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Abstract

In this paper, we propose a two-step framework to advance our knowledge of how to identify and evaluate opportunities presented by emerging information technologies (IT). As a first step, we match the features and limits of the IT innovation with the requirements of the application areas in question, typically on the business process level. As a second step, we sketch out guidelines to evaluate these windows of opportunity in a quantitative way. To further explain the framework and showcase its applicability, we provide a proof-of-concept case study, reporting on the application of wireless technologies to enhance an electronic procurement application at Motorola, Inc.

1. Introduction

Despite a wealth of research on the impact and value of information technology (IT) investments, poor estimations of the impact and value of new technologies still tend to be the norm rather than the exception. Bill Gates is said to have observed, "The impact of technology is generally overestimated in three years and underestimated in 10 years." The recent phenomenon of over inflated stock prices of companies that were somehow based on or connected with emerging Internet technologies constitute a clear indicator for such a development. Ever since the so-called Internet-bubble burst stripping many investors of their money, employees of their jobs, and entrepreneurs of their companies, market observers have been searching to discover the "next big thing." Mobile technologies are one of the areas that have received particular attention, and chances are that the circle of overestimation/underestimation is just beginning anew.

Rather than providing an overview of usage scenarios for mobile technologies in organizations (see for example Tarasewich et al. 2002 for such an overview), we intend to develop a more general, structured framework of how to assess the value of emerging technologies. We propose a two-staged model that can help identify application areas for emerging technologies and allow for a realistic evaluation of their economic benefits. With our framework, we hope to contribute to breaking the circle of overestimation/underestimation of the value of new technologies, as well as to provide a tool that can ultimately help business managers deploy IT in a more targeted way.

The structure of the paper is as follows. We begin with an overview of earlier research on IT value, and point out missing elements to identify and assess the opportunities for the application of an emerging technology. We then propose a framework to close the gap, and demonstrate its applicability with a real-life case, the use of wireless technology to enhance an electronic procurement system. Finally, we point out a number of issues that need to be addressed in further studies to complete the framework.

2. Literature Review

Much research has been undertaken to assess the value and impact of information technology (IT) and the investments that are necessary for its deployment. Mirroring the fact that this topic is very rich and multi-faceted, a number of areas have been at the focus of attention. One stream of research discusses the advantages and disadvantages of evaluating IT investments at different levels, such as the economy and industry level (Loveman 1994), firm level (Mahmood & Mann 1993), process level (Mooney et al. 1996) and from the perspective of the individual (Davis 1989). Others emphasize the importance of including complementary factors and taking a holistic approach, versus isolating the impacts of technology and

focusing on IT alone (Teece 1987, Barua et al. 2001). Similarly, there is a distinction between tangible benefits and intangible factors (Brynjolfsson & Hitt 1996). Finally, several researchers have pointed out the relevance of expected and potential value versus realized impacts, which takes into consideration possible inhibitors of IT success (Davern & Kauffman 2000, Chircu & Kauffman 2000).

There seems to be some consensus that, ideally, the assessment of IT impact and value should be at the level of the implementation (Barua et al. 1995), and that it is desirable to take into consideration as many contingency factors as possible, be they related directly or indirectly to the IT system of study (Mooney et al. 1996). Given the complexities of organizational structures and interrelated factors it comes at no surprise that such a comprehensive approach is a very difficult undertaking and has to be based on a clear understanding of the technologies, of the areas of application and of their, often unanticipated, implications and consequences. As a result, the use of some of the more sophisticated methods to evaluate IT might be problematic in the context of innovative IT applications, as the assessment of the value and further reaching impacts require a certain learning process to have taken place.

One additional point is worth mentioning. With the exception of Bennett & Weill (1997) who explored different uses of electronic messaging infrastructures, very little attention has been paid to the question of how to identify areas of application for emerging technologies and the related question of how to select starting points of deployment.

3. Evaluation Framework

Our quest to identify and evaluate areas of application for a specific, emerging technology can draw on previous research to assess IT value. Significant gaps remain, though, which can for the most part be attributed to different research perspectives.

First, much of the earlier research described above has essentially focused on the question of whether or not to deploy IT at all. We would rather like to address the question, however, what type of IT to select in a particular situation. Moreover, we are interested in identifying areas of application for a specific type of technology, which reverses the research perspective to some extent. Our focus is relevant for IT managers who observe the emergence of IT innovations, as has been the case frequently, in particular in recent years.

In order to "catch the boat" and benefit from new technologies, but at the same time avoid the development and deployment of expensive, yet useless toys, a careful assessment of the opportunities and limits is essential. So, we propose a two-staged model to answer the questions of "What are possible areas of deployment for a specific technology?" and "Where should we start?" The two-staged model is depicted in Figure 1.

As a first step, we need to find out about the characteristics of the new technology, and where it could be applied within the organization. We chose to conduct a qualitative analysis to match the characteristics of the emerging technology with respect to its potentials and limits with the requirements of the organization and underlying processes. In line with the postulation to perform an assessment of IT value at the level of the actual implementation, we focus our attention on the level of the business process. The results of this first step are termed "Windows of Opportunity" and serve as the input for the second part of the analysis.

