

The Efficacy of Wireless B2B e-Procurement: A Pilot Study

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Working Paper, accepted for presentation at HICSS'36

Last updated 9/15/2002

Abstract

This paper reports on an empirical study to assess the impacts and benefits of wireless applications to enhance an electronic procurement system, as well as some critical success factors. For different user groups, we analyze the role of the work environment for the usage and, ultimately, the benefits of the wireless applications. The study provides a basis for a broader framework to improve the design and management of business applications based on emerging technologies.

Keywords: Electronic procurement, wireless technologies, technology management, empirical study

1. Introduction

Frequently, the impact of emerging technologies on organizational processes is overestimated in the short term and underestimated in the long term, as Bill Gates is said to have observed a few years ago. Wireless applications could be one of the latest example of such over-/underestimation that typically start out with high hopes regarding the potential of the technology and are followed by disappointment when the early estimates do not materialize as quickly or pervasively as anticipated [11]. Earlier examples include electronic data interchange (EDI) [5], application service providing (ASP) [8], or public electronic marketplaces (B2B electronic commerce) [14].

Lately, wireless applications and technologies have been expected to be the "next big thing," followed by huge investments and some disappointment, as developments have

progressed slower than anticipated (see for example the bidding activities for the UMTS licenses in Europe which yet have to pay off for the telecom companies [2]). To date, wireless technologies have primarily been applied in consumer-oriented areas, while the business world still awaits larger-scale usage, evoking the memories of similar developments related to the use of the Internet in the 1990s. For personal as well as business use, voice communication far outweighs data transfers, replacing traditional, wired telephones, rather than desktop computers [15].

Although we do have a general sense of application areas for wireless technologies in business environments [6], we still know very little about the conditions for wireless applications to enhance business processes, about their implications or benefits, or about how to measure the impacts. To allow organizations to determine realistically the opportunities and requirements of these emerging technologies, we need to answer questions such as the following: What are the sources of benefit from wireless business applications? Will the benefits come mostly from improved operational efficiency as handheld devices provide for easy access to enterprise data systems? Will they improve the adoption of information systems among employees who resisted using computers so far? Or will wireless applications primarily help improve decision processes by giving managers access to relevant information instantly from anywhere? What are the bottom line impacts of such effects, and how should we measure them?

With our work, we want to contribute toward improving the design and management of wireless business applications, as they are currently emerging. In a broader context, we see our work help mitigate the circle of overestimation/underestimation of the impact of technological innovations that has occurred so many times. This paper focuses on the following two questions: From the perspective of the end user, (1) what are the impacts and benefits of providing wireless access to an electronic procurement system, and (2) what are the critical success factors for such an application.

After positioning our work with respect to information systems (IS) and related research (Part 2), we outline our research framework (Part 3) and report on the results of a pilot system, implemented at Motorola, Inc. to enhance an electronic procurement application

with wireless access (Part 4), before we draw conclusions and lay out the next steps to develop a more comprehensive evaluation framework (Part 5).

2. Previous Research

A rich body of literature exists to guide the design of information systems, to help identify the requirements for their success, and to assess the impacts of their usage. Emerging applications, such as Internet-tools to support procurement processes and wireless applications have also spurred interest among researchers as well as industry professionals. While we can draw upon the earlier research and early experiences to address our research questions, our focus differs in some ways, limiting the applicability. In addition and given the newness of wireless technology and their use in organizational settings, very little research exists on the very topic to date.

We consider previous research in the following general areas: Value of information technology (IT), IT adoption, and technology assessment (task-technology fit). In addition and more specifically, we include studies on the impacts, value, and success factors of electronic procurement systems, and of wireless applications, as they have been conducted so far.

Much research has been undertaken to assess the value and impact of information technology (IT) and the investments that are necessary for its deployment [1]. To determine the value of emerging technologies *before* they are deployed on a larger scale (ex ante) existing frameworks for the evaluation of already existing IT systems (ex post) have limited applicability. Firstly, actual user data is not available, as by definition the user population and usage figures are very small or non-existent. Secondly, the technology itself is typically still under development, often in cooperation with participants of pilot projects, which further limits our understanding of the implications, benefits, and requirements for success.

Adoption research, such as the widely used Technology Acceptance Model (TAM) [3] points to the importance of careful consideration of individual user requirements as a critical success factor for IT applications. Early studies on the adoption of wireless

technologies are under way but not yet completed [10], [13]. To make a stronger case for adoption management in an organizational setting, we also need to consider the implications from a business perspective. For wireless applications, such benefits could include productivity improvements of managers, as well as the dependents waiting for management decisions, reduced cycle times from timelier notification, better handling of emergency situations etc.

The issue of matching technologies with specific tasks and the resulting impact on individual user performance and system success (task-technology fit, media-richness theory) has been discussed in the context of group support systems [9], [16], and is also relevant in the context of wireless applications.

The use of Internet-based technologies to support the procurement function has gained widespread interest during the 1990s. Large organizations in particular have soon realized the advantage of decentralizing part of the procurement activities. Involving the end-user requisitioner means relieving the central procurement group of operational tasks, as the system ensures compliance with corporate purchasing procedures. In addition, benefits from the automation of formerly paper-based processes, as well as cost savings from better utilization of corporate purchasing power have been attempted [4]. Although to this date not all expectations have been met, and many obstacles still have to be overcome, early adopters report some significant results. Our study focuses on the changes resulting from adding wireless access to these applications.

The literature on benefits, impacts and success factors of wireless applications in organizational settings is more scarce [15], constrained by the small range of available applications, low actual usage, and limited experience.

