

# “MOBILE-LIZING” THE CONSTRUCTION AND REAL ESTATE INDUSTRY: AN ENHANCED ECONOMIC EVALUATION OF MOBILE SOLUTIONS

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**Abstract:** While mobile information technology is claimed to be a key driver for innovation in modern organizations it is far from obvious how this technology can be adopted to improve business processes in an organization. In this paper the authors present the gained experience from the German research project MOBIKO analyzing possible applications of mobile computing in the construction and real estate industry. It is shown that the Enhanced Economic Evaluation (EEE) offers a valuable assistance for the design and implementation of innovative mobile services.

## 1 Introduction

The influence of mobile devices in today’s society is growing. In all areas mobile devices like tablet PC’s, cellular phones, PDA’s and solutions for augmented reality enrich and/or replace traditional media for communication like letters, notepads, etc. and therefore support a wide range of business processes. With the growing acceptance of mobile technology, its devices and services, there is a paradigm shift towards “always and everywhere” communication. The realisation of these new possibilities of mobile computing is one of the biggest challenges in today’s information and communication market.

For this reason the German research project MOBIKO ([www.mobiko.de](http://www.mobiko.de)) was funded which focuses on mobile collaboration for the construction and real estate industry. This sector is a very interesting and challenging area of examination as it managed to live without extensive restructuring and didn’t succeed in initialising processes actively. “Mobile-lizing” this industry could help to solve its structural problems and re-win the reputa-

tion that is adequate for its social and economic importance. But how can we calculate and express economic efficiency in the domain of mobile business?

While mobile technology has evolved rapidly over the past few years, the research of the potential of its application has not kept up; especially as far as the economic efficiency of the related investments is concerned. Since Conject (www.conject.com) is introducing mobile information technology in its solutions it has to face the challenges of analysing and evaluating the benefits of mobile services. The challenges can be summed up as follows:

- How does mobile computing influence the work in this domain (on a workplace level as well as on an organizational level)?
- How does it pay off for the different stakeholders (investors, architects, construction managers and even society)?

## 2 Mobile collaboration

According to The National Assembly of Health and Human Service Organizations “collaboration is the process by which several agencies or organizations make a formal commitment to work together to accomplish a common mission-related [...] issue” [N97]. It “requires a commitment to participate in shared decision-making and allocation of resources relative to activities responding to mutually identified needs.”

As Coleman states, “collaborative working yields improvements in decision making and shorter cycle times/improved performance in everything from research, to product development to marketing, to sales to hiring practices” [Co97]. Mobile collaboration has its own rules. Some of its most important characteristics are summarised in Figure 1.

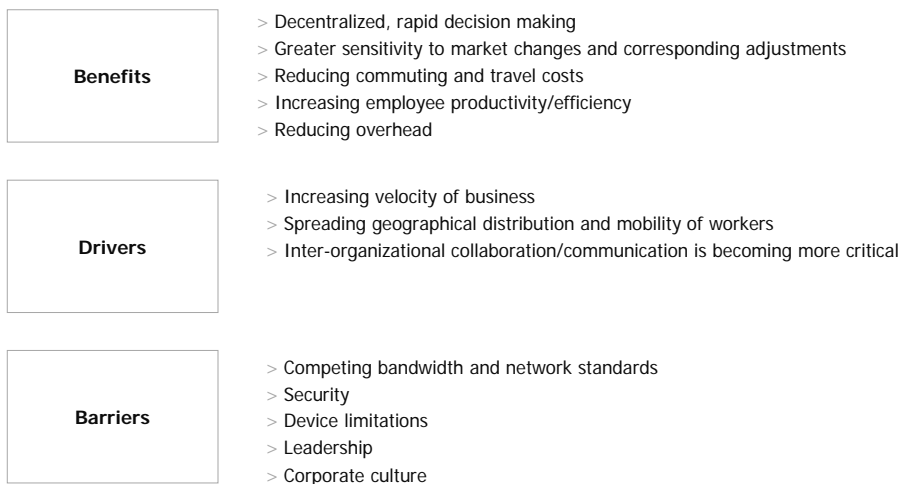


Figure 1: Benefits, drivers and barriers of mobile collaboration [Wa02]

### 3 German construction and real estate industry

Germany's construction and real estate industry was mainly and strongly shaped in the post-war period. Despite facing the severe recessions in 1967, 1975, 1982 and 1993, the industry managed to live without extensive restructuring. It responded to different requirements and economic developments but didn't succeed in initialising processes actively. Instead of solving internal problems on its own the majority of the companies always called for the state in order to do so.

