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EMPIRICAL RESEARCH

An organizational perspective on m-business: usage factors and value determination[†]

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Abstract

Mobile technologies have increasingly become an integral part of individuals' work and personal lives. Although research exists in this domain, most of it focuses on the customer's adoption factors rather than assessing the value or the impact of mobile business (m-business) usage on firms. The present study fills this gap in the literature through the analysis of the value m-business can provide for firms. The Technology-Organization-Environment framework, Diffusion of Innovation theory and Resource-Based theory ground this research's conceptual model for assessing the post-adoption stages of usage and value of mobile business from an organizational perspective. The value of m-business includes the impact on marketing and sales, internal operations, and procurement. This research uses a mixed method research design; interviews are first conducted to develop a model to assess m-business usage, and survey data collected from 180 Portuguese organizations is then used to test the proposed model. The results indicate that seven of the nine proposed antecedents of m-business usage are significant, and that m-business usage has a positive and significant relationship with m-business value. Furthermore, the three dimensions of value (marketing and sales, internal operations, and procurement) are significant, but only two of them have direct positive impacts on firm performance. Implications of these findings for practice and research are discussed.

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Introduction

The telecommunications sector has changed dramatically since 2000, when there were more fixed line subscribers than mobile subscribers. By 2011, mobile subscriptions accounted for 65% of all subscriptions in OECD countries (OECD, 2013) at 1.3 billion. This corresponds to 109 subscribers per 100 inhabitants (OECD, 2013). In these countries, mobile revenues accounted for 47.8% of all telecommunications in 2011, up from 28.6% a decade earlier (OECD, 2013). 'Globally, more than 500 million smartphones are now said to be purchased annually', and this growth has also led to increased availability of mobile broadband services (OECD, 2013, p. 102).

Today, these new mobile technologies provide a unique channel for marketing and can facilitate new business opportunities and help improve organizational performance. The use of mobile technologies for business is often referred to as 'mobile business' (m-business) or 'mobile commerce' (m-commerce). There has been an increased usage of mobile business applications in the organizational context (Stieglitz & Brockmann, 2012). However, it is not yet clear how mobility can affect traditional businesses nor electronic businesses, or what are the implications of mobile technology usage at the organizational level (Gebauer & Shaw, 2004). Furthermore,

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companies making mobile business investment decisions need to consider the value creation of m-business (Basole, 2005; Peltomaki *et al*, 2009). Despite several case studies on m-business from an organizational perspective (Gebauer & Shaw, 2004; Lee & Shim, 2006; Gruhn *et al*, 2007; Liang *et al*, 2007b; Balocco *et al*, 2009; Peltomaki *et al*, 2009; Sharma & Gutiérrez, 2010), there is presently no unified view of how companies can leverage the potential value of m-business and no empirical research regarding the development of successful m-business strategies (Barnes & Scornavacca, 2006; Ngai & Gunasekaran, 2007; Wen-Jang, 2007; Lehmann & Scornavacca, 2010). Despite the potential of m-business, there remains a need to justify its viability, usefulness and value for various stakeholders (Nah *et al*, 2005), ensuring its business value is as substantial as suppliers claim (Westelius & Valiente, 2006). Yet, Mallat *et al* (2009) suggest 'compared to e-commerce, mobile computing provides access to information, communication, and services independent of time and place' (p. 191).

As the mobile environment continues to grow, it is crucial for researchers and practitioners to better understand how mobile business can create value for organizations. This research addresses this issue by proposing and testing a comprehensive research model of m-business usage and value from an organizational perspective. The following research questions therefore guide this paper: (1) what are the determinants of m-business usage and value at the organizational level? (2) how can organizations leverage m-business to create value and ultimately affect their overall performance?

The paper provides several contributions to practitioners and researchers. For practitioners, this paper highlights important impacts m-business may have towards firm performance. It also provides them with a list of metrics to evaluate their own m-business initiatives. For researchers, it offers a validated model of m-business usage, confirming the usefulness of the Technology-Organization-Environment (TOE) framework for organizational level studies. The research also validates three key dimensions of m-business value for firms: impact on marketing and sales, impact on internal operations, and impact on procurement. This supports the Resource-Based Theory (RBT) as a theoretical foundation for studies of value of IT initiatives. The paper also constitutes one additional example of combining qualitative and quantitative approaches to conduct research.

The paper is organized as follows: the next section presents the literature review focusing on the unique characteristics of m-business and the theoretical foundations, followed by the research model. The subsequent sections describe the exploratory study, the confirmatory study, a discussion of the findings and conclusions, including the limitations and implications of this research.

Background

In this research, we adopt a broad definition of m-business to include the transactions and related interactive business processes that may occur before and after those

transactions, utilizing handheld mobile devices and wireless communication networks to conduct the transactions (Tarasewich *et al*, 2002).

M-business unique features and value propositions

There are several fundamental differences between m- and e-business, stressing the need for the development of an integrated model to analyze m-business usage and value. Mobile technologies' unique features compared with the physical marketplaces and fixed electronic channels provide time and location flexibility, enabled by portability (ability to readily carry them), user or product identification (through SIM card or RFID), localization (ability to identify the geographic position of the mobile user), and instant connectivity (ability to be reachable and to have access at any time and in any place). These unique characteristics suggest that although many of the existing e-business applications can move to the mobile environment, m-business also involves new applications and functionalities that are unique to mobile devices and infrastructures.

As m-business relaxes the independent and mutual constraints of space and time for many organizational activities, it provides a superior value-for-time proposition that e-business cannot achieve, thus offering distinct value propositions from those provided by e-business (Coursaris *et al*, 2008; Wu & Hisa, 2008). The time and space independency is often referred to as mobility, upon which m-business can create distinctive value propositions of (i) ubiquity, allowing easier real-time access to information; (ii) convenience, through devices that store data and have easy and quick connections to the Internet, intranet or extranet, or other mobile devices; (iii) personalization through individual client identification and localization of both clients and products or services; and, (iv) unison, having real-time access to organizational databases through mobile applications (Clarke, 2001; Watson *et al*, 2002; Camponovo & Pigneur, 2003; Sharma & Gutiérrez, 2010; Picoto *et al*, 2013) as illustrated in Figure 1.

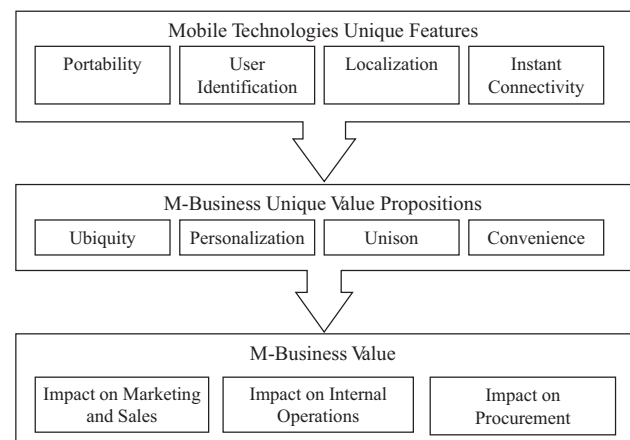


Figure 1 M-business unique value.

Ubiquity refers to access to the wireless network anytime and anywhere, fulfilling the need of real-time information. Ubiquity also suggests that users do not leave mobile devices behind at the workplace, meaning that the boundary between work and life has become fuzzy and that computing devices have penetrated individuals' lives beyond their work (the experiential computing concept suggested by Yoo (2010)). Personalization relies on the capability of geographically locating the mobile user and identifying the person or object using the SIM (Subscriber Identity Module) card or RFID. This provides the opportunity to offer location- and context-specific value-added services, such as the promotion of restaurant offers in the area where the m-user is, or information about available technicians near a specific location, or tracking the location of a product. Interestingly, although e-business and the Internet suggested that location could be irrelevant, in m-business location matters again (Watson *et al*, 2002). Unison refers to having a consistent view of information with data integrated across multiple applications with data synchronization (Watson *et al*, 2002). Mobile users can access data from organizational core systems, such as ERP or CRM, synchronize phonebooks or calendars, or share applications with colleagues. Convenience is the agility and accessibility provided by mobile technologies (Clarke, 2001) and the possibility to always have the device at hand (Camponovo & Pigneur, 2003). This enables, for example, a sales manager to receive an approval request while on a train to visit a client in another city, or a client to get stock quotations while on vacation in a foreign country.

