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ORGANIZATIONAL CONSEQUENCES OF THE ADOPTION OF MOBILE ERP SYSTEMS: CASE STUDIES IN BRAZIL

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ABSTRACT

The use of ERP systems via mobile/wireless devices is a subject rarely studied in academic research. The aim of this paper is to explore the following research question: what are the consequences of mobile ERP use for organizations? The research method adopted was the multiple case studies in three companies located in the South of Brazil. The research results show that, in the analyzed companies, the use of mobile ERP had "positive" consequences such as increases in productivity, efficiency and effectiveness, and improvements for the users' quality of life. However, the use also had "negative" consequences such as increased surveillance and control over employees.

Keyword: Enterprise Mobility; ERP (Enterprise Resource Planning); Consequences of mobile ERP systems use

1. INTRODUCTION

The widespread adoption of mobile/wireless technology is providing a new platform for business through some benefits of mobility (Scornavacca & Barnes, 2008). With the increasing availability and use of mobile technologies, companies today are beginning to understand the consequences of enterprise mobility, which stands for the application of mobile and wireless information technologies in business processes (Kalakota & Robinson, 2002; Sorensen, 2011).

Quick access to information anywhere can be beneficial in many business situations. Consequently, essential information systems such as ERP also need to be accessed via mobile devices, such as cell phones, smartphones or tablets (Kurbel et al., 2003).

Although the concept of enterprise mobility has been addressed in the literature, its consequences are not yet completely understood (Basole, 2008; Sorensen et al.,

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2008). Searching in some of the major academic databases (EBSCO, Science Direct, Scirus, Scielo e AIS - *Association for Information Systems*), one can see that there are few academic papers about the use of ERP systems through mobile technology. The few references available address technical features such as architectures (for example: Dabkowski and Jankowska, 2003; Al Bar et al., 2011) and not the business value or organizational changes and consequences related to the use of mobile ERP. There seems to be a knowledge gap in this subject.

The aim of this paper is to explore the following research question: what are the consequences of mobile ERP use for organizations? The term "consequences" is used instead of the term "impact", because we want to consider both "positive" and "negative" or unanticipated consequences of technology use, considering the duality of technology when it is applied to a specific context (Orlikowski, 1992). We present a set of propositions of possible consequences of mobile ERP use in organizations and we test them via multiple case studies, in three companies located in the South of Brazil.

Next, sections 2 and 3 present the research theoretical basis, leading to the propositions of this study. Section 4 explains the research method adopted; section 5 shows the research results and, finally, section 6 shows final remarks and suggestions for future research.

2 – THE CONSEQUENCES OF ERP USE

ERP are information systems that integrate a company through a single database with transaction processing in real time (Davenport, 2002). In general, ERP are modular commercial software packages or software services, aiming to support the majority of business processes (procurement, manufacturing, financial, HR, etc.).

For Davenport (1998), ERP systems impose its own logic to the strategy, culture and organization of a company. It is a generic solution that reflects a series of hypotheses about how firms operate through the incorporation of "business best practices" used in the market.

Reviewing the literature, one can find that there are many studies about ERP systems in the academia (see Esteves & Bohorquez, 2007), but most of them do not focus on the consequences of ERP use after the system adoption. The content of the few articles found with this focus is summarized in Figure 1.

The literature review indicates that the consequences of ERP use are diverse. Efficiency, effectiveness and cost reduction are among the most cited "positive" consequences. Among the "negative" consequences (few articles address this issue) are: constant costs for maintenance and upgrading, constant surveillance/control over employees, increased standardization and bureaucratization, as well as dependency on an ERP vendor.