As a second step of our framework, we need to answer the questions of "how much can be gained from the new technology" and "whether an organization should invest in it." Consequently, a quantitative element is added to the analysis. For each of the windows of opportunity that were identified during the first part, situation and context-specific variables would have to be evaluated. The result is a measure of economic value that will help a manager identify the areas where the deployment of the new technology promises to be most beneficial.

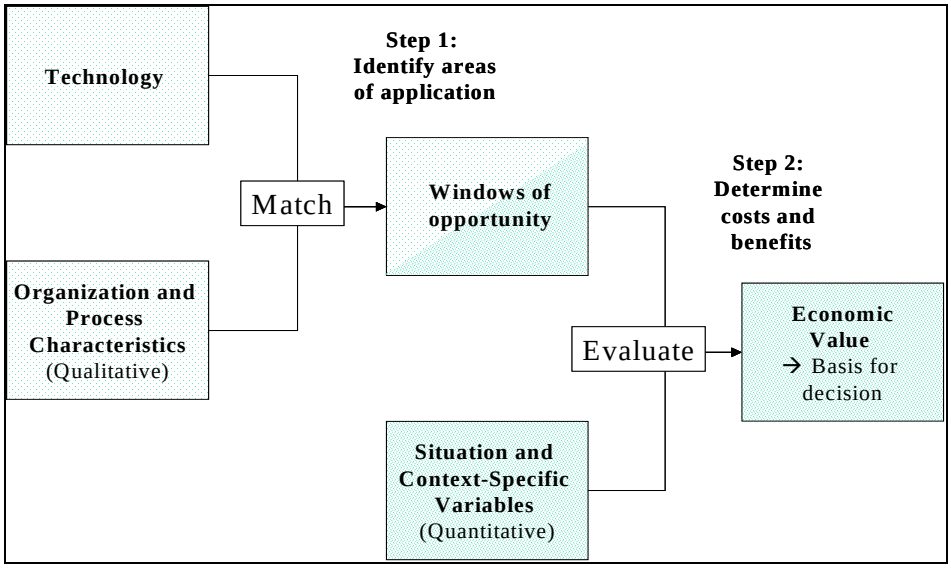

Figure 1: *Evaluation Framework (Overview)*

The consideration of context and situation-specific variables is essentially in line with the postulation of assessing the value of IT holistically, that is, viewing technology embedded into a larger system. Accounting for the fact that we want to develop a framework that is most of all applicable to emerging technologies, the assessment of complementary factors receives comparatively less emphasis, though, reflecting the early position on the learning curve. We also want to point out that the result of our second stage, the economic value of a technology, to some extent is

in line with the notion of potential or expected value, the significance of which has been pointed out by Davern, Kauffman (2000), and Chircu and Kauffman (2000).

In the next sections, we use the proof of concept model to explain the model in more detail.

4. Proof of Concept

We will now elaborate further on the evaluation framework and demonstrate its applicability to wireless technologies to enhance business-oriented electronic commerce applications. Despite our narrow focus to demonstrate the concept, we see the framework to be applicable on a broader basis, beyond procurement processes and possibly also beyond wireless applications.

Our proof of concept is based on a project that we conducted in collaboration with Motorola, Inc., where the successful implementation of an electronic procurement system lead to considerations to enhance its functionality and reach with the application of emerging, wireless technologies. Such a step would allow managers, for example, to perform the approval of requisitions, especially urgent ones, with a two-way pager or cell phone. Further cycle time reductions and increased productivity beyond what has already been achieved with the electronic procurement solution are the expected results.

The application of electronic commerce technologies to support business processes within and between organizations has brought numerous benefits, including transaction cost and cycle time reductions, improved data transparency, and streamlined processes (Saloner, Spence 2002). One area that has gained significant attention is the use of Internet-based applications to support and automate non-production procurement processes (Fitzgerald 2000). During the late 1990s, a number of organizations started to implement applications that would allow employees to order operational supplies from their desktops without having to go through the central purchasing department or to fill out a large number of paper forms. Purchasing requests are submitted electronically by an end-user, routed automatically for approval according to organization-internal business rules, to automatically result in a purchase order that is then sent to a supplier for fulfillment. To date, most implementations have been undertaken in large organizations, involving hundreds, often thousands of users, and large numbers of suppliers and business rules. Reported results are typically significant although they do not come easy, given the complexity of most projects often leading to unanticipated hurdles.

Some of the limitations that remain can be attributed to the technology that is being used, rather than organizational issues, and could possibly be resolved by enhancing the current solutions with appropriate technologies. Traditionally, business applications are accessed from workstations or personal computers stationed in a corporate or home office. Situations where employees are away from their desks

without access to a computer or dialup connection, e.g., while traveling, typically also preclude access to these applications. As a result, email-messages, notifications and requests, e.g., to approve a purchasing requisition, are delayed until desktop access is regained. The implications in terms of cost and productivity losses can be significant and possibly ripple through larger parts of the organization.

