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THE VALUE OF MOBILITY FOR BUSINESS PROCESS PERFORMANCE: EVIDENCE FROM SWEDEN AND THE NETHERLANDS

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ABSTRACT

Identifying and assessing the benefits of mobile technology in a business context is often problematic. In this paper we start from the position that the benefits of mobile technology are hard to quantify in isolation, and that the unit of analysis to identify value should be the business process. An exploratory case study approach is used to identify the benefits of mobile technology at the level of the business process. We discuss one case from Sweden (vehicle dispatching) and one case from the Netherlands (mobile parking). We illustrate that benefits are contingent to the difficulty of coordinating mobile actors. Next, the value of mobility is contingent to the costs of not *being able to coordinate during the period that the actors are difficult to reach. It is also related to the costs of available* substitutes *for mobile technology in a business process.*

1. INTRODUCTION

Two important novel technology success stories over the last decade have been the Internet and the mobile phone. Development and spread of these technologies have been rapid, and this development has over time resulted in substantial and sometimes unforeseen changes in consumer behaviour. Lately, interest has grown in applying mobile technology not only in consumer markets but also in business markets. Because of this, the linkage between mobile technology usage and business performance improvement has become an issue of practical concern.

Companies with an interest in selling mobile technology and services provide numerous success stories on actual business benefits (the so-called "killer applications"). While these stories are useful in many ways, they also tend to distort our understanding of the linkage between mobile applications and actual performance improvement. As most of them are vendor and product-biased, it is quite understandable that the benefits are overestimated and the drawbacks underestimated. How organizations can adopt and deploy these technologies to create business value remains an issue which has seen little rigorous study (Kristoffersen et al., 2000).

In this paper we are interested in exploring the linkages between the usage of mobile technology and the actual improvement in business performance. We take the position that the benefits of mobile technology are hard to quantify in isolation, and that the unit of analysis to identify value should be the *business process*. The purpose of the research described in this paper is to explore the benefits of mobile technology at the level of the business process.

To meet the research objective, the project has employed the case study method, combined with a literature review and expert sessions. The methodology used is explorative in nature, and has sought to identify important constructs and relationships between them. In this paper, we report on the conceptual and empirical study, and present the findings in the form of three generic propositions (c.f. Yin, 1994).

The paper is structured as follows. First, we discuss the research to date on mobility, in a search to identify what it is that makes mobile technology useful in a business setting. We then seek to link these findings to the literature on business process improvement. This eventually results in a conceptual framework that we used as a venture point for our case study research. Two of the cases are described in section three. We also expand our study design in this section. In section four, we discuss these cases and derive the propositions. Finally, we discuss the limitations of our study and suggest directions for further research.

2. MOBILE BUSINESS PROCESSES

2.1. Mobility

Research on mobile technology in an information systems (IS) setting has been very limited, and has - to the best of our knowledge – only lately appeared in major IS journals and conferences. A number of recent publications about mobile technology focus specifically on application development (Mennecke & Strader 2001; Eklund & Pessi 2001; Varshney & Vetter, 2001) and marketing strategies (Kannan et al, 2001). These papers reflect the increasing interest of IS academics in mobile technology, but they do not specifically deal with the use of mobile technology in business markets. Therefore, they will not be covered here.

This is not to say that the implications of mobile technology in a business environment have gone completely unnoticed. A few authors have focused on the *mobility* of the users, and how mobile technology can improve this mobility. For example, there are different types of mobility in performing music. Both a marching band and a street musician require mobility to perform. Yet the former plays while moving whereas the latter plays at different locations. Kristoffersen et al. (2000) distinguish between three different types of mobility, namely *travelling*, *wandering* and *visiting*. Depending on the required mobility, different technologies will support activities in different ways. Another approach, presented by Abraham (2001), describes two main functions of enterprise mobile computing: *synchronization* and *information access*. This classification is targeted towards the attributes of communication.