Consequences of ERP use	Definition	References
Productivity gains	<ul style="list-style-type: none"> • ERP use allows the redesign, optimization and automation of activities, improving organizational processes. • ERP users have more information and thus can perform their tasks better and faster, with higher productivity. 	Turban et al. (2001); Saccol et al. (2004).
Increased Organizational Effectiveness	<ul style="list-style-type: none"> • The use of ERP improves decision making processes by providing access to real time information, which increases organizational effectiveness. • Information decentralization improves decision-making and contributes to increased efficiency. 	Saccol et al. (2004); Velcu (2007); Ross (1999).
Increased Organizational Efficiency	<ul style="list-style-type: none"> • ERP provides more information about products and services, improving the organizational processes. • Greater flexibility and better information quality increase organizational efficiency. 	Saccol et al. (2004); Gattiker & Goodhue (2005); Hsu & Chen (2004); Spathis & Constantinides (2004), Zwicker & Souza (2003).
Improved communication	<ul style="list-style-type: none"> • Improved communication between different units of an organization. • Production can schedule manufacturing and sales can also see what products inventories and delivery dates are. 	Hsu & Chen (2004).
Better relationship with suppliers	<ul style="list-style-type: none"> • ERP use reduces lead-time by improving interaction and information exchange with suppliers. 	Turban, Mclean, Wetherbe (2001); Velcu (2007).
Better relationship with customers	<ul style="list-style-type: none"> • ERP provides more information about customer demands and thus helps to improve the relationship with them. 	Ross (1999); Velcu (2007).
Cost reductions	<ul style="list-style-type: none"> • Reduction of administrative costs (ex: accountancy) • Lower costs in case of faults and errors in the products and in processes information. 	Spathis & Constantinides (2004), Poston & Grabski (2001); Velcu (2007).
Higher market value	<ul style="list-style-type: none"> • Financial markets tend to reward ERP adopters with higher company market value. 	Hitt, Wu & Zhou (2002).
Maintenance costs	<ul style="list-style-type: none"> • Maintaining and updating ERP generates permanent costs 	Zwicker & Souza (2003).
Increased surveillance and control	<ul style="list-style-type: none"> • Company is integrated by a single system, it means that employees are under control and surveillance 	Wood Jr. et al. (2003).
Increased standardization / bureaucratization	<ul style="list-style-type: none"> • Companies using the same ERP systems become standardized and this may result in a loss of competitive advantages. 	Wood Jr. et al. (2003).
Dependence on ERP vendor	<ul style="list-style-type: none"> • The adopting company can become dependent on the ERP vendor. 	Zwicker & Souza (2003).

Figure 1: Main consequences of ERP use in organizations.

3 – ENTERPRISE MOBILITY CONSEQUENCES

Currently, digitization reached a new level. This is due to the large scale dissemination of mobile and wireless technologies, such as cell phones, personal digital assistants (PDAs), laptops, smartphones and tablets - whose physical and functional features allow for interaction, information processing, collaboration and learning at mobile work (Wiredu, 2005; Sorensen, 2011).

Literature shows many examples of the dialectical change caused by the use of mobile and wireless technologies, their implications for individuals, companies and societies - see Figure 2.

Mobility consequences	Definition	References
Better relationships with customers	<ul style="list-style-type: none"> • Real time information to customers, regardless of their location, can improve their satisfaction. • Access to customers' information anywhere, anytime, helps companies to deliver better products/services. 	Basole (2009); Rodina, Zeimpekis & Fouskas, (2003); Picoto & Palma-dos-Reis (2010); Kadyte (2004); Kumar & Zahn (2003).
Increased efficiency	<ul style="list-style-type: none"> • Better communication between employees, even at a distance, leads to improvements in organizational efficiency. • The increased visibility of work processes improves efficiency. • Real time data collection (in fieldwork) avoids rework and errors. • Automating internal processes in fieldwork streamlines internal process of the entire company, improving efficiency. 	Basole & Rouse (2006); Kumar & Zahn (2003); Scornavacca & Barnes (2008); Barnes (2004); Kadyte (2004); Ali and Al-Qirim (2003); Picoto & Palma-dos-Reis (2010).
Cost reductions	<ul style="list-style-type: none"> • Physical spaces are no longer necessary for employees to perform their tasks. • Commuting /transportation costs are reduced. • Mobility leads to cost reductions in the sales cycle and thereby reduce costs. 	Basole & Rouse (2006); Rodina, Zeimpekis & Fouskas, (2003).
Increased organizational effectiveness	<ul style="list-style-type: none"> • The increased visibility of processes using mobility improves effectiveness. • Mobility improves organizational agility. • Staff becomes better informed even outside the company, which improves decision-making and effectiveness. 	Gebauer e Shaw (2004); Scornavacca & Barnes (2005); Barnes (2008); Kadyte (2004); Streng & Beulen (2002).
Productivity gains	<ul style="list-style-type: none"> • Information can be received directly from customers; there is an improvement in production. • Real time data collection and in receiving sales orders; it is no longer necessary to wait for orders to be input into the system at the end of the day. 	Gebauer & Shaw (2004); Rodina, Zeimpekis & Fouskas, (2003); Ali & Al-Qirim (2003); Davis (2002).
Increased revenues	<ul style="list-style-type: none"> • Company's improved efficiency and higher customer satisfaction leads to increased revenue. • Creation of new sales channels through mobile devices can generate revenue gains. 	Rodina, Zeimpekis & Fouskas; (2003); Picoto & Palma-dos-Reis (2010); Kalakota & Robinson (2002).