Diffusion of innovation theory and technology-organization-environment framework

The objective of this paper is to analyze the post-adoption stages of usage and value of m-business from the organizational perspective, and thus the unit of analysis is the organization. To study m-business usage in organizations, innovation diffusion theories that explain how innovations are adopted and used by organizations (Hsu *et al*, 2006) are necessary. Two of the most prominent theoretical models of IT innovation adoption at the organizational level are the TOE framework proposed by Tornatzky & Fleisher (1990) and the DOI theory proposed by Rogers (2003, first edition published in 1962). Both models have been applied in e-business-related organizational studies (e.g., Zhu & Kraemer, 2005; Hsu *et al*, 2006; Zhu *et al*, 2006a; Soares-Aguiar & Palma-dos-Reis, 2008; Wang *et al*, 2010). We build on those theoretical foundations and prior research with an organizational perspective of mobile business (van der Heijden & Valiente, 2002; Gebauer & Shaw, 2004; Brodt & Verburg, 2007; Liang *et al*, 2007b; Li *et al*, 2009; Sheng *et al*, 2010; Wang *et al*, 2010) to determine the antecedents of m-business usage.

The DOI theory (Rogers, 2003) focuses on how an innovation or technological idea moves from conception to adoption and implementation. According to DOI, the perceived innovation attributes and organizational

characteristics determine adoption. Although the innovation characteristics are presented at the individual level, Rogers (2003) argued that they could also be applied to adoption models at the organizational level. The innovation characteristics include: relative advantage, compatibility, complexity, trialability, and observability. A meta-analysis study shows that the most common significant and relevant characteristics are the first three (Tornatzky & Klein, 1982), which are going to be considered in this research. Relative advantage is the degree to which an innovation is perceived as providing greater benefits than its alternatives (Rogers, 2003). For example, m-business has several unique characteristics that distinguish it from previous innovations: portability, user identification, instant connectivity, and localization. Compatibility is the degree to which an innovation is perceived as being consistent with existing practices and values (Rogers, 2003). In m-business, compatibility could be how existing processes are similar to the processes required to conduct m-business. Complexity is the extent to which an innovation is perceived as relatively difficult to understand and use, and it usually constitutes an inhibitor for innovation adoption (Rogers, 2003). Tsai & Gururajan (2007) argue that m-business requires developing applications for different devices, multi-transaction services, flexible location, flexible service and configurations, different user experiences, and enterprise integration, which could be highly complex.

The TOE framework proposes that three types of factors influence the adoption and implementation of a technological innovation by organizations: the (i) technological, (ii) organizational, and (iii) environmental contexts (Tornatzky & Fleischer, 1990). The organizational context is typically defined by descriptive features concerning the organization. Prior research suggests that in the context of m-business, organizational factors would include the technical competence of the organization, the level of technology integration, and managerial obstacles. Technology competence is a function of the organizational IT infrastructure and workforce (Zhu *et al*, 2006a, b). M-business requires that firms are able to use mobile technologies in an efficient and effective way to conduct their business. Technology integration is the capability of the organization to integrate m-business applications with its existing systems. In m-business, unison refers to this capability of having a consistent view of information with data integrated across multiple applications (Watson *et al*, 2002). This enables mobile users to access or update data from organizational core systems, such as ERP or CRM. Regarding managerial obstacles, as in the general IT literature, previous m-business studies 'have shown that one of the most critical factors in technology adoption decision is the support and vision of top management, as well as the leadership readiness' (Basole, 2005, p. 370). Liang *et al* also (2007b) proposed that top management support has a significant impact on m-business usage.

The environmental context is 'the arena in which a firm conducts its business – its industry, competitors, access to resources supplied by others, and dealings with

the government' (Tornatzky & Fleischer, 1990, p. 154). Although DOI does not provide potential determinants in the environmental factors category, the TOE framework suggests that important environmental factors in m-business would include external pressure from competitors and business partners, and the mobile environment (level of mobile technology usage and support in the market). Competitive pressure, the degree to which an organization is affected by competition in the market, is an important factor in e-business usage (Zhu & Kraemer, 2005). Dholakia *et al* (2004) argue that intense competition is likely to influence m-business use. Partner pressure facilitates innovation usage (Teo *et al*, 2003). Similarly, when the organization's customers or providers have adopted an innovation and pressure the organization to use it, depending on the power of these trading partners, the organization may be 'forced' to use it. Finally, the mobile environment influences the adoption of mobile business. For example, Khalifa & Cheng (2002) found that exposure to mobile technology influences m-business adoption.

In summary, both DOI and TOE treat with equal importance the technology innovation and organizational characteristics when explaining adoption and usage, but TOE provides additional insights since it also includes environmental factors. Thus, in the present research, we combine these two models to derive an integrative research model for m-business usage and focus on a set of variables that are the most common antecedents in prior IT, e-business, and m-business research. The combination of TOE and DOI was found to better explain post-adoption e-commerce usage when compared with having only one of them (Zhu *et al*, 2006a).

Resource-based theory

The RBT aims to 'explain the internal sources of a firm's sustained competitive advantages' (Kraaijenbrink *et al*, 2010, p. 350). It suggests that a company creates value

based on its heterogeneous resources that are (i) economically valuable, (ii) relatively scarce, (iii) difficult to imitate, and (iv) immovable across companies; and it creates performance advantages by integrating resources that work together in creating organizational capabilities (Barney, 1991; Barney *et al*, 2011). The RBT has its roots in the strategic management field, but has also been applied in several IS studies (e.g., Bharadwaj, 2000; Zhu & Kraemer, 2005; Zhu *et al*, 2006b). The way infrastructure components (hardware, software, networks and communication) are integrated with the business processes and are aligned with the company's overall strategy is key to organizational effectiveness. In fact, more attention is given to the processes underlying the relationships proposed by RBT since the firm's context influences the nature of its processes (Barney *et al*, 2011). Using the RBT, technology is considered as a strategic resource that could directly influence organizational performance (Oh & Pinsonneault, 2007). Following this reasoning, organizations that embrace m-business more broadly and deeply into their value chain activities (i.e., use m-business to a greater extent) can create superior business value from their usage of m-business. Even though the mobile technology itself could be considered a commodity, the specific way in which an organization 'digests' this technology in its business processes and integrates it in its supply chain is unique. Higher degrees of m-business usage will therefore be associated with firm performance improvements.

Research model

M-business usage is the extent to which mobile technologies are used along the value chain activities, and is measured by the breath of use for different business activities and depth of use for each activity using the mobile platform (adapted from Zhu & Kraemer, 2005). The determinants of m-business usage in the research model (Figure 2) were derived from TOE and DOI and prior m-business research

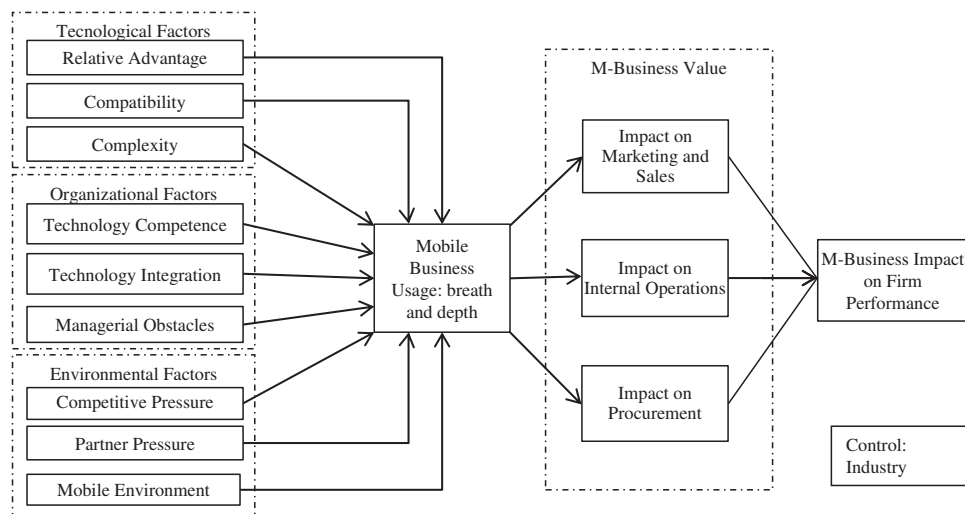


Figure 2 A research model for M-business usage and value.

(Picoto *et al*, 2014). The TOE helped to identify the relevant categories of determinants while the DOI literature helped on identifying the most salient determinants, in particular for technological and organizational factors.

The DOI suggests that an innovation's value depends on the extent to which it is being used to conduct business activities (Zhu *et al*, 2006a). An organization must first use m-business to be able to acknowledge its impact on downstream, upstream and internal dimensions. In this study, we leverage on the RBT to claim that there is a link between m-business use and value. The deeper and wider the use of m-business, the greater the likelihood that the organization creates IT capabilities that, according to the RBT, are difficult to imitate by competitors, valuable, and sustainable over time. Following this reasoning, we argue that there is a theoretical linkage between m-business usage and value. Therefore, higher depth and breadth of m-business usage increases m-business impact on sales and marketing, internal operations, and procurement dimensions.