Mobility is an ambiguous concept which proves difficult to define in a meaningful way (Kristoffersen et al., 2000). One approach to capture the concept of mobility is to look at some of its attributes. The removal of *geographical constraints* has been identified as an important part of mobility (Abowd et al, 1997). Location theory emphasizes geography as a factor for location decisions and has been used fruitfully to describe the role of location-based mobile services (Mennecke & Strader 2001). Distance is therefore a major aspect when studying mobility.

Another attribute of mobility is derived from its *temporal* characteristics. Mobility enables performance independently of time. It allows continuity of a certain activity avoiding time interruptions that would, otherwise, appear. This fact relates to the possibility of information access whenever you need it, often referred to as connectivity.

2.2. Business process performance

The business value of mobile technology –like other applications of information technology– is typically hard to evaluate in isolation. There is general consensus that the value needs to be assessed in conjunction with the *business process* that is affected or enabled by the technology (Davenport & Short, 1990; Davenport, 1993).

The concept of business process has been used in a large number of contexts and for far different purposes. Several authors have developed definitions of business processes (Davenport & Short, 1990; Davenport, 1993; Hammer & Champy, 1993; Melan, 1992; Pall, 1988). We adopted the well-known definition of Davenport (1993) that a business process is a specific ordering of work activities across time and place, with a beginning, an end, and clearly identified inputs and outputs (p. 5). Business processes have different degrees of complexity (Fiedler et al, 1995), and typically cross departmental boundaries and even organisations (Seibt et al., 1997).

An underlying assumption often adopted is that business processes can be improved through the adoption and integration of new technology (see Hammer & Champy, 1993 for strong views on this topic). Indeed, a number of measurements and indicators connected to the performance of business processes have been identified in former research efforts. For example, the EU Cebusnet project distinguishes between 'generic' performance indicators and 'dedicated' ones. Dedicated indicators are closely connected to specific business processes whereas generic can be generalized along a larger number of processes. Some of the generic indicators identified in the project are *customer satisfaction*, *effectiveness*, *efficiency*, *lead-time* and *flexibility* (Seibt et al. 1997).

A research framework based on the elements described above was developed to guide the field study and the data collection of this study, cf. Yin (1994, p. 28). This „blueprint" for our case studies is depicted in Figure 1. The diagram expresses the notion that both business processes and mobile technology together determine the benefits that are derived from mobile technology. These benefits, in turn, may impact business process performance.

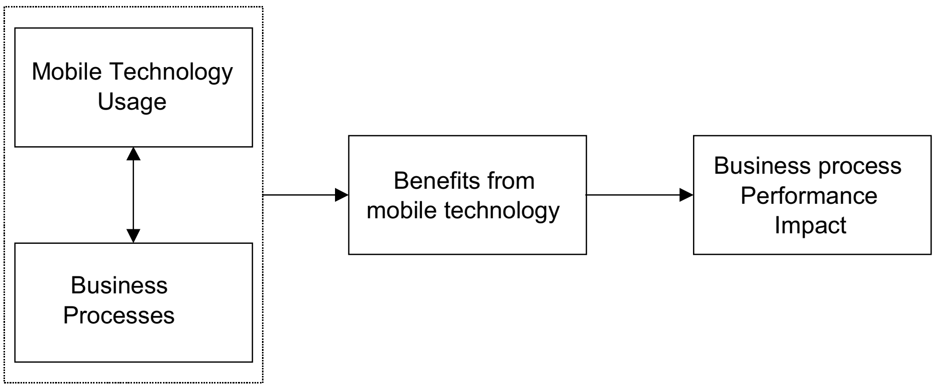

Figure 1 Preliminary research framework used to study the cases

3. FIELD STUDY

3.1 Study Design

A multiple case study was adopted to further explore the relationships between mobile application usage and business process performance (cf. Yin, 1994). Specifically, we selected business processes that met two primary criteria: (1) proven mobile technology was demonstrably used, and (2) the technology was used in the core of the business process, not in the peripheral parts.