Today, as customers make great demands on a building's quality and functionality, more specialised knowledge is required which can be spread all around the globe. Therefore, Braschel claims the application of present-day information and communication technology to bring together all the specialists which are needed for a high-quality result [Br02]. Thereby, task-oriented, permanently transforming virtual organisations will emerge.

Projects in the construction industry are usually characterised by the involvement of multiple geographically dispersed project participants. Therefore, efficient project management becomes a difficult task, due to the temporary nature, time pressure and heterogeneous communication environments of these projects. Construction sites are temporarily established units where multidisciplinary groups of stakeholders have to be aligned in order to achieve a common goal and, thereby, create collaborative value. Therefore, suitable environments for mobile collaboration between dispersed project teams have to enable mobile and wireless access, transfer, exchange and synchronization of relevant information of multiple sources and various applications. An example that vividly illustrates the necessity for the 'mobile' nature of collaboration in this context is the project manager visiting a site who immediately needs relevant information from the office (e.g. dimensions, statements of costs, contact information).

A recent analysis of project management in the construction industry shows that construction companies have to improve their organizational structures to increase their weak returns. Besides a transparent description of their core processes and a tight implementation of responsible functions, the design of a continuous flow of information is critical for success. Within this flow of information internal and external members of the project team have to be considered in order to lead to a frictionless realization of the project [Se01]. This is supported by Braschel who calls for an increase in quality and a structural reorientation [Br02].

Allen highlights the following requirements for a project collaboration solution that are critical to completing construction projects on time, under budget and in high quality [Al02]:

- Project initiation: Invite new project participants via automatic e-mail. Users have a single user name and password across multiple projects.
- Project repository: A single place for storing and sharing all project-related information. Access by means of a web browser and available through role-based security to any authorized project stakeholder.

- Project-wide communication: Threaded discussions simplify comments and feedback on project issues. Automatic subscription-based alerts are sent to the appropriate person when action is required. Broadcasts to announce milestones or general project news.
- Forms and workflows: Use HTML or PDF forms to mirror existing documents. Expedite project processes with customisable workflows. Report status of documents in the review process. Automatic notification to project participants and tracking of resultant actions (or inactions).
- Document management: Application-independent view and zoom. Redline drawings and documents. Supports all major CAD file types, including AutoCAD and MicroStation. Secure version control with full audit trail and check-in/check-out system.
- Easy navigation: Project information is organized for quick access with customisable folders and hierarchical project trees. Easily add and view documents and drawings.

The aim has to be the integration of all construction-related activities to a continuous, interdisciplinary and holistic design and construction process (Figure 2). Thereby, the industry can overcome its structural crisis and introduce innovative processes.



Figure 2: Integration of all construction-related activities (Source: conject)

## 4 MOBIKO: A solution for a mobile collaboration platform

Without living project collaboration wholly, collaboration cannot evolve its whole efficiency on project management. Therefore, mobile services can provide easy to handle solutions for always and everywhere project management and the integration of all stakeholders of the value chain. It does not matter, where and when the participant is requesting or sending information. The complete integration of every stakeholder provides a complete transparency for project managers and investors (Figure 3).