3. Research Framework and Hypotheses

To assess the impacts and benefits of wireless access to an electronic procurement system, and to identify the critical success factors for such an application, we studied the situation at a large telecommunications manufacturer (Motorola) where the development and introduction of a set of wireless applications is under way to enhance an existing

electronic procurement system [7]. The initial implementation of the mobile procurement solution concentrated on three areas: to wirelessly enable users to create purchase requisitions, to approve requisitions, and to check requisition status (Figure 1).

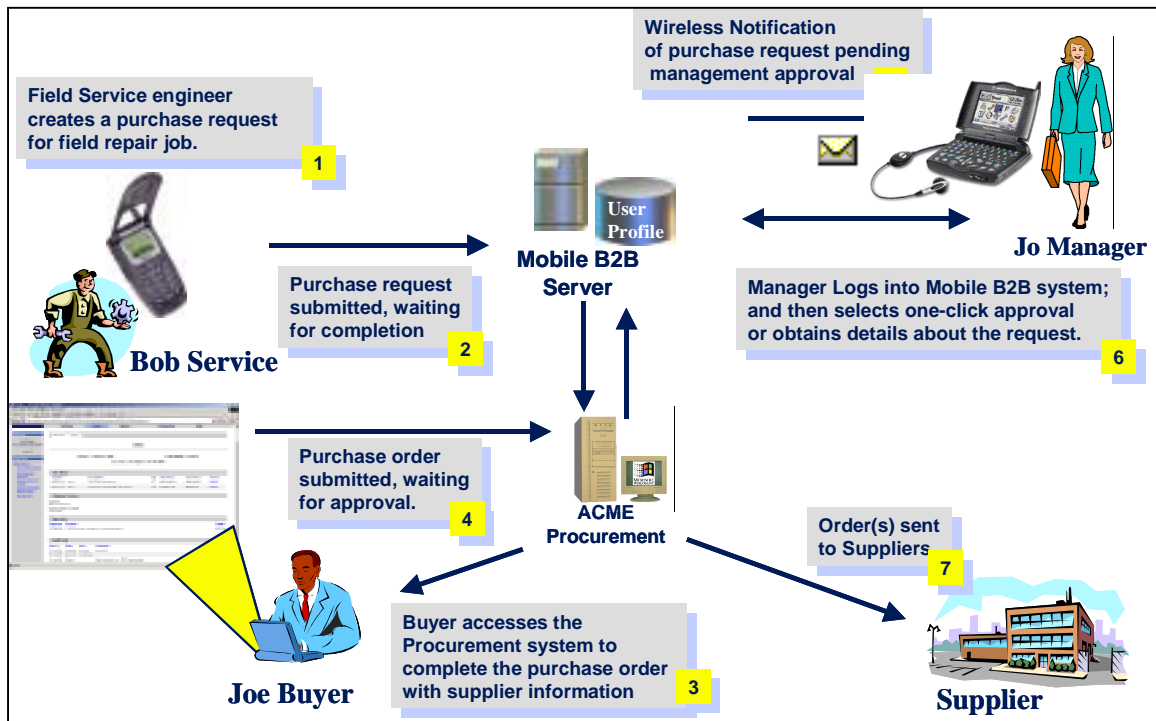


Figure 1 – Purchasing Process, Supported With Wireless Applications

Approval processes can roughly be grouped into two categories: approvals that are processed by managers, allocating the budgets under their supervision, and administrative approval processes (accounting, finance, etc.) to ensure that procedural rules are followed correctly. Typically, a purchasing request has to be approved by both types of approvers.

So far, usage of the system has been limited as the system is accessible only to a small group of employees who signed up for a pilot project. Several issues are relevant to answer our research questions, such as: characteristics of the user work environments (Who should utilize the system?); system-related issues such as usage patterns; user requirements, and system characteristics (How should the system be designed and how could it be used?); and impacts and benefits (What and how significant will the impact be?).

Figure 2 depicts the research framework explained in more detail below.