Eventually, we selected three cases for our study. It is fair to say that in the final selection, motivations of site accessibility also played a significant role. A great deal of mobile business processes we identified were either (1) in a very early stage of the life cycle, (2) abandoned prematurely, or (3) considered too confidential by the companies involved. A significant amount of our time went into reviewing candidate business processes that were eventually discarded because they looked promising but after close inspection did not meet our requirements.

The study used graphical methods for describing the business processes studied. Modeling has become a useful method for business process analysis, especially for studying cross-departmental and cross-organisational processes (Steneskog et al, 1996). There are a large number of methods to describe different aspects of business processes, usually borrowed from related areas such as IS system design, manufacturing, architecture, engineering, etc. P-Graphs is one of these methods that describe business processes in a semi-formal way (Steneskog et al, 1996). P-Graphs model process components such as actors involved, activities and time, and they have been used in earlier research in similar settings (e.g. the EU Cebusnet project, Konrad & Schäfer, 1996).

We studied the cases from September to November 2001, and used public material, interviews, P-graph modelling, documentation and personal experience for our data collection. Case study reports were reviewed by the interviewees, and two expert sessions were organised to discuss our findings. The project involved international cooperation between the Vrije Universiteit Amsterdam in the Netherlands and the Stockholm School of Economics in Sweden. This was materialised by five joint meetings in Sweden and the Netherlands during the fall semester of 2001.

The three cases we studied were Taxi Stockholm (Sweden), Graninge (Sweden) and Mobile Parking (Netherlands). Space limitations inhibit an extensive description of the Graninge case. Briefly, Granninge is a forestry and sawmill company in mid-Norrland (Northern Sweden) that uses mobile information systems to improve the supply chain management of timber. The company has implemented a radio-based information system to enhance co-ordination between units operating in the forest (harvesters & forwarders) and the main office for management and planning of transports at Bollstabruk.

Taxi Stockholm and Mobile Parking will now be described in more detail.

3.1 Taxi Stockholm

Taxi Stockholm AB is a taxi driver company owned by Taxi Trafikförening, a 101-year-old Swedish cabdriver cooperative with a membership of about one thousand taxi owners. Operating in a deregulated market, Taxi Stockholm runs by far the largest taxi circuit in Sweden, with over 1,500 vehicles, and a total capacity of around 50,000 transport requests per day. Year 2000 drivers completed 9.3 million trips representing a turnover of SEK 1,500 million. Taxi Stockholm employs 163 people and has 3840 cabdrivers associated. Year 2000 revenue was 9.1 million SEK.

Taxi Stockholm's heart is located at Luntmakargatan 64 in Stockholm where the dispatch system matches around 25,000 transport requests per day with available cars. Reservations pass through the customer service centre and are relayed on to drivers via the taxi dispatch system.

The technological platform of Taxi Stockholm is build upon four different systems whereas the dispatch system is one of these four components. The *Telecom system* is the interface used when the customer proceeds with a Taxi reservation. Once the customer transport need has been registered, the *Dispatch System* matches the requirement with an available car. This system represents the heart of the Taxi business. Next piece of technology is the *Radio system* keeping track of Taxi Stockholm's entire taxi fleet. Finally the *Mobile Equipment* constitutes technology located at each particular car and represents the driver's daily work-toolset.

Today it takes around six seconds to allocate an idle car from the instant the customer contacts Taxi Stockholm's call centre. The underlying dispatching process can be divided into four different steps as described here. First, a customer contacts the call centre through any of the channels available (telephonist, Interactive Voice Response, Internet etc). Secondly, the *confirmation of location* process starts. The main objective is to identify the origin of the customer. Thirdly, the dispatch system allocates a car. Finally the car is contacted and it picks up the customer (cf. fig 2).

