

BUSINESS ENGINEERING WITH MOBILE WORKFORCE SOLUTIONS

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ABSTRACT

An analysis framework is presented that can be used to assess important issues of mobile workforce solutions, based on recent literature on mobile business. Within this framework we did two exploratory mobile workforce case studies, one at a rail company, and one at a highway inspection organization, both in the Netherlands. Preliminary evidence shows that mobile workforce solutions have a direct impact on many aspects of an organization's work practices, though they do not radically change the organizational structure and business processes within a company. The results of the case studies indicate a need for an engineering approach that integrates a consideration of the potential impact of mobile workforce solutions on an organization, its business process and the individuals who work for it. In this study the foundations are laid for further research into improving business processes using mobile workforce solutions.

Keywords: Business process engineering, Mobile workforce, Mobile solutions.

1. INTRODUCTION

The identification of opportunities for "mobility" is increasingly becoming a core issue for many companies. However, many organizations, even though they may have taken up mobile solutions quite early, have difficulties realizing business transformation, and business process redesign. A main reason could be that "too much attention has been paid to commercially available and proved technologies and applications and, unfortunately, too little attention has been paid to the commercial conditions for success and, ultimately, value creation and competitiveness" (Christensen and Methlie 2003).

Based on their research into the adoption of mobile technologies in business, Kohler and Gruhn (2004) indicate that: companies frequently follow a technology-driven approach without precise knowledge of the potential benefits that may be realized. They further suggest that a systematic approach to mobile solutions is required if a verifiable economic benefit is to be created by using mobile technologies, especially in larger organizations with complex business processes.

It has also been observed (Meijer, et al. 2002) that individual worker's adoption of solutions based on mobile technologies follow the known principles of diffusion theory (Parker 1994) where social context, risk and divisibility are key factors. Many mobile solutions have failed to produce the expected results due to neglect of these key adoption factors.

Our observation is that mobile technologies are maturing, but their accompanying business applications lack a corresponding maturity. The barriers to the adoption of mobile solutions in organizations are not the technology challenges; hundreds of vendors now provide initiatives such as system integration, device management, routine support and maintenance. Thus, many packages and tools are available in the current market to help organizations deploy mobile technologies.

The real challenge is how to instantiate available mobile technologies and form a business solution that is suitable to a specified organizational environment. To deal with this challenge, we see a need to embed a business engineering perspective into the approach used to adopt mobile technologies. Business engineering is not straightforward, it is a very complex process that involves more than just restructuring the workflow; it also involves changing the information flows around the business process and the knowledge management capabilities of a chosen process (Sawy 2001). So, our research question is: "What is an appropriate approach to engineering mobility in organizations?"

In this paper we present an analysis of empirical situations to get a better understanding of the issues involved when engineering mobile solutions in business processes. The structure of the paper is as follows: in the next section we present our analysis framework. This is followed by an outline of our case study methodology and case study descriptions in sections 3 and 4. We discuss the results in section 5, and we conclude the paper with an outline of our further research activities in section 6.

2. ANALYSIS FRAMEWORK

Business Engineering (BE) has become a popular term in the business and information systems literature that is used to denote organizational transformation focusing on the integral design of both the information technology (IT) and organizational processes and structures presented in an organization (Davenport 1993, Davenport and Short 1990, Dennis, et al. 1993, Fried 1991, Grover, et al. 1993, Hammer 1990, Kaplan and Muirdock 1991, Meel 1994, Vogel, et al. 1993).

There are three different forms of Business Engineering, infrastructure engineering, process engineering, and task engineering (Smith and McKeen 1993, Sol 1992). Each form has a focus on engineering "organizational changes" of a certain nature and magnitude. Infrastructure engineering deals with executive management, process engineering concentrates on changing operational business process, and task engineering deals with job design and screen layout. This division implies the process of three operational levels when examining an organizational system: an organizational level, a process level and an individual level.

In this research, we use this three level division to have us take an in depth overview of the impact of mobile workforce solutions. Our proposition is that any implementation of "mobility" can be expected to penetrate an organization to its core functions and structures, so the units of analysis need to be similarly comprehensive: individuals, processes and the organization as a whole.