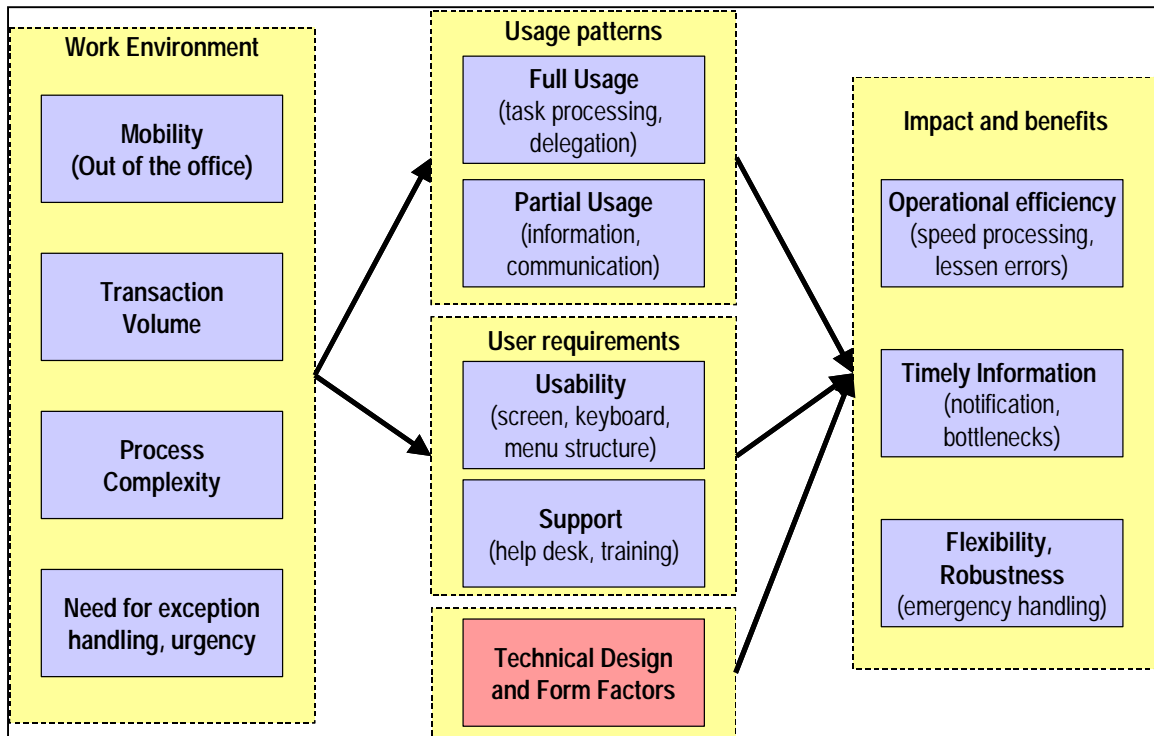


Figure 2 – Research Framework

3.1 Work Environment

The first issue concerns the question: Who should utilize the wireless application at all? We would assume that an employee who never leaves her desk during work hours has much less use for wireless access than a manager who travels two weeks out of every month, or an engineer leading a project out in the field. Through our interaction with the project team at Motorola and from studying the wireless applications and process descriptions, we identified four factors of the user work environment as relevant: mobility (time spent out of the office), transaction volume, process complexity, and the need for exception handling (urgency). The latter point relates to the need to be notified about a request and to respond to it immediately, and could be measured by the opportunity cost arising from delays. Exact measurement of this construct is difficult, given the stochastic element involved.

3.2 Usage Pattern and Requirements

The second part of our framework focuses on the wireless system itself and asks about the main application areas (usage patterns) and user requirements.

Wireless access to an enterprise application can mean several things, which also entails one of the factors that distinguish wireless systems from standard desktop-based applications.

For once the wireless application can allow a user to access the main system and *fully* perform a task, such as approving a purchasing request, very similar to using a desktop-based application. We want to label this type of usage as "full usage." Delegating a task to a secretary or co-worker on an ad-hoc basis would also fall under this category, as it "gets the job done" after the user is notified about it.

In addition, wireless devices can be utilized to perform *parts* of a task such as getting back to a requestor or supplier for more information by using the mobile device as a communication tool (phone) or to access data that are stored elsewhere in the enterprise system (information gathering). We refer to this type of usage as "partial usage." After the user regains access to a desktop-machine, the task can then be finished, based on the preparations done earlier.

Depending on the tasks, and other user characteristics, we assume that a user has specific requirements concerning the application. Such requirements concern the usability of the application itself, including factors such as screen size, keypad, menu structures and login procedures, as well as support factors including helpdesk support and training.

3.3 Impacts and Benefits

The third part of our research framework concerns the main impacts and benefits of the applications.

Many authors have written about the impacts and benefits of IT systems in general [1]. Often, a distinction has been made between impacts from automating formerly manual

processes and as a result increasing operational efficiency, and impacts from providing better information to decision makers [12], [17]. These categories are relevant in a wireless environment as well (and correspond to some extent with our distinction between full and partial usage), with notification playing a major role similar to Zuboff's concept of informing to improve the results of decision-making processes. In addition, and similar to process changes that occur as organizational learning effects happen over time, we also expect changes of flexibility and the ability to react to environmental changes and to handle emergency situations (flexibility, robustness).

3.4 Technical Design and Form Factors

Finally, we want to explore the question of what requirements are key to success, again from a user perspective.

In addition to the usage patterns, we expect the actual design and handling of the system to have a significant effect on the system impact and benefits. In mobile environments, such characteristics are sometimes referred to as form factors, and they include features such as the scope of the application, menu structure and technical support. We consider it important to match the requirements with the actual form factors because we cannot assume the "perfect" system due to the newness of the technology and because of the fact that it is still under development, partly in collaboration with the user community.

3.5 Hypotheses and Research Approach

So far, our research framework has evolved as a result of our interaction with the corporate partner, literature review, practical observations, and intuition. To develop an applicable tool, we need (1) to validate the components of the framework (are they valid as well as comprehensive?), and (2) to study the relationships between the different parts of the framework.

Our set of hypotheses regarding the efficacy of wireless business applications is emerging and can be summarized as follows (Table 1), referring back to the research framework (Figure 2).

Table 1 - Research hypotheses about the efficacy of wireless applications to improve enterprise processes

Work environment and usage patterns	
H1	High mobility is related with high overall usage.
H2	High volume is related with high overall usage.
H3	High complexity is related with high requirements.
H4	High complexity is related with high partial usage (rather than full usage).
H5	High sense of urgency is related with high overall usage.
Usage patterns and benefits	
H6	Full usage is related with benefits from increased operational efficiency
H7	Partial usage is related with benefits from information.
H8	High overall usage is related with high benefits from improved emergency handling (flexibility).
H9	High overall usage is related with high overall benefits.
Requirements and Form Factors	
H10	Low overall usage is related with high requirements of setup, training, and help
H11	High overall usage is related with high requirements of usability (menu structure, keyboards etc.)
H12	The larger the gap between user requirements and matching form factors, the lower the overall benefits that can be achieved.
Overall benefits	
H13	The use of wireless applications results in improvements operational efficiency.
H14	The use of wireless applications results in more timely communication and information.
H15	The use of wireless applications results in improved flexibility and ability to handle emergency situations.

