Business Patterns: Towards Conceptual Modeling for Mobile Workforce Solutions

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Abstract: Business patterns describe reusable approaches to the solution of particular business problems, based on previous success in defining solutions to the same or similar business process. Although mobile workforce solutions offer organizations the potential to optimize employee performance and business operation, research has shown that it is complex to design mobile workforce solutions due to lack of theories and methods. There is need to provide effective design approaches that can be used to develop solutions that meet these challenges. Considered from a problem solving perspective, the application of business patterns to design mobile workforce solutions is investigated in this paper. Different business patterns are presented, and a dispatching pattern is explained based on a real case. Through the case we found out that using business patterns may enhance the efficiency in conceptualizing the mobile workforce processes, and hence improve the design approach of mobile workforce solutions.

Key-Words: Business pattern, mobile workforce solution, conceptual modeling

1 Introduction
Mobile workforces are defined as people whose professional tasks can only be completed in a “mobile environment”, which refers to the user’s mobility and the lack of wired infrastructure for telecommunications (Anker 2003). Examples of mobile workforces are salespeople in the field, traveling executives, people working in corporate yards and warehouses, and repair or installation employees who work at customers’ sites.

Mobile workforce solutions are interventions that intend to blend voice, video and data communications seamlessly to exploit the potential for mobile workforces anytime and anywhere. Specifically, they enable a business or public service to optimize employee performance having the right information in the adequate format, delivered in the demanded way, when and wherever they need it and/or have to report back. The main advantages of mobile workforce solutions are: standardized work processes; dynamic dispatch/scheduling; improved workflow management; enhanced on-site decision making; increased customer satisfaction; efficient collaboration and coordination; and better administration of mobile personnel.

Current research and practice has shown the complexity of designing mobile workforce solutions, and highlighted the challenges faced when doing research in this field. Kalakota and Robinson (2002) use the term “mobility-enhanced” to characterize the new set of business processes and point out that implementing mobility-enhanced internal and external business processes will be most difficult and challenging because there is a lack of theories and methods in this specific domain.

Yuan and Zhen (2005) point out that while mobile technologies promise to have great potential to fundamentally change the way of doing business, how to make the change and how to deal with it are still unclear. The dynamic workplace and irregular work temporal structure are the most important characteristics for mobile work, how to deal with them is very important for the design of a mobile workforce solution. This research issue is the trigger of our study.

The main research question is therefore formulated as: what is an effective design approach for mobile workforce solutions? Using a problem solving perspective, we suggest that conceptualization is the first step towards such an approach. We present our preliminary research results in this paper. The remainder of the paper is structured as follows. In section 2, we conduct a literature review on existing design approaches. In section 3, we introduce a simulation-based problem solving process, which lays a ground for the development of our design approach; we further discuss the importance of conceptual modeling in such a design approach, and propose the use of business patterns for efficient conceptual modeling. In section 4, we present how the business patterns are...
implemented. In section 5, we present our conclusions of the paper.

2 Literature Review
The approaches and technologies for supporting new ways of work, such as mobile collaborative work, are still the subject of research. Nevertheless, they are likely to "borrow" concepts and technologies from a variety of fields, such as workflow systems, CSCW, software architecture, mobile computing, and so on. We therefore reviewed literature from different disciplines.

Sallnas (1998) discusses how informal and subtle aspects of social interaction are critical to accomplishing work and consequently need to be taken into special account in design or redesign of technological support systems for mobile team workers. The research by Sallnas (1998) reveals the most important patterns of activities for communication, coordination, cooperation and production and consumption of information.

Dyson and Er (2004) propose a hybrid design approach to the development of mobile systems in the construction field, which 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 Information Technology 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.

Pulli and Antoniac (2002) present a scenario-based analysis and design approach for mobile and ubiquitous service development. They propose early visibility of services through partial service scenarios and use of different levels of abstraction and detail during lifecycle of development in order to narrow-down design choices yet allow creativity and innovation. They propose to start looking into a biological view of system development through Darwinian evolution, i.e. try to encourage diversification through experimentation ("mutations"), and to evaluate and constrain the best variations for further development ("breeding") through a value function framework ("selection by nature").

Sorensen et. al (2002) suggest different attributes that could be used to describe mobile work processes. They presented a characterization framework which focuses on the mobile work itself and tries to derive the functionality, architecture and hardware required to support specific mobile scenarios. Sorensen et. al (2002) believe that the usage of such a framework will allow them to explore typical classes of mobile work with different process and transaction support.

Sawyer and Tapia (2003) view mobile work from the work redesign tradition. Work redesign provides a means to link work to the larger context including the use of various technologies. Sawyer and Tapia (2003) propose a 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 literature review shows that a number of solutions to mobile process support have been developed to address the needs of workers whose work situation is inherently mobile. Different design approaches have been proposed or practiced, but none of these approaches are rooted in a problem solving thinking. We look at designing a mobile workforce solution as a problem solving process due to the fact that several possible courses of action can be identified to improve the problem situation, and that the new mobile workforce environment contains factors that affect the possible courses of action that we as designers can take.

Designing mobile workforce solutions is a complex activity that can be seen as solving an ill-structured problem and one that involves many actors i.e. problem owners and stakeholders, who have different goals and objectives in the design process. The problem owners are organizations that want to implement the mobile workforce solutions, while the stakeholders include the workers in such organizations. Several problem-solving cycles can be used to address ill-structured problems, and in the next section we present one such cycle based on the concept of simulation, that can provide support for the design of mobile workforce solutions.

3 Towards Business Patterns
3.1 Problem solving process
Simulation is a powerful problem solving methodology that is widely used in business process modeling, and one through which models can be used to provide organizations with dynamic insights into the complex world of mobile workforces. A simulation-based problem solving process is given by Sol (1982) based upon (Mitroff, et al. 1974), as shown in Fig 1.

In this problem solving process, four stages are illustrated linked by activities. The four stages are
the perceived problem, the conceptual model, the empirical model and the solution. The conceptual model defines the variables that will be used to specify the nature of the problem in broad terms. The empirical model specifies the conceptual model in terms of the system.

The first activity in the process is the creation of a mental model of the current problem situation. The second activity is to make a detailed specification of the problem situation to construct a descriptive empirical model. Before this model can be used to diagnose problem situation, it has to be tested to determine if it is a sound representation of the problem situation. This activity is called a correspondence check. The next activity is to analyze the problem situation and generate solutions for it based on the empirical model. Solutions are translated into the terms of the empirical model, transforming the descriptive empirical model into a prescriptive empirical model, the experimental model. Solutions generated by the empirical model that shows a good correspondence, have to be consistent. The consistency check activity is used for this purpose. Finally, in the last activity of the problem solving process the solution has to be implemented in the organization to solve the problem situation.

Fig 1 Problem solving process (Source: Sol (1982))

In this paper, we hold the perspective that designing mobile workforce solutions needs to follow a problem solving process. The first stage in all types of problem solving is to understand the area of concern, and we limit ourselves to the conceptualization stage of the problem solving process model presented by Sol (1982) in the remainder of the paper. There is a need for reusable knowledge to solve “conceptualization” issues that are common in designing mobile workforce solutions and process.

One way of effectively modeling concepts in a business process is through the use of patterns. Patterns are about the reuse of knowledge, and provide general conceptual models that allow the sharing of ideas and abstractions between business analysts during the conceptualization phase (Eriksson and Penker 2000). In this paper, we hold the following proposition: using patterns for conceptual modeling is more efficient than constructing conceptual models without patterns. In the next section, we present a discussion on the use of patterns in conceptual modeling.

3.2 Using patterns for conceptual modeling

Patterns can be used to help, first, understand a problem situation in the context of business modeling and, second, how to deal with problems in that situation (Eriksson and Penker 2000). Patterns are thus useful in analyzing business situations -- the conceptual modeling phase. Analysis can be focused on understanding existing business process through modeling; it can also be an attempt to model an improved business process in order to implement it.

Patterns are a general solution to a recurring problem within a given context, as proposed by Christopher (1979). The three key parts of the pattern definition are:

Generic Solution. This means that a pattern does not define a specific solution. Rather, it identifies the ‘class’ of problem and how that problem might be solved with a particular approach, based on some demonstrable evidence. Its power is derived from the fact that it is an abstraction that can be leveraged across a large number of situations.

Recurring Problem. This means that patterns are useful when the problem is not unique, and are most useful when the problem occurs a lot.

Defined Context. This means that you have to put bounds on the generic solution because there are no universally true solutions (at any useful level). So you have to understand the circumstances in which this generic solution is valid, and hence how to elaborate on it to create your own specific design.

The ideas presented by Christopher (1979) are rooted in architecture. Since the 1990’s, ideas of patterns derived from his work are applied in software engineering by a number of researchers. Recently, many new applications for patterns have emerged, such as organizational patterns (Coplien and Harrison 2004), business patterns (Eriksson and Penker 2000), knowledge management patterns (May and Taylor 2003) and patterns for business process modeling (Kavanagh 2004).

In our work we are concerned about the use of business patterns. A business pattern describes a re-usable approach to the solution of a particular business problem, usually scoped by a business
process (Teale and Jarvis 2004). It offers a solution based on previous success in defining solutions to the same, or similar, business problems.

Kavanagh (2004) proposes a pattern language for business process modeling, given that “there is often a lack of precision in the terminology used to describe processes, for example flow diagrams, activity diagrams, and information models, all of which are used synonymously with business processes”. The pattern language aims to offer a more standardized approach to business process modeling, presenting business processes in a consistent, communicative and less complex manner.

Grounded on the work of Eriksson and Penker (2000), May and Taylor (2003) and Kavanagh (2004), we define the format of our patterns as presented in Table 1.

<table>
<thead>
<tr>
<th>Name</th>
<th>Every pattern has a short, distinct Name, which is a metaphor for the pattern. The name should be one that can be easily associated with the structure of the pattern.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intent</td>
<td>The Intent section describes and summarizes the general purpose of the pattern, answering the questions: what does the pattern do? What problems does it solve?</td>
</tr>
<tr>
<td>Context</td>
<td>The context in which the pattern emerges</td>
</tr>
<tr>
<td>Solution</td>
<td>The solution stated in a few sentences</td>
</tr>
<tr>
<td>Related pattern</td>
<td>A list of patterns that are closely related to this one</td>
</tr>
<tr>
<td>Example</td>
<td>The example section provides a concrete model, an implementation example, where the pattern is used to solve a problem.</td>
</tr>
</tbody>
</table>

Table 1 Format of the pattern

4 Implementation

4.1 Business patterns

In this subsection we present nine patterns for designing mobile workforce solutions based on the work in Table 1. These patterns, as well as the relations between them, are sketched in Fig 2.

- Track and trace pattern: to handle issues of tracking and tracing mobile workers
- Dispatching pattern: to handle matters related to dispatching mobile workers
- Job allocation pattern: to handle workload management for mobile workers
- Performance measurement pattern: to solve problems in measuring mobile workers’ performance
- Time management pattern: to solve time-management problems of mobile workers
- Information update pattern: to solve problems of synchronizing information among mobile workers
- Mobile inquiry pattern: to solve problems in accessing enterprise information systems from the field
- Task automation pattern: to solve problems in changing paper-based tasks to electronic-based tasks
- Field authorization pattern: to solve authorization problems of remote access to enterprise information systems

Fig. 2 Patterns and their relations

In this paper, we do not explain all these patterns in details, and instead take “mobile inquiry pattern”, “task automation pattern” and “dispatching pattern” as examples. To get more details on what each pattern looks like, the reader is referred to Table 2, 3, and 4. Given the limited space, we only illustrate the dispatching pattern with a concrete example, see subsection 4.2.

<table>
<thead>
<tr>
<th>Name</th>
<th>Mobile inquiry pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intent</td>
<td>Increase productivity of mobile workers by providing enterprise data at the point of performance.</td>
</tr>
<tr>
<td>Context</td>
<td>The mobile workers perform certain tasks that need an access to enterprise data, such as ERP, CRM or SCM systems.</td>
</tr>
<tr>
<td>Solution</td>
<td>Real-time or instant connection through GPRS</td>
</tr>
<tr>
<td>Related pattern</td>
<td>Field Authorization pattern</td>
</tr>
<tr>
<td>Example</td>
<td>N.A. (not available)</td>
</tr>
</tbody>
</table>

Table 2 Mobile inquiry pattern
### Task automation pattern

<table>
<thead>
<tr>
<th>Name</th>
<th>Task automation pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intent</td>
<td>Streamline existing business processes by eliminating reliance on costly, time-consuming paperwork. Improve accuracy and timeliness of data collection to meet customer needs and enhance management's decision-making capabilities.</td>
</tr>
<tr>
<td>Context</td>
<td>Many mobile workers accomplish their work by collecting data in the field and make reports in paper forms.</td>
</tr>
<tr>
<td>Solution</td>
<td>Choose appropriate handhelds and applications, like electronic forms. Develop applications to synchronize the data in handhelds and the enterprise information systems.</td>
</tr>
<tr>
<td>Related pattern</td>
<td>Info. Update pattern</td>
</tr>
<tr>
<td>Example</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

Table 3 Task automation pattern

<table>
<thead>
<tr>
<th>Name</th>
<th>Dispatching Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intent</td>
<td>Increase routing efficiency of mobile workers by knowing their positions. Mobile works that have operational tasks, like repairers and maintenance workers, are traditionally dispatched in an inefficient “batch-processing” manner</td>
</tr