Within these three levels we further focus on specific issues. The literature in the field of mobile business shows that the introduction of mobile solutions in an organization reflect the character of the business at hand and the solution used (Barnes 2003, Derballa and Pousttchi 2004, Gebauer and Shaw 2004, Harmon 2002, Hoefling 2003, Manzoni and Angehrn 1998, Walker and Barnes 2004). For our research, we abstract the core aspects of an organization that will be directly affected by implementing mobile workforce solutions, see Table 1.

Our proposition is that Table 1 can be used as a framework to examine the issues of mobile workforce solutions and we use this framework to analyze two case studies, aiming to achieve a comprehensive understanding of the issues involved when introducing engineering mobility in businesses.

Table 1 Analysis framework for impact

Level	Issue Category	Why it is an issue
Organization	<u>Workforce management</u> Balance of work factors, such as optimal staff levels, anticipated workloads, and resource availability.	Workforce management is not a new issue, but by combining traditional methods with mobile applications, new capabilities will become feasible, e.g. tracking and controlling mobile workforces. These new capabilities allow companies to improve workload forecasting and resource scheduling directly.
	<u>Organization structure</u> The way organizations link workforces and the way to support their collaboration.	Mobile workforce solutions have a major influence on distributed work, and they create the possibility to link workforces together across locations to get a “virtual working” environment according to (Hoeffling 2003). Organizations have the opportunity to transform a virtual workforce into a functioning virtual organization by adopting appropriate structures, for example, decentralized, team-based and distributed structure etc.
	<u>Knowledge management (KM)</u> Networking and sharing corporate information, including data management, and information management	For the time being, the potential of KM is usually limited to stationary workplaces. This excludes a multiplicity of mobile workers, many of them in charge of knowledge-intensive activities. An organization’s capabilities to support KM may be extended through the introduction of mobile technology usage. For an extensive discussion on the contributions of mobile technology for supporting KM in the different phases of the KM process i.e. knowledge retrieval, knowledge exchange and knowledge creation, we refer you to (Derballa and Pousttchi 2004) and (Huysman and Wit 2004).
Process	<u>Automation</u> The use of computer systems and software to automate a process.	Processes can be completely automated, so no human intervention is required, or semi-automated, when some human intervention is required to make decisions or handle exceptions (Harmon 2002). Mobile devices and applications can provide the “hardware” and “software” needed to trigger business process automation. Process automation is the primary function of current mobile workforce solutions. Examples: automated meter reading to save costs, a filed inspection data registration process.
	<u>Alignment</u> The creation of tighter coordination among the discrete business activities conducted by different work units.	Internal business process alignment is essential for successful mobile workforce solutions. The nature of work and job roles may be transformed by the mobile medium.
Individual	<u>Capability</u> The abilities of workforces when they execute tasks in the field based on certain supports.	Mobile solutions mainly have an influence on a workforce’s mobility and reachability. Mobility refers to the level of geographic independence of mobile workforces, and reachability refers to their ability to be contacted despite mobility.
	<u>Task</u> The functionalities and scope of tasks attached to the job role.	Gebauer and J.Shaw (2004) adapt the concept of task/technology fit to account for the fact that mobile applications potentially cover a wide area of tasks. Their analysis suggests that it is important to ensure compatibility between the requirements of a task and the mobile capabilities of an application. For example, the requirement for accomplishing a task via (e.g.) standardized and personalized mobile applications.
	<u>Acceptance</u> Attitudes towards usage and intentions to use the technology.	The adoption of mobile technology has a direct influence on the human aspect of workforces, for example, their working habits and work motivation. We refer you to (Liang, et al. 2003, Venkatesh, et al. 2003) for an extensive discussion of this factor.

3. CASE STUDY METHOD

Consulting company X¹ is a large ICT service provider and supplier of turn-key mobile solutions to all major market areas. It has over ten years experience with the introduction and adoption of mobile solutions and offered a rich body of project data to base our research upon. We cooperated with the project teams directly involved in these projects to choose case studies that could provide insight into the relevant issues during business process improvement projects.

We chose the “Railpockets connection” project and the “RWS inspection” project as the two cases met the following criteria (Yin 1989): relation to the research topic, rationale for multiple-case design, power to access, and geographical location. The Railpockets connection project ran from 2002 to the end October 2004, and consisted of three phases: design, develop and roll out. The RWS inspection case concerns the design of a pilot solution, started in 2003 and executed in January 2004.