Consider the case where the purchase of a computer for a new hire is delayed because the approval manager has left for an offsite meeting and is, thus, away from his desk and out of reach. For such situations, increasing the accessibility of the applications beyond desktop computers could prove beneficial. Wireless technologies feature just the required functionality as they could provide an additional access channel. Using an Internet-enabled cellular phone or handheld device, users would log into the application by using a personal ID, and then navigate through a simplified menu by using the keypad of the device and perform the required tasks from (almost) anywhere at any time.

The areas of application need to be assessed carefully, however. Wireless technologies cannot be seen as a panacea or full substitute to "traditional" electronic commerce systems, as they have their own limitations, while at the same time requiring significant investments.

4.1 Technology Assessment – Identification of Opportunities

In order to identify areas of application for wireless technologies, we need to obtain a good understanding of the business requirements, as well as of the opportunities presented by the emerging technologies. In the following, we first describe a typical business-to-business electronic commerce application, as it is represented by Motorola's electronic procurement system. A brief outline of the major components is followed by a discussion of the benefits and limits of the system. Second, we turn to emerging, wireless technologies, and provide an overview of the possible benefits and limits, as they are relevant in the context of our representative electronic commerce system.

4.1.1 Benefits and Limits of Electronic Procurement Applications

In 1997, Motorola embarked on a major project to improve the organization of its non-production procurement processes on a corporate level. At the time, non-production procurement at Motorola was highly decentralized with diverse business routines and multiple procedures throughout the different parts of the corporation, resulting in a situation where the company was not really able to take advantage of its combined annual non-production spend of several billion dollars. In addition, most processes were paper-based resulting in long cycle times, frequent errors, and costly double-data entries.

The efforts to re-organize the process concentrated on three, closely interrelated areas. On the one hand, the project team started to apply strategic sourcing concepts as they are typically used in strategic, production-oriented procurement to the non-production area. Commodity managers were appointed to analyze purchasing patterns within and across organizational units, to assess supplier performance, and to identify opportunities for corporate-wide supplier contracts. On the other hand, the project team made an effort to streamline business procedures and establish corporate wide standards, in particular for approval routines. The third element of the integrated approach was the application of an electronic commerce system to automate standard buying processes and to capture corporate procurement information. The system provides a browser interface to employees and enables them to purchase items from pre-defined electronic catalogs and have their requests routed to higher-level managers for approval according to built-in business rules. Approved requests automatically generate purchase orders that are sent out to the suppliers. Figure 2 provides an overview of the system architecture.

In combination with the organizational changes, the IT-system provides a number of benefits. For once, it frees purchasing personnel from routine, operational tasks, as end-users can now perform purchasing requests directly from their desktops, instead of submitting forms to the purchasing group. Instead of a procurement manager, it is the system that checks for compliance with corporate buying standards and automatically notifies approval managers, and other areas involved such as receiving, and accounting personnel. As a result from channeling the users to preferred suppliers, purchases under pre-negotiated contracts have increased resulting in an overall higher leverage of Motorola's buying power, as well as improved availability of items. The centralized system also facilitates the analysis of spending patterns and supplier performance on a corporate-wide basis, in ways that were not feasible before. In addition, the elimination of paper-based procedures resulted in a reduction of cycle-time from weeks to a few days.

Motorola's electronic procurement system is comparable to many projects initiated elsewhere, mostly in larger corporations, throughout the late 1990s, in terms of scope and benefits, but also in terms of complications. Similar to the experiences at other organizations, the implementation of a centralized front-end application at Motorola turned out to be quite complex, as were the changes that this implementation brought with it. In order to establish corporate wide standards and business routines a heterogeneous set of systems and procedures had to be integrated. Technical hurdles had to be overcome, such as the integration of supplier data into a single, aggregated online catalog or linking the desktop-application with backend enterprise data systems. Organizational challenges included end-user training, as well as convincing managers that they had to give up "their" suppliers and oftentimes long-established business routines.