4. Empirical Study

We had the opportunity to take a first step towards validating our framework and hypotheses by conducting an empirical study among the participants of the wireless e-procurement project at Motorola.

During February and March of 2002, we developed a questionnaire in cooperation with our corporate partner, and collected a number of responses from early users and employees who had signed up for the pilot study. The responses were partly submitted electronically and partly filled out on our side during structured phone interviews with the respondents. The respondents represent a small and selected sample with a natural strong interest in the wireless application. Although this selection makes it problematic to generalize the results, we did obtain some interesting insights.

The survey contained questions on the usage of the (wired) electronic procurement system; general experiences with the wireless solution; areas of application and benefits of the wireless solution to support approval, requisitioning, and receiving processes; and perceived limits. In addition, the survey asked for personal, mostly job-related information, and provided space for comments. Respondents could fill in part or all of the different areas, and in particular select between questions about approval, requisitioning, and receiving processes, as they pertained to their individual situation.

4.1 Survey Participants and User Groups

In our data set, we identified four user groups according to the job descriptions, as well as reflected by the data describing the work environment: management approvers, finance and accounting approvers, requestor and receivers, and occasional users. As the group of the occasional user only consisted of one data point, we omitted this group from separate analysis.

Figure 3 and Table 2 depict the work environments of the different groups as characterized by the four variables: volume, complexity, mobility, and urgency. To ensure comparability, all variables have been coded to span a range of 0 to 5, with higher

values representing higher degrees of the variable. Given, that requestors typically also act as receivers for they request both are grouped into one category for this analysis.

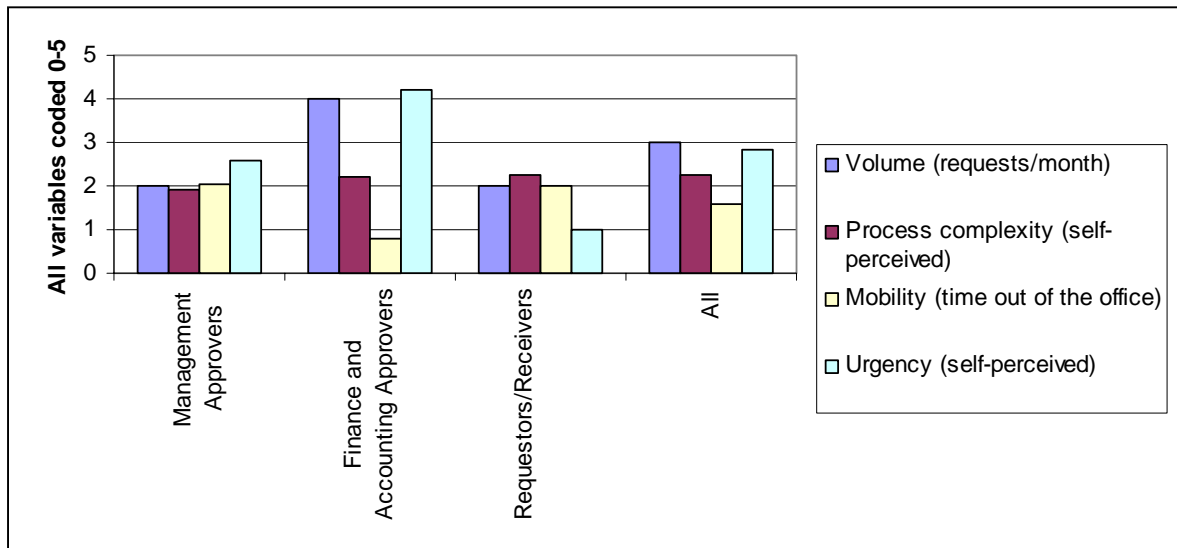


Figure 3 – Work Environment of Different User Groups

Table 2 - User Groups

Group	Volume	Complexity	Mobility	Sense of urgency
Management approvers	Low to Medium	Low-medium	Medium to High	Medium
Finance and accounting approvers	High	Medium	Low	High
Requestors/ receivers	Low to Medium	Medium	Medium to High	Low

A few additional points are worth mentioning:

- Some respondents filled in the questions addressed to approvers as well as the questions addressed to requestors and receivers, indicating they were indeed involved with both (or even all three) processes.
- The construct for process *complexity* was vague, eventually limiting its usability as an independent variable. We tested for differences between complexity of a specific process (e.g., approval procedures for purchases of services) that was perceived by

the individual and the average measures for all users, but the analysis did not provide meaningful results.

- Although we asked participants to report the monthly *volume* of procurement-related transactions, we eventually decided to use system-generated figures as a more objective basis for analysis.
- In the questionnaire, we did not have a good construct to measure *urgency* (the need for emergency handling). We assessed this variable indirectly through a question about the benefits of a wireless application; assuming that benefits from improved emergency handling implied a need to do so. We do realize the limits of this workaround.

Most of our respondents were located in the United States. In addition, we gathered responses from Asia (Hong Kong, Singapore) and the Europe (UK). Due to the small numbers, however, we could not identify significant differences between the responses from different locations and did not distinguish between them further.

4.2 System Usage

Approximately half of our respondents had actually worked with the system and accessed procurement functionality wirelessly. Of the non-users some had completed the sign-up process successfully but not actually used the application, while some still needed to obtain the equipment necessary to initiate their participation. Given that even for the users the actual usage was in fact very limited, we have to treat the responses about usage as perceived usefulness in the sense that they reflect a respondent's perception about how the application could support his or her work in the future.