The data collection was done using semi structured interviews and a document study. The document study provided us with good material which we used to prepare for interviews. The insights gained during the interviews were also used to direct a further document study. Any inconsistencies and questions arising during the analysis phase were discussed with the project team leaders. In total six interviews were carried out in autumn 2004. The interviewees were selected, taking into account their roles in the project, and included business analysts/ICT professionals from company X and the operation managers/ICT managers from the involved organizations. An overview of the characteristics of the two cases is provided in Table 2.

Table 2 Characteristics of cases

	Railpockets connection	RWS inspection
Stage	Analysis/design	Pilot
Target group / process	Many functionalities, Complex processes	Few functionalities, Simple process
Initiator	Central office	Local department
Type of organization /work	Public transport/ Full distributed work environment	Government/ inspection Field work
Project cooperation	Problem owner & solution provider	Problem owner & solution provider
Control mechanism	IT project	IT project
Type of mobile Solution	Online Comprehensive services	Offline Location based services

4. CASE STUDIES

We will now describe the background, the project content, and the mobile solution of the project for each case study

4.1 Case study one: Railpockets connection

Background

The largest Dutch Railway company, Nederlandse Spoorwegen (NS), is experiencing continuous problems with providing their core capability, public transport. NS aims at providing relevant and timely information to its customers however it faces difficulties in managing its 10,000 strong mobile workforce maintaining a dynamic view of staff activities, and in distributing



¹ Not named here for reasons of confidentiality.

operational and travel information. Enabling efficient communication between mobile workers, called “frontliners” within NS, i.e. conductors, drivers, service personnel, and engineers, and supporting these frontliners in providing up-to-date information to railway passengers therefore become an important issue for NS.

Since 2000, all frontliners have been equipped with stand-alone Personal Digital Assistants (PDAs) called Railpockets which are used to provide a travel planner and reference information. This has released frontliners from the need to cope with complex paper versions of train schedules and manuals when dealing with a request for information. Besides providing information, the Railpocket is also used for registering daily occurrences such as delays, number of passengers per journey, ticket sales, incidents of aggressive behavior, damage reports etc. Train conductors uploaded the gathered information to central computers on a daily basis, via PCMCIA memory card, so NS management are provided with the daily update on all information gathered by the frontliners.

Frontliners are also equipped with GSM phones for voice communication in emergencies. A special SMS application has been embedded in the GSM phones, which is capable of providing real time alerts on delays and scheduling. This has improved customer service and the cooperation between frontliners and back office staff. The situation at NS is summarized in Table 3 below.

Table 3 Current mobile workforce solutions in NS

Tasks of frontliners	Mobile solution	Benefit
Registering daily delays Registering number of passengers per journey Registering ticket sales on the train Registering incidents of aggressive behavior Registering damage reports Providing travel planning Providing other information	 Railpocket	NS management is provided with the daily information gathered by the conductors. Frontliners are released from paper versions of train schedules and manuals
Receiving delay alerts and up to date information on scheduling	 SMS	Improved customer service and cooperation between frontliners and back offices
Voice communication in emergency	GSM phone	Improved coordination in an emergency/delay situation

Project

The aim of the project was to enable the online component in the Railpocket to provide instant access to real time information about disruptions and changes to train schedules using the large display. When looking at return on investment and its long-term strategy, NS also noticed a need for the Railpocket Connection to support more business applications in the upcoming three to four years, e.g. the integration of electronic ticketing inspection.

As a train operation company, NS did not have sufficient knowledge on mobile technology and related solutions, hence turned to company X for consultancy and implementation. The project team consisted of business analysts and ICT professionals from company X, and operation managers and ICT managers from NS. They worked at NS headquarters to guarantee team working efficiency and coordination. The project's challenge was summarized in the question: How can the mobile online concept be leveraged to create more business applications towards an overall improvement of NS' business performance?

The project team started with a process analysis that focused on structuring the primary work process of NS frontliners. A process-modeling package, ARIS (see <http://www.ids->

scheer.com/), was used to describe all processes and information flows. Particular attention was paid to understanding what information was used or produced by frontliners at which moments during the process analysis. The project team defined the concept “contact moment” as a concrete and structural moment in the business process when a frontliner works/communicates with the help of mobile support. Seventy-two contact moments were identified based on the process models. The evaluation of improvement was carried out for these contact moments and eighteen contact moments were found to be improved as a result of introducing Railpocket Connection.