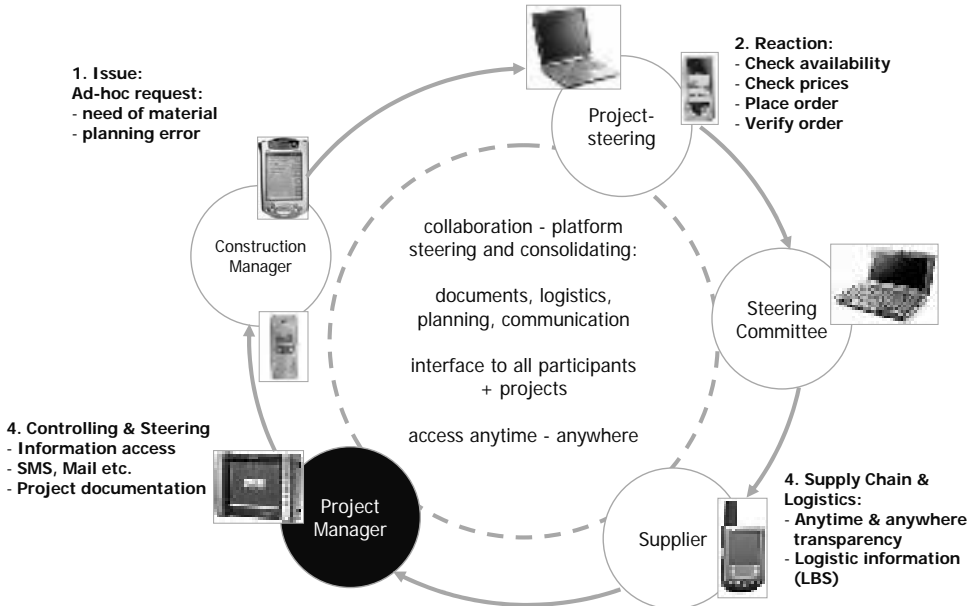


Figure 3: Mobile project management on construction sites (Source: conject)

conject is participating in the German research project MOBIKO which aims at developing a framework for mobile collaboration on construction sites. Partners of conject within this project are T-Systems, BIBA (University of Bremen) and Nemetschek. The main goals of MOBIKO are:

- Improving the processes in the real estate industry: Reduce risks and costs, enhance flexibility, fasten communication and ease documentation.
- Qualifying the construction managers and participants in the application of new technologies.
- Examining opportunities and efficiency potential of mobile services and collaboration processes – especially in respect to costs, time and quality.

The MOBIKO architecture (Figure 4) shows a possible mobile collaboration framework. The project will provide a collaboration platform with mobile gateways and functionalities for mobile access. A mobile middleware will establish, retain and control mobile access to the platform via W-LAN or UMTS. BIBA and Nemetschek will develop front-end applications for mobile devices. T-Systems will develop a mobile middleware for IP Roaming. With this technology, the user will not recognise, if he's connected to the MOBIKO System via GSM (GPRS etc.) or a Wireless LAN connection. Further it will establish a mobile IP and handle latency issues as well as session problems, i.e. if a connection is lost, the user still can go back to his last process.

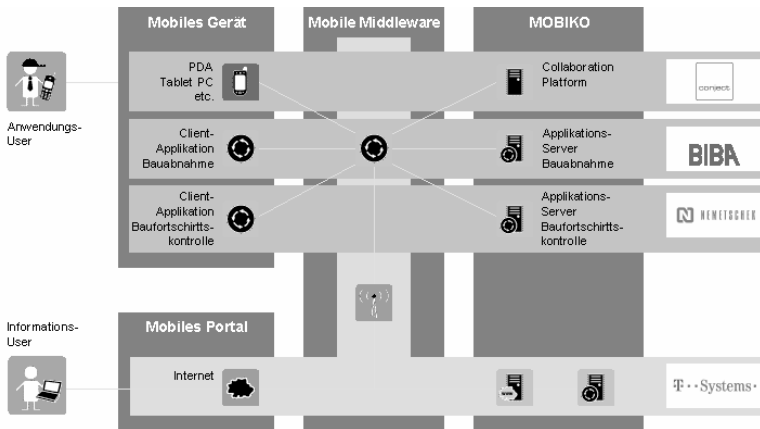


Figure 4: MOBIKO architecture (Source: MOBIKO)

## 5 Application Scenario: The project manager on construction sites

Within the MOBIKO project, different scenarios have been evaluated. The main scenarios will focus on project management, project documentation, construction audit and mobile acceptance. One scenario of MOBIKO that vividly illustrates the necessity for the 'mobile' nature of collaboration is the project manager visiting a construction site. The project manager has to check and compare the progress of the project with the project plan and document the present status. In order to immediately acquire relevant up-to-date information (e.g. dimensions, statements of costs, contact information) he needs wireless access to his headquarters where the requested information is hosted. The project manager possesses a W-LAN-enabled tablet PC which automatically connects to the preinstalled wireless LAN on the construction site. Via the construction site server, which provides a GPRS air interface, the project manager can seamlessly interchange information after identifying himself. Whenever he moves away from this spot, the mobile middleware will provide him a mobile-IP via W-LAN, GPRS or UMTS. The user himself will not recognise the change of the mobile gateway. If the providing of a mobile-IP is not possible, the session will be contained so that essential data will not be lost.