Figure 4 depicts the perception of usefulness of the wireless application for approval processes. Figure 5 and 6 depict the perception of usefulness as indicated by requestors and receivers respectively.

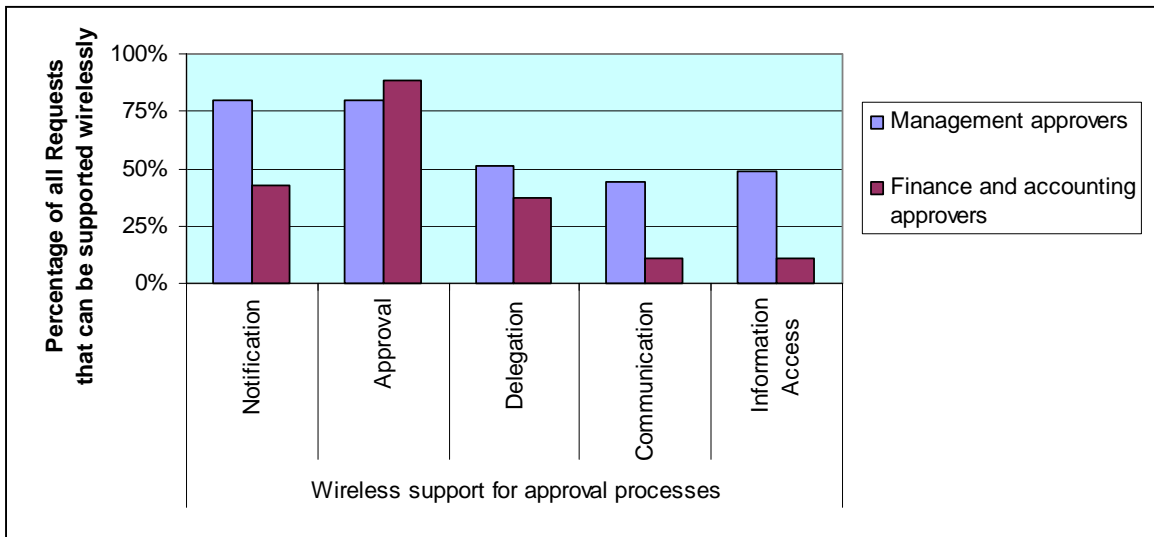


Figure 4 – Wireless Support for Approval Processes

Manager Approvers. Most important areas of application for manager approvers are approval and delegation of approval authority when out of the office. Managers reported that on average 80% of all approvals could actually be processed wirelessly. In addition, managers stated that for 80% of the waiting requests they would like to be notified.

Managers also responded that for close to 50% of all requests they could utilize the wireless system to delegate approval authority, to access information and to communicate.

Finance and Accounting Approvers. Most important area of application is actual approval, with all other areas ranking much lower, such as notification delegation, communication and information access.

Requestors and receivers. Most important areas of application for the wireless solutions are tracking an order through the approval process and changing orders after they have been submitted. The numbers are lower than for the approval processes, though.

In the receiving process, most important areas of application are notification and tracking (Figure 6).