A technology scan was conducted in parallel with the aforementioned activities, consisting of an evaluation on the possibilities of wireless communication, GPRS, WLAN, Bluetooth, and the necessary hardware, GSM handset, PDA, taking into account the specifics of the target group, i.e. desk-less workforce working in moving trains.

Solution

The analysis showed that most information used by frontliners was still static or semi-static, meaning that only actual information needed to be accessed online. So the applications were based on the “fat client on a thin wire principal”, where all the static data is held on the Railpocket and only changes taking place during the working day are accessed using online communication. Besides migrating current applications to a new platform, the solution also includes four new business applications.

- Application 1: a map of The Netherlands where disrupted routes are displayed as a red line. Selecting the red line allows detailed information about the disruption to be retrieved from the back office and displayed to the user.
- Application 2: an overview of actual departures per railway station is displayed, where changes to the schedule are highlighted. As the large displays commonly present in stations are used to provide actual information to passengers, it was highlighted to use the same information source in the back office without adding intermediate systems.
- Application 3: all information is personalized for specific employees, i.e. context driven. Based on his or her personal schedule the Railpocket knows where the employee is and which tasks he or she is performing. Information targeted at these activities is presented to the user.
- Application 4: online information on the maintenance of individual trains and registration of defective parts are provided. Using this application, the maintenance department can be alerted about the status/defects of a train before it rolls into a workshop at night. This allows maintenance to be planned, repair crews can be informed of defects and the crew can bring along the correct spare parts required to deal with a defect.

The project team proposed an open platform for current and potential functionalities by choosing standards like PDA with Windows Mobile Operating System, GPRS handsets and Bluetooth technology, see Figure 1. A new type of PDA (HP iPAQ) was adopted, which can be accessed via Bluetooth/GPRS and receive information alerts via SMS.

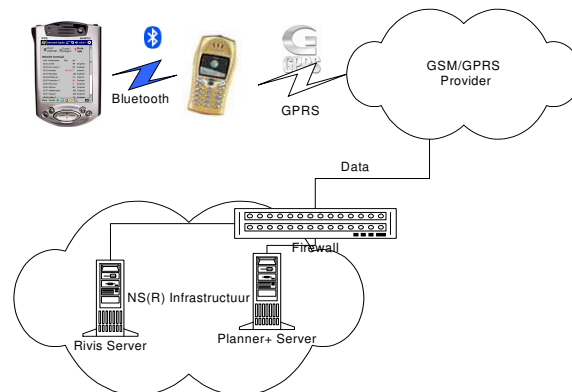


Figure 1 Railpockets connection based on bluetooth/GPRS

4.2 Case study two: RWS inspection

Background

Rijkswaterstaat (RWS) is the Dutch name of the Netherlands' "Ministry of Transport, Public Works and Water Management". RWS has five main departments and each of which has 3-5 sub-departments. This project was targeted at the sub-department "highways" which is responsible for inspecting the national highway systems. Inspection tasks are allocated per geographical region. This results in decentralized data collection, and RWS has had problems with integrating and updating their central database of highway inspections. RWS wants to standardize the inspection work to improve the accuracy and efficiency of data collection and management.

Driving along the highway of the regions, the inspectors have two main tasks: report the accidents and the state of the highway, e.g. report damage caused by a traffic accident, obstacles caused by the bodies of dead wild animals. The inspectors write down inspection details and make a report at the end of a day; the data are sent weekly to the central department, where all data are entered into the database; the central database is updated monthly. The identified problems are: data are not reported in time, the delay for entry is big; double entry makes the work less efficient; nobody has an overview of the data analysis and thus no action is taken, e.g. wild animals are often found on highways passing through a forest but no fence is built to prevent frequent accidents.

Project

In September 2003, the highway inspection department of the RWS in the region of Apeldoorn started to think about making improvements in their high way inspection work. At the time, most inspection activities were done using pen and paper to collect field data. The handwritten data had to be typed into a report every weekend. Typically, the inspectors were expected to record the inspection information, for instance the type of an incident and its location. This occupied most of the inspectors' time when they were carrying out field inspections. Traditionally, inspectors often provided location information coupled with comments to refer specific conditions, e.g. 100 meters away from exit 4 of highway A20. The ambiguous nature of the location information often caused inconvenience for the cooperative administration and later data retrieval. Eliminating this inconvenience became the most important reason behind the idea of using location based services.