This particular process has a number of mobile actors which need to be co-ordinated, namely the customers and the drivers. The call centre, situated in the heart of Stockholm, carries out the allocation of customers and taxi drivers. The origin of the customer is the main parameter that influences the allocation process. Drivers are located in a particular taxi zone. Taxi Stockholm divides Stockholm into 200 zones. A zone with a customer, that has required a taxi, is denoted a *primary zone*. Each zone has a number of adjacent zones called *backup zones*. The mobile actors are represented in the process graph as independent lanes interacting with the other actors (cf. fig 2).

Finally a number of co-ordination patterns arise for the allocation of the mobile resources. These patterns are represented in figure 2 as dashed lines. Co-ordination between the call centre and the customer is required during the contact and confirmation process. Cars need also to be co-ordinated during the allocation process. Information regarding location and status of the car is sent to Taxi Stockholm's headquarters. Another co-ordination pattern arises in order to contact the allocated car. Information about the address where to meet the customer, special instructions to the drivers, tariff based parameters, etc. must be forwarded to the cars.

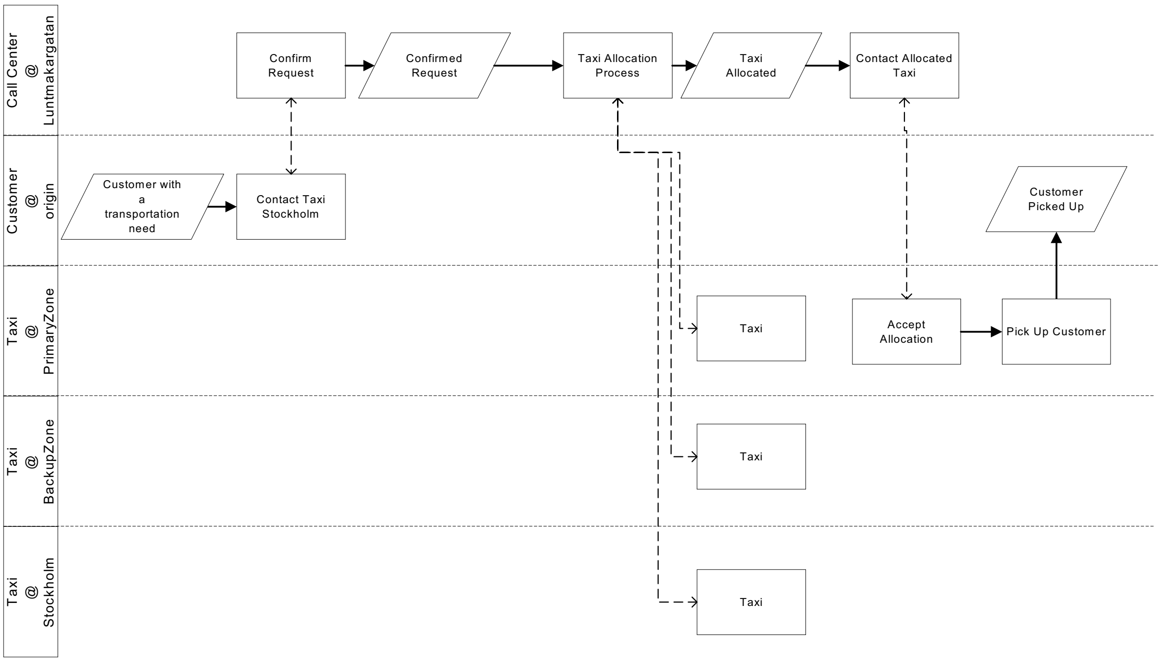

Figure 2 P-graph of Taxi Stockholm dispatch business process

Based on a number of requirements the company has identified an opportunity to improve the dispatching process through the use of improved mobile technology based on GPS, radio communication and information system technology. Better load balance, automatized checking process and future customer information requirements represent the main change drivers.

