the traditional safety measurement process where observations are collected with pen and paper and then how the mobile safety measurement service improves the process. The value propositions of their service and different ways of identifying and measuring the business performance impacts from their customer point of view were discussed. As the service was still in pilot use, they needed information on the impacts in order to have references to attract new customers. The safety measurement process with and without the mobile service were modeled and compared in order to analyze the benefits. The identification and classification of various performance impacts was considered to be useful as such (i.e., without any particular measurement information) when illustrating the potential benefits for customers. Time savings in different work phases were also calculated and converted into cost savings.

In Case C, the researchers participated in several workshops with the representatives of the case company in order to discuss the findings from the interviews and to produce and evaluate the content of the measurement tool that was utilized in their company. Both usability and business perspectives were utilized in the measurement tool, and thus people from different departments participated in the content creation during workshops. This multidisciplinary work for developing content was considered worth the effort as it resulted in a more relevant measurement tool for the case company and also enhanced researchers' knowledge about the impacts of a specific type of mobile service and mobile context in which it is used. In addition, this case study provided experiences of applying the measurement tool in practice.

## ***Measurement tool in use - Questionnaire***

A questionnaire has a twofold role in this dissertation – it is a result of this study as the purpose is to develop measures for performance impacts but it is also used as a data collection method when the measurement of impacts is conducted in practice (Case C). In order to measure the impacts at employee level and to collect data from the users of mobile business services, the questionnaire was first developed and tested (Pilot tests, Papers III, IV) based on the expert interviews and previous case studies (Case A and B) and then used as a tool for collecting data in one case study (Case C, Paper V).

The questionnaire included structured statements and open-ended questions. The respondents were asked to respond to the statements according to their experiences when using the particular mobile business service. For the statements, a 7-point Likert scale from 1 = “Totally disagree” to 7 = “Totally agree” was used. In addition, there was also an option “Don’t know”. In Case C, the content of the questionnaire was created in close collaboration with the service provider through workshops as discussed in previous chapter.

The questionnaire was administered by the researchers using a web-based survey tool. In the first pilot test, the data was gathered by paper questionnaire as taxi drivers are highly mobile and they are not using desktop computers during the work day. Table 7 summarizes how many responses were gained in each study.

**Table 7 Responses to pilot tests and questionnaire in Case C**

|                      | <b>Pilot test #1</b> | <b>Pilot test #2</b> | <b>Pilot test #3</b> | <b>Case C</b> |
|----------------------|----------------------|----------------------|----------------------|---------------|
| <b>N</b>             | 48                   | 84                   | 34                   | 115           |
| <b>Sample size</b>   | 100                  | 163                  | 100                  | 195           |
| <b>Response rate</b> | 48%                  | 51%                  | 34%                  | 59%           |

Data analysis for the questionnaire responses was conducted using descriptive statistics (frequencies and percentage distributions) and correlations (Spearman’s rho) with a statistics program (SPSS). Spearman’s Rho correlations were used as the answers were not normally distributed. The open-ended questions were analyzed qualitatively similar way than the interview data and combined with the earlier findings.

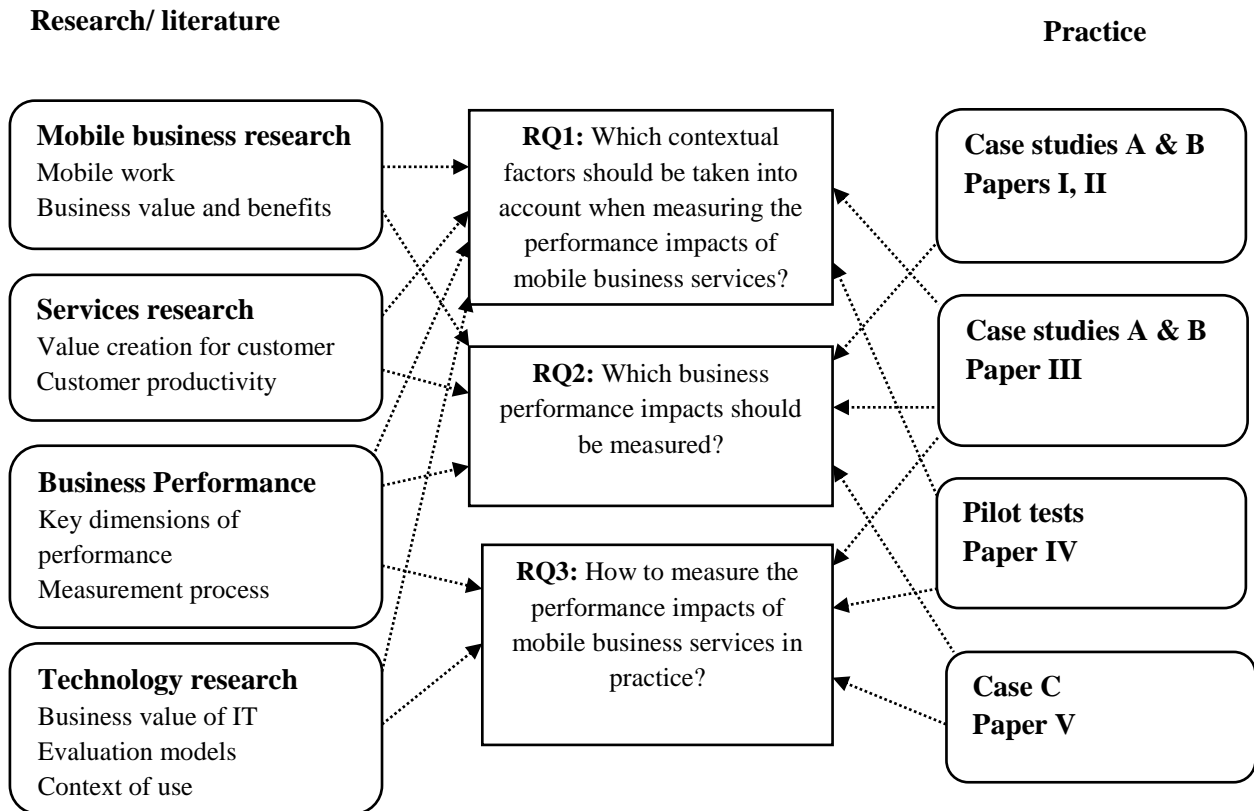
## **2.4 Summaries of the research publications**

The results of this dissertation emerge from combining the findings of five research papers published in international peer-reviewed academic journals (4) or conference proceedings (1). All of these papers utilized empirical data with different methods, focus and purpose (Table 8). The papers address the multidimensional nature of business performance impacts from using different types of mobile services in the work context. In addition, development and use of a measurement tool is described.

**Table 8 Research papers used in this study**

| <b>Paper</b>     | <b>Title</b>  | <b>Case(s)</b>  | <b>Keywords</b>  | <b>Focus</b>                          | <b>Purpose</b>   |
|------------------|---|-----------------|--|---------------------------------------|--|
| <b>Paper I</b>   | Identifying and measuring the success factors of mobile business services                           | Case A          | Success factors (Usability, business performance) Balanced Scorecard | Service provider, Customer/user       | Identifying and categorizing the performance impacts of a specific mobile business service   |
| <b>Paper II</b>  | Intangible benefits of mobile business services   | Case A, Case B  | Intellectual capital, intangible benefits                            | Customer/user                         | Identifying and categorizing the intangible impacts of two mobile business services  |
| <b>Paper III</b> | Identifying usability and productivity dimensions for measuring success of mobile business services | Case A, Case B  | Usability and productivity measurement                               | End-user (employee)                   | Identifying the performance impacts of two mobile business services<br>Constructing a preliminary measurement tool for measuring the impacts |
| <b>Paper IV</b>  | Developing a questionnaire for evaluating mobile business service experience                        | Multiple -cases | Usability, context, productivity Subjective measurement              | End-user (employee)                   | Developing and testing a questionnaire for measuring the impacts   |
| <b>Paper V</b>   | Productivity impacts of a mobile office service   | Case C          | Customer productivity Subjective productivity measurement            | End-user (employee), Customer company | Identifying and measuring the productivity impacts of a specific mobile business service   |

These five papers together with the background theories and literature provide answers to the research questions. Figure 7 presents the relationships between the three research questions, background theories and empirical data used in each research paper.



**Figure 7 Theoretical and empirical material in relation to the research questions.**

Summaries of the five research papers:

**I. Identifying and measuring the success factors of mobile business services**

Markova, M., Aula, A., Lönnqvist, A., & Wigelius, H. (2008)

*International Journal of Knowledge Management Studies*, Vol. 2, No. 1, pp. 49-63.

The first paper identifies the success factors of a mobile business service used on construction sites through a case study (Case A). In this study, a balanced business performance measurement approach was used and the success was considered from the perspectives of service provider and customer company (especially the user and the process). The success factors were identified and then classified according to the four perspectives of Balanced Scorecard: financial, customer, internal business processes, learning and growth. Our study showed that the success factors of mobile business services are varied, ranging from positive effects on the image of the service provider to time savings in the business processes of customer organization. Moreover, the study showed that the usability of the service has marked effects on business performance. In addition to identifying the success factors, the study presented concrete ideas on how the factors can be measured.

## II. **Intangible benefits of mobile business services**

Vuolle, M. (2011)

*International Journal of Learning and Intellectual Capital*, Vol. 8, No. 1, pp. 50-62.