Interruptions at work	<ul style="list-style-type: none"> • Real time information and communication cause interruptions, since employees are always receiving data or calls. 	Cooper (2002); Ling, (2004).
Information overload	<ul style="list-style-type: none"> • Information, always available, can cause its overload 	Davis (2002).
Loss of quality of life	<ul style="list-style-type: none"> • People receive information and communications even beyond working hours (e.g. at leisure times, at home). 	Davis (2002); Gant (2001); Cipriano & Nicolaci-da-Costa (2009).
Loss of privacy	<ul style="list-style-type: none"> • The use of mobile devices everywhere, anytime causes loss of privacy for users. 	Davis (2002); Gant (2001).

Figure 2: Some consequences of enterprise mobility

References cited in Figure 2 show that the consequences of enterprise mobility are also diverse. Improved customer satisfaction, efficiency, effectiveness and organizational productivity are among the “positive” consequences. Among the negative consequences are the decreased quality of life of users, loss of privacy, work interruptions and information overload.

Based on the main consequences of ERP and enterprise mobility use identified in the literature, we have developed research propositions on the possible consequences of using these technologies altogether (ERP systems accessed via mobile devices/platforms).

The number of propositions is high due to the exploratory nature of this research and the novelty of the issue. These propositions have guided our study and can serve as a basis for future research:

- P1 – The use of mobile ERP leads to increases in organizational productivity.
- P2 - The use of mobile ERP leads to increases in organizational efficiency.
- P3 - The use of mobile ERP helps to reduce organizational costs.
- P4 – The use of mobile ERP leads to increases in organizational effectiveness.
- P5 - The use of mobile ERP improves relationships with customers.
- P6 - The use of mobile ERP improves organizational communication.
- P7 - The use of mobile ERP improves relationships with suppliers.
- P8 - The use of mobile ERP generates ongoing maintenance/upgrading costs.
- P9 - The use of mobile ERP leads to company’s higher market value.
- P10 - The use of mobile ERP generates increased surveillance and control.
- P11 - The use of mobile ERP increases organizational bureaucracy.
- P12 - The use of mobile ERP generates increased revenues for the organization.
- P13 - The use of mobile ERP generates more interruptions at work.
- P14 - The use of mobile ERP leads to information overload.
- P15 - The use of mobile ERP generates losses to the users’ quality of life.
- P16 - The use of mobile ERP generates loss of privacy.

4 – METHOD

The research is qualitative and exploratory, because, according to Collis & Hussey (2005), this type of study should be conducted when there are few or no previous studies on the researched issue. The data collection happened during the first semester of 2011. We adopted the method of multiple case studies (Yin, 2010).

Considering the literature on ERP and enterprise mobility and the research propositions, we designed a case study protocol to guide the multiple case studies with companies that had adopted mobile ERP solutions. According to Yin (2010), the case study protocol increases the reliability of case study research and it is mandatory for multiple case studies. The protocol was validated by an academic expert, a professor from the area of Information Systems, and also by a senior consultant in ERP implementation. Both of them made the constructs validation (Collis & Hussey, 2005) that reveals the degree to which a phenomenon and the variables involved in it were properly defined and measured (operationalized). The interview scripts designed in the case study protocol were also validated (face validity) by a manager of one of the companies studied; this manager uses a mobile ERP application.

For the multiple case studies, three companies were selected according to the criterion of accessibility; they needed to use a mobile ERP solution. Companies will be here called ONE, TWO and THREE, in order to protect their identities. All of them are located in the South of Brazil, in the state of Rio Grande do Sul.

Data collection was conducted with on-site interviews and observations of the mobile ERP solution adopted. Twelve (12) interviews were made in total (at least 3 in each company), with people from different sectors in the studied companies, including: three general managers, two IT personnel, two financial managers, one HR manager and four salesmen.

Content analysis techniques (Bardin, 2009) were used for data analysis. The main categories of analysis were the possible consequences of mobile ERP use, defined in each one of the research propositions (see section 3).

5 – RESULTS

Initially, we present a brief profile of each one of the companies studied, the type of mobile ERP solution adopted and a summarized description of the adoption process.

Company ONE - This Company was founded in 1978. Its business is the distribution and sale of soft drinks, beers, juices, mineral water and the like. Its major clients are restaurants, grocery stores, snack bars, convenience stores and stores, bakeries and drugstores.

The company is located by the coast, and therefore it has seasonal sales. In months of low season it has 52 employees, and in high season it has 80 employees.

The mobile application was added to the ERP package already owned by the company as a new feature, in 2006, and it is used only to support the sales process. The functionalities of this mobile ERP application are: placing orders, queries and updating

of the customer database, sales reports, financial reports and control of actions taken by salespeople. The device used to access this solution was the Palm Treo®.