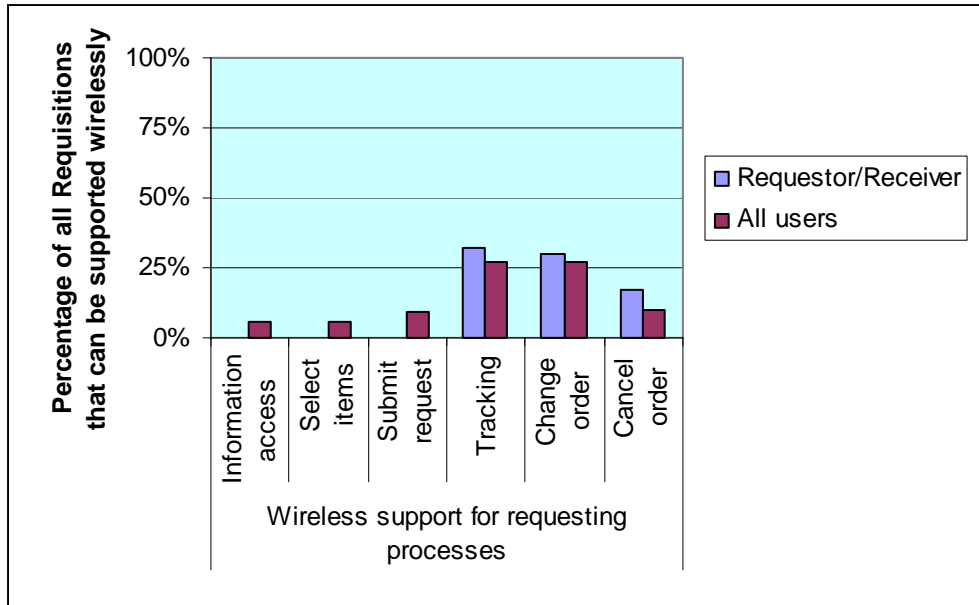


Figure 5 – Wireless support for Requesting Processes

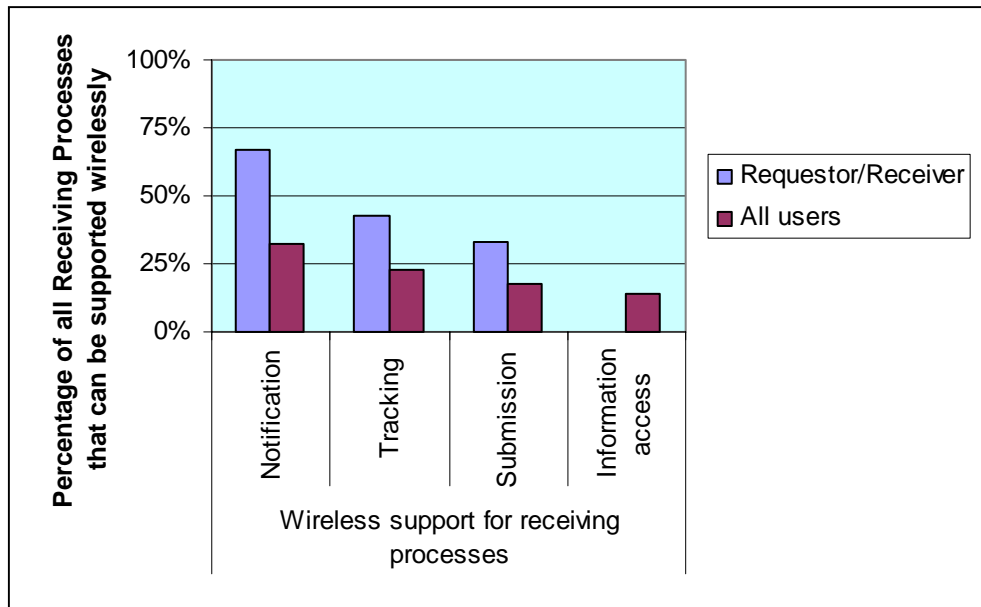


Figure 6 – Wireless support for Receiving Processes

Before we apply our observations to the hypotheses stated before, we list the different types of usage with respect to whether they relate to full or partial support (Table 3).

Table 3 - Full vs. Partial Usage of Wireless Applications to Perform Procurement Tasks

	Partial usage	Full usage
Approval		
Notification	X	X
Approval		X
Delegation		X
Communication	X	
Information Access	X	
Requesting		
Information access	X	
Select items	X	
Submit request		X
Tracking		X
Change order		X
Cancel order		X
Receiving		
Notification	X	X
Tracking		X
Submission		X
Information access	X	

Our small sample size does not allow us to derive statistically significant results regarding the hypotheses. We want to point out, however, for which of the hypotheses we found some evidence in our data (we also indicate the direction) and for which of the

hypotheses we would need to change the research setting in order to be able to answer them.

Table 4 - Findings Regarding Work Environment, Usage Patterns and User Requirements (H1-H5)

H	Expected results	Evidence?	Construct valid?
H1	High mobility related with high overall usage	Some evidence to support H1, but mixed results	Some inconsistencies in the responses regarding usage; also, usage has to be interpreted as perceived usefulness in our data sample.
H2	High volume related with high overall usage	Some evidence to reject H2 (high volume related with low usage)	
H3	High complexity related with high system requirements	Some evidence to support H3	Have to improve the construct of complexity (individual perceptions vs. objective measures, such as number of steps involved to process a task)
H4	High complexity related with high partial usage	Very little evidence (almost no correlation), higher correlation between complexity and support from notification	
H5	High sense of urgency related with high overall usage	Some evidence to support H5	Have to improve the construct of urgency

4.3 Impacts and Benefits

To assess the most significant impacts and benefits from the wireless solutions, we asked the respondents to not only tell us about where they saw the benefits (Figure 7) but also how a typical process was broken down (Figure 8). The answers are revealing.

Management approvers. Close to half of the processing time of a purchasing request by a manager is due to the managers being out of the office (47% on average). Maybe not surprisingly, the most significant benefits are seen in speeding up the overall processing time of an approval request as well as from notification about a waiting request.