The second paper focuses on the intangible benefits derived from using mobile business services. These benefits have been less studied as regards evaluating the value of mobile service investments. Intangible aspects are usually neglected as they are challenging to identify and measure. The paper investigates if the intellectual capital approach could help in identifying and categorizing intangible benefits from the customer's point of view. Based on a literature review and two case studies (Case A and B), this paper categorizes the intangible benefits of mobile business services into three components of intellectual capital: human capital, structural capital and relational capital.

## III. **Identifying usability and productivity dimensions for measuring success of mobile business services**

Vuolle, M., Aula, A., Kulju, M., Vainio, T., and Wigelius, H. (2008)

*Journal of Advances in Human-Computer Interaction*, Vol. 200, doi:10.1155/AHCI.

The third paper reviews existing measures used for evaluating the usability of information systems and those used for evaluating the level of the productivity of a company. The usefulness of the existing measures in the mobile business context, where both mobility and work context pose specific demands for the mobile business services is discussed. The review showed that the existing measures rarely consider the great contextual variation caused by the mobility of the services and the demands this poses on usability, which, in turn, affects productivity. To build a measurement tool that better meets the requirements of mobile business services, we completed case studies (Case A and B) on two mobile business services, one used in passenger transport and the other on construction sites. In light of the understanding gained from the case studies, we propose a list of dimensions and items addressing both usability and productivity aspects that work as the basis for a multidisciplinary measurement tool. In addition, contextual factors are included as an important success factor.

## IV. **Developing a questionnaire for evaluating mobile business service experience**

Vuolle, M., Kallio, T., Kulju, M., Tiainen, M., Vainio, T., & Wigelius, H. (2008)

The proceedings of the *10th International Conference on Human Computer Interaction with Mobile Devices and Services (MobileHCI 2008)*, September 2-5, 2008. Amsterdam, the Netherlands, pp. 53-62.

The fourth paper conceptualizes three dimensions that represent elements of mobile business service experience, namely usability, mobile working context and mobile work productivity. By combining these perspectives, the aim is to understand the nature of mobile work and how mobile business services could support users in this context. A questionnaire, MoBiS-Q, for measuring these dimensions has been developed and tested in three pilot studies (Multiple-case study) during real service development processes. Iterative item generation and refinement were conducted through examination of the literature, expert interviews and pre-testing. MoBiS-Q is



a multidisciplinary tool that provides a basis for joint development between relevant parties and departments in an organization, including user representatives, sales, marketing, product management, technology, and usability.

## V. Productivity impacts of mobile office service

Vuolle, M. (2010)

*International Journal of Services Technology and Management, Vol. 14, No. 4, pp. 326-342.*

The fifth paper aims to understand and evaluate the productivity impacts of a mobile office service. The potential impacts are first identified in two mobile work groups by means of a literature review. After that, an empirical case study (Case C) is conducted in a telecommunications company with knowledge workers and sales people using a mobile office service. The case study includes data from interviews, group discussions and a questionnaire (N=115). This paper uses the questionnaire developed in Paper III and Paper IV in a practical setting. The results show that the main productivity impacts from the use of the mobile office service examined in the case study are the ability to accomplish tasks that need a rapid reaction or response, better situation awareness and better utilization of idle time while on the move.

Three of the research papers have been written in collaboration with other researchers and industry representatives. The author was the main author in all of the papers. Table 9 describes the role of the author in each co-authored paper.

**Table 9 Role of the author in papers with more than one author**

| <b>Paper</b>  | <b>Role of the author</b>   |
|---|---|
| I Identifying and measuring the success factors of mobile business services                             | <ul style="list-style-type: none"> <li>• Designed the study together with the co-authors</li> <li>• Collected and analyzed the data together with the co-authors</li> <li>• Coordinated the writing of the paper</li> <li>• Wrote and reviewed the paper together with the co-authors</li> </ul>  |
| III Identifying usability and productivity dimensions for measuring success of mobile business services | <ul style="list-style-type: none"> <li>• Designed the study together with the co-authors</li> <li>• Collected and analyzed the data together with the co-authors</li> <li>• Developed items for the measurement tool (especially work productivity)</li> <li>• Coordinated the writing of the paper</li> <li>• Wrote and reviewed the paper together with the co-authors</li> </ul>   |
| IV Developing a questionnaire for evaluating mobile business service experience                         | <ul style="list-style-type: none"> <li>• Designed the study together with the co-authors</li> <li>• Developed the content of the questionnaire (especially productivity statements)</li> <li>• Gathered measurement data together with the other authors</li> <li>• Analyzed the results together with the co-authors</li> <li>• Coordinated the writing of the paper</li> <li>• Wrote and reviewed the paper together with the co-authors</li> </ul> |

## **3 RESULTS**

### **3.1 Which contextual factors should be taken into account when measuring the performance impacts of mobile business services?**

The first research question served to elicit contextual factors that influence the measurement of performance impacts. Contextual factors are described next in relation to three aspects: the requirements of the business context, the characteristics of the mobile context and the nature of performance impacts. These factors affect the way the measurement process is carried out in practice: the identification of performance impacts and the choices of measures to be used are dependent on the circumstances in which these measures are used.

#### **Requirements of business context**

The contextual factors related to measuring the performance impacts of mobile services in business context include the level of analysis, goals of stakeholders and purpose of measurement. These can be seen as general business requirements for deploying mobile business services and the actual measurement objectives of the impacts. The business context links the service to wider business targets and describes the role of the measurement as a managerial tool. Firstly, as the impacts of consumer services are mainly derived at individual level, business services aim at providing benefits beyond the individual employee for business processes, organizations and their customers as discussed in Papers I, II and V. Therefore, the measurement of performance impacts may be challenging as the impacts can be seen at various levels. For example, Gebauer and Shaw (2004) found that the use of mobile business applications had positive effects not only on the user but indirect effects on the employees interacting with the user of the service. Moreover, an impact may be positive at one level but negative at another level. Ioimo and Aronson (2004), for example, found that field computing did not improve field officers' productivity but increased the productivity of others in the department instead. By understanding the level of analysis it is easier to have a more comprehensive view on the performance impacts and also to identify the locus of impacts and potential value for a company (Davern & Kauffman, 2000).

Secondly, there may be various and also mixed goals for the deployment of mobile business services among stakeholders. As discussed in Paper III, success means different things for different stakeholders: the users of the service might emphasize ease of use while improved productivity or revenues may be the goal from the company's perspective. These conceptions of success are not necessarily incompatible. Often the easy-to-use service is also more successful financially as the need for training decreases and then employees can focus on working instead of taking part in training courses. In addition, the time lag between the use and business impacts may get shorter. Thus in order to identify the relevant success factors to be measured, the business goals and needs of various stakeholders and units needs to be taken into account.

The third business requirement when measuring the business performance impacts is to consider the purpose of measurement (Tangen, 2004; Chiesa et al., 2008). Various purposes for measurement in general were discussed in Chapter 1.3.3. In this dissertation, the measurement of impacts was approached for managerial purposes, thus the measurement is seen as being pragmatic and case sensitive rather than a generic research instrument. The expert interviews and case studies revealed that service providers need to collect measurement information in order to better understand customer productivity and to support service development and sales activities. Customer productivity implies understanding how the use of mobile business services affects the real users and the benefits and outcomes from customer perspective. Through this understanding service providers could develop the services together with the customers, for example, by introducing new functions to the service in order to better support the mobile workers. In addition, service providers can collect customer references and help new customers in decision-making by setting realistic goals when deploying services and then measuring whether the goals are achieved or not. This helps customers in determining the value of mobile business service investment.

Managerial use of measurement also implies that there are some limitations and compromises to be made when designing measures. Especially when the information is collected from customers, the data collection for measures needs to be easy in order not to disrupt the productive time of the customers and their employees. As discussed in Papers III and IV, using measures and interpreting results need to be easy and fast due to the speed of development cycles of mobile business services. These factors are also mentioned as a general requirement for performance measures (Hudson et al., 2001). Different methods should be applicable in various service development phases for example, in pilot testing as well as actual usage of the service. It was also suggested that the results should be comparable in order to benchmark the mobile service against its competitors or earlier versions or to measure the level of and change in performance impacts over time.

### **Characteristics of mobile context**

The mobile context is an important factor to consider when measuring the performance impacts as it is the main differentiator compared to non-mobile services and other systems. The mobile context provides service specific factors for understanding the impacts and it links the service to work tasks. As discussed in Chapter 1.3.1 and research papers, the different types of mobile business services provide different kinds of value to mobile work tasks and processes and thus, the impacts may vary between the mobile contexts in which the services are used. These aspects also affect the choice of the mobile business service that is being deployed. For example, according to Bouwman and van de Wijngaert (2009), the use of specific mobile technologies is largely dependent on the interaction of physical context (urgency and location), the way information is handled (push, pull, retrieved, administrated) and task characteristics. For example, when the mobile work task is very routine in nature, mobile services providing data processing are useful but in cases of non-routine tasks, communication and information access are found to be more important functions (Gebauer et al., 2010).

In order to better understand the nature of the different types of services and the mobile context in which they are used, Table 10 provides a comparison between the case services based on the

contextual characteristics of mobile work discussed in Chapter 1.3.1., that is, mobile service functions, mobile worker and context of use (technical, task, temporal, physical, social).