The project focused on identifying the needed improvements for current work processes. Two types of work processes done by inspectors were considered in the functional design of the application, one, work processes in the field, and two, processes carried out at a central location/office. A number of functionality requirements were elicited in a sense of discussions with inspectors and the management team. These are listed below:

- More accurate location information. This should enable inspectors to identify accurate location information.
- Better information support. This should enable inspectors to access the historical inspection record at a point of need.
- Rapid communication of information between inspectors and the RWS' organizational systems. This will allow information gathered by inspectors to be utilized by other functions in the administration chain without delay.
- Improved quality of planning. This should facilitate job planning; especially the planning of collaborative work between inspectors.
- Improved the productivity of an inspector. Automation of certain activities should produce improvements in productivity.
- Capabilities for efficient driving. Since the inspectors spend most of their time driving, navigation support is needed to enable them to follow a planned inspection route easily.
- Time savings in the processing of inspection notes. This should reduce the time inspectors spend on reporting, note: many inspectors do not like to type a report weekly.
- More effective management of inspectors. This should allow the administration to know the locations of inspectors at all times and improve time management for inspectors.

- Personalization. The system should be able to filter relevant information and tailor services to the needs of particular users, e.g. provide personalized information).

Solution

Regarding the functionality requirements, the project team came to two conclusions. Firstly, mobile geographic information systems (GIS) applications may be suitable for application in the highway inspection work processes. Secondly, real-time data access is rarely required in a field environment.

Following on the first conclusion, the team chose the HP iPAQ to use as a handheld device taking into account its clarity for daylight viewing and its ability to configure various storage media for map files used in conjunction with GIS applications. GIS is widely used by a variety of public and private agencies to store and manipulate data about specific locations in specific areas. Coordinates data form the basis for GIS applications. A GPS (global position system) unit connected with GIS can be used to determine locations. The project chose to couple a Pocket PC GPS receiver to the HP iPAQ.

Following on the second conclusion, the project developed RWS application-specific software and data. The handheld device will synchronize data with the host application, store it locally while it is used and updated, and then return the modified data to the host. The map application and other data entry forms were developed in ArcPad, a popular commercialized GIS development platform, for use on the iPAQ. The screenshots of some applications are presented in figure 2.

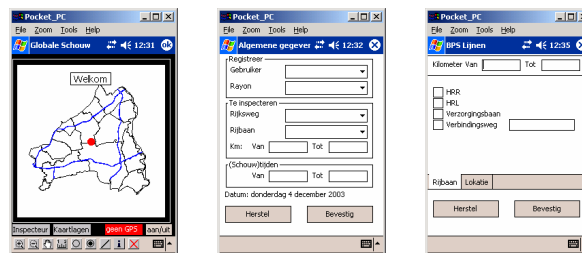


Figure 2 Screenshots of applications

The developed applications were loaded into several pocket PCs for a pilot test. A number of inspectors participated in the three-week long test. The time saved on the inspector’s work processes was evaluated after the pilot, see Table 4.

Table 4 Time saving of inspector’s work

	Old situation	Min	New situation	Min
Start	The inspector chooses a route to inspect based on his planning and knowledge.	30	The inspector checks his route on his PDA	1
Inspect	Write down the location of an incident	1	Click the location of the incident in the PDA	1
	Contact the relevant institute and request recovery/disposal services	30	Contact the relevant institute and request recovery/disposal services	30
	Write notes in a sheet	10	Fill in the electronic form using the user-friendly interface on the PDA.	3
End	Type a standard work report based on the daily notes once a week.	120	Put the PDA in the cradle and upload all inspection data to the information system	2
	Print a report and hand in.	8	No longer necessary.	0

5. DISCUSSION

Our case study findings are summarized in table 5 below.