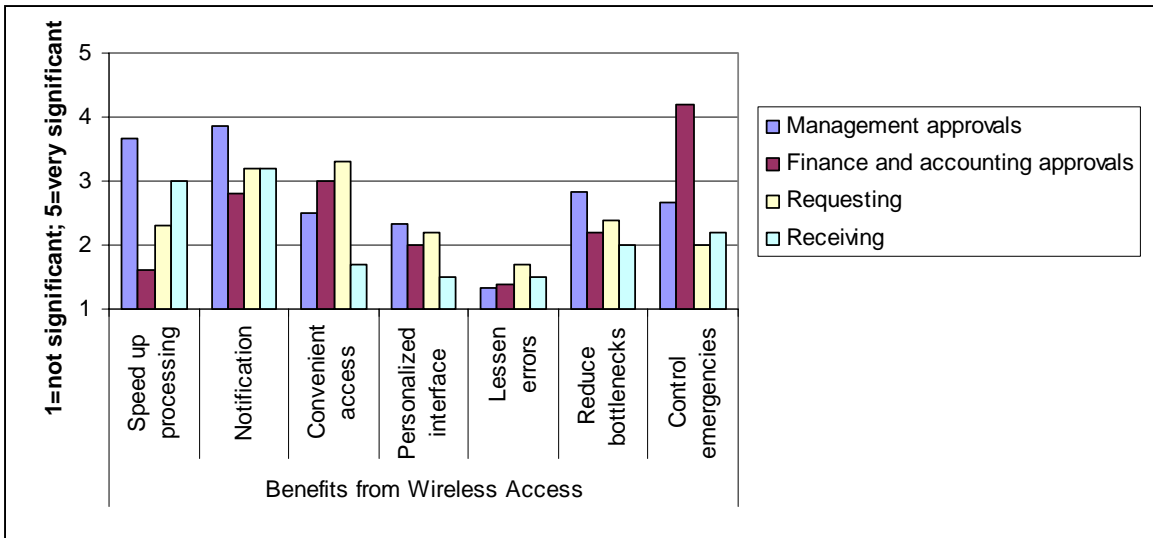


Figure 7 – Benefits from Wireless Support

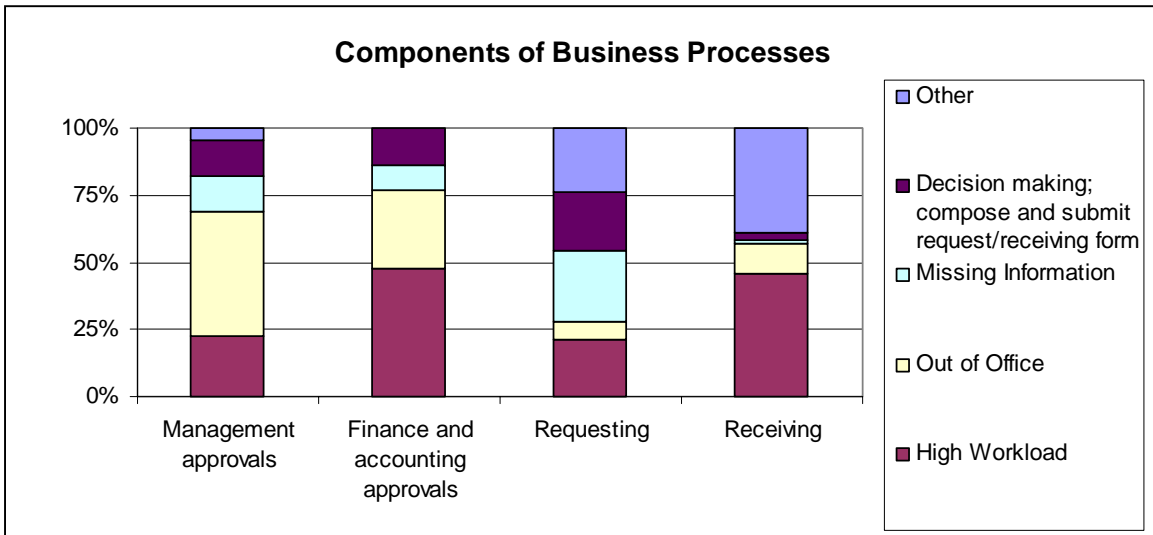


Figure 8 – Process Cycle Time Components

Finance and accounting approvers. Approximately half of the processing time of a purchasing request by a finance and accounting manager is caused by high workload (48%). Most significant benefits of wireless access are seen from being better able to control emergencies and to conveniently access the system (remember: these approvers have a high volume of purchasing requests. One respondent told us that she is frequently the final approver of a request, primarily ensuring compliance with internal procedures. As a result, decisions are fairly straightforward and requestors sometimes wait for her to come back from lunch and sign off the request immediately. To prevent unnecessary

process delays she values access to the system at times when she can not come to the office, because she has to take care of a sick child.

Requestors and Receivers. According to our respondents, the time it typically takes to submit a purchasing request is pretty equally divided between high workload, missing information, searching and composing the request, and other activities. In their comments, however, the respondents indicated that the other activities mainly concerned waiting for management approval and following up on the managers, and that this part of the requisitioning process was considered to be especially painful. The requestors most often indicated benefits from convenient access to the purchasing system through the wireless application, from notification, and from reduced bottlenecks. Possibly even more relevant is a more indirect impact, however: the requisitioners frequently indicated hoping to benefit from more direct access to the approving (and often traveling) managers to speed up the approval process.

The lead times of the receiving process are much longer than the other processes (days to weeks instead of hours to days as in the case of the other processes). Here, the most significant components are high workload, and other activities, which include forgetting to enter a receiving note into the system and, thus, effectively closing the related purchase order and releasing payment to the supplier. Respondents, thus, indicate most often hoping to benefit from delivery notification and shorter processing times. An indirect effect might come from improved supplier relationships due to shorter payment cycles, as one respondent indicated.

Again, we relate our data with the hypotheses stated earlier and point out where we found some evidence and where the constructs need to be refined to allow testing of the hypotheses (Table 5)

Table 5 - Findings Regarding Usage Patterns and Benefits (H6-H9)

H	Expected results	Evidence?	Construct valid?
H6	Full usage related with benefits from automation	Evidence too weak to accept or reject H6	Distinction between full and partial usage could be

H7	Partial usage related with benefits from information	Some evidence to reject H7	improved, results are not very robust, small data set, only used data from approvers (manager and finance)
H8	High usage related with high benefits from improved emergency handling (flexibility)	Good evidence to accept H8 (data is best for notification, less strong for information and communication though)	
H9	High usage related with high overall benefits	Good evidence to accept H9	Data best for approvers (finance and managers)

4.4 Requirements and Challenges

We did not see any noticeable differences between the different user groups with respect to requirements of the systems or its reported challenges (mismatch between requirements and actual system features and form factors). With only a very small number of actual users, our data set is too small for serious statistical interpretation. In the following, we summarize our observations.

Most often, users stated the limitations of screen and keyboard, as well as the limited range of applications as current obstacles. Usage and convenience were also mentioned, while the issues of privacy, cost, and security seemed to play smaller roles.

Most all of our interviewees mentioned their experiences with the set up and login procedures, as well as handling of the application. Typically, the questionnaires filled in by the respondents contained similar comments.

Most users reported problems with the usability, training and support of the system, as well as with the diversity of devices and networks. While some of this diversity was actually part of the trial system, and some of the cumbersome procedures to set up and to log into the application are due to company-internal security requirements and the attempt of the project team to balance these requirements with usability, the reported

difficulties can be seen as the major hurdle to actual system use at this point, providing us with some evidence to accept Hypothesis 12.