Company TWO - This company is in sales and distribution of sweets and chocolates, since the year of 2008. Its main clients are supermarkets, restaurants, snack bars and bakeries and it has 18 employees.

The ERP system has been used since the company's foundation in 2008. The mobile application adopted (in January 2011) was a module of the ERP system, provided by the same company that provided the ERP. The ERP mobile application is used only in sales, and has functionalities such as: sales request, queries and updating of customer database, sales reports, financial reports, route planning, control of actions taken by the salesmen and registration of new customers. The device used was a Samsung smartphone.

Company THREE - This Company was founded in 2008 and it has 20 employees. It is a factory that sells bottled water to wholesale and retail businesses. Its main customers are beverages wholesalers.

The company's mobile ERP access was adopted along with the full ERP system in 2008. They do not have a specific mobile module of the ERP; they have a mobile application that accesses the database of their ERP. This solution has been used since the foundation of the company, therefore they do not have perceptions about “before and after” the use of mobility with ERP, as occurred in the other two case studies. The mobile application has always been used in the sales process, and it has features such as: access to financial information and customer registration, sales reports and registration of sales orders. The device used by this company to access the ERP was the smartphone Qtek.

Figure 3 shows a summary of which research propositions were evaluated with similar results in all of the three cases studied. For the remaining propositions, there were no conclusive results to be reported.

	Confirmed	Not confirmed
Productivity gains		
Increased organizational efficiency		
Lower costs (*)		
Increases in organizational effectiveness		
Better relationships with customers		
Improved organizational communication		
Better relationships with suppliers		
Increased surveillance and control		
Information overload		
Loss of quality of life of users		

Figure 3: Main results of the research propositions

(*) Note that some costs were reduced but others (telecommunications costs) increased

Based on Figure 3, it can be stated that, in the studied companies, the research propositions that could be confirmed were the following:

Proposition 1: The use of mobile ERP leads to increases in organizational productivity – Confirmed. For instance, in the studied companies, the use of ERP with mobility allowed more customers served per employee and the agility of employees has increased.

Proposition 2: The use of mobile ERP leads to increases in organizational efficiency - The use of ERP with mobility in the studied companies allowed the decrease in the number of employees needed to perform sales processes, the number of hours worked were reduced and the number of overtime hours also decreased. The range of time between taking customer orders and delivering the products has decreased.

Moreover, sales orders are taken and sent to the company's headquarters in real time, from the field, whereas it used to be necessary to wait for the return of salespeople to the office in order to enter the orders into the ERP. The logistic/delivery processes occur sooner, which reduced the company's lead-times. Customers receive the goods faster, the error rate is lower; for example, errors in sales orders, which used to be made by hand before the mobile ERP solution, were reduced.

Proposition 3: The use of mobile ERP helps to reduce organizational costs - In the companies studied, the use of ERP with mobility helped to reduce costs of commuting, transportation and administrative costs (paper, pens and printed material). Two managers, from company ONE and company TWO, respectively, indicated a reduction in staff members. According to the respondents, fewer employees would be required to carry out bureaucratic processes, such as placing of orders, reporting on customers' purchases, etc.

However, the adoption of this technology has generated increased telecommunication costs, involving the purchase of a larger number of devices, and contracting data services, among others. In company THREE telecommunication costs for using the ERP with mobility were even greater because this company is located in a rural area with fewer communication services available. Due to that, they had to install an antenna on a private property to get Internet access, which was not accessed until then.

Proposition 4: The use of mobile ERP leads to increases in organizational effectiveness - This proposition was confirmed due to several evidences. As an example, in company TWO, according to the manager and one of the interviewed salesmen, the use of ERP with mobility changed the goals set. The management of the company can drill down data on sales goals achievement, knowing even if one employee really visited a customer. Everyone can access the sales goals and performance anytime, anywhere, and then pursue them more intensively. The quality of delivery of products to customers improved.

Proposition 10: The use of mobile ERP generates increased surveillance and control - The use of mobile ERP in the companies brought an increase in surveillance and control over employees because managers have records on what time the salespeople visited customers, how long they have been with them and how many customers were visited every day.

In the three studied companies, some research propositions were not confirmed, as described below.

Proposition 5: The use of mobile ERP improves relationships with customers - According to the respondents, the use of ERP with mobility did not provide better relationships with customers, because communications with them were still the same. The means and channels for communication with customers have not changed due to the ERP implementation. Thus, this proposition, based on the literature previously studied, was not confirmed in our study.