Since organizations use m-business with the main purpose of improving performance (Stieglitz & Brockmann, 2012), our ultimate endogenous variable is the overall organizational performance. In addition, there are some industries where m-business applications may be more suited, such as industries with significant resources (Gruhn *et al*, 2007) or those requiring different levels of mobility (Scornavacca & Barnes, 2008). We therefore include industry in the model to control for possible variance introduced by differences in the organizations' industry.

Methodology and Data Analysis

Given the existing gap in the literature, this study applied a mixed-method approach (Venkatesh *et al*, 2013) to increase the current understanding of m-business usage,

value, and their impact on firm performance. A sequential research design, as suggested by Mingers (2001), was used so that a qualitative exploratory study fed a subsequent confirmatory study. The combination of different methods in this investigation strengthens its meaning, discussion and conclusions and was carefully selected to study the proposed research questions. Furthermore, this choice follows the guidelines suggested by Venkatesh *et al* (2013, p. 21) 'if the objective of a research inquiry is to identify and test theoretical constructs and mechanisms in a new context, a qualitative study followed by a quantitative study is appropriate'. The qualitative study's objective was to validate a new concept definition (m-business value) and to assess the impacts that the usage of m-business has at the organizational level through expert interviews since there is limited information available on the concept of m-business value from an organizational perspective. The results of this exploratory study (Study 1) also served as input to the next study (Study 2); the validation of the nomological net with data collected from 180 Portuguese organizations. Figure 3 presents the research outline with the various steps that were performed to achieve the research objectives.

Exploratory study 1

Given the newness of the concept and the absence of existing theoretical models of m-business value, we conducted a study to validate the definition of m-business value and to explore additional insights on m-business value that may ground future research. The empirical material was obtained through in-depth semi-structured interviews (Myers, 1997) with key informants (Yin, 2003), company documents, and secondary data from the companies' reports, financial statements, and published articles.

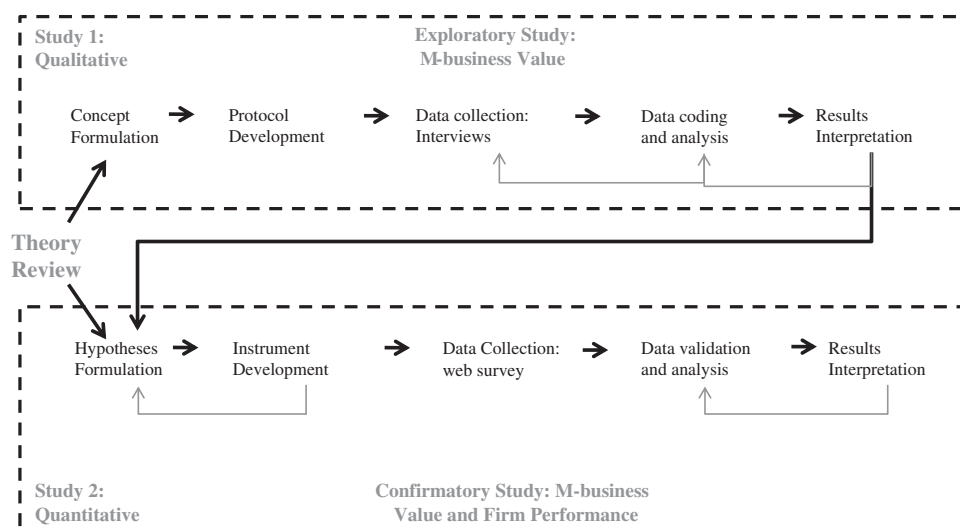


Figure 3 Research outline.

Based on the value hierarchy presented in Figure 1 and on prior research on m-business (Picoto *et al*, 2013), m-business leverages the potential of mobile technologies' unique features to create value that improves business performance. Building on a theoretical model to measure the potential impact of IT on firms (Zhu & Kraemer, 2005), we propose that m-business value represents the impact m-business usage has on firm performance, which is measured by three major organizational value chain activities: (i) marketing and sales; (ii) procurement, and (iii) internal operations.

Study 1 seeks to validate these m-business construct definitions and measures. The sample of interviewees was identified using the purposeful sampling strategy, which increases generalizability of results (Yin, 1994; Lyytinen & Rose, 2003) by selecting individuals representing different industries within Portugal. In Portugal, the mobile broadband penetration rate has been growing exponentially. In 2010, 25% of the total Portuguese population accesses the Internet via mobile broadband connections (Anacom, 2010). In 2011, Portugal was the third country with the highest mobile broadband penetration rate in the European Union (EU) (OECD, 2013) with 157.7% penetration rate compared with 109% for the EU. In 2012, 42% of Portuguese organizations with more than 10 employees equipped workers with mobile devices, and this ratio is 92% when considering only large Portuguese companies (INE, 2012). These statistics suggest that Portugal is a good choice from which to draw the sample for the present study, leveraging on the Portuguese high mobile penetration rates.

Five companies (banking, telecommunication, distribution, and utility sectors) with identifiable uses of m-business were selected, and seven individuals from those firms were interviewed. The selected subjects were experts who have participated in well-known m-business projects. In prior research, executives' perceptions regarding IT business value have been used to assess the actual impact of IT in value chain activities (Tallon *et al*, 2000; Chang & Shaw, 2009). Appendix A presents background information on these interviewees. We also interviewed an m-business expert based in London from one of the largest multinational technology companies, who has been developing mobile applications. Finally, we interviewed an academic m-business expert based in Brazil. The number of interviews was determined by saturation, a standard approach to data collection in qualitative research (Nah *et al*, 2005), which was obtained after the seventh interview, although nine interviews were made. The interviews were carried in the beginning of 2010, and each of them lasted approximately 1 hour, and was conducted in Portuguese. They were recorded when possible, and then transcribed. Telephone conversations or emails were used to clarify any issue that arose during transcription. The interview protocol, which was tested for face validity (Yin, 2003) with three researchers not involved in this research, included a variety of elements that are summarized in Appendix A.

Data analysis and results

The transcribed material was analyzed based on the techniques of content analysis proposed by Bardin (2004). A coding template was developed and validated with two researchers, and two of the transcripts were then coded by two coders. After two rounds of coding, the coders were able to achieve an inter-rater reliability close to 100% as measured by Cohen's Kappa. One researcher then coded the remaining interviews. The interviews were then analyzed using frequencies.

Aggregating responses across the interviews was done by dividing the frequency of identification of each impact into three categories: highly recognized (7–9 interviewees), often recognized (4–6 interviewees), and sometimes recognized (1–3 interviewees). The results are presented in Table 1. Some specific examples of these impacts include a company that adopted mobile banking to interact with their customer base where the application helped improve customer satisfaction with several clients preferring to use their mobile devices for banking and payment purposes. The mobile portal implemented by another company also allowed employees to have all the information they required easily accessible anywhere and anytime. Having the mobile portal fully integrated with the company's information systems, it was possible to improve internal efficiency and increase employee effectiveness and productivity. In fact, the employees could now answer any client inquiries immediately or print required product labels without having to move around the store. Since the intent of study one was to (1) validate impacts of m-business usage on firm performance identified in the literature, (2) identify new impacts of m-business usage (not from the literature), and (3) validate that there were three categories of impacts (or identify new ones) the categorization into widely, frequently and sometimes recognized impact was deemed sufficient for model building.

The results provided important information about m-business fundamental values. The constructs regarding the organizational impacts presented in Table 1 resulted from the literature review and were validated in the interviews. Five new impacts were identified in the interviews: (i) better information quality (real-time information can improve decision making and organizational control); (ii) improved employee learning (highly mobile employees can be informed and trained remotely); (iii) increased employee effectiveness (resources can be directly delivered to field employees); (iv) innovation incentive; and (v) facilitated inventory management (with RFID usage, for example). These new impacts allow us to extend business value literature to the mobility context.