**Table 10 Comparing the mobile contextual factors of different types of case services**

| <b>Case service</b>                   | <b>Safety measurement (Case A)</b>                         | <b>Taxi dispatching (Case B)</b>   | <b>Mobile office (Case C)</b>                                      |
|---------------------------------------|--|--|--|
| <b>Mobile service (Functionality)</b> | Mobile data processing                                     | Mobile notifications, information access, location tracking, navigation, real-time job dispatching | Mobile communication, mobile office functions (calendar, contacts) |
| <b>Mobile worker</b>                  | Site supervisor  | Taxi driver  | Knowledge worker, manager, sales force                             |
| <b>Technical context</b>              |  |  |  |
| <i>Mobile device</i>                  | Smartphone   | Fixed in-car device, smartphone  | Smartphone, communicator   |
| <i>Connectivity</i>                   | Online   | Online   | Online   |
| <b>Task context</b>                   |  |  |  |
| <i>Task structure</i>                 | Routine  | Routine  | Non-routine  |
| <b>Temporal context</b>               |  |  |  |
| <i>Time criticality</i>               | Task needs to be done in a specific time and day           | Urgent – Task needs to be done right away  | Varies a lot   |
| <b>Physical context</b>               |  |  |  |
| <i>Mobility</i>                       | 100% (during the task)                                     | 100% (all day)   | Varies a lot during the day  |
| <i>Modality</i>                       | Wandering – walking and standing                           | Travelling – sitting and driving   | Wandering, Travelling, Visiting                                    |
| <i>Environmental context</i>          | Outdoors and indoors at construction site                  | Traffic  | Any place  |
| <i>Location variety</i>               | Low - Always at a specific location (at construction site) | High - Always at different locations   | Varying from same to different locations                           |
| <i>Location flexibility</i>           | No freedom of choosing a place                             | Limited freedom of choosing a place  | Varying freedom of choosing a place                                |
| <i>Location dependency</i>            | Equipment location   | Other people’s location, travel directions   | Self-location, other people’s location                             |
| <b>Social context</b>                 |  |  |  |
| <i>Persons present</i>                | Industrial safety delegate, construction workers           | Customers (passengers), other taxi drivers, dispatchers  | Customers, co-workers, random people                               |

In this dissertation, case studies were conducted in order to collect empirical evidence from three different types of mobile business services and their performance impacts: one used on construction

sites for the safety measurement process (Case A), the other used in passenger transport for taxi order dispatching (Case B) and the third type of service was mobile office service used by knowledge workers (Case C). Functionalities and contextual factors vary widely between these services as they are used for different purposes and in different industries. For example, the safety measurement service provides a way of gathering information from the field and sending it automatically into the database but does not provide any location-based or communicative functionality. It is a good example of a quite simple industry-specific service used in a particular routine work process in the same location while walking and standing in various environmental conditions. The taxi dispatching service is the most complex example of these three services and provides many different functionalities from messaging, information access and real-time job dispatching to navigation and location tracking. The use of the service is dependent on time and place, as the work needs to be done immediately when the customer request is achieved. The service is in use throughout the working day and it is thus a crucial part of the work. The mobile office service, on the other hand, is an example of a horizontal service that can be used in every industry to support the communication and time management of mobile workers. The use of the mobile office service is more ad hoc: it can be used every now and then, any time, any place when the need arises.

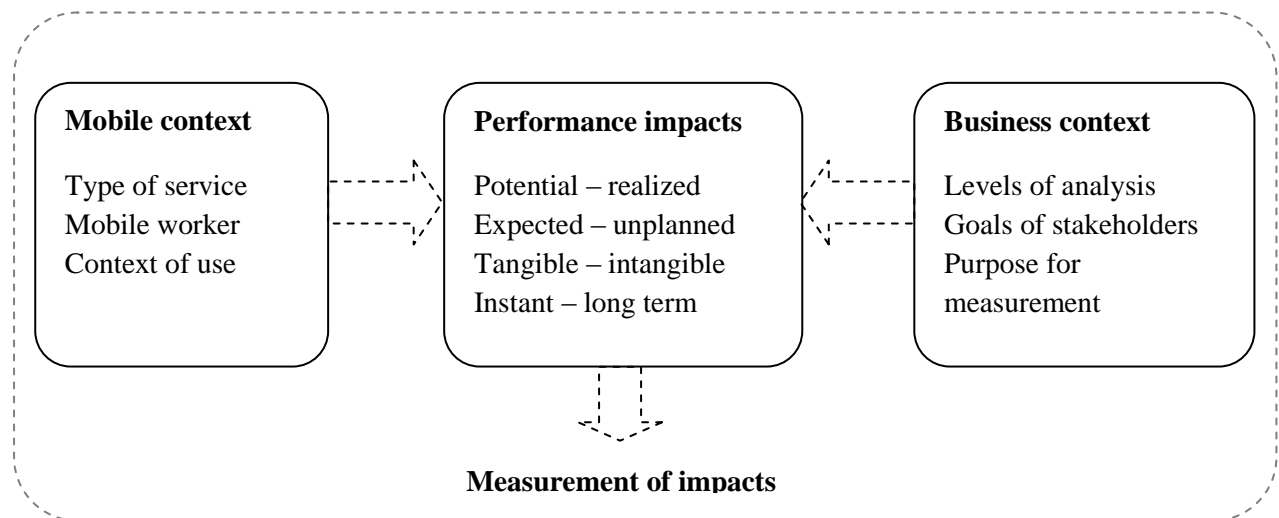
### **Multidimensional nature of performance impacts**

Performance impacts can be challenging to measure due to their multidimensional nature. In order to understand what it is relevant to measure, potential impacts should be identified beforehand and then measure what impacts were realized (Davern & Kauffman, 2002). The performance impacts may be tangible (i.e. financial and non-financial) or intangible and this affects the way the impacts can be measured and what types of measures can be used. In addition to the potential impacts expected, unplanned impacts may also occur. As business use usually focuses on efficiency, productivity or profitability, there may also be some softer impacts that are more important to users but may not be part of the company's goals for the deployment. For example, there may be social and emotional impacts that may initially be neglected but can also have an impact on productivity and competitiveness in the long term through job satisfaction and motivation. Sheng et al. (2005) found that using a mobile business service helped sales representatives to appear more confident and knowledgeable and thus enhanced their professional image, which in turn improves the image of the company. They also found that employee satisfaction increased significantly due to the reduction of overall workload, better utilization of time, and a sense of belonging to a community. Similar results were found from the case studies of this dissertation, for example, the company image was found to be important in Case A, a sense of belonging to a community in Case B, and convenience and better utilization of time were addressed in Case C.

The time perspective for the realization of performance impact needs to be analyzed in order to understand when the expected impacts are to be achieved and when they are measurable. The performance impacts, if any, may be measurable instantly, after a short time or after a long time. There are also several reasons why potential impacts may not always be realized. For example, there may be some technical problems such as poor network connections that disrupt the use of the service, as was found during the safety measurement process in Case A. In some situations, the mobile business service may not be used properly or at all. For example, old habits, cultural or

technical factors may inhibit the use of specific functionalities, thus extensive use of mobile services is not adopted. As was found in Case B, some taxi drivers still prefer to drive to stands to pick up customers instead of making efficient use of the mobile taxi dispatching service. In addition, sending notifications about safety issues via SMS or email was not introduced on construction sites in Case A, because not everybody had mobile phone or access to the Internet during the working day. In addition, a specific mobile business service may not suit all mobile work situations or processes. For example, Gebauer et al. (2010) note that use situations associated with high user-distraction and low quality of network connection are particularly difficult to support and in these cases there are few benefits to be achieved. In some cases there may also be problems in measurement practices that may explain why no impacts can be observed: the performance impacts are measured with bad measures, in wrong time or at the wrong level.

Figure 8 provides a summary of the main findings discussed in this chapter. The mobile context can be seen as an enabler of performance impacts as it influences what kinds of potential impacts may be realized at various levels if any. The business context, on the other hand, influences the level of analysis and determines eventually what performance impacts it is appropriate to measure in that specific context in relation to goals. Finally, the nature of the performance impacts affects the decision on what type of measures and way of measuring can be used and when.



**Figure 8 Contextual factors influencing the measurement of performance impacts.**

Summary – In order to better comprehend various contextual factors related to measuring the performance impacts of mobile services in business use, general business factors, such as purpose for measurement, goals of various stakeholders and the level of analysis needs to be understood. In addition, there are also mobile service specific factors including the type of mobile service, mobile worker and context of use that influence what to measure and how the measurement can be carried. Furthermore, the multidimensional nature of performance impacts also affects the way of measuring and types of measures to be used.

## 3.2 Which business performance impacts should be measured?

The second research question identifies various business performance impacts that it may be relevant to measure depending on the context. These results are mainly derived from Papers I, II and V and the examples provided for each impact are from these papers including Cases A, B and C.

As discussed earlier, the impacts vary between different types of mobile business services and between the goals of the company. In the cases studied in this research, three different types of services were studied. The main differences in perceived performance impacts can be summarized as follows: Mobile service for construction sites provides process efficiencies and time savings through information input while on the move. There are also some motivational issues as the use of mobile service decreases the paperwork needed and provides better information quality due to the absence of problems related to recognizing handwriting. The use of the service is voluntary and it can be used instead of paper form and pen. The mobile service for taxi drivers increases revenues (more profits per kilometer) through a more efficient dispatching process, location awareness and navigation. The use of the service is mandatory and it replaced the previous system. The mobile office service, on the other hand, is convenient and offers communication efficiency. The use of the mobile office service is voluntary and it complements the use of laptops or is used instead of laptops in some situations.