Proposition 6: The use of mobile ERP improves organizational communication - In the companies, the use of ERP with mobility had no consequences for organizational communication, since, according to the respondents, they are still communicating mostly via e-mail and telephone, it means that, although the mobile ERP increases the volume of data and information available to the sales force, the interaction between people in the companies still relies on phone calls and e-mail.

Proposition 7: The use of mobile ERP improves the company's relationship with suppliers - According to the interviewees, nothing has changed in the relationship with suppliers. The communication between the companies and their suppliers is still mainly based on the use of e-mail or phone calls. There is no integration between the ERP systems of the companies and the ERP systems of their suppliers. In company ONE, for example, suppliers do not have access to the company's ERP system. Purchase orders are placed and printed on paper.

Proposition 14: The use of mobile ERP with leads to information overload - According to the respondents, the use of mobile ERP caused no information overload for users, but instead, it provided more information quality to support the contact with customers, helping to qualify the sales force.

Proposition 15: The use of mobile ERP generates losses to the users' quality of life - According to the respondents, the use of ERP with mobility provided them with *higher* quality of life, because it facilitates the fieldwork and reduces the number of working hours, as well as the time spent on commuting, which, especially according to the salesmen, aid in their quality of life.

If we analyze the propositions not confirmed, we can realize that are two sets. The first one is related to possible consequences of ERP use for communication and relationships with customers and suppliers. Previous researches such as Saccol et al. (2004) indicated a little impact of (non-mobile) ERP in the strategic variables *clients* and *suppliers*. Caldas & Wood Jr. (2000) also studied ERP in Brazil and their research indicates that many companies did not perceive improvements in customer service. Saccol et al. (2004) highlight that the main contribution of ERP systems is related to productivity and efficiency gains (both confirmed in our research). Therefore we can conclude that the main consequences of the non-mobile ERP have similarity with those of mobile ERP.

The other set of elements that were not confirmed in the study are related to the negative consequences of the mobile ERP for individual users, regarding possible information overload and lower quality of life due to constant connectivity, both suggested by previous studies involving mobile applications (for instance: Davis, 2002, Sorensen, 2011, Orlikowski, 2007). The data from the cases indicate that the participants did not perceive these negative consequences because they mentioned gains due to the increased flexibility and mobility obtained by mobile ERP use, in the sense that they save commuting time. These points have to be tested again in future studies, because the data can also indicate a lack of criticism of respondents, biased by the benefits of mobile technology, since the media in general associate this type of

technology with modernity and professional agility (Saccol and Reinhard, 2006). Another negative effect - increased surveillance and control – was confirmed in our data, such as previous studies on ERP in general (Wood Jr. et al., 2003), therefore it is important, in future studies, to look deeper into the possible negative effects of mobile ERP.

5 – FINAL REMARKS

The main objective of this study was to explore the ways by which ERP systems have been used in a perspective of enterprise mobility and what the consequences for organizations are.

Among the main results, it was found that the mobile ERP applications have been used only for sales force automation in the studied cases. There are no other modules of the ERP been accessed via mobile.

Regarding the consequences of adopting mobile ERP solutions in the studied companies, it helped them to get productivity gains, higher efficiency and organizational effectiveness. The use of mobile ERP also resulted in reductions of some types of organizational costs (e.g., printed material, administrative costs and extinction of some job positions), but telecommunications costs increased. There was also an increase in surveillance and control over employees, since now companies have detailed records on their daily work in the field. All these propositions were supported by the literature considered in this study.

However, some research propositions were not confirmed in all of the three studied cases, for example, no improvements occurred in the relationships with customers or suppliers, and in organizational communication.

Finally, two research propositions were different from the expected (according to the previous literature). First, it was found that the use of the mobile ERP did not cause information overload for users; on the contrary, respondents claimed that this technology helped to qualify the sales force. Likewise, according to the respondents themselves, there was improvement (not decrease) in the users' quality of life, because they can avoid commuting and operational work (e.g. data entry of orders manually into the ERP system).

Since there are few studies that address the question of the use of ERP systems from a mobility perspective, this work can serve as a reference for future studies on the topic. The research results may also be relevant to other organizations that want to adopt mobile ERP solutions. The results can also generate relevant insights to suppliers of ERP and mobility solutions.

As research limitations, a small number of cases were studied, and all the studied companies are small or medium sized, using only mobile ERP applications for sales force automation.

Future research needs to investigate companies of all sizes, sectors, and with other mobile ERP solutions (e.g. for business intelligence). Our case study protocol can be used as a basis for other cases of even for designing a survey instrument. It can be accessed in Pavin & Klein (2012).

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