M-business value can indeed be defined as the impact m-business usage has on firm performance, which is measured by the three major organizational value chain activities: (i) marketing and sales; (ii) procurement, and (iii) internal operations. Therefore, we suggest the following proposition: *Mobile business value can be measured along three dimensions: impact of mobile business on marketing and*

Table 1 Impacts of m-business identified by interviewees

Impact freq. Category	Sometimes (1–3 interviewees)	Often (4–6 interviewees)	Highly (7–9 interviewees)
Marketing and sales		<ul style="list-style-type: none"> ● Increased sales ● Widened sales area 	<ul style="list-style-type: none"> ● Improved product and service innovation ● Increased customer satisfaction ● Increased convenience ● Improved customer service ● Facilitated communication and relationship with customers
Internal operations	<ul style="list-style-type: none"> ● Increased organizational profitability ● Reduced of number of employees 	<ul style="list-style-type: none"> ● Improved organizational flexibility ● Increased control ● Reduce administration workload 	<ul style="list-style-type: none"> ● Compressed business processes ● Better information quality ● Improved employee learning ● Facilitated communication among employees ● More efficient internal operations ● Increased staff motivation ● Improved employee effectiveness ● Increased staff productivity ● Improved decision making
Procurement	<ul style="list-style-type: none"> ● Decreased inventory costs ● Decreased procurement costs ● Facilitated inventory management ● Improved coordination with suppliers ● Facilitated communication with suppliers 		

sales, internal operations, and procurement. Additionally, interviews results show that the impact on procurement is not as prominent as the other two. This leads to the sub-proposition: *Mobile business usage has less impact on the procurement dimension than on marketing and sales and internal operations dimensions.*

Confirmatory study 2

Study 2 involved testing the research model with a survey research approach. The questionnaire's structure and design were based on the theoretical discussion of m-business, on the findings from the exploratory study, and also on existing instruments adapted to fit the m-business context. For the antecedents of m-business usage, we adapted items from prior literature (Appendix B). The measurement of m-business value was based on items identified in Study 1.

One important issue that should be taken into account when developing the instrument is the nature (either reflective or formative) of each construct (Petter et al, 2007). When measures are used to examine an underlying latent variable, and it is the latent variable that causes the measures, the measures can be referred to as reflective indicators. When the indicators determine an underlying construct, they are called causal or formative indicators

(Petter et al, 2007). Based on those definitions and the set of decision rules proposed by Jarvis et al (2003), we classified the nature of each construct as presented in Appendix B.

As the survey was conducted in Portuguese, we followed the suggestions of Sekaran (2003) to apply the back-translation technique to ensure the instrument was correctly translated into Portuguese. We also conducted a pre-test with five researchers to get an initial indication of the scales' conceptual validity. Minor changes were done. Then, a pilot test involving 111 top-level executives from Information Systems, Operations and Marketing departments was conducted and items that did not contribute to the reliability of their scales were dropped. We followed Henseler et al's (2009) suggestions to assess the measurement model in terms of its internal consistency, convergent validity, and discriminant validity. We eliminated three items with low AVE; since these were for reflective constructs, there is no impact on the study results and the questionnaire maintained its conceptual integrity. Those items are marked as deleted in Table B1 (Appendix B). For the formative measurement model, we analyzed the multicollinearity and the significance of weights. Appendix C discusses the details of the formative measurement model assessment in the pilot study. After this assessment, the scales were further refined. Appendix B presents the final instrument.

Data collection

The sample was drawn from the Dun and Bradstreet database for organizations operating in Portugal. The web survey was sent to 400 organizations by email (to Director/Responsible of IS, Operations, or Marketing departments). Since the unit of analysis is the organization, it is important to have senior respondents to get the most accurate perspectives possible (Grover & Goslar, 1993). Data were collected between March and May of 2011. We received a total of 150 responses, which corresponds to 133 organizations and to response rates of approximately 15% individually and 40% at the organizational level, which is a good response rate for this type of research. In order to increase our sample size, we used 71 responses from the pilot test from respondents with a Director or Department responsible job function who had responsibility for their own departments. To test whether these additional observations were different, we used the Mann-Whitney *U*-test to compare the median for the pilot test group and the final survey group. For almost all variables, the distributions and the medians are equal between groups. Therefore, we included those additional responses in our final data set. After deleting 15 observations for duplicate organization response and 26 observations for large amounts of missing data (17% of the total responses), we had 180 usable responses.

In the final data set, three types of industries are represented (services 52%, manufacturing 25% and distribution 13.9%). Also, 42% of respondents are from the IS department, 21.7% from Marketing, 11.7% from Operations and 24.4% from other departments. The majority (92.2%) of respondents are Directors or head of departments, enhancing the quality of the data source. Potential bias from IS vs non-IS respondent and from non-respondents were analyzed using the Mann-Whitney *U*-test. In both cases, there were no differences of medians between the different groups of respondents. Therefore, those biases were not a concern for this data set. Common method bias can exist when using self-reported data (Liang *et al*, 2007a) and was assessed by the Harmon one-factor test (Podsakoff & Organ, 1986). Results from this test show that 12 factors are present and that the most covariance explained by one factor is approximately 31%. This result indicates common method bias is not a likely contaminant of results.

Data analysis and results

Smart PLS 2.0 (Ringle *et al*, 2005) was used to evaluate the measurement and structural models. PLS (Partial Least Squares) was chosen as the technique to analyze the data since the model has both formative and reflexive constructs, and is complex with some constructs presenting mixed scales. Additionally, given the predictive nature of the research model, PLS is a suitable technique (Gefen *et al*, 2011).

Measurement model For the assessment of the measurement model, different analyses were performed according

to the nature of the construct (i.e., reflective or formative). Following the guidelines of Henseler *et al* (2009) and Gefen *et al* (2011), the reflective measurement model assessment was performed for internal consistency, indicator reliability, convergent validity, and discriminant validity (Tables D1 and D2 from Appendix D). The internal consistency was evaluated by Cronbach's alpha and composite reliability. All latent variables show good performance in terms of internal consistency with Cronbach's alphas between 0.66 and 0.95 and composite reliabilities between 0.80 and 0.97 (Table D1). Overall, the instrument presents good indicator reliability.

The convergent validity criterion states that the AVE values should be greater than 0.5. As can be seen in Table D1, all constructs present AVE values above 0.5 (between 0.57 and 0.94), indicating that the constructs represent one dimension and the same underlying construct, and also that the latent variable is able to explain more than a half of the variance of its indicators (Henseler *et al*, 2009). The discriminant validity was tested with two criteria: the Fornell-Larcker (1981) (AVEs should be greater than the squared correlations and each indicator should have a higher correlation to the assigned latent variable than to any other latent variable) and the cross loadings analysis. As can be seen in Tables D2 and D3 (Appendix D), both criteria are satisfied for all constructs and indicators, which indicates that the instrument has good discriminant validity.

For the formative measurement model evaluation, the multicollinearity and the significance and sign of weights were assessed. Regarding multicollinearity, the VIF for each indicator was computed and is presented in Table D4 (Appendix D). For all items, the VIF is below the cut-off value of 3.3 (Petter *et al*, 2007). Table D4 also presents the weights and their significance. Some of the indicators (i) are not significant and (ii) show a co-occurrence of negative and positive indicator weights in a same latent variable. Comparing with the results from the pilot test, several constructs improved in the final sample. Although the formative measure raises some issues with regards to negative and insignificant weights, these potential problems do not represent a hazard to the structural model nor to the conclusions of the study in terms of the structural paths' significance; they only make more difficult the interpretation of the meaning of weights (Cenfetelli & Bassellier, 2009; Bido *et al*, 2010). Other studies using the PLS with formative constructs have encountered the same problem and also decided to retain all indicators for theoretical reasons (Dowling, 2009).

Structural model After assessing that the measurement model holds good psychometric proprieties, we assessed the structural model. The significance of paths was calculated by means of bootstrapping procedure generating 5000 random samples (as suggested by Henseler *et al* 2009 and Hair *et al*, 2011) of size 180. The results, reported in Figure 4 and Table 2, show that only CM->BU, CX->BU

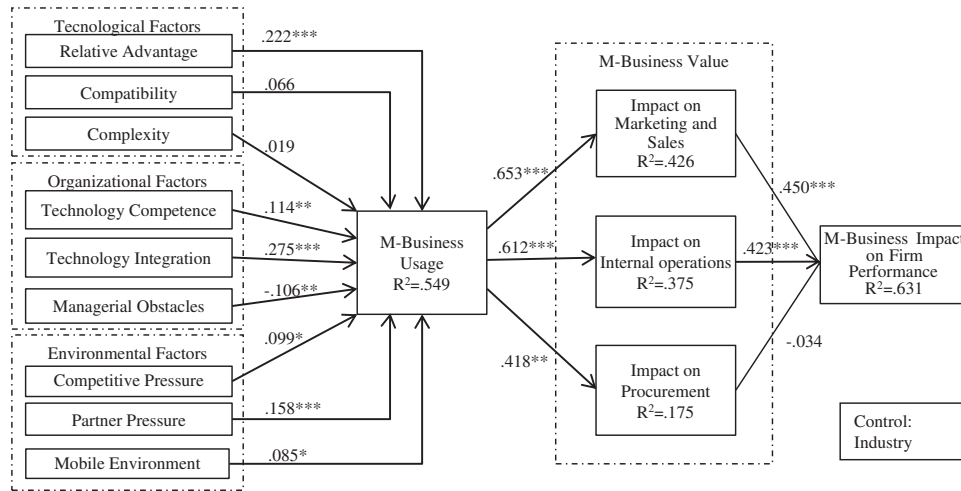


Figure 4 PLS results (n = 180).