The downloaded information is exchanged via a XML/SOAP interface and integrated into his local hosted project management application. The next step will be to check the performed work on the site and compare it to the project plan. Deviations are electronically documented and saved in form of text, audio, picture or video. After performing this task, the project manager uploads the modified plan and its documentation wirelessly to the MOBIKO system. Changes in the project plan require coordination efforts from the project manager meaning to contact and to exchange information with different stakeholders who are affected by the deviations. This will require mobile collaboration between stakeholders and the project manager in order to prevent the consequences arising out of information loss, delays and interruptions within the project.

## **6 Inspection of profitability**

### **6.1 Detecting the Gaps: Analyzing Processes**

To assess the effects that mobile services can have for the construction and real estate industry, we first have to get a clear understanding where and how new IT technologies will affect this sector the most. From the technical point of view our approach to identify process improvements is similar to the business reengineering approach as suggested by Hammer and Champy [HC93]: The basis for a structured analysis of existing processes is the use of IT as a driving force of change.

However, in contrast to complete reengineering, we are rather interested in a gradual improvement of business processes. Therefore, it is important to identify the current processes as they are actually performed in the organization and not as they are supposed to be performed. This approach evaluates organizational change from different points of view (work place level, process level) and becomes even more important when assessing the effects of the improvements inspired by an IT-driven analysis on the business process. Consequently, our incremental approach suggested here is similar to Total Quality Management (TQM) and Quality Function Deployment (QFD) [Ma98].

Mobile solutions offer three possibilities which are not available with traditional IT infrastructure: mobile information processing, mobile communication and constant availability. The Enhanced Economic Evaluation focuses on three kinds of gaps which can be closed using mobile services [Hö03]:

- Gaps caused by data replication: Information is reproduced at different steps in the process. The infrastructure does not allow reusing the produced information.
- Gaps caused by access centralization: Information is only available at certain locations or steps in the process. The infrastructure supports on-line access only by means of indirection.
- Gaps caused by passive processes: Information is only available at request (“information pull”). The infrastructure does not actively distribute information to possible clients (“information push”).

To analyze business processes where mobile services can be applied, a four-step approach is used: In the first step, the general tasks of the construction and real estate industry are examined to describe the overall structure of the organization and the main information flows. In the second step, a more in-depth analysis of the actually performed activities is carried out. Its purpose is to identify activities accessing or producing information and to analyze whether this information is available on-line or off-line. Furthermore, the participation of the system in distributing the information (“information pull” vs. “information push”) is assessed. In the third step, activities which require access to information in the identified business processes are analyzed. Especially for the “information push/pull” analysis the initiating events for the generation and the use of information have to be identified. In the final step, the business processes are developed from the description of its activities by linking the workplace processes based on the described information flow. As a result of evaluating those links in the defined processes possible gaps can be detected, overcome and documented.

## **6.2 Defining the Objectives: Quantifying Improvements**

The Enhanced Economic Evaluation offers an appropriate and extensive approach to assess the influence of the implementation of mobile services on an organization [RHW96, PRW03]: In addition to the consideration of quantitative and qualitative (i.e. non-monetary) criteria it supports an integrated view of a decision’s impact. The Enhanced Economic Evaluation addresses the issues of network effects, economies of scope as well as shifts in time and space. Furthermore, this approach considers the specific circumstances and the impact of organizational change. As a consequence, many different variables for success evaluation have to be integrated.

In order to systematise the impact, the Enhanced Economic Evaluation uses a multi-layer reflection to integrate different points of view into one analysis. This idea dates back to research initiatives in Germany for information technology and telecommunication systems and characterizes a way to get an integrated view on organizational issues [An95; Ba96; Bod84; Ni88; PR87; RHW96; Re00; Za88]. It differs the following layers:

- **Workplace:** The impact on a specific workplace or workstation that arise from the introduction of mobile services is analysed.
- **Processes:** The focus lies on the effects of the work flow in the organization (e.g. preliminary process steps).
- **Organization:** he value effects of mobile services to the long term efficiency of an organization are gathered.
- **Society:** Analysis of the impact of mobile services on the labour market and the assurance of the location of the industry and the economy.