Overcoming the current obstacles with system use and user support, poses a significant opportunity to the company, given that our respondents also clearly saw the usefulness of the applications and signaled willingness to give them a(nother) try. The issue of adoption will have to be explored further, however. Table 6 summarizes our findings regarding requirements and form factors.

Table 6 - Findings Regarding Requirements and Form Factors (H10-12)

H	Expected results	Evidence?	Construct valid?
H10	Low usage related with high requirements of support	No evidence	Information regarding support requirements not included in questionnaire, came up during interviews
H11	High usage related with high requirements of usability	Some evidence that H11 can be accepted	
H12	Gap between requirements and form factors lowers overall benefits	Good evidence that H12 can be accepted (mostly anecdotal)	Many user comments support this hypotheses, need to improve empirical construct

5. Conclusions

Although our empirical survey is based on small numbers, we were able to obtain some interesting results, which we will use to further develop our framework.

5.1 Overall Benefits

Despite the limited experience with the wireless application, users are open to the new technology and realize the potential for productivity improvements.

The responses to our survey, however, indicate that rather than from providing another channel of automation and speeding up data input and reducing errors, the main benefits

of the wireless solution seem to come from improved flows of information, such as notification.

Relating the wireless applications to the available alternatives will help explain this finding. Given that enterprise applications have long been available to automate data processing and to support organizational workflow processes, it seems to be difficult for wireless systems to further improve operational efficiency. As one of the accounting approver told us, processing an approval request with the wireless application takes three times as long as using the regular desktop application. Lengthy login procedures, slower connections, and limited capabilities for navigation were cited as the reasons.

Consequently, we have to reject H13, and conclude that so far, the wireless application has not led to operational efficiency improvements, in terms of reduced processing times. Note that this concerns the time that it takes to process the request per se. The overall cycle time (overall time that elapses until a request is processed) could still be reduced, but this effect falls under "benefits from information" according to our research framework.

What was difficult, however, in the past, was to provide remote access to an enterprise application to employees and managers that were out of the office and therefore without access to a desktop computer. Delays or general delegation of tasks have been the results and workaround. Wireless applications promise to help keep employees and managers better informed about required activities and organizational events, even when out of the office (benefits from information). Several of our respondents confirmed this finding, and as one manager approver told us, "Today, I delegate all requests when I travel, but I would prefer to be notified and delegate on an ad-hoc basis." Interesting to note is that such benefits can come even from partial usage enabling the users to take some action remotely after being notified. Such action can then have wider implications, e.g., on the productivity of employees who are dependent on the decisions of a traveling manager. Requestors for example, expect to benefit from better access to the manager approvers, more of an indirect benefit in addition to improving the requestor's own productivity with the wireless application. Similarly, suppliers would benefit from being paid earlier as the receiving process is streamlined for the receivers. One respondent mentioned the indirect

impacts on the supplier relationships, which are very valuable for her environment. We have strong (albeit mostly anecdotal) evidence to accept H14.

In addition, the possibility to actually perform organizational tasks remotely and actively respond to emergencies as well as unexpected opportunities (in addition to merely being notified about a waiting task) can help improve organizational flexibility and agility. In one case, the timely response of an accounting approver has helped the organization win a large contract that depended on the approval as an internal procedure. Although this anecdote could be seen as a single occurrence and actual evidence is limited, similar situations are only a matter of time. We have no good way of measuring this kind of benefit so far, given the difficulties to assess opportunity cost and given the stochastic element involved. Still, we have some evidence to accept H15. Table 7 summarizes the findings regarding H13 to H15.

Table 7 - Findings regarding overall benefits from wireless applications (H13-15)

H	Expected results	Evidence?	Construct valid?
H13	Use of wireless applications results in improvements of operational efficiency.	Evidence to reject H13 (mostly anecdotal)	Need to improve the actual measurement of the different types of benefits
H14	Use of wireless applications results in more timely communication and information.	Good evidence to accept H14 (well supported by user comments)	
H15	Use of wireless applications results in improved flexibility and ability to handle emergency situations.	Some evidence to accept H15 (limited data, though)	Measurement of benefit difficult (opportunity cost, stochastic element)

5.2 Outlook

The procurement process is just one area of application; other areas possibly yield even more benefits, such as sales support, helpdesk functions, or general management.

The wireless application is strongly perceived as a complement rather than a replacement of the wired, traditional desktop-based purchasing application, explaining our finding that the impacts of automation (operational efficiency) are less strong than the impacts from improved information. Users see the benefits in combination and as an add-on to the existing systems.

Open questions remain. First, our sample size is very small and needs to be increased. We would also like to measure actual increases in productivity due to the use of the system, such as overall process cycle times etc.

We consider our study as a pilot to validate our research framework on a larger basis, taking into consideration the results reported in this paper. In particular, we need to develop a construct to measure the benefits and impacts of improved flexibility and robustness of the organization due to the use of wireless technology (e.g., opportunity cost from not being notified about urgent requests).

To improve and complement our framework from a user perspective, we have started to study adoption issues of mobile technologies and find out how relevant earlier studies are on the adoption of information systems in general. In addition, we also plan to investigate issues of wireless applications from a process and interorganizational perspective. We see strong synergies between the different components as they represent different perspectives: (1) economic and operational perspective, (2) a user acceptance perspective, and (3) an organizational dynamics perspective. Based on what we have found so far (1), the addition of components (2) and (3) are needed to complete our picture and to develop a more comprehensive and empirically sound framework to assess the value and success factors of wireless applications to support business processes.

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