*Significant at $P < 0.1$, **significant at $P < 0.05$, ***significant at $P < 0.01$.

Table 2 Partial least squares results (n = 180)

Dependent variable	Independent variable	Path coefficient		R ²	R ²	R ²
		(Theoretical model)	(Full model)			
M-Business Usage (BU)	RA	0.222***	0.221***	0.549	0.558	0.096
	CM	0.066	0.060			
	CX	0.019	0.035			
	TC	0.114**	0.104**			
	TI	0.275***	0.257***			
	MO	-0.106**	-0.100**			
	CP	0.099*	0.086*			
	PP	0.158***	0.169***			
	ME	0.085*	0.086*			
Impact on Sales and Marketing (SI)	BU	0.653***	0.652***	0.426	0.426	0.047
Impact on Internal Operations (II)	BU	0.612***	0.645***	0.375	0.388	0.013
Impact on Procurement (PI)	BU	0.418**	0.424**	0.175	0.208	0.020
M-Business Impact on Firm Performance (OI)	Impact on Sales and Marketing (SI)	0.450***	0.456***	0.631	0.634	0.027
	Impact on Internal Operations (II)	0.423***	0.424***			
	Impact on Procurement (PI)	-0.034	-0.041			
BU	Manufacturing		-0.107***			
	Distribution		-0.039			
SI	Manufacturing		-0.012			
	Distribution		-0.012			
II	Manufacturing		0.137**			
	Distribution		-0.050			
PI	Manufacturing		0.193***			
	Distribution		0.100*			
OI	Manufacturing		0.017			
	Distribution		0.058*			

*Significant at $P < 0.1$; **Significant at $P < 0.05$; ***Significant at $P < 0.01$.

and PI->OI present non-significant path coefficients. As all R^2 are greater than 0.33 (except for the impact on procurement), there is moderate and substantial model fit. In Figure 4, two of the paths for impact variables to Firm Performance are significant and of high magnitude, but not the impact of procurement. This supports our findings from the exploratory study.

The comparison of the proposed theoretical model with the saturated model was made by calculating the effect size f^2 as suggested by Gefen *et al* (2011). In the model, the f^2 values were 0.28, 0.32 and 0.47 for Impact on Marketing and Sales, Impact on Internal Operations and Impact on Procurement, respectively. Although Impact on Marketing and Sales and Impact on Internal Operations have a medium effect size, Impact on Procurement has large effect size. This can be explained by the fact that m-business impact on procurement is not recognized by the majority of the respondents, leading to low variability; hence, the theoretical model is able to explain only a small portion of its variability when compared with the saturated model.

Control variable: industry Three different industries were in the sample (manufacturing, distribution, and services). Therefore, the control variable Industry was added to the model as done in prior e-business research (Zhu & Kraemer, 2005; Hsu *et al*, 2006; Zhu *et al*, 2006a). Following the method used by Hsu *et al* (2006) and Liang *et al* (2007a), we created two dummy variables for each industry (services industry was the reference category) to test their effects. Comparing the full model with the control model (Table 2), the full model explains a substantive incremental variance of 46.2, 37.9, 37.5, 18.8 and 60.7%, for M-Business Usage, the value dimensions, and M-Business Impact on Firm Performance, respectively. When comparing the full model with the theoretical model, the difference of variance explained is only of 0.9, 0, 1.3, 3.3 and 0.3% for these same variables. This suggest the theoretical model is substantive enough (Teo *et al*, 2003) to explain a large proportion of the variance in usage of m-business, value of m-business, and impact of m-business on the firm's performance. The manufacturing industry dummy variable has a significant negative path coefficient on m-business usage, meaning the manufacturing sector is lagging in usage of m-business when compared with the distribution and services industries (Table 2). This indicates that the manufacturing industry is using m-business less than the others are. Yet, this variable also has significant positive paths for Impact on Internal Operations and on Procurement, suggesting the impacts of those dimensions are higher than in the other industries. One possibility is that manufacturing organizations focus more on activities related to internal and upstream processes (instead of marketing and sales). When compared with the services sector, the distribution industry also has a positive significant path coefficient for the impact on procurement. This suggests organizations from the services

industry place less emphasis on mobile procurement activities when compared with the other two.

Discussion

Given that mobile business still lacks a theoretical foundation from an organizational perspective, one of the purposes of this research was to explore m-business value and its components from an organizational point of view. The research therefore provides an integrative model that draws broadly on the combination of TOE and DOI theories to explain m-business usage, on the RBT to support the linkage between m-business usage and value, and on research on IT business value to define m-business value creation.

Antecedents of m-business usage

The results show that relative advantage, technology competence, technology integration, managerial obstacles, competitive pressure, partner pressure and mobile environment are significant antecedents of m-business usage. This supports the combined use of DOI and TOE as theoretical foundations for the model since the antecedents together explain a substantial variance in m-business usage ($R^2 = 0.549$). In fact, a major contribution of this research is the combination of DOI and TOE to explain post-adoption m-business usage. For organizational and environmental factors, all of the proposed antecedents are significant, while only one antecedent in the technology category is significant (relative advantage). Overall, technology integration and relative advantages are the antecedents with the largest coefficients.

Technological context Relative advantage is the second strongest factor among all factors with effects on m-business usage. This finding is consistent with Zhu *et al* (2006a) for e-business but inconsistent with Wang *et al* (2010), who were unable to conclude that relative advantage is a significant determinant of RFID adoption. Similarly, compatibility and complexity are not significant antecedents of m-business usage in this study, which is different from prior work (Wang *et al*, 2010 and Zhu *et al*, 2006a). A possible explanation for this is the focus on mobility in this study, which is different from e-business in general used in these prior studies. Organizations evaluate the costs and benefits (relative advantages) of an initiative before investing in it. In the context of mobility, an individual's use of technology is personal and imbedded into daily life; therefore, complexity and compatibility personally affect individuals. Organizations, however, have the necessary resources to handle complexity and make their processes compatible if they find that the innovation brings them enough advantages. These results however suggest that there is a need to further evaluate the DOI theory in the context of organizational level studies where some of the factors may be less relevant.

Organizational context The results suggest that organizations with higher levels of technology integration tend

to achieve greater extent of m-business usage, as do organizations with higher levels of technology competence. This finding is consistent with Zhu *et al* (2006b). They argue that in developed countries organizations tend to be more advanced in terms of use of technologies and as a result they must make more profound usage of technology to achieve competitive advantages. The positive effect of technology competence on m-business usage is also consistent with prior work (Zhu & Kraemer, 2005; Hsu *et al*, 2006; Zhu *et al*, 2006b; Soares-Aguiar & Palma-dos-Reis, 2008). It confirms that organizations that have already adopted technologies such as extranet, intranet, VoIP, WLAN, etc., and have more IT resources (not just equipment but also human resources) make greater use of m-business. Finally, Managerial Obstacles has a negative effect on m-business usage. This is consistent with Zhu *et al* (2006b) who found that managerial obstacles have a negative effect on the three stages of e-business assimilation: e-business initiation, adoption, and routinization. It is not surprising that the difficulty of integrating the mobile platform into the overall business strategy and processes, lack of staff with m-business expertise, or insufficient top management support are significant inhibitors of m-business usage.

Environmental context All factors in this category (competitive pressure, partner pressure, and mobile environment) are significant and positive antecedents of m-business usage. Among the environmental factors, partner pressure is the strongest in influencing m-business usage. Not surprisingly, organizations are most aware of their business partners' needs, pushing or pulling organizations to engage more and more in m-business initiatives. Many of them recognized that if business partners use certain innovations, the added value of also using it would increase. The TOE framework is useful in determining antecedents of organizational usage because it broadens the factors beyond the traditional technology adoption models to include environmental factors. Extending this framework to include the mobile environment as a driver for m-business usage allowed us to find empirical evidence to support the idea that the specific conditions regarding the mobile infrastructure available represent critical determinants of the usage of mobile systems.