These Layers must not be analysed separately, but linked tightly. They represent different views to one economic action (i.e. the introduction of mobile services). For this reason we use them as an analytical separation to point out the correlations and network effects of



mobile services. Using this multi-layered approach we can apply different views within the construction and real estate industry.

The utilisation of distributed information is thereby reflected as one of the main problems of implementing new technologies in organizations. Experiences in the field of reorganizations show that the most part of information is already available within the organization but distributed in different locations [An95, De03, PRW03]. In the Enhanced Economic Evaluation the union of the distributed information proceeds as a moderated group process with the participation of employees from all relevant layers. In order to minimize the risk to adulterate the results it's necessary for the discussion to be moderated by a person outside the organization.

Every decision in an organization is related only to a specific situation: The potentials of processes, organizational structure and human resources demand an evaluation approach that considers the "subjective" needs and specific targets of an organization. The Enhanced Economic Evaluation approach uses a criteria catalogue to support the evaluation process in an efficient way and to present details of the specific situation clearly showing the decisions, which led to the obtained results. This catalogue consists of different basic sets of criteria and can be modified to match the specific needs.

Finally, for aggregating all criteria containing several layers it turned out to be useful to apply the value benefit analysis. Therefore, the different criteria get on the one hand a weight assigned according to their importance to the participants of the workshops. On the other hand the criteria are linked to a scale that helps to attach the parameter value of criteria to an achievement of objectives. To get a integrated evaluation meeting the specific needs and including the distinctions of an organization the points of criteria are multiplied with their weight and summed up to get the result of the evaluation.

### **6.3 Identifying Solutions**

As described above, by the usage of business process analysis we obtain a detailed description of the interactions performed during in-field business processes. By focusing on the activities generating and using information and later on identifying classes of coherent information, we are able to extract the data flow behind those processes. This method leads to an information-centric view instead of a process-centric view. Using the information centric-view, the interactions from the business processes can be used to develop a life history of the different classes of information including its generation, transformation/update, use and destruction.

Assuming different possible mobile IT infrastructures, different optimized processes can be defined. However, the optimized business processes describe a system that is optimized with respect to the functional data flow of the organization. For the adaptability of this mission-critical solution, non-functional aspects of the solution often are of even bigger impact than the functional aspects. As mentioned above, using the Enhanced Economic Evaluation, we obtain metrics to quantify the impact of a solution on the individual as well as on the organizational level by including different aspects like costs, time and qual-

ity, as well as flexibility and personal situation, or public appearance and security [RHW96].

To apply this approach, different improvements have to be described in form of configurations. These configuration include:

1. Select the processes to be substituted and the substituting processes (since in different configurations different organizational changes are assessed).
2. Identify the necessary IT infrastructure (possibly fixing possible variables like bandwidth, reaction time and size of display).
3. Develop usage profiles (number of users, number of request, amount of data etc.).

Using these configurations, we can describe a possible optimized system in sufficient detail. For example, an optimized mobile access to a database can offer the following positive factors:

- **Flexibility:** Access to data base is independent of time and space and leads to a secure communication and documentation.
- **Quality:** Possible errors in the transmission are minimized and facilitate project steering and control, help to avoid information-loss and make the current project status available at anytime and anyplace.
- **Time:** Time to obtain information is reduced (elimination of delay times) and leads to real-time communication and project management and better tracking of essential information.
- **Public appearance:** Minimized interaction time with involved parties and higher quality of response lead to better acceptance, better quality and better results for project reviews. New processes will lead to minimized risks, costs, enhanced transparency and a better reputation of the construction and real estate industry.

## 7 Conclusion

Mobile collaboration can be seen as a key to solve the main problems of the construction and real estate industry: Internal processes and bad reputation. By addressing these problems actively the industry can re-win the reputation that is adequate for its social and economic importance. This offers the possibility for a paradigm shift from traditional, hierarchical to project-oriented organisations. We introduced the Enhanced Economic Evaluation (EEE) as it offers a valuable assistance for the design and implementation of innovative mobile solutions. As far as non-quantitative goals are concerned, this approach helps to find suitable criteria set for a holistic evaluation. Therefore, the Enhanced Economic Evaluation is regarded as a promising approach for finding a solution for a mobile collaboration platform which is the main aim of the German research project MOBIKO. Of course this approach can also be used for a wide variety of other problems.

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