There are a number of benefits associated with the implementation of the technology. Frequency re-allocation and upgraded data-rate have increased the capacity of the radio network by 50%. The main benefit is increased information flow, which enables improved coordination of resources. The installation of GPS equipment in the cars allows for automatized checking process into a zone. With the previous system, drivers used to check into a zone manually. This process was inefficient and the reason for reduced car load. For example, drivers were aware of the high demand on the route Kista – Arlanda (route joining a dense industrial suburb with the Airport). Many drivers on their way to Arlanda checked in the Kista zone, even though they were still at the airport. Available cabs arriving to Kista were allocated high queue numbers on check-in at the area. A large number of available taxis left therefore the zone, discouraged of getting any customer although no free cabs were available at Kista because they had not arrived yet.

Finally, the new information system performs a large number of measurements. The company has been able to identify savings by a reduction of the distance from vehicle to customer by 20%. Other benefits for taxi drivers are better information access, new services available and improved work environment. Customers experience reduced estimated time of arrival and faster reservation process. The traffic control office is able to perform real-time information retrieval from the cars and at the same time benefits from location based retrieval advantages, improved information retrieval from the mobile resources and finally, real time notification advantages are also achieved.

3.4. Mobile parking

“Mobile parking” is a term used to describe situations in which car drivers use their mobile phones to pay for the occupation of a parking space. The business process can be described by a few simple steps (cf. Fig. 3). First, users register with parking authorities for participation in the project. This is most often done by returning a leaflet to the municipality, but can also be done through a website. Upon successful registration, participants can pay for parking through the use of their mobile phone instead of the parking meter. When they arrive at a designated parking space, they call a central information system (either using IVR or WAP). This system authenticates drivers using their mobile phone numbers and then logs the parking arrival time. When drivers leave the parking space, the system needs to be notified again, and the departure time is logged accordingly. Drivers are then billed by a clearing house according to the parking tariff for that zone.

In our case, we focused on a mobile parking project in the Netherlands that was carried out during the fall of 2001 in the city of Haarlem. To accommodate mobile parking, the city also introduced a novel mobile application used by parking enforcers as they walk around the neighbourhood. If they spot a mobile parking transponder (a credit card) behind the windshield of the car, they can check whether the car is legally parked through their mobile phones. After the enforcer has logged on to the system, he or she can transmit the city and the zone. The application will check its ongoing transactions database and return all licence-plates that are currently operational in this zone (the „white list“). The enforcement application is optimised for the Ericsson R380 smartphone, which has a relatively wide screen. A lightweight printer on to their belt is connected to the phone using Bluetooth and it prints a parking ticket when the license plate of the car is not in the white list.

The business process benefits for the mobile parking case are as follows. From the perspective of the car driver, the benefits include greater convenience, and savings because drivers only pay for actual time parked (with parking meters, drivers usually overestimate the parking time). Of course, parking authorities do suffer loss because of this, but gain because the number of parking meters (who are very costly to maintain) can be reduced. Surprisingly, one of the greatest benefits the enforcers saw in their application was the fact that mobile phones were very lightweight compared to the „system“ they use now. Their former system was a wearable device consisting of a PC and a printer. It weighted 3.5

kilogram and they had to carry it around for around 4 hours. Since there was no backlight (and hence could not be accessed during the night), carrying around a flashlight was also required.