M-business value and firm performance

An important set of findings is that the linkages between m-business usage and the impacts on marketing and sales (downstream dimension), internal operations (internal dimension), and procurement (upstream dimension) are positive and significant (see Table 2 and Figure 4). Consistent with the RBT, the results suggest that higher degrees of m-business usage are associated with improved impacts on each value-chain dimension, with the impact on marketing and sales being the greatest. It is interesting to note that both the preliminary evidence obtained through interviews from m-business experts and the survey data from the 180 firms suggest that m-business has greater

impacts on sales and marketing and on internal operations dimensions than on procurement. This finding is not surprising since procurement employees tend to work in traditional offices as opposed to sales or support staff. One possible explanation is that while it is really important to reach the client or the employee exactly where they are and when a decision needs to be made, it likely matters less to make a purchase order on the road rather than waiting to get back to the office. These findings are new and different from those of e-business research (e.g., Zhu & Kraemer, 2005) and highlight the importance of focusing on the marketing and sales and internal operation dimensions of the value chain activities. Thus, our empirical results suggest that when considering different projects for mobility, executives might want to prioritize the ones aimed at clients or employees, as they are more likely to create business value through mobility.

The model shows that m-business value explains a very high amount of the variance of the impact of m-business on firm performance ($R^2=0.631$). This finding is very important as it confirms that the use of an innovation such as m-business can indeed improve overall firm performance. Most prior research focuses on usage only, and neglects the ultimate effects on value creation and firm performance.

Contributions

The paper provides both theoretical and practical contributions. For researchers, it offers a validated model of m-business usage and value that identifies significant antecedents of usage to include relative advantage, technology competence, technology integration, managerial obstacles, competitive pressure, partner pressure, and the mobile environment. As such, the research confirms the usefulness of the TOE and DOI frameworks for organizational level studies. Combining these frameworks could be useful to researchers interested in studying the usage of other technologies at the organizational level of analysis. However, the research also suggests that the DOI framework needs further evaluation before being used unilaterally in organization-level studies. The research also focused on the depth and breadth of m-business usage beyond the binary choice of adopted/not adopted to look into the extent of m-business usage. Using a more extensive evaluation of usage provides researchers with more insights into various aspects of usage that can be useful in future studies of continued technology use.

The research also validates three key dimensions of m-business value for firms: impact on marketing and sales, impact on internal operations, and impact on procurement. The first two of these impacts are then determinants of firm performance. The study therefore supports the use of RBT as a theoretical foundation for studies of value of IT initiatives. It also extends previous work on IT usage and post usage evaluation (e.g., Zhu & Kraemer, 2005) that does not look beyond usage into the overall impact IT innovations can have on organizational performance.

Future research should consider extending studies beyond the evaluation of usage to explore the impact it has on value creation and firm performance. In addition, future studies should investigate the direct effects of the TOE and DOI variables on IT value in order to understand these possible direct relationships.

Finally, for researchers this paper also an example of conducting research using a mixed-method approach that relied on the combination of a qualitative study based on expert interviews and quantitative study that collected data through a web survey. The combination of approaches has the potential of offering a more thorough and reliable development of theoretical knowledge.

For practitioners, this paper presents the relative importance of several impacts m-business may have towards firm performance, including newly identified impacts such as better information quality, improved employee learning, increased employee effectiveness, incentive for innovation, and, facilitated inventory management. The research also provides a list of metrics or impacts for each value dimension that practitioners can use to evaluate their own m-business initiatives and to compare where they stand within their industry. By identifying the relationship between m-business usage and its value dimensions across different industries, the research offers decision makers a way to evaluate the possible impacts m-business projects can have in their firms.

Limitations

There are limitations to this study that should be noted. First, the impact measures are subjective, based on perceptions of executives about mobile business impacts in their organization. Second, the formative measurement model highlights some issues with regards to negative and insignificant weights. Despite the fact that this does not create a threat for the structural model, it complicates the interpretation of the meaning of weights for those formative variables. Additionally, when compared with the saturated model, the f^2 obtained are medium and large, leading us to suspect that additional paths can be added to the model to explain the procurement dimension. The study also collected data from organizations in one country only.

Conclusions and future research

As the number of mobile subscribers continues to grow worldwide, organizations can take advantage of mobile technologies to provide new applications to business partners, customers, and employees. The m-business applications can help organizations become more efficient and effective, and can improve overall organizational performance. Yet, few studies have actually explored the value of m-business at the organizational level. To address this gap in prior research, this study tested a model of

m-business value (Figure 2). Drawing on the TOE, DOI, RBT and literature on IT value and e-business, the model offers an integrated view of m-business usage, value, and firm performance. The results indicate that seven of the nine proposed antecedents of m-business usage are significant, and that m-business usage has a positive and significant relationship with m-business value. Furthermore, the three dimensions of value (marketing and sales, internal operations, and procurement) are significant, but only two of them have direct positive impacts on firm performance.

The research highlights several avenues for future research. First, decisions were made as to which antecedents of m-business usage were selected based on the DOI and TOE theories. For parsimony, only the antecedents found to be most often significant in prior research were selected. However, it is possible that other antecedents of m-business usage would be relevant given the context of mobility, which has not been studied extensively. Therefore, future research should explore additional potential antecedents by drawing on these (DOI and TOE) or even other frameworks. The industry effects on m-business usage and value could also be further explored in order to analyse the different patterns of usage of m-business within each industry. In fact, one of the interviewees mentioned that the benefits of mobile business were 'highly depend on the kind of business' and another expert stated that the value of m-business depends on the kind of work that employees do. Therefore, studying m-business in the context of different industries might provide interesting insights.

Another possible venue for future research is to consider a multi-level analysis of m-business usage, operationalizing the construct of m-business usage as a multilevel construct as was proposed for system usage by Burton-Jones & Gallivan (2007). In such a study, dyadic relationships between employees and customers could be considered. Alternatively, employees vs the organizations could be studied across levels of analysis. This would allow matching the understanding from the employees' point of view and the organization's point of view regarding the implications of m-business usage at both levels of analysis.

Finally, it might be interesting to investigate the effect of culture on m-business value and usage. The deployment of this study's questionnaire in other countries with different mobile technology assimilation could bring interesting insights about culture and the mobile environment's influence on m-business usage and value.

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Appendix A

Study 1 Details

Study 1 involved a series of interviews with m-business implementers or experts.

Respondents

The seven respondents from business organizations worked for one of five firms, named A, B, C, D, and E for maintaining the confidentiality promised to them. They are briefly described below.

- Firm A is a utility company with over 7000 employees. We interviewed the business consultant involved with the mobility project. The project itself involves providing customized mobile equipment to access personalized real-time utility data.
- Firm B is a mobile telecommunications organization with approximately 1000 employees and over seven million customers. We interviewed the Director of data, content and roaming services. The main project is meant to provide mobile phones internally to employees and serve as a demo for clients.
- Firm C is a bank with over 1000 branches and 10,000 employees. We interviewed the Director of Information Systems and the Director of New Channels. The m-business project involves providing mobile devices internally for information dissemination and externally for support of a mobile banking portal.
- Firm D is in the distribution business. It has over 30,000 employees using m-business and approximately 400 points-of-sales. We interviewed the Director of business development and innovation about a project to provide mobile PDAs to employees in department stores for

handling logistical and operational processes and to serve as portals for information dissemination.

- Firm E is a traditional telecommunications company with more than 2000 employees and a market of 11,000 companies. We interviewed the consultant for mobile solutions and the Director of enterprise solutions. The project was to provide mobile phones and mobile applications to be used both internally and by clients.

High-level protocol questions (further probing was done when appropriate)

1. Which of the following mobile business functionalities is your company actually using, and which are the ones you wish to be using?
2. What are the main reasons for you to adopt m-business? (is m-business part of your company's overall strategy?)
3. What were the initial goals for your m-business initiatives?
4. How much is the total amount expended on m-business initiatives?
5. What are the Impacts on the Downstream Dimension (sales)
6. What are the Impact on Internal Dimensions (internal operations)
7. What are the impacts on Upstream Dimensions? (procurement)
8. Are there other impacts that m-business have in your company that were not mentioned yet?
9. Are there any aspects of m-business that you want to comment on?

Additional questions pertaining to demographics and characteristics of firms are not included.