As a summary of the business performance impacts of these three types of mobile business services, the impacts are categorized under four main dimensions, namely employee impacts, structural impacts, relational impacts and monetary impacts. These four dimensions are based on the empirical findings and their linkage to the business performance measurement frameworks and the dimensions of intellectual capital discussed in Chapters 1.3.2 and 1.3.3 and in Papers I and II. In contrast to a pure intellectual capital approach, the three perspectives other than monetary impacts include both intangible and tangible (non-financial) aspects that are deemed important. These dimensions are also in line with some of the classifications of impact in the mobility models discussed in Chapters 1.4.1 and 1.4.2. Examples from the case studies are provided to better illustrate each dimension.

### **Employee impacts**

Employee impacts refer to the performance impacts at the individual worker level (cf. human focus (Edvinsson & Malone, 1997)). These aspects have previously been addressed under the concepts of individual impact (DeLone & McLean, 1992; Goodhue & Thompson, 1995), mobility of employees (Barnes, 2003) and employee satisfaction (Sheng et al., 2005). Case studies revealed temporal and location related impacts as well as convenience and job satisfaction that are expected to also affect employee productivity.

*Temporal impacts* provide important contextual value from mobile services (e.g., Chen & Nath, 2004). For example, the use of the mobile safety measurement service in Case A enables data gathering while on the move, thereby eliminating the need to input the data observed into the

information system after the safety measurement process and time savings can be achieved. Some tasks, such as reading and responding briefly to e-mails and accepting notification about meetings, can be performed with mobile office service regardless of time and place, which also improves the fluency and flexibility of work (Case C). As mobile business services allow mobile workers to accomplish more tasks while in the field, they therefore spend less unnecessary time travelling from and to the office during the working day (Alanen & Autio, 2003; Verburg et al., 2006). It was found in Case C that time can be saved as there is no need to go back to the office after the customer visit in order just to check important e-mails.

Better utilization of time is another time related impact that has also been addressed in earlier studies (e.g., Evans, 2002; Perry et al., 2001; Gebauer & Shaw, 2004). Access to critical, real-time information is an important productivity driver that improves employees' efficient use of working time while on the move. For example, mobile workers can remain productive in situations where they would otherwise experience down-time, including waiting in a hotel room or at an airport and travelling to and from work or client sites, and around the corporate campus (Perry et al., 2001; Evans, 2002). In Case A, it was found that the mobile safety measurement service reduces the overall workload and safety inspector can utilize their time better to be used for more productive work. Moreover, mobile workers using the mobile office service in Case C can utilize their idle time better for doing and planning work tasks while waiting or travelling.

Time can be a critical aspect in situations where fast decision-making and reaction to urgent work tasks is needed (Evans, 2002; Gebauer & Shaw, 2004; Yuan et al., 2010). By having mobile access to real-time e-mails, calendar and contacts at any time in Case C, mobile workers can react to emerging situations and answer their colleagues' or customers' questions more quickly, make more informed decisions faster, manage their work time better and also plan their work days more easily.

*Location related impacts* can be achieved especially when coordination between the mobile workers is needed (van de Heijden & Valiente, 2002), for example, in order to allocate unscheduled work to field workers (Verburg et al., 2006). This was also the case with the taxi dispatching service in Case B, where the dispatching process was improved due to the location information of the nearest available taxis. Information access while on the move increases taxi drivers' location awareness. The map and the fact that it is linked to the GPS make it easy to find addresses in unfamiliar areas, to locate oneself, the customer and other drivers on the map and navigate to the destination. Forecasting work opportunities can also be improved based on location information. Due to information access, taxi drivers can now predict orders better. For example, on the queue page in the mobile taxi dispatching service they can easily see the need for taxis at different locations. Moreover, they can see if there are going to be pending requests in a certain location and drive there to catch more customers.

*Convenience* has been pointed out in earlier studies (Basole, 2004; Gebauer, 2008) and it is about making work easier with minimum effort, for example, by eliminating an unsatisfying task of documenting safety observations first on paper and then on the system (Case A) or manual positioning that was considered burdensome by taxi drivers (Case B). The mobile business service can also be considered a handy option compared to the alternatives (similar to consumer services, see Pihlström, 2008). For example, due to the mobile office service there is no need to carry laptops



everywhere in order to stay informed. However, the interviewees agreed that mobile services do not replace laptops but that laptops and the mobile service complement each other. For example, when in an idle period of less than half an hour, a mobile service in a mobile device was seen to be more beneficial than using a laptop with a mobile connection.

*Employee satisfaction* can be increased due to the reduction of overall workload, better situation awareness and a sense of belonging to a community (Perry et al., 2001; Sheng et al., 2005). It was noted in all case studies that having appropriate and modern tools could improve employee satisfaction as such. Mobile business services can also create better situation awareness for mobile workers through information access and sharing. Situation awareness was mentioned several times as a benefit of the mobile office service. Workers can be more prepared when they come back to the office as they are aware, for example, of changes in the calendar or e-mails requiring their attention. In this way they are not so stressed as they can plan how to use their working time more productively. In earlier studies it was also found that mobile workers can monitor the activities of remote colleagues to stay informed of what is going on in the office as well as to build a sense of community (Perry et al., 2001). Similarly, the mobile taxi dispatching service enables taxi drivers to monitor other drivers and send messages to taxis. Drivers can, for example, locate co-workers in order to invite them to have lunch or coffee. This social impact was considered to have a positive effect on employee satisfaction by building a better sense of communality although working mobile. Experiences of stress when using the mobile office service were considered to be one example of emotional impacts that affect satisfaction. It was mostly reported that work-related stress decreases as mobile workers know better what is going on. However, work-related stress was also seen to increase due to a fear of longer working days (i.e., doing work outside working hours) and losing flexibility and freedom at work due to stricter control. Moreover, mobile workers might feel addicted to mobile email in both negative and positive ways. Work can easily follow the workers home if the service is used continuously.

Improved employee *productivity* is an important impact of using mobile services at work and it has also been emphasized in earlier studies (Gebauer & Shaw, 2004; Rangone & Renga, 2006; Bouwman & van de Wijngaert, 2009). According to Gebauer and Shaw (2004), productivity improvements can be gained from reduced idle time and the opportunity to distribute workloads more evenly across time and space. Similar results were found in the use of the mobile office service. In addition, Rangone and Renga (2006) noted that the automation of order entry improved in-field productivity as the same activity takes less time for mobile employees and also improved in-house productivity as some tasks can be eliminated since the data is transmitted directly from the device to the corporate information system without any additional work or human error. The mobile safety measurement service did not actually shorten the work process in-field but provided time savings when the worker came back to the office, thereby improved in-house productivity.

### **Structural impacts**

Structural impacts include changes related to the company's internal aspects such as information, processes, management, values and culture as well as working atmosphere (cf. structural capital, internal structure and the internal business process perspective). These factors have been discussed,

for example, under informational benefits and enterprise transformation (Basole, 2007), process (Barnes, 2003), efficiency and effectiveness (Chen & Nath, 2004; Sheng et al., 2005), operational impact and organizational flexibility (Gebauer & Shaw, 2004) as well as impact on internal efficiency, productivity and flexibility (Picoto et al., 2010). In the case studies of this dissertation, structural impacts were related to informational impacts, communicational impacts, process efficiencies as well as working atmosphere and environment.

*Informational impacts* include the quality and quantity of information through faster and easier access to internal and external information as well as more useful, accurate and reliable information (Basole, 2007). For example, the use of the mobile safety measurement service in Case A automatically generates documents and information in digital form and there is no need to go back to the office to input the data. In addition, the quality of information could be improved. For example, earlier the observer might make careless documentation on paper and the message might change when later inputted into a computer due to human error.

*Communicational impacts* include internal communication and knowledge sharing (e.g., Sheng et al., 2005). The mobile office service as such is a communication tool that provides communicational impacts for mobile workers (Case C). In addition, it was noted in Case A that the use of the mobile safety measurement service could increase internal knowledge sharing as data is collected into one shared place and is accessible to all employees. It is also possible to send notifications via SMS or email but these features have not yet been taken into use. The use of the mobile taxi dispatching service in Case B, on the other hand, has improved internal communication and knowledge sharing through messaging. For example, information about traffic jams and locations where there are many customers waiting for taxis can be easily communicated.

*Process efficiencies* are related to improvements in business processes (e.g., van de Heijden & Validente, 2002; Gruhn et al., 2007) and can result from increased productivity (Rangone & Renga, 2006). For example, unnecessary steps were eliminated from the safety measurement process as data is automatically inputted in an appropriate format via the mobile service in Case A. Due to automatic GPS positioning, the mobile taxi dispatching service has also improved the business process. For example, taxi drivers do not have to position themselves manually as they did before and the dispatching process is more efficient as the system can track the location of the taxis and send the customer request.

Changes related to *workplace* are also part of structural impacts. For example, working atmosphere can be improved by creating a stronger culture and sense of belonging to a community as was found in the use of messaging in the taxi dispatching service. The physical working environment has also become quieter due to the mobile taxi dispatching service. Earlier, information was shared through a speech system that was quite noisy and disturbed both drivers and their customers.

## **Relational impacts**

Relational impacts capture all the impacts related to relationships with customers and other stakeholders as well as the organization's image and brands (cf. relational capital, customer perspective, external structure). Relational aspects are discussed, for example, under strategic

benefits (Basole, 2007), market value proposition (Barnes, 2003), customer service and company image (Sheng et al., 2005) also under impacts downstream and upstream (Picoto et al., 2010). The relational impacts found in the case studies include customer service and satisfaction, external knowledge sharing and company image.