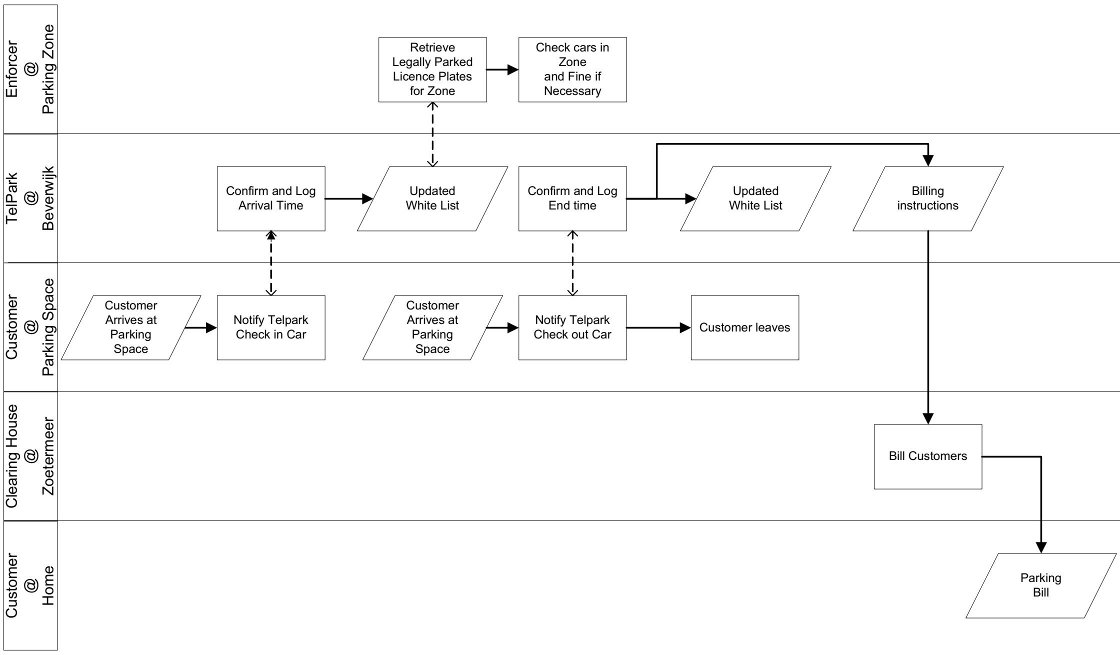

Figure 3 P-graph of Mobile Parking business process

3. DISCUSSION OF FINDINGS

Each case focuses on a specific business process and the complementary mobile technology. In this section, we will study what they have in common. This will be done along the lines of three propositions that we have derived from the case studies.

Proposition 1

A business process can benefit from mobile technology if coordination is required between business process actors who are (temporarily) difficult to locate

In the cases we studied, mobile technology is applied for the purpose of *coordination.* For clarity of exposition it is useful to distinguish between one *central* actor and several *decentralised* actors. Central actors coordinate the business process, and decentralised actors carry out the business process (they are, to a certain extent, „subject" to coordination). The following table depicts who the coordinating actors and operating actors are in each case.

Mobile technology is used because it solves coordination problems that arise when the operating actors are difficult to locate by the coordinating actor. In each of the three cases, the coordination actor is at a fixed location, and the operating actors are at variable locations. The location of the coordination actor is stable and hence certain, and the locations of the operating actors are dynamic and uncertain. Because of location uncertainty, operating actors are difficult to reach. Mobile technology alleviates this difficulty by making the actors "accessible" to the coordination actors. In all three cases, the business process can "continue" because the actors are traceable even while they are on the move.

Table 1 Business processes, coordinating actors and operating actors

Case	Business Process	Coordinating actor	Operating actors
Taxi Stockholm	Taxi dispatching	Call centre	Customers Taxi drivers
Telpark	Parking enforcement	Municipality	Customers (car drivers) Enforcers
Graninge	Supply chain management	Management & Planning Transport Office	Harvesters

In the three cases, we could see that mobile technology enabled coordination adjustments because it allows 1) location-based and/or 2) real-time information be exchanged between coordination actors and operational actors. Therefore, we can argue more specifically that a business process can benefit from mobile technology if a) knowing the location of the operating actors is required for coordination purposes, and b) timeliness of information retrieval or information access is required for coordination purposes. The first condition follows directly from the observation that location is unknown. The second condition follows from the first, in that sending information to or receiving information from an actor can only occur if the location of the actor is known.

Our cases provide empirical evidence that mobile technology has addressed the difficulty of coordinating operating actors. Table 2 displays the specific coordination problems for each case and what the mobile benefits were.