Appendix B

Measurement Items

Table B1 Operationalization of constructs

Construct	Indicator code	Indicators	Scale	Source
Relative advantage/R	RA1	Please rate the degree to which your organization expected m-business to help increase sales	(1~5)	Adapted from Zhu <i>et al</i> (2006a) and Wang <i>et al</i> (2010)
	RA2	Please rate the degree to which your organization expected m-business to help reduce costs Please rate the degree to which you agree with the following statements:		
	RA3	My company expects m-business to reduce paperwork		
	RA4	My company expects m-business to help quick data capture and analysis		
	RA5	Does the adoption of mobile technology affect the value of the brand and partnership?		
Compatibility/R		Please rate the degree to which you agree with the following statements:	(1~5)	Adapted from Zhu <i>et al</i> (2006a) and Wang <i>et al</i> (2010)
	CM1	Selling over the mobile platform is compatible with your organization current selling process		
	CM2	Buying over the mobile platform is compatible with your organization current procurement process		
	CM3	Conducting transaction over the mobile platform is compatible with existing distribution channels		
	CM4	Doing m-business is compatible with your organization corporate culture		
	CM5	M-business is compatible with existing information infrastructure		
CM6	M-business is compatible with my firm's existing experience with similar systems			
Complexity/R		Please rate the degree to which you agree with the following statements:	(1~5)	Adapted from Grover (1993)
	CX1	My company believes that m-business is complex to use		
	CX2	My company believes that m-business development is a complex process		
Technology competence/F	TC1	Approximately how many of the following mobile devices are currently in use in your organization? Mobile phones/SmartPhones/RFID (tags readers)/Laptop/TabletPC/Netbook/Kiosks/Vehicle-mounted mobile technologies	#	Adapted from Zhu & Kraemer (2005)
	TC2	Approximately how many IT professionals are located in your organization?		
	TC3	Please check the box describing technologies used in your organization (check as many as apply): have a public website/have a public website with transactional features/Internet/Extranet/Intranet/mobile Internet/have the necessary software for implementing mobile business applications/WLAN/VoIP		
Technology integration/R	TI1	Please rate the extent to which your mobile applications are electronically integrated with your internal databases and information systems	(1~5)	Adapted from Zhu <i>et al</i> (2006b)
	TI2	Please rate the extent to which your company's databases and information systems are electronically integrated with those of your suppliers and business customers		
Managerial obstacles/R		Please rate how significant the following obstacles are to your organization's ability to conduct m-business	(1~5)	Adapted from Zhu <i>et al</i> (2006b) and Pan & Jang (2008)
	MO1	Integrating the mobile platform into your overall strategy and business process		
	MO2	Lacking staff with m-business expertise		
	MO3	Insufficient top-management support		
	MO4*	Unfriendly operating platform or interface		

Competitive pressure/R	Please indicate:		
	CP1	My company experienced competitive pressure to implement m-business	(1~5)
	CP2	My company would have experienced a competitive disadvantage if m-business had not been adopted	
	CP3	Degree to which the ICT influences the competition in your industry	
	CP4*	Degree affected by competitors in the local market	
	CP5*	Degree affected by competitors in the national market	
Partner pressure/F	How important was the following to your organization's decision to begin using the m-business:		
	PP1	Customers demand it	(1~5)
	PP2	To improve coordination between suppliers and customers	
	PP3	Suppliers require it	
Mobile environment/F	Please rate the degree to which you agree with the following statements:		
	ME1	There is adequate availability of bandwidth on mobile networks	(1~5)
	ME2	There is adequate availability of mobile client devices	
	ME3	There is adequate availability of security data standards for mobile applications	
	ME4	There is adequate adoption of cellular standards by your country	
	ME5	There is adequate availability of mobile applications software packages	
	ME6	There is a cost-efficient mobile platform available in the market	
M-business usage (Breath)/R	BU1	Check the box describing the functionalities available in mobile devices in your value chain process (check as many as apply): providing information mobile, making sales mobile, providing services mobile, making purchases mobile, workflow, product searches and comparisons by consumers post-purchase customer support, delivery tracking system, mobile banking or mobile micro-payments, mobile brokerage, target advertising using demographic and current location of users information, collect information about user needs, providing services to user proactively, asset management, job dispatch, CRM, data collection; stock/inventory management; wireless data on resource availability; fleet management, decision support system	#
M-business usage (Depth)/R	DU1	Please rate the extent to which your mobile business support employees to work independently of corporate office	(1~5)
	DU2	Please rate the extent to which your mobile business support employees to work immediately when necessary	
	DU3	Please rate the extent to which your internal process are conducted on the mobile platform	
	DU4	Please rate the extent to which your consumer sales activities are supported by the mobile platform	
	DU5	Please rate the extent to which your business sales activities are supported by the mobile platform	
	DU6	Please rate the extent to which your procurement activities are supported by the mobile platform	
	DU7	Please rate the extent to which your consumer services activities are supported by the mobile platform	

Table B1: (Continued)

Construct	Indicator code	Indicators	Scale	Source
Impact on Marketing and Sales/F		Please indicate the extent to which your mobile applications have impact in...		
	SI1	Sales increasing	(1~5)	Results from the Exploratory Study
	SI2 ^a	Widening sales area		
	SI3	Product and service innovation improvement		
	SI4 ^a	Customer service improvement		
	SI5	Customer satisfaction increasing		
	SI6 ^a	Increasing the convenience to customers		
SI7	Facilitating the communication with customers			
Impact on Internal Operations/F	II1	Making internal operations more efficient (example: speed up processing, reduce bottlenecks, reduce errors, notification, control emergencies)	(1~5)	Results from the Exploratory Study
	II2 ^a	Increasing staff productivity		
	II3	Facilitating communication among employees		
	II4 ^a	The compression of business processes		
	II5 ^a	The organizational flexibility		
	II6 ^a	Making the corporate systems and information accessible from any location		
	II7	Increasing control		
	II8 ^a	The staff motivation increasing		
	II9 ^a	Reducing the number of employees		
	II10	Improving decision making		
	II11	Reducing administration workload		
	II12	Increasing organization profitability		
	II13 ^a	Improved employee effectiveness		
	II14 ^a	Improved employee learning		
	II15	Better information quality		
Impact on Procurement/F	PI1	Inventory costs reduction	(1~5)	Results from the Exploratory Study
	PI2	Improving the coordination with suppliers		
	PI3 ^a	Decreasing the procurement costs		
	PI4	Facilitate inventory management		
	PI5 ^a	Facilitating communication with suppliers		
M-Business Impact on Firm Performance/R		Please rate the degree to which you agree with the following statements:		Adapted from Gattiker & Goodhue (2005)
	OI1	In terms of its business impacts on the organization, the m-business system has been a success	(1~5)	
	OI2	M-business has seriously improved my organization's overall business performance		
	OI3	From the perspective of my organization, the costs of m-business outweigh the benefits		
	OI4	M-business has had a significant positive effect on my organization		

^aare the items marked for deletion.

Constructs modeled as reflective are marked with (R) and constructs modeled as formative are marked with (F).

Appendix C

Pilot Test of the Formative Measurement Model

To assess multicollinearity, Variance Inflation Factors (VIF) were computed. All formative latent variables, excepted SI, II and PI, were lower than the cutoff value of 3.3 (Petter *et al*, 2007; Cenfetelli & Bassellier, 2009; Henseler *et al*, 2009). For SI, II, and PI, we followed the suggestions of Bido *et al* (2010) and Cenfetelli & Bassellier (2009). First, we conducted a conceptual validation and then a correlation analysis for items considered to capture a same domain. As a result of these analyses, the indicators SI2, SI4 and SI6 were deleted from the latent variable Impact on Sales and Marketing dimension; II2, II4, II5, II6, II8, II9, II13 and II14 were deleted from the latent variable Impact on Internal Operations; and finally, PI3 and PI5 were deleted from the latent variable Impact on Procurement. Despite these deletions, the meaning and theoretical validity of three formative constructs SI, PI and II were not harmed.

For formative validity, the estimated weights of formative variables should be significant (Henseler *et al*, 2009). In PLS, some of the indicators (i) were not significant

and (ii) showed a co-occurrence of negative and positive indicator weights in a same latent variable. To deal with this problem, Cenfetelli & Bassellier (2009, p. 696) suggest the researcher could 'keep all indicators forming a single construct and include a discussion of the absolute contribution of the indicators. If the indicator remains non-significant across multiple studies, researchers should interpret this as evidence against the conceptual foundations for its inclusion'. Following this suggestion, we kept all items that resulted from the pilot study after deleting the ones mentioned in the prior paragraph. Given it is the first time the constructs TC, PP, ME, SI, II and PI are being measured, we kept the constructs as defined since they were well grounded in the existing literature and in Study 1.

Appendix D

Study 2 Details

In this appendix, we report the results for the reflective and the formative measurement models in Tables D1-D4.