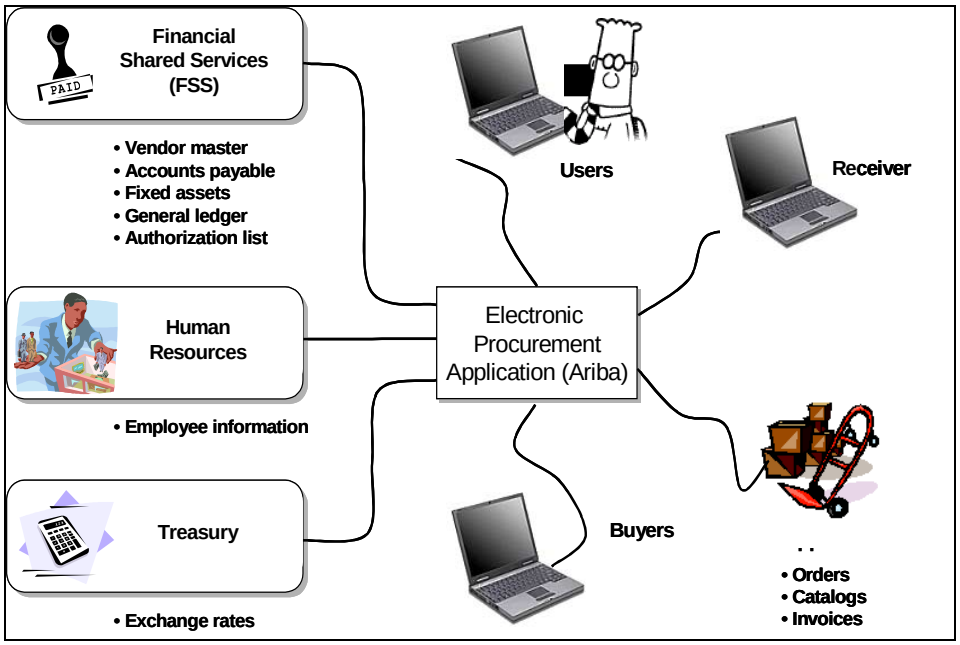

Figure 2: *Architecture of Motorola's Integrated Electronic Procurement System*

One challenge that can possibly be addressed with wireless technologies is system access (Figure 3). The project team feels that significant inefficiencies are still part of the process. Examples include delays in the approval process when a manager in charge is out of the office and cannot access the procurement application from a desktop computer, or urgent requests for equipment as they might occur out in the field when a trip to the next hardware store is significantly shorter and more convenient than returning to the office and booting a desktop machine. Increasing the reach of the application to include mobile access promises productivity improvements through further cycle time reductions, and increases of overall system usage and process compliance.

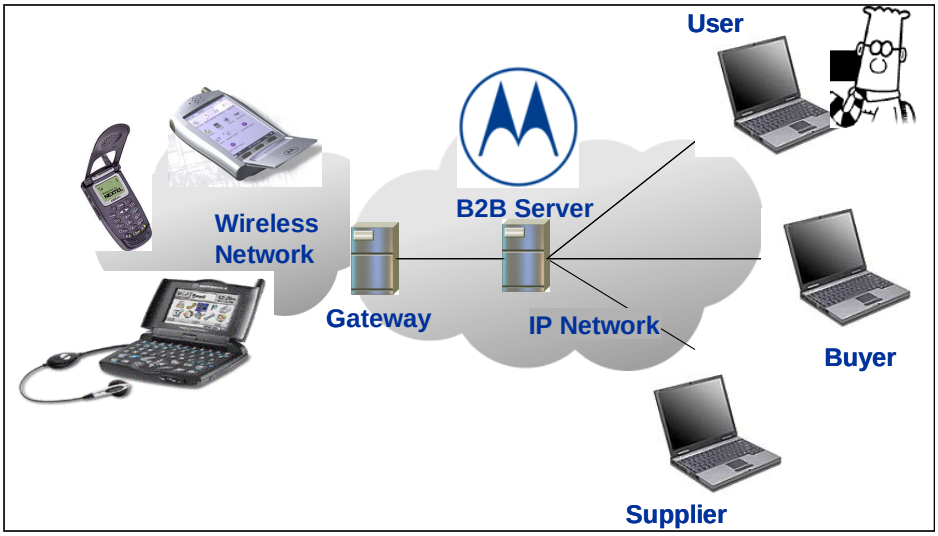

Figure 3: *Infrastructure to Enable Wireless Access to Business Applications*

4.1.2 Benefits and Limits of Wireless Technologies in Business-to-Business Settings

To this date, it is unclear what impact wireless technology will have on business processes and organizations. Although the penetration of wireless devices, including cellular phones, two-way pagers, PDAs and other handheld devices, is already quite impressive and continues to grow (see text box below), the number of commercial applications is low, and most of the usage occurs on an individual level.

Wireless Penetration:

- An estimated 108 million mobile phones in the U.S. as of the end of 2000, with another 25 million expected by the end of 2001. (source: Morgan Stanley, January 2001)
- Currently 12 million data-enabled phones available in the U.S., with 112 million expected by the end of 2004 (source: IDC, Phone.com, December 2000)
- 1.3 billion wireless data subscribers worldwide in next four years (source: Cahners In-Stat, September 2000)
- 18 million PDAs and mobile phones bundled with J2ME will be sold by end of calendar year 2001 (source: Sun Microsystems)
- By 2003, more than a billion cellular subscribers are expected to create a $83 billion marketplace for wireless services (source: Yankee Group, February 2000)

In other words, wireless devices (in particular cellular phones) are most often used for inter-personal communication, replacing a regular telephone, rather than to access information systems or to transmit data, which would be comparable to using a personal computer. A number of applications are available, though, as cellular phones and two-way pagers provide access to stock market data, and allow trading assets, checking weather reports, purchasing theater tickets, or sending short messages to other phones and computers. Using an Internet-enabled cellular phone or handheld device, users log into an application by using a personal ID, and then navigate through a simplified menu by using the keypad of the device.

To this date, however, and particular when comparing the situation in the United States to Japan or even Europe, the volume of data traffic over cellular devices is only a fraction of voice traffic, and, again, for the most part concentrated on personal and consumer-oriented applications. When it comes to business-oriented mobile applications, most organizations are still waiting for the "killer-application" that would propel the use of wireless technology, similar to the way that email or the World Wide Web helped spread the Internet.