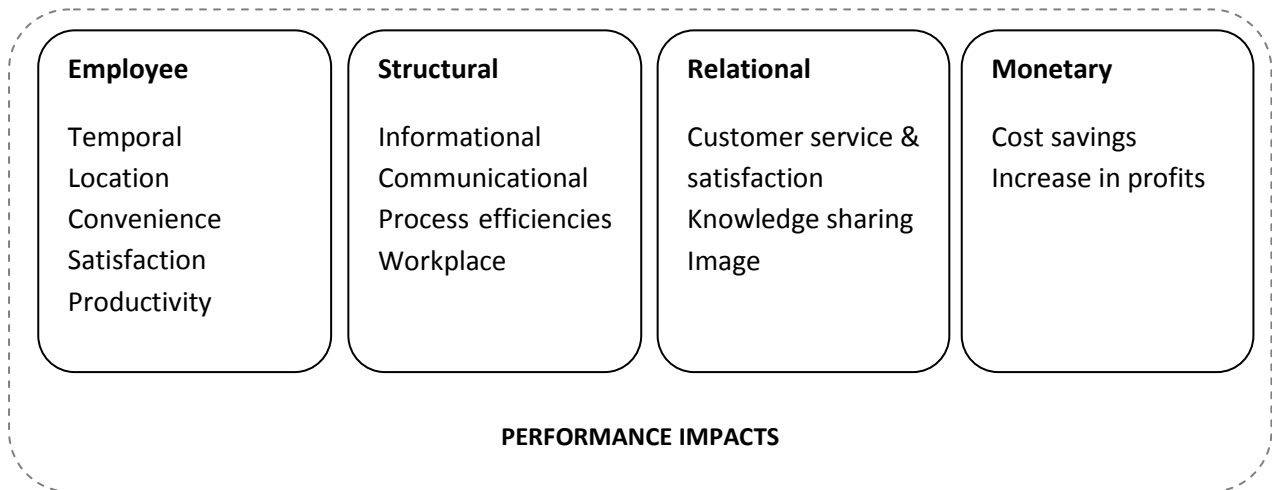
Improved *customer service and satisfaction* are important structural impacts from mobile business services that also give companies a competitive advantage (Rangone & Reanga, 2006). Customer satisfaction can be improved through minimizing customer waiting time. For example, automatic GPS positioning in Case B allows the nearest available taxi to respond to the request, so customers now get the taxi faster than before. In addition, customer service has improved due to an increase in the information available to inform the customers about the incoming taxi. For example, taxi drivers can estimate and input the time of pick-up (estimated arrival time) when accepting incoming requests. This information is useful for the dispatchers if the customer calls back and asks about the arrival of the taxi and thus, the service improves *external knowledge sharing*.

At the time of conducting Case A, a company that utilizes mobile business services can be considered a technological forerunner in the construction industry. This status may boost the *image of a company* and, in that sense, the use of the mobile service may be considered important as such, regardless of the possible process improvements or financial benefits. In addition, when data is gathered and communicated in real-time to several stakeholders, the mobile safety measurement service may speed up the correction of safety problems and help reduce the number of accidents. Reduction of accidents due to the use of mobile service may also have a positive influence on the company's image.

### **Monetary impacts**

The monetary impacts of mobile business services have been addressed in previous studies, for example, in terms of cost savings and revenue increase (Alanen & Autio, 2003; Evans, 2002; Kornak et al., 2004), perceived cost savings and cost effectiveness (Kim, 2008), increase in revenues and profits (Lee & Park, 2008) as well as transactional benefits (Basole, 2007). Monetary impacts were not emphasized in this study as much as the productivity impacts and intangible benefits were in focus in the case studies. However, in the case studies, two types of monetary impacts were perceived: *cost savings* through time savings in Cases A and C and *increased profits* per kilometer in Case B. The cost of not being able to react to customers' enquiries (e.g., project proposals, purchase offers) was also discussed in Case C.

Figure 9 provides a summary of the main findings discussed in this chapter.

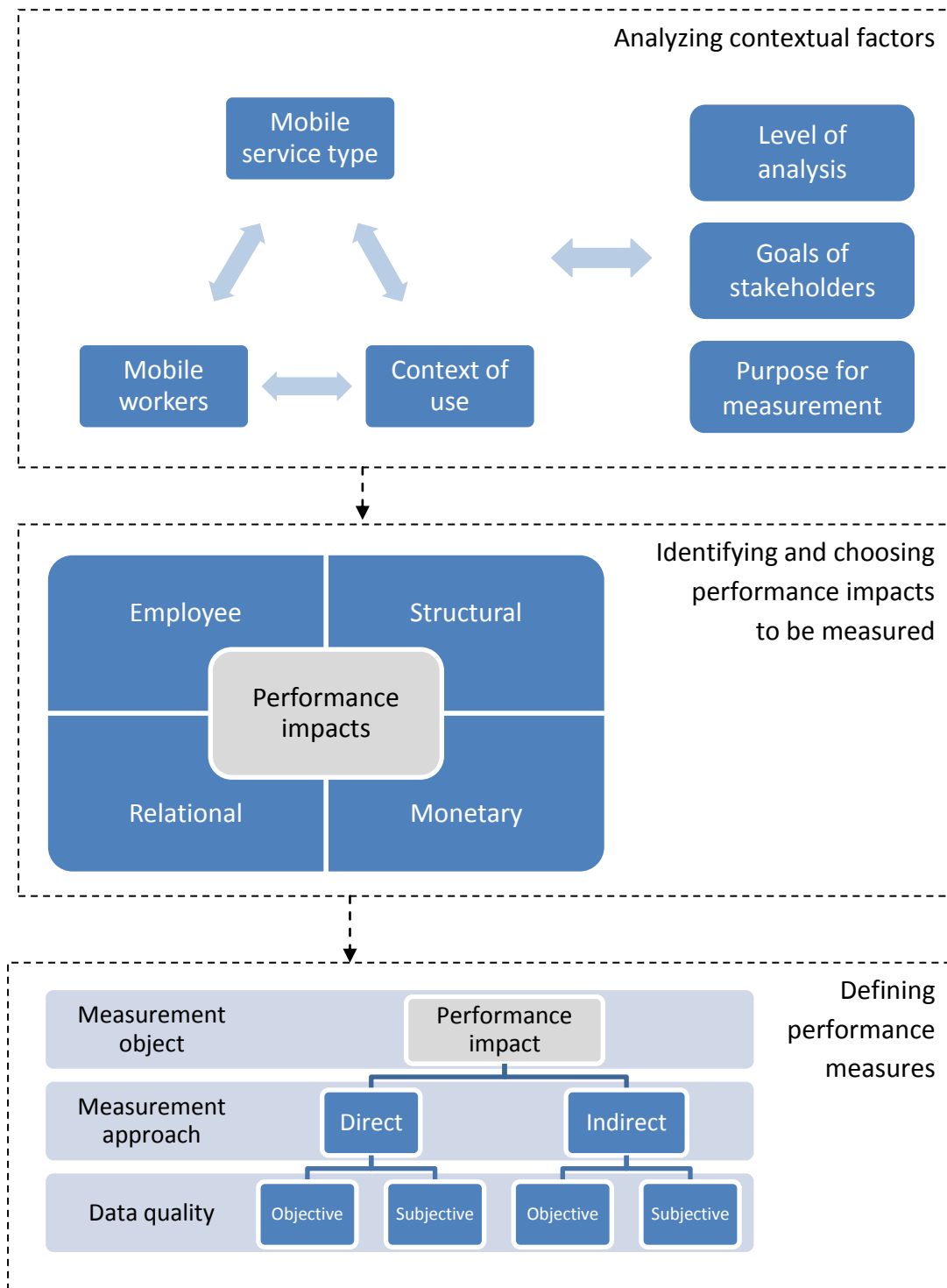


**Figure 9 Summary of the performance impacts of mobile business services.**

Summary – In order to achieve a balanced and comprehensive view of the business performance impacts of mobile business services, four general dimensions were identified. Business performance impacts may be related to employee, structural, relational and monetary levels and they may be tangible or intangible in nature. The impacts of mobile services may have contextual perspectives, such as temporal or location-related impacts. Most of the business performance impacts identified in the case studies of this dissertation can be categorized under two dimensions, that is, employee impacts and structural impacts. In addition, most of the impacts were intangible.

### **3.3 How to measure the performance impacts of mobile business services?**

The third research question was posed in response to a need for more research on how to conduct the measurement of business performance impacts in practice. Figure 10 provides a conceptual framework for measuring the performance impacts of mobile business services. In this framework, the measurement is approached as a process of three phases: 1) analyzing contextual factors, 2) identifying business performance impacts, and 3) defining performance measures. These phases are discussed next together with the findings from the measurement tool development process and Case C. Measurement tool development is described in detail in Papers III and IV and the case study (Case C) where the measurement tool was applied and used is described in Paper V.



**Figure 10 Framework for measuring performance impacts of mobile business services.**

**Phase 1 - Analyzing contextual factors**

The first phase consists of analyzing contextual factors and includes both the characteristics of the *mobile context* and the requirements of the *business context*. These contextual factors were already

discussed in Chapter 3.1. Performance measure design processes usually start by identifying success factors based on strategy or stakeholders' wants and needs (Bourne et al., 2000; Neely et al., 2001). It is also suggested that operative objectives can be used as a starting point (Franco-Santos et al., 2007). However, it is also important to consider the contextual factors before designing the performance measures. For example, Chiesa et al. (2008) identify contextual factors within the R&D environment as they influence the design of the performance measurement system.