Table D1 Reflective constructs reliability criteria, loadings and *t*-statistics

Reflective multi-items (Cronbach's alpha/ Composite reliability/AVE)	Construct composite	Indicator code	Mean	SD	Loadings	Conv. Validity (<i>t</i> -stat)
RA	Relative advantage (0.90/0.93/0.72)	RA1	2.97	1.23	0.82	32.16
		RA2	3.17	1.27	0.89	42.38
		RA3	3.22	1.23	0.86	27.86
		RA4	3.55	1.25	0.79	18.20
		RA5	3.27	1.22	0.87	43.20
CM	Compatibility (0.89/0.91/0.64)	CM1	2.90	1.39	0.81	31.44
		CM2	2.95	1.29	0.77	18.04
		CM3	3.14	1.26	0.87	44.28
		CM4	3.38	1.20	0.84	32.26
		CM5	3.50	1.15	0.79	17.67
		CM6	3.39	0.85	0.71	14.28
CX	Complexity (0.94/0.97/0.94)	CX1	2.86	1.20	0.97	60.21
		CX2	2.89	1.15	0.97	117.97
TI	Technology integration (0.66/0.85/0.74)	TI1	3.23	1.40	0.90	42.95
		TI2	2.75	1.00	0.82	16.75
MO	Managerial obstacles (0.71/0.80/0.57)	MO1	3.01	1.21	0.93	5.03
		MO2	2.98	1.25	0.60	2.37
		MO3	2.74	1.28	0.71	3.28
CP	Competitive pressure (0.71/0.84/0.64)	CP1	2.83	1.39	0.92	54.22
		CP2	3.09	1.47	0.90	45.89
		CP3	4.26	1.03	0.52	5.73
BU	M-business usage (0.89/0.91/0.57)	BU1	7.02	4.80	0.75	22.04
		DU1	3.20	1.41	0.69	12.73
		DU2	3.18	1.38	0.80	25.00
		DU3	2.85	1.25	0.74	19.65
		DU4	2.09	0.91	0.80	30.04
		DU5	2.33	0.98	0.75	24.40
		DU6	2.11	0.88	0.69	14.49
OI	M-business Impact on Firm Performance (0.95/0.97/0.87)	OI1	3.20	1.26	0.94	74.11
		OI2	2.94	1.25	0.94	95.73
		OI3	3.12	1.26	0.91	53.70
		OI4	3.13	1.27	0.94	92.02

Table D2 AVE and latent variables correlations

	RA	CM	CX	TC	TI	MO	CP	PP	ME	BU	SI	II	PI	OI
RA	0.846													
CM	0.674	0.799												
CX	0.310	0.235	0.971											
TC	0.258	0.381	0.098	NA										
TI	0.464	0.448	0.169	0.446	0.861									
MO	-0.023	-0.198	0.198	-0.137	-0.223	0.757								
CP	0.562	0.550	0.372	0.436	0.471	-0.104	0.800							
PP	0.571	0.538	0.224	0.113	0.253	0.031	0.354	NA						
ME	0.181	0.219	0.145	0.163	0.188	0.003	0.176	0.195	NA					
BU	0.593	0.565	0.225	0.410	0.588	-0.202	0.528	0.455	0.261	0.752				
SI	0.626	0.582	0.290	0.311	0.454	-0.130	0.492	0.471	0.183	0.653	NA			
II	0.585	0.474	0.290	0.309	0.402	-0.123	0.398	0.491	0.226	0.612	0.732	NA		
PI	0.438	0.465	0.334	0.212	0.228	-0.006	0.245	0.536	0.109	0.418	0.557	0.632	NA	
OI	0.646	0.537	0.293	0.287	0.461	-0.148	0.536	0.536	0.252	0.656	0.743	0.734	0.486	0.935

Note: The diagonal are the values of AVE squared root and the off-diagonal represents the correlations. The value NA refers to formative constructs where the AVE is not applicable.

Table D3 Cross loadings

	RA	CM	CX	TI	MO	CP	BU	OI
RA1	0.822	0.536	0.306	0.355	0.008	0.563	0.552	0.563
RA2	0.887	0.618	0.272	0.384	0.019	0.453	0.492	0.530
RA3	0.855	0.572	0.237	0.379	-0.013	0.406	0.459	0.532
RA4	0.792	0.506	0.203	0.354	-0.046	0.351	0.431	0.499
RA5	0.871	0.610	0.280	0.479	-0.064	0.565	0.550	0.595
CM1	0.574	0.810	0.308	0.337	-0.097	0.425	0.470	0.487
CM2	0.507	0.765	0.362	0.213	-0.058	0.359	0.425	0.370
CM3	0.593	0.870	0.195	0.368	-0.178	0.497	0.454	0.450
CM4	0.552	0.843	0.112	0.358	-0.206	0.535	0.478	0.476
CM5	0.526	0.788	0.152	0.420	-0.154	0.467	0.420	0.445
CM6	0.469	0.708	0.005	0.446	-0.246	0.344	0.454	0.338
CX1	0.294	0.237	0.968	0.164	0.188	0.363	0.207	0.255
CX2	0.308	0.221	0.974	0.164	0.196	0.358	0.228	0.311
TI1	0.497	0.434	0.181	0.900	-0.237	0.461	0.567	0.474
TI2	0.276	0.328	0.100	0.819	-0.136	0.338	0.431	0.299
MO1	-0.049	-0.224	0.180	-0.204	0.927	-0.076	-0.212	-0.135
MO2	0.088	0.019	0.373	-0.070	0.599	-0.03	-0.013	0.065
MO3	0.026	-0.078	0.116	-0.170	0.708	-0.12	-0.110	-0.127
CP1	0.526	0.543	0.331	0.441	-0.107	0.915	0.515	0.492
CP2	0.548	0.494	0.406	0.413	-0.100	0.902	0.469	0.519
CP3	0.175	0.194	0.058	0.250	-0.014	0.520	0.213	0.197
BU1	0.524	0.486	0.202	0.388	-0.074	0.441	0.751	0.526
DU1	0.435	0.365	0.146	0.343	-0.159	0.397	0.736	0.555
DU2	0.553	0.462	0.176	0.453	-0.163	0.495	0.801	0.677
DU3	0.518	0.496	0.203	0.455	-0.226	0.428	0.750	0.589
DU4	0.284	0.330	0.138	0.386	-0.134	0.274	0.690	0.289
DU5	0.388	0.430	0.146	0.531	-0.178	0.399	0.803	0.449
DU6	0.351	0.331	0.207	0.384	-0.074	0.274	0.685	0.306
DU7	0.428	0.449	0.128	0.594	-0.188	0.401	0.795	0.429
OI1	0.622	0.506	0.260	0.460	-0.167	0.509	0.598	0.939
OI2	0.638	0.561	0.255	0.453	-0.165	0.494	0.618	0.944
OI3	0.561	0.410	0.266	0.368	-0.076	0.473	0.609	0.913
OI4	0.591	0.524	0.313	0.437	-0.139	0.524	0.629	0.942

Note: Bold numbers indicate item loadings on the assigned constructs.

Table D4 Formative measurement model evaluation criteria

	<i>Formative constructs</i>	<i>Indicator</i>	<i>Mean</i>	<i>SD</i>	<i>Weights</i>	<i>VIF</i>
TC	Technology competence	TC1	5.599	1.675	0.172 *	2.126
		TC2	3.113	1.880	0.155 *	1.291
		TC3	6.313	1.667	0.842**	2.025
PP	Partner pressure	PP1	2.742	1.303	0.120	1.359
		PP2	2.872	1.280	0.972**	1.386
		PP3	2.105	1.068	-0.041	1.625
ME	Mobile environment	ME1	3.392	1.036	-0.406 *	2.438
		ME2	3.787	0.909	0.567**	2.335
		ME3	3.251	1.011	-0.369	2.117
		ME4	3.554	1.017	0.743**	2.430
		ME5	3.347	0.937	0.134	2.229
		ME6	3.006	1.006	0.375*	2.055
SI	Impact on sales and marketing	SI1	2.616	1.272	0.613**	1.780
		SI3	3.049	1.336	0.068	2.315
		SI5	3.439	1.256	0.420**	2.945
		SI7	3.581	1.265	0.038	2.317
II	Impact on internal operations	II1	3.340	1.290	0.717**	2.781
		II3	3.413	1.178	-0.061	2.934
		II7	3.061	1.293	-0.004	2.567
		II10	2.825	1.259	0.169**	2.482
		II11	2.360	1.209	0.030	1.967
		II12	3.218	1.247	0.091	3.287
		II15	3.647	1.286	0.206**	2.442
PI	Impact on procurement	PI1	2.344	1.276	0.157 *	2.721
		PI2	2.623	1.298	0.709**	2.024
		PI4	2.519	1.323	0.239 *	2.876

Note: * $P < 0.10$; ** $P < 0.01$.