Returning to our two-step approach to assess the application for mobile commerce in inter-organizational settings (see Figure 1), we want to single out the idiosyncrasies of the new technology in relation to traditional electronic commerce systems. What makes mobile applications special? How is the new technology similar and how is it different from the technology used in "traditional" business-oriented electronic commerce systems? What are possible areas of application? Similar to other innovations, we expect opportunities to complement existing systems, rather than to substitute them, at least in the shorter term.

The *opportunities* provided by wireless devices, as compared to stationary computers and wired laptops include: wider reach of business applications as access is not confined to an office or desk; faster access to applications in cases where booting up a computer takes a long time; and advantages from integrating data and voice communication into one device. In addition, the simplicity of the devices and the fact that "they are not a computer," might increase acceptance where employees feel uncomfortable with using a regular desktop PC. At the same time, wireless devices are typically also cheaper than regular computers.

Limits of the technology restrict the complexity of the information that can be displayed, which often results in complicated usage procedures and deep navigation structures. Reasons for these limits are small screens, limited graphical functionality, and a comparatively small number of keys. Further limits restrict the amount of data that can be processed wirelessly: limited bandwidth and performance, restricted signal availability, and limited on-device storage space. Unresolved security and standardization issues, as well as per-minute, and often very complex, fee structures that are different from how Internet-access is typically priced, can pose additional hurdles.

4.1.3 Windows of Opportunities

Based on these opportunities and limits, we recommend their use in situations and processes that are characterized by one or several of the following statements:

- Task is urgent and typically triggered by notification (push, rather than pull)
- Task is a simple transaction or routine process
- Task is a simple decision process, where the amount of information to be processed is limited
- Requirement to navigate through application menu structure is low and the task does not require the use of multiple applications or databases
- Communication process does not require access to large files or complex graphics
- Situation allows or even requires to combine both voice and data communication
- Data security is not a major issue

After having identified the general areas of application for wireless access, we break down the processes in question, to identify specific subtasks that are suited for full or partial support. The appendix provides an example of how this breakdown could be done, focusing on a request for approval.

In procurement, wireless systems could provide full support for the following processes:

- Creation and submission of simple purchase requests
- Processing of simple approval requests
- Delegation of approval authority
- Status checks (tracking) of orders and shipments
- Delivery confirmation (receiving) and payment release

Additional areas of application can be identified if we include situations where wireless technology provides a complement rather than a complete substitute to perform a task with a wired application. In such situations, mobile commerce supports a task *partially* and enables a manager to "do something" until desktop access is regained. An approval manager, for example, who is unwilling to delegate general approval authority while away from the office, could review a complex request briefly on a high level, and then hand over approval rights to a trusted colleague on an ad hoc-basis, together with detailed instructions, given over the phone. Complex decisions that are as such too complex to be performed with a handheld device only could be performed in part, e.g., by contacting sources of information to confirm supplier quotes, and by doing or delegating "as much as

possible" while on the road. In such situations, access to information of how to contact colleagues and fellow employees, business partners, and third parties, and how to access additional data sources proves essential. The biggest advantage of the wireless systems is probably their ability to integrate data with voice communication into one device.

In this context, the task of identifying opportunities for wireless-commerce opportunities can be facilitated if we include additional parameters into the analysis, such as product complexity, the degree of organizational centralization and vertical integration, as well as user characteristics and external pressures. All other things equal, we assume that:

- Procurement processes of complex products lend themselves to partial support by wireless applications, while the procurement of simple products can more often be supported in full.
- Decentralized organizations and constructs of virtual organization where independent units collaborate on a specific project, typically feature more situations where requests are urgent, and manager are out of the office, compared to centralized organization structures.
- Organizational groups that are familiar with the use of technology, in particular wireless devices, will be more comfortable with using wireless applications in new contexts, and acceptance levels will be higher than in organizations where users are not very technology savvy.
- External pressure, e.g. in very competitive markets and fast changing business environments, will increase the need to improve productivity, and thus create an environment that is favorable for the application of wireless applications to enhance existing systems.