Table 2 Coordination requirements, location properties, and mobile benefits

Case	Required for coordination (from the viewpoint of the coordinating actors)	Location attributes for operational actors	Mobile benefits
Taxi Stockholm	Locations of taxis, locations of customers, real-time notification to taxis	Location a priori unknown both for customers and for taxi drivers	Access to locations of taxis Notification to taxis
Telpark	Customers Real-time notification of white list to parking enforcers	Locations known, but moving between zones	Freedom of movement Access to white list
Graninge	Real-time access to daily work done Real-time notification of revised production plans to region chiefs	Locations known (at least to some extent), but no fixed line infrastructure available	Access to daily work done, notification of production plans

Proposition 2 ("price of non-mobility")

The benefits of mobile technology are related to the opportunity costs of not being able to coordinate during the time when actors are difficult to locate

Severeness of the missed coordination opportunity turned out to be an important driver for the perceived value of mobile technology by the case study participants. It is not that mobile technology *by itself* contributes to value, it is simply that without mobile technology there would not be coordination in the first place! If operating actors are "on the move", they can no longer be subject to real-time or location-based coordination adjustments. In each of the cases, this problem was critical.

This finding also has implications for business processes in which operating actors are *sometimes* on the move. A typical example is the employee on an international business travel. The value of mobile technology for this employee is dependent on the severeness of him or her not being able to communicate with head office during this time. One of the interviewees with which we discussed our findings spoke in this context about the “price-tag of non-mobility”: indicating that the *opportunity costs* of not being able to be coordinated determined the eventual value placed on the mobile application.

Proposition 3

The benefits of mobile technology are related to the attractiveness of substitutes to solve the coordination difficulty. Substitutes include fixed terminals, predetermined fixed locations, and the usage of different coordination modes (typically standardisation)

It is important to recognise that mobile technology is not the only solution to the coordination difficulty. The cases demonstrate that substitutes are available and will be used. First, the process owners could install fixed terminals along the way so that coordination adjustments could take place there. The parking meters are an example of this. Second, operating actors could go to a pre-arranged location to make themselves known. Taxi ramps are an example of this. Third, the lack of coordination adjustments could be circumvented by more stringent coordination *before* the operating actors go on the move. These are usually called “standardisation” coordination structures (e.g. Mintzberg, 1979). The attractiveness of each of these substitutes also impacts the added value placed on the use of mobile technology.

5. CONCLUSION AND RECOMMENDATIONS

In this paper we have been concerned with the value of mobile technology at the level of the business process. We have examined the literature on the subject of mobility and business process performance. Using the preliminary framework that arose out of this literature, we have studied three cases from Sweden and the Netherlands. A number of generic findings were condensed from the empirical evidence available.

Based on the findings, we can conclude that a business process can benefit from mobile technology if coordination is required between difficult to locate actors. The value of mobility is contingent to the costs of *not* being able to coordinate during the period that the actors are difficult to reach. It is also related to the costs of available *substitutes* for mobile technology in a business process.

These findings have implications for practitioners who seek to identify opportunities for mobile communication in their business processes. We believe such an identification process need not be haphazard and can in fact be structured: our findings suggest that a systematic analysis of actor locations in a business process, and the difficulty of coordinating them can be productive. Spotting substitutes is one element of this identification process, and “complicating” the existing locations another (so that the mobile technology can enable the business process to continue even in more difficult to reach locations). A useful area of further research would be to develop a step-wise method to seek mobile opportunities for existing business processes.

We realise that our analysis has been bottom-up, and that another selection of cases would likely have produced a different set of findings. For example, we have not been able to explore a case with a *mobile* coordination actor, but clearly these business processes exist (consider for example Airforce One). We would encourage other researchers to study other mobile business processes, and see how and why these applications contrast with our findings.

The value of mobile technology at the level of the business process is still a relatively unexplored area. We believe that the three cases that we have studied offer some insight into the relationships at issue, but we also acknowledge that we are not yet in the “theory testing” stage. Nevertheless, our research has been a first step towards a better understanding of the relationships between mobile technology and business process performance.

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