The mobile context includes mobile service type, mobile worker and context of use (i.e., other external contextual factors of technology usage: technical, task, temporal, physical and social contexts). The characteristics of the mobile context affect the choice of services and functions that can be used for supporting mobile workers. The type of service affects the goals and potential impacts that can be achieved and are relevant to measure. The mobile context can be analyzed, for example, using the mobile contextual factors discussed in Chapters 1.3.1 and 3.1. These factors also affect the user experience (Forlizzi & Ford, 2000; Hassenzahl & Tractinsky, 2006). In addition, mobile business processes can be analyzed and modeled in various ways (van de Heijden & Valiente, 2002; Gruhn et al., 2007; Wigelius et al., 2007). Measurement can be conducted in different ways in different mobile contexts. For example, during the research projects related to this dissertation, various methods for analyzing and measuring the impacts were proposed and also tested, for example, process modeling and cost savings calculation based on time savings (see, Wigelius et al., 2007). Those methods were deemed beneficial when the mobile service was used in a work process that is quite routine and includes specific steps and phases that can be measured in terms of duration. However, mobile services are also used to support non-routine work tasks where the need for using the service may emerge suddenly and be limited to certain situations. In these cases it may be difficult or even impossible to collect objective data for measuring the performance impacts in a similar way. Thus subjective measurement was applied.

The business context, on the other hand, sets targets for deploying the service and measuring the performance impacts, such as the purpose of measurement and level of analysis. For example, the case company needed information on how the use of the mobile office service affects the productivity of mobile workers. As they had other solutions for mobile mail in use, they needed a method that could be used for comparing different services and evaluating the effects of wider deployment. The goal of the case study was to create and test a set of statements that could later be used to gather more feedback from the case company's customers. At the time of the study, the feedback that was collected from customers was mostly related to technical problems rather than benefits that could be derived from using the service. A further objective was to collect experiences from real users in order to produce evidence-based arguments for sales. The measurement of business performance impacts can be utilized from various perspectives and at different levels. In Case C, the measurement was conducted at employee level.

### ***Phase 2 - Identifying business performance impacts***

The second phase includes identifying and choosing the business performance impacts to be measured (Bourne et al., 2000; Medori & Steeple, 2001). As noted, performance impacts (or success factors) can be identified, for example, based on company strategy, operative goals or

stakeholders' wants and needs. Performance impacts can be realized at various levels and include financial and other tangible impacts as well as intangible impacts. In this dissertation, it is suggested that the impacts can be structured under employee, structural, relational and monetary impacts. Various performance impacts of mobile business services were identified in Chapter 3.2. It should be noted that the illustration of impacts is simplified and does not capture the complex cause and effect relationships that may exist between the impacts.

Performance impacts can be identified, for example, by conducting interviews or workshops with the representatives involved. During the measurement tool development process of this research, three dimensions were first identified to represent elements of broader mobile business service experience: usability, mobile working context and mobile work productivity. In Case C, the previous version and dimensions of the measurement tool were taken as a starting point. Various success factors were identified and discussed in close collaboration with the service provider during workshops (action research) and finally two main dimensions were chosen: usage of the mobile office services (including usability and contextual aspects) and impacts of the service on work (productivity). A broader term (impacts on work) was chosen instead of using productivity as this may be difficult to interpret or may even have a negative sound. Due to the focus of this dissertation, aspects related to the technical perspective (i.e., usability and technical context) are not discussed or analyzed further. The contribution of this study focuses on adding productivity related factors to more traditional technology use and usability perspectives

Customer productivity in the service literature consists of inputs such as time, effort, cost and emotional energy and outputs include experience (e.g., satisfaction), outcome and value (Parasuraman, 2002; Johnston & Jones, 2004). The improvement (productivity impact) can be achieved in various ways, for example, when output increases faster than input, more outputs are achieved from the same or fewer inputs or the same output is achieved with fewer inputs (Misterec et al., 1992). Based on these assumptions, various success factors related to productivity were chosen, including customer inputs and outputs such as temporal and emotional aspects (work-related stress), satisfaction, efficiency and the outputs of work in addition to productivity as such (i.e., direct productivity measure).

### ***Phase 3 – Defining measures***

After identifying and choosing business performance impacts that are relevant in a specific context, actual measures can be developed for each impact (Bourne et al., 2000). At this point, the requirements of a particular context need to be considered. According to Tangen (2003), the choice of a suitable measurement approach depends on a number of factors, including the purpose of the measurement; the level of detail required; the time available for the measurement; the existence of available predetermined data; and the cost of measurement. According to Habermann & Pousttchi (2009), mobile business value measures should be defined in relation to the business objectives for which the technology is deployed.

Performance impacts can be measured with an appropriate method including various types of measures and ways of measuring (objective vs. subjective, direct vs. indirect). These different ways

for measuring productivity impacts are illustrated in the third phase of the framework in Figure 10, which is based on Kemppilä and Lönnqvist (2003) and also on Lönnqvist and Pirttimäki (2006).

In the research papers included in this dissertation, subjective measurement is used at individual (employee/user) level as a method for collecting the needed information about the level of and changes in performance. The motivations for developing and testing subjective measurement arose from the industrial partners of the research projects of this study. As subjective measurement is also typically used in mobile technology evaluation models (Chapter 1.5.1), it provided a good basis for combining mobile specific aspects and the business performance perspective. In addition, it was a good way of including indirect and intangible aspects when measuring the impacts of mobile business services. Moreover, subjective measures make it possible to compare the productivity between different work tasks which is not possible with objective measures.

In order to define the measures for each performance impact, statements for the questionnaire were iteratively generated and refined on the basis of the literature on earlier studies of mobile systems, earlier case studies (Case A and B) and expert interviews. The existing usability questionnaires were used as the basis for the present tool, although they needed to be revised for present purposes because they did not specifically focus on the issues relevant for the mobile work context as they were mainly developed for desktop environments or consumer use. Thus, the otherwise relevant statements from the existing questionnaires were revised to better measure the success factors that are important for mobile business services. In addition, new dimensions and statements needed to be added to capture all the important factors, such as the issues related to technical context (e.g., mobile device, network connections and the overall system), physical context (e.g., environment, mobility and location) as well as safety and mobile work productivity. Co-creation of content was deemed important so that the measurement tool could provide relevant information and be a basis for joint development between relevant parties and departments in an organization, including user representatives, sales, marketing, product management, technology, and usability. The validity of the statements in Case C was further established by literature reviews and interviews with managers, sales workers and product specialists who were also users of the mobile office service.

The users were asked to respond to the statements according to their experiences when using the mobile office service. The statements related to productivity impacts are provided in Table 11 in relation to various dimensions discussed in the previous chapter.



**Table 11 Productivity related statements of the questionnaire in Case C**

| <b>Dimension</b> | <b>Statement</b>  |
|------------------|---|
| Convenience      | My work has become more fluent<br>Planning and anticipating work tasks has become easier  |
| Temporal         | I have been able to accomplish tasks needing a rapid reaction or response<br>Additional traveling (e.g., from and to the office) has decreased<br>I have been able to utilize idle time (e.g., waiting time) to do my work<br>Decision-making concerning my work has become faster<br>My time management has improved<br>My free time has increased |
| Communicational  | Communication and information sharing have improved   |
| Satisfaction     | My work satisfaction has been improved<br>My work-related stress has increased<br>My situation awareness has improved   |
| Productivity     | My productivity has improved<br>I have been able to increase the outputs of my work<br>My work has become more efficient  |

Other aspects related to performance impacts were also addressed within the statements of actual usage, for example, addiction (“I am addicted to use the mobile office service”) and social impact (“Using the mobile office service affects my image positively”).

The limitations of a measurement approach also affect the choice. For example, subjective measurement is related to collecting only users’ subjective opinions, there may be difficulties when interpreting the statements and concepts used, absence of personal contact and relatively general level of analysis. Therefore, it is suggested that questionnaires should not be the only tool to use for measuring the performance impacts. However, it is a good and fast tool in specific use situations where information is needed to capture especially the intangible impacts.

### ***Implementing and using measures***

After appropriate measures are defined, the measures are implemented, used and updated (Bourne et al., 2000). The phases of performance measurement are overlapping in practice (Bourne et al., 2000), thus the measurement tool development was also iterative. In order to evaluate how the questionnaire works in various contexts, three pilot tests were conducted. The results were then compared to find out whether the statements were suitable for measuring the success of a certain mobile business service (Paper III). Data collection was conducted using a web-based survey tool that also provides support for analyzing the results. A link to the online questionnaire was sent to all sales workers, managers and product specialists using the mobile office service via email on behalf of the service provider. A questionnaire was seen as a relatively easy, efficient and cheap tool to gather information from a large number of real users. With an online questionnaire it is easy to contact people regardless of their physical location. Due to the speed of mobile service

development, it was considered important that the analysis, synthesis, results generation and use should be supported by the survey tool in use.

During the pilot tests, it was found that fast, real-time, continuous and close feedback from real users is one of the keys for successful service development. This feedback was considered to be easy to collect with a questionnaire having generic enough statements and open-ended questions. Details from open feedback can bring the needed added value for developing the service experience further. Although only subjective information can be collected, qualitative and intangible impacts can be captured by using a questionnaire. The use of a questionnaire to collect feedback related to productivity impacts also proved useful in the case company during Case C. Productivity impacts can be measured together with technical and contextual factors that may also have an effect on productivity. Productivity related statements were introduced in a broader setting, including not only workers of the case company in Finland but also customers and workers in other countries.