Table 5 Case study results in framework of analysis

Issue	Railpockets connection	RWS inspection
Work force mgmt.	Tracking mobile workforces is feasible in the new platform. The management better understand their employees' work state and performance. The management team was aware of the need for new policies for the personnel being "monitored".	Employee tracking function is not achieved "real timely" in the project, since the current solution does not support real time data transmission between field and central office. The project team has developed an application to record an inspector's location and time regularly during work, and this information is uploaded daily into a database.
Org. struct.	NS has complex internal business process, and it is an information-intensive, highly distributed, and time critical organization. Its core business is operational processes in a routine but dynamic environment. The coordinating mechanism is not radically changed by the solution.	Collaborative work planning is improved by the solution, because the route planning information becomes transparent: it is shared and shown on the map page using daily updating (download). It is easy to know, for each inspector, who is inspecting which route and which route was inspected earlier.
Know. mgmt.	Conductors have instance access to actual departures, which is the same as the information known in the back office. Thus helps to prevent inconsistent information being given to passengers.	Integrating GIS into the system has stimulated the use of uniform application data and thus brought advantages for data management. Data analysis becomes fast and easier with the GIS. Broader data accessibility and more efficient use of data become possible. It provides the opportunity to develop more applications to support the inspector's daily work and RWS' management activities.
Automation	The new solution enables conductors to report train defects to the maintenance department through a PDA instead of using a registration sheet, which makes the reporting process more efficient and simple.	Registration process becomes "smart" and friendly because an inspector automatically receives accurate location information with all the relative road/geographic information integrated. The inspection report can also be generated easily, saving inspectors can save a lot of time.
Alignment	Application 4 aligns inspection processes and maintenance processes. The team viewed the application to be a result of studying collaboration among the intra organizational business processes. They concluded it was important to expand perspectives when discovering process alignment, and to not be constrained in one process horizontally, but to focus on the relations and interdependencies between processes vertically.	Inspection information collection, distribution and administration processes are aligned much better than before. The inspector can provide the collected data to the administration in electronic form by synchronizing the data with a desktop PC at the office. This eliminates the paper report and the customary data re-entry process done by the administrative staff. Elimination of the paper reports also includes saving time spent on filing, copying and archiving paper reports.
Capability	Conductors' mobility and reachability are improved because of the online function of the PDA.	The GIS based applications allows the inspectors to view the inspection route on a map and verify the location using integrated GPS. The history of inspection site information can now be retrieved.
Task	Conductors' main tasks changed from "check tickets" to "inform passengers".	There is evidence to show that the inspector's job role has changed.
Acceptance	The lack of a full size keyboard and the relatively small display were identified as the two shortcomings of the new PDA. In order to address these concerns, the design of the user interface received special attention. NS also recognised that whilst the recipients of Railpockets wouldn't always be technically minded, user adoption is extremely important.	The inspectors and their coordinators gave a very enthusiastic reception to the developed application both for field use and office work. The application is simple to understand and thus fast to learn. So there is no need for expensive/long training time before use. The performance of hardware, i.e. Pocket PC, GPS receiver, and PC was also satisfying, especially during the night, GPS provides lots added value.

Our analysis shows that mobile workforce solutions have a direct impact on many aspects, but that they do not radically change the organizational structure and business processes within a company. This finding is in line with the finding of (Krogstie 2003): "To address the needs of workers whose work situation is inherently mobile, a number of solutions to mobile

process support have been developed over the last five years. Based on the development, introduction and take-up of these types of systems over a number of years in different organizational settings, we have found that rather than dramatically changing the organizations taking these kinds of systems into use, the changes in work practice are much more gradual and evolutionary.”

At present, mobile workforce solutions basically support the automation of existing and traditional business processes, for instance, the transition from paper-based processes. The case studies do not show that innovative businesses processes are created by using mobile services. The power of “mobile services” has not been fully explored. There is surely a potential for organizations to engineer “mobility” further. Toward the achievement of this, different design approaches have been proposed in the recent literature. The exiting research work can be grouped within the framework according to its focus at the different engineering levels: individual, process and organization.

We find that most design approaches for engineering mobility are targeted at issues found at the individual level. For example, Sawyer and Tapia (2003) view mobile work from the perspective of the task redesign tradition. Work redesign provides means to link work to a larger context including the use of various technologies. They propose a (work redesign) framework to explore and understand organizational governance of mobile work by focusing on four elements: design of the work tasks, including allocation of subtasks, coordination needs, and oversight requirements; group norms of process and performance; composition of the group, including both people and tools to support people’s work; and governance structures and requirements.

The work of Dyson and Er (2004) is an example of design approaches focusing on individual acceptance issues. They propose a hybrid design approach to the development of mobile systems in the construction field, where the participation of expert colleagues supplements user participation in the early paper-based prototyping phase. This approach is designed to overcome challenges like resistance to IT use by construction workers, reluctance by management to spend money on untried technologies and on training, and practical difficulties which effectively limit user participation in the design process.