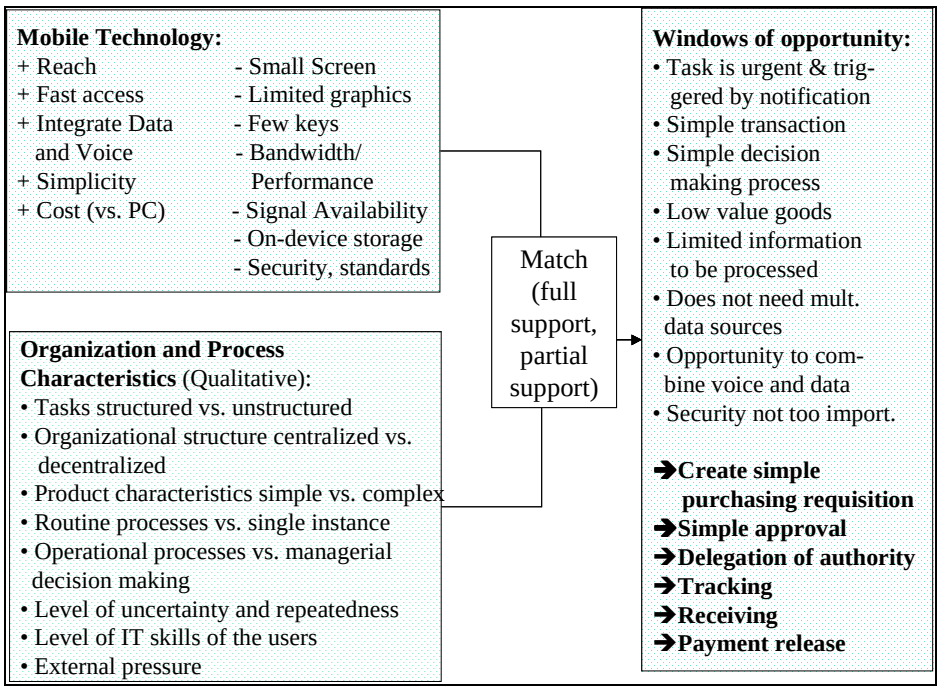

Figure 4: *Step 1: Identify Windows of Opportunity for Wireless Technologies to Support Purchasing Processes*

The list is not exhaustive, but can serve as a good start (Figure 4 summarizes our findings). Our understanding about the opportunities and limits of wireless devices allows us to analyze individual business processes and their subtasks and to address the question of how well they could be supported by wireless applications, either in part or to full extent.

4.2 Evaluating the Opportunities

The guidelines that we introduced help identify situations where the application of wireless technologies is potentially beneficial. In other words, they help to determine which processes and sub-tasks, product categories, and organizational groups are the best candidates for full or partial support by wireless applications. After having identified such opportunities, an economic evaluation has to be performed to quantify the benefits and efforts to implement the solution.

Quantifiable parameters include user characteristics, such as frequency of system use, time spent out of the office, and urgency.

- *Frequency of system use*. If a user accesses the electronic procurement solution only very infrequently, there is probably no need to extend the wireless

solution to him or her. Denying wireless (and therefore continuous) access to frequent users, however, might result in significant delays in situations where the capacity of the individual to process requests is reached during peak periods. The application of queuing models as they are used elsewhere to optimize manufacturing schedules, can help demonstrate these effects clearly, and provide evidence for the benefits of smoothing out the peaks. In this case, frequency of use corresponds with the number of tasks in a queue.

- *Percentage of time spent out of reach of traditional applications*. The percentage of time that a user is out of reach for traditional applications can be interpreted as delays in the queue, if we assume that during this time, no requests are being processed. We would assume that, other things equal, only users that spent a significant amount of time out of their offices would qualify for the use of the wireless solution. Otherwise the investments required to equip these users with an additional access channel will be hard to justify.
- *Percentage of requests (or tasks) that can be considered urgent*. Urgency is another factor that we want to consider, although it is somewhat harder to quantify than frequency and out-of-office time. A possible proxy for urgency is the loss in productivity that occurs elsewhere in the organization if a request is not processed promptly (e.g., a new hire sits idle without office desktop). Another consequence would be the fines that have to be paid if projects are not completed in time.

The parameters can be considered as mutually enforcing. In cases where two or even all three factors are high (e.g., high frequency of system use and significant out-of-office time), we will probably more often be able to justify the application of wireless access on economic grounds (reduced cycle time, increased productivity), than if only one variable is high.

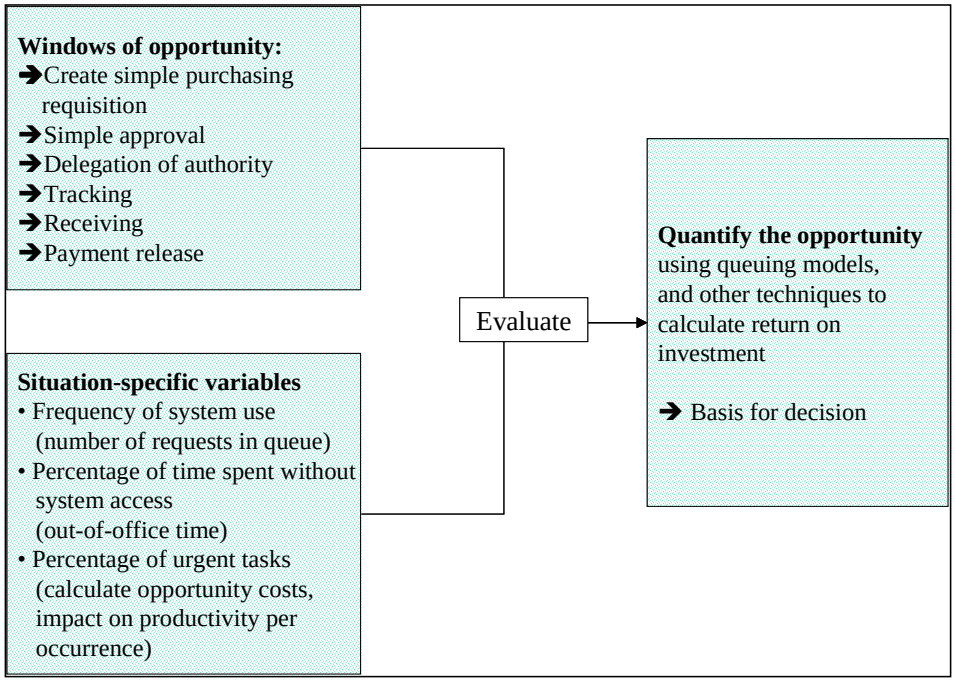

Figure 5: *Step 2: Evaluate M-Commerce Opportunities*

In addition and to ease the task of quantifying the variables somewhat, we can also relate the quantitative variables with some of the qualitative characteristics that we derived earlier to gain insight regarding the potential benefits. Figure 5 depicts an example, pairing process complexity and out-of-office time. Interesting areas for mobile commerce would be sections II and IV, while section I is probably less relevant.

Additional parameters can play a role, depending on the individual implementation or application. Given the limitations of a wireless device, for example, the menu structure and tasks that can be performed with it will have to be kept simple, as pointed out above. As a result, we expect situations where the task to approve a purchasing request can actually be performed faster than by using a traditional, desktop-based system. On the other hand, however, the use of an addition channel and new device will probably require significant user training and a new support infrastructure focused on wireless access to applications.

Figure 6 summarizes the variables that we considered relevant to evaluate the application of mobile commerce to support business processes.

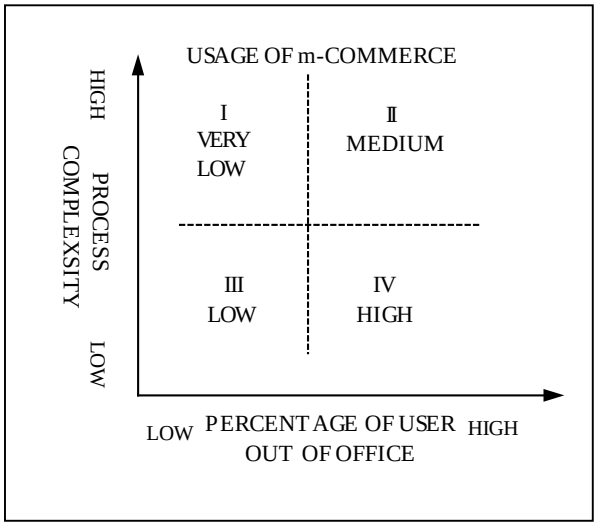

Figure 6: Process Complexity vs. Out of Office Time

5. Outlook

So far, our project has resulted in an "educated guess" about the parameters and issues that are relevant to assess the benefits of wireless solutions to improve business processes. Our considerations are based on input that we received from the project team of one company and on the application of our own knowledge on electronic procurement applications, organizational processes and wireless technologies. Our area of interest has been very narrow, as we focused on the well-structured family of non-production procurement processes and on the extension of so-called desktop procurement systems with wireless access. While our analysis has not brought about novel areas scenarios of application for wireless technologies (and did not intend to), it is novel in its attempt of identifying the opportunities for wireless technologies in a more structured way than has been done in the past, and in providing a basis for a realistic evaluation of these opportunities.

More work is necessary, though, to refine the tool and finally apply it in a real-life setting. Many questions remain open. Did we include the right parameters? Which parameters did we omit that should have been included? How relevant are our results? How valid is our underlying conceptual model? How applicable are our considerations to different processes, situations, and other technologies?

During the next phases of the research project, we plan to validate our preliminary findings with the corporate partner. We also plan to refine and test the tool by collecting real-life data in the form of user interviews and actual system usage. Simulations based on the statistical data will help us test the applicability of queuing models in this context. Finally, we hope to be able to peg a number with

respect to the economic benefits of the solutions in the case of a specific corporation.

Our project will bring us closer to answering a question, such as "what makes a technology special and how should we manage it? In this case, we looked at wireless applications and their role to ultimately enable ubiquitous commerce.

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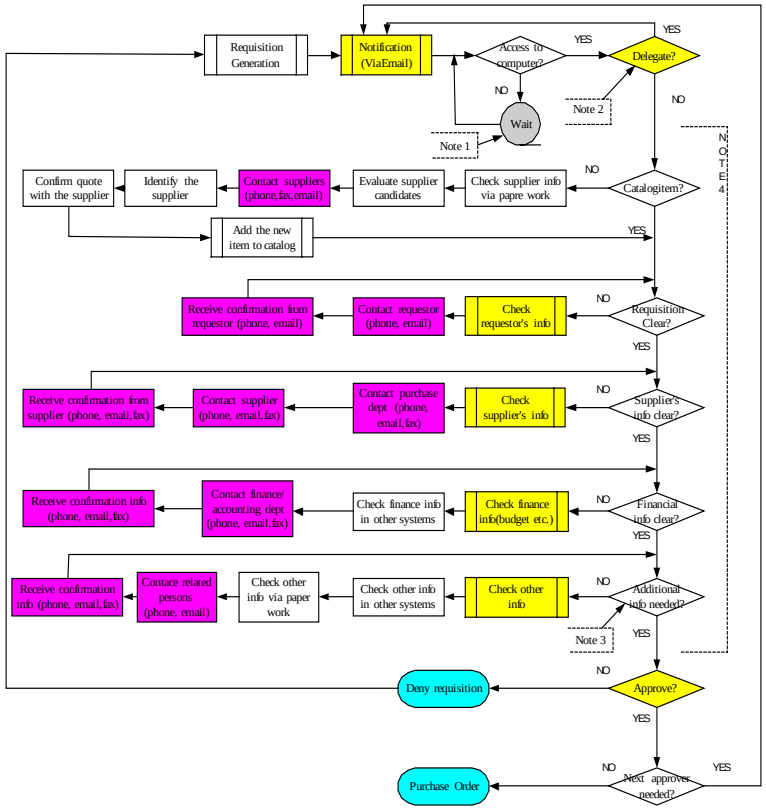
Appendix

In the following, we describe our concept of analyzing a business process to answer the question of how well it can be supported by wireless applications. We use the process "approval of a purchasing request" to demonstrate the concept, rather than to provide a full analysis, which would have to be validated in a real-life setting.

In a first step, we break down a process into subtasks and depict the interrelationships with a flow chart (Appendix-Figure 1).

Appendix-Figure 1: *Break-Down of Approval Process into Subtasks*



Note: Standard flowcharting symbols are used in this diagram.

Wireless Process:

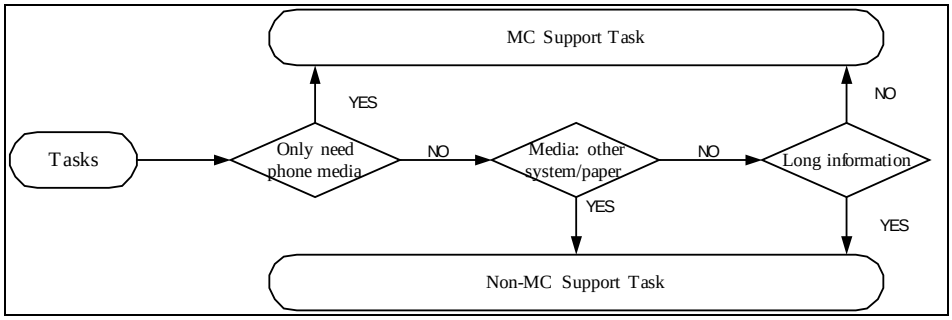
We then analyze each subtask according to its ability to be supported in part or fully by wireless technology (Appendix-Table 1).

Appendix-Table 1: *Subtask Analysis*

Task	Medium	Volume of Data	Structured Level	Decision Complexity	Mobile Sup
Notification	Email/Phone	Low	High	No	Full
Delegation	Email/Phone	Medium	High	Low	Full
Check requestor's info	EP	Low	High	Low	Full
Check supplier's info via EP	EP	Low	High	Low	Full
Check financial information (1)	EP	Low	High	Medium	Full
Deny	EP	Low	High	Low	Full
Approve	EP	Low	High	Low	Full
Contact supplier	Phone/Email/Fax	Low to high	Low	Low	Partial (phone, sin
Contact requestor	Phone/Email	Low to high	Low	Medium	Partial (phone, sin
Receive confirm form requestor	Phone/Email	Low to high	Low	Low	Partial (phone, sin
Contact purchase dept	Phone/Email	Low to high	Low	Medium	Partial (phone, sin
Receive confirm form supplier	Phone/Email/Fax	Medium	Medium	Medium	Partial (phone, sin
Contact finance/accounting dept	Phone/Email	Medium	Low	Medium	Partial (phone, sin
Check supplier's info via paper work	Paper	High	Low	High	Non
Evaluation supplier candidate	EP/paper	High	High	High	Non
Identify the supplier	——	High	Low	High	Non
Confirm quote with the supplier	Email/Fax/Paper	High	High	High	Non
Add new item to the catalog	EP	High	High	Low	Non

The criteria we use to perform this analysis include: the communication medium that has been used traditionally (email, phone, paper, face to face), volume of data required to perform the task (high, medium, low), level of task structure (high, medium, low), and decision complexity (high, medium, low). Our decision criteria are depicted in Appendix-Figure 2).

Appendix-Figure 2: *Suggested Framework to Identify Tasks That Can Be Supported With Mobile Commerce (MC)*



Full support can be given in cases where the traditional medium of communication is email or phone, the volume of data required to perform the process is low, the level of structure is high, and the complexity of the decision is low. Partial support is possible for subtasks that are traditionally done by email, phone, or fax, and where the complexity of the decision is low to medium, and the complexity of the decision is low to medium. Tasks that traditionally rely on large volumes of data to be processed, use paper forms to transfer information, and involve complex decisions might not be suited well for wireless support.

Finer breakdown schemes might be adequate to analyze an individual situation. Additional of criteria to be considered include characteristics of the products in question (complexity and value), the underlying organizational structure (centralized vs. decentralized), and some characteristics of the potential user groups (e.g., IT skills). As mentioned in the text, environmental factors might also play a role, such as market pressure, uncertainty, or the regulative structure.