The results of the questionnaire can be used, for example, when benchmarking the new versions of the service and the success of the service against competitors, for indicating the actual benefits the service provides for the end users and companies deploying the service and the level in which the users of the service perceive the productivity of the service to be. Moreover, by reusing the questionnaire, the results can be used for detecting changes, for example, in satisfaction and productivity over time. The results help the service developers in developing more successful services and they are also useful for the company using the service. For example, information about the level of perceived productivity and problems related to productivity in mobile work can be used as diagnostic tools to improve productivity over time.

The questionnaire was found useful at the individual level. Similarly, it could provide information about the relational impacts, for example, how customers of the company deploying mobile services perceive the impacts related to customer service, communication or image of a company. Objective performance data (task time, customers/day, cycle times or revenue) could, on the other hand, be collected when appropriate at process and company levels in order to complement the subjective measurement.

Summary – The measurement of business performance impacts can be seen as a process of analyzing contextual factors, identifying performance impacts and defining performance measures. After that, performance measures can be implemented and used. Measurement can focus on one or more levels at a time and on one or more success factors at the time depending on the purpose of measurement. The measurement of performance impacts can be conducted using a method suitable to a particular mobile and business context including various types of measures and ways of measuring. In the case study included in this dissertation, the measurement was conducted at the level of individual employee and the focus was on the perceived productivity impacts. Productivity impacts were viewed broadly, including intangible aspects that may have an effect on productivity. Both indirect and direct subjective measures were used in addition to open-ended question related to benefits achieved by workers using the mobile service. The subjective productivity measures were incorporated with the traditional statements of usability and technology use, thus the results were considered to be beneficial for various parties and departments.

## **4 CONCLUSIONS**

### **4.1 Contribution of the research**

#### **4.1.1 Contribution to prior research**

Conceptual and theoretical perspectives on the performance impacts of mobile business services have been many sided and unorganized as the research has been done in many fields. There are some studies that have identified potential benefits and business value of using mobile technology in companies (e.g., Chen & Nath, 2004; Sheng et al, 2005; Picoto et al., 2010). However, practical application of these conceptual mobile models and especially the operationalization and measurement of various dimensions of these models has been scarce. There has also been a lack of mobile studies specifically focusing on the concrete measures to capture achieved business value (Habermann & Pousttchi, 2009). This study contributes to the prior literature by bringing different perspectives together (technology, services and business performance) and providing new empirical knowledge on measuring the performance impacts of mobile business services. The main contribution is to bring applied knowledge into this narrow but multidisciplinary research phenomenon. This study identified four typical dimensions for business performance impacts that are relevant for mobile business services and took also contextual aspects into consideration. In addition, this research operationalized some of the performance impacts through developing measures and conducting the measurement in a practical setting. The findings of this study were structured into a conceptual performance impact measurement framework for mobile business services (Figure 10, p.58). This framework provides understanding on the measurement process that can be utilized in different contexts and it is not dependent on a specific technology. Thus the framework is also relevant in the future in spite of rapid technological development.

A secondary contribution was to bring new knowledge to each theoretical approach or field that was used as background theories in this dissertation. As mobile business services are technology-based services, utilizing technology research seemed reasonable. The focus of traditional popular technology evaluation models has been on usage intentions (Davis, 1989) and individual performance impacts (Goodhue & Thompson, 1995). The focus of IT business value measurement, on the other hand, has been on financial perspective and operational efficiency at company level while neglecting the role of individual user. These perspectives are combined and broadened in this study by emphasizing on what comes after utilization and what other levels are relevant in addition to individual users when using technology in companies. For this purpose, four dimensions of business performance impacts were introduced, namely employee, structural, relational and monetary impacts. In addition, this study also put emphasis on intangible aspects as they are usually neglected in IT value measurement (Irani, 2002; Gunasekaran et al., 2006). This study showed that intangible and non-financial impacts seem to be more common than financial impacts and that most of the impacts are derived at employee and process levels (in contrast to strategic (relational) impacts) at that particular point of time when the case studies were conducted. This study also identified contextual aspects that are important in mobile business use and that should be taken into

consideration when choosing mobile business services and setting goals for their usage. Moreover, contextual and business performance perspectives were added to the practical measurement of technology (e.g., usability) and this study developed new statements and also applied statements used in earlier studies to measure perceived performance impacts at individual level.

Services research was used in this study in order to avoid the pure technical perspective and to discuss more about the value creation for customers instead. Mobile services have been studied a lot within service marketing field with consumer focus (e.g., Pihlström, 2008; Wessels & Drennan, 2010) and some similarities can be found. For example, in addition to the company's efficiency and productivity goals, mobile workers are also technology users and may appreciate similar factors at individual level than consumers, including social and emotional factors (Pihlström, 2008). Service productivity and its measurement have been one challenging research topic due to the nature of services, their production process and the identification of the outcomes of services as they are usually intangible (Vuorinen et al., 1998; Parasuraman, 2002; Johnston & Jones, 2004; Sahay, 2005; Anitsal & Schumann, 2007). This dissertation provides examples of one type of technology-based services (i.e., mobile business services) and their business performance impacts and how to measure these impacts in a practical setting. By utilizing a service approach to business performance or productivity impacts, the perspective is turned naturally to focus on the customer. This dissertation integrates perspectives from different fields in order to better understand, measure and manage services. This multidisciplinary approach is part of what is suggested as being services science research (Stauss et al., 2008).

Finally, this study also contributes to performance measurement design research through the application of structural and procedural frameworks used for measuring the business performance and intellectual capital of companies and departments in a mobile business service context. There are various ways of measuring business performance impacts in general (e.g., Kaydos, 1999; Simons, 2000; Lönnqvist, 2004) and many measurement frameworks and processes are provided in performance measurement and intellectual capital literature to guide the designing of performance measures (see e.g., Neely et al., 2000; Bourne et al., 2000; 2003; Folan & Browne, 2005a; Pun & White, 2005; Nudurudati et al., 2001; Tangen, 2004). In this research, the performance impacts of mobile business services are structured based on four dimensions and it is suggested that the performance measures can be designed through three stages: analyzing the mobile business context, identifying performance impacts and defining measures. As the appropriateness of using a particular performance measurement method is highly influenced by the particular practical circumstances (Tillemma, 2005; Garengo & Bititci, 2007), this study contributes to the existing research by discussing the requirements of business use, the multidimensional nature of performance impacts and the characteristics of the mobile context in order to better understand the contextual factors. This study also applied subjective productivity measurement in a practical measurement setting and thus, provided empirical evidence on the applicability of such measurement approach. Subjective productivity measurement included both tangible and intangible factors that were measured using direct and indirect measures. The measurement of business performance impacts was considered from the perspective of the customer thus this study also moves the traditional productivity discussion towards the customer perspective. This study also incorporated performance measurement into traditional technology evaluation field. This study

pointed out that it is beneficial to measure the business performance impacts in close connection to other service development activities in order to gain easy access to information when measuring other important aspects related to technology use. It was also noted that technology (e.g., usability) as well as other contextual factors can have marked effects on the realization of business performance impacts; they should be taken into account when measuring the impacts.

#### **4.1.2 Contribution to management practice**

In some cases, mobile business services may be fairly cheap and easy to deploy compared to other broader enterprise system investments and thus, the measurement of performance impacts may not achieve major importance. However, there is still a high degree of uncertainty associated with the adoption of new technologies in terms of benefits, risks and costs (Irani, 2002; Gunasekaran et al., 2006) In addition, if measurement is neglected or misunderstood, managers may refuse to deploy services that could be beneficial or choose services that do not bring value to their users. As Farbey et al. (1999) suggest, measurement should be viewed as positive activities leading to clearer understanding, better decisions, tighter control, happy users and greater benefits. In this chapter, the results and importance of measurement are considered from the managerial perspective.

This dissertation had a very practical starting point: companies (service providers) needed better understanding of the business performance impacts of mobile business services and tools for measuring these impacts. This practical problem was explored using a pragmatic approach. The results of this study are expected to be useful for both service providers (developers, marketers) and customer (user) companies (decision-makers). Although this dissertation focus on the practical measurement activities of a service provider, the implications are also relevant for companies deploying mobile business services as they can use the same approach in their companies.

In order to be able to measure and manage mobile business services better and to support mobile workers with proper tools, managers need knowledge about the measurement process. This dissertation provides knowledge about the process of identifying relevant performance impacts of mobile business services and designing measures for these impacts. This research also provides examples of the performance impacts of specific mobile business services and how to measure these impacts in practice using subjective measurement. The practical contribution of this dissertation is related to three managerial measurement tasks: determining the value of mobile business services, communicating the value propositions to customers and supporting service development through measures.

Business performance impacts are related to different types of mobile business services, the mobile context of use and the goals of the companies deploying the services. These aspects need to be understood when developing or choosing proper mobile services for workers. Various business performance impacts should be identified in order to communicate the potential of mobile business services for customer and to set goals for the deployment at customer organization. After the business performance impacts are identified, measures for each individual impact can be developed and then used in order to determine the realized value in use. Some questions merit consideration:

- Which types of mobile services (including a set of functions) support mobile workers in a specific mobile context of use?
- What kinds of performance impacts can be expected from the use of these mobile services?
  - o What are the goals of various stakeholders in the deployment of these services?
  - o Are the services providing the value the customer is after?
- What is the purpose for measuring performance impacts in a specific situation? Who needs the measurement information?
- When and how to measure the impacts that are deemed relevant? With what type of measures?
  - o Are the impacts tangible or intangible? At what level are they expected?

When the measurement of business performance impacts is integrated into the service development process together with the technological perspective (e.g., usability) and contextual factors, it supports the joint development of mobile business services and benefits various stakeholders. In this research, the measurement tool was developed and tested in a real life context through action research, which improves the practical relevance of research (Baskerville & Myers, 2004). The conceptual dimensions related to various performance impacts were operationalized in the mobile business services context and made measurable in practice so the results of this study are ready to be applied in companies. The experiences related to measures used in this research were positive and the case company (Case C) adopted the measures.

## 4.2 Assessment of the research

Establishing the quality of research is traditionally approached through the concepts of validity and reliability. These concepts have their roots in quantitative research and it has been debated if they are also applicable in qualitative research. As a solution to this “validity issue,” other terms have been suggested, such as trustworthiness, confirmability, credibility, transferability and dependability (Morse et al., 2002; Riege, 2003; Onwuegbuzie & Johnson, 2006). Moreover, as both quantitative and qualitative approaches are combined in mixed methods research, validity is also termed legitimation (Onwuegbuzie & Johnson, 2006). In order to remain consistent, validity and reliability are used in this dissertation as they are also argued to be overarching constructs that can be appropriately used in all scientific paradigms (Morse et al., 2002).

**Validity** addresses whether the researcher is actually studying the phenomenon she or he intends to study (McKinnon, 1986). Validity can be classified into three main types: internal validity, construct validity and external validity (Yin, 2009). *Internal validity* in case study research aims at establishing phenomena in a credible way (Riege, 2003). Thus, it can be first assessed whether measuring the performance impacts of mobile business services was well established in this study. Due to the scope of this research and practical limitations, there are some issues that can be criticized. For example, the phenomenon was only examined from the customer company’s point of view (their employees, processes and customers) although many of the impacts may also affect the service provider, suppliers, network operators, device manufacturers and society as well. These

could have been included as a part of relational impacts but would have needed more data and network level analysis. However, it can be claimed that the performance impacts from customer point of view were well established. This study also focused on business-to-employee services not all types of business services. The shorter term ‘mobile business service’ was used in order to be consistent with the research papers. This concept was defined in Chapter 1.3.1 for the purposes of this research. The performance impacts of mobile business services were identified at various levels but the actual operationalization of impacts and their measurement was only done at employee level due to the practical purposes of case companies and availability of data sources.

*Construct validity* refers to identifying correct operational measures for the concepts being studied. Construct validity can be increased, for example, by using multiple sources of evidence and having key informants review draft case study reports. (Yin, 2009) In this research, construct validity can be said to be well established. Several research methods were used as presented in Chapter 2.3.3, and data was collected from various sources. Interviewees reviewed the transcriptions of the interviews and industry representatives and the academic supervisors of the research projects reviewed case study reports. The content of the measurement tool was created on the basis of earlier case studies and findings from the literature and discussed during workshops. The five research papers included in this study also went through a peer-review process which ensures the quality of the results.

*External validity* defines the domain to which a study’s findings can be **generalized** beyond the immediate case study. This can be achieved in the research design phase using theory in single-case studies and using replication logic in multiple-case studies. (Yin, 2009, p. 41) In this study replication was used by examining the same underlying phenomena in three individual cases in order to identify the performance impacts of different types of services. This improves the external validity as the results are compared and generalized at some level. Three types of mobile business services in different industries in Finland were studied resulting in various similarities but also differences due to contextual factors that were pointed out in Chapters 3.1 and 3.2. The performance impacts identified were categorized under four general dimensions that can be used regardless of mobile technology or service. It is not, however, clear how the specific impacts would be applied to other type of services in different industries or countries and this is suggested as a subject for future studies. For example, there may be some critical success factors missing from the performance impacts that were categorized under the four quite generic dimensions.

In order to provide a more general measurement tool that can also be adjusted in a specific use context, the questionnaire was developed and pilot tested in three distinct service development processes and then developed further and used in one specific measurement context. Subjective productivity measurement is only one way of measuring performance impacts and there are many other approaches that could be utilized depending on the purpose or measurement, type of mobile service as well as the task or process in which it is deployed. The results of this study were further combined and generalized by developing a conceptual framework for measuring the performance impacts of mobile business services. The nature of this framework is generic as it is not limited to any particular technology or service but contributes to the process of measuring the performance impacts and especially to designing measures. Contextual factors influence the way of conducting measurement so these are added as a first phase of the measurement process.

**Reliability** refers to demonstrating that the operations of a study, such as data collection procedures, can be repeated with the same findings and conclusions. The goal of reliability is to minimize the errors and biases in a study. (Yin, 2009) In case studies reliability is problematic as they are conducted in a natural real-life setting and even if other researchers can follow each step precisely, the results may still differ (Riege, 2002). In order to ensure the reliability of the data in this research, all meetings, case plans, workshops and the data collected were documented carefully and saved to the same case database. For example, interviews were recorded and transcribed and observations were documented as concretely as possible so that other researchers can use and analyze the data.

According to McKinnon (1988), observer-caused effects, observer bias and data access limitations are typical threats to validity and reliability in field studies. An observer's presence may affect the behavior and conversations of the participants during observations. Interviews, observations, action research and analysis of quantitative data can all be influenced by the researcher's selective perception and interpretation. In addition, limitations to data access can be related to a limited period of time that can be used for observing the phenomena or the research host may impose restrictions on access to certain documents, events or people.

**Triangulation** is a method for improving the validity and reliability of research or evaluation of findings (Golafshani, 2003). Denzin (1978; in Johnson et al., 2007) define triangulation as "the combination of methodologies in the study of the same phenomenon" (p. 291). Denzin outlined the following four types of triangulation: (a) data triangulation (i.e., use of a variety of sources in a study), (b) investigator triangulation (i.e., use of several different researchers), (c) theory triangulation (i.e., use of multiple perspectives and theories to interpret the results of a study), and (d) methodological triangulation (i.e., use of multiple methods to study a research problem). These were all applied in this research. Data triangulation provided a more comprehensive view on the performance impacts as data was collected from users, service developers and decision-makers representing different departments and companies. Case studies were conducted with a research team including researchers from different research so the results were not so biased by one researcher. However, as the researchers worked closely together they were not independent researchers. Using three theoretical backgrounds provided a broad view on the measurement of performance impacts but can be criticized as being too elaborate and thus the analysis may be not be so profound. Multiple methods were used in order to verify the findings.

### **4.3 Suggestions for future research**

The research focusing on the business performance impacts of mobile business services has provided models for understanding the potential of mobility in enterprises but the actual measurement in a comprehensive way has still been less studied. This research identified various performance impacts at four different levels but the actual operationalization of the impacts and measurement was done from one perspective, that is, the productivity related impacts perceived by the users at the individual level. Therefore, there is still a lack of company-level measures and also



objective measures at individual level on how mobile business services affect the customer organization's employees, structures, relations and monetary aspects. One important step for future research is therefore to develop and test the performance impact framework for mobile business services. Now that this research has provided knowledge about the impacts and how to measure these impacts in practice, both subjective and objective measures could be developed for various contexts in order to measure and study performance impacts more profoundly. It would be interesting to study how different characteristics of mobile business services are linked with different types of performance impacts and to measure what types of impacts can be achieved in relation to service characteristics such as functions or contextual factors. Balanced view should also be utilized in the future in addition to combining objective measures with subjective measures at various levels. In addition, various relationships between the performance impacts should be studied to find how they are connected to each other.

As this study focused on benefits, negative impacts should also be studied in the future. Moreover, the barriers and reasons behind the performance impacts not being realized should also be scrutinized. This dissertation focused mainly on the design phase of the performance measurement, that is, identifying the performance impacts and developing measures for particular impacts in a specific measurement situation. In addition to this, research related to the implementation and use of performance measures is needed in the mobile business context.

The results of this study could also be applied to other industries than construction, passenger transport and the knowledge workers of technology-intensive companies, for example, for health care, where local and remote mobility is high and use situations are time critical. The usefulness of the questionnaire and its validity should be tested by collecting data from a larger number of respondents and the questionnaire could be tested in different countries and continents to make comparisons related to performance impacts. Longitudinal research would also be beneficial in order to measure how the performance impacts change in the long run and to differentiate short-term and long-term impacts. This would also help when considering when a particular performance impact is measurable.

As mobile technology has developed and new mobile business services have emerged since the empirical parts of this study were conducted, it would be interesting to study what new types of impacts can be identified and if the locus of impacts has changed, for example, towards the strategic level. Strategic aspects would be relevant as companies are deploying more broad and integrated services in order to increase enterprise mobility. The relational impacts (usually strategic) of the case services in this study were relatively low as the services were not integrated into enterprise systems (e.g., CRM) or were not used in such a way that they would provide much value for other stakeholders. For example, the results of weekly safety measurement were still printed on a notice board instead of real-time information being disseminated all parties concerned and the information on the taxi's estimated arrival time or arrival did not reach the waiting customer automatically, for example via text message, although this would be valuable information for the customer. Moreover, the mobile office service did not have much impact on the external communication as the service was not considered a proper tool for communicating with customers. Some of these aspects can be considered as technological but also cultural or social barriers that need to be studied in order to better understand the impacts that can be realized in specific conditions.

The cross-disciplinary approach used in this dissertation could also be useful in future studies. Including business performance measurement insights - intangible aspects together with productivity and financial perspectives – in technology research was proven to result in new tools for measuring the performance impacts of technology use. In addition, a cross-disciplinary approach provides a better understanding of the mobile use context and service experience and their interaction with business performance impacts. For example, services research related to service systems would afford new insights, especially when measuring more complex mobile service systems, service production networks and analyzing the impacts at network level.

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