There are a few research attempts with a clear “process” perspective. For instance, Sorensen et. al (2002) suggest different attributes that could be used to describe mobile work processes. The focus of MOWAHS characterization framework that is presented is mobile work itself and an attempt is made to derive the functionality, architecture and hardware required to support specific mobile scenarios. They hold the perspective that “in a real mobile work situation there are more factors than mobile technology to consider, such as co-operative work and time and location constraints of the tasks themselves.” They believe that the usage of such a framework will allow them to explore typical classes of mobile work with different process and transaction support.

The work of Pulli and Antoniac (2002) is another example of a “process” centric design approach. They present a scenario-based analysis and design approach for mobile and ubiquitous service development. They propose early visibility of services using partial service scenarios and different levels of abstraction and detail during lifecycle development to narrow-down design choices, yet allow creativity and innovation, i.e. try to encourage diversification through experimentation, and to evaluate and constrain the best variations for further development using a value function framework.

We find no design approach has been reported that focuses of issues at the organizational level. Probably it is too early to be an issue now and we will see this in management literature when the changes taking place at the process and the individual level become more concrete. We believe that the changes in the design of organizations caused by implementing mobile workforce solutions should be on tomorrow’s agenda. As Cousins and Robey (2003) indicate: although researchers have speculated on the benefits and unintended consequences of nomadic computing, empirical studies remain rare. There may be new forms of use, new social actions, unanticipated responses and unintended consequences as organizations and individuals adapt to this environment.

6. CONCLUSION AND FUTURE WORK

Mobile solutions offer value to certain business processes. The implementation of these mobile solutions requires changes to be made at the organizational, business process and individual task level. However, as the two cases presented show, there is no evidence that the implementation of mobile workforce solutions cause radical changes. We derive the following statement from the case studies: developing a mobile workforce solution is a complex task, particularly in its implementation. Though many approaches have been proposed, they mainly focus on solving some of the issues listed in our analysis framework but not all, e.g. task redesign or user acceptance.

The analysis framework presented in this paper may help decision makers to focus on relevant issues during engineering “mobility” phases. Particularly, it may help managers to evaluate the complexity and the coverage of the issues of a proposed mobile workforce solution; it may raise awareness for the need to apply an appropriate engineering approach to deal with the complexity. The framework may also help managers to predict circumstances where deploying mobile workforce solutions would add value.

There is a lack of insight into how business processes can be radically changed by leveraging mobility. An all-embracing design approach that includes all issues in our framework is of course unrealistic. However, the framework can be used to raise decision makers’ awareness of the design issues for engineering mobile workforces, and it can serve as a checklist. Furthermore, it can be expanded by adding that arise in the future.

Based on our literature study and case studies analysis we formulate the following requirements for a design approach that facilitates optimal use of mobile solutions in business processes.

- There is a need for decision-making support. Supporting quick discovery of “as-is” models is not sufficient, because decision makers need to “rehearse” the future. So “what-if” models should be provided at the point of need. Further, it should be possible to design “what-if” models to research the integration of mobile solutions with existing business processes and to provide measurement function in terms of efficiency and productivity.
- There is a need to facilitate collaboration. Designing mobile workforce solutions is often conducted in a context of multi-actor systems. It is important to stimulate the participation of the involved actors and to support their interaction. Collaborative business engineering “thinking” is therefore needed rather than ICT system design “thinking”.
- There is a need to incorporate the process management paradigm. Mobile workforce projects usually take long time in the design phase and are hard to roll out. As time passes, technology becomes obstacle; good documentation of the current situation is important; the solution should be flexible and scalable. The project management paradigm has limits when dealing with dynamics and continuous “engineering”. Process management (Bruijn, et al. 2002) however, aims to enhance constantly chaining and unique matching process.
- There is a need to cope with the organizational and individual “impact” of any mobile solution introduction. Organizations need to be notified of the potential impact of mobile workforce solutions on their intra-organizational business environments. Employees should also be helped to find creative ways of coping with the changes caused by mobile workforce solutions.

An approach that fulfills the above requirements should lead to the better design and implementation of mobile workforce solutions. Eventually, an organization’s mobility can be better engineered in its business processes.

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Received: June 3rd, 2005

Accepted in final format: September 27th 2006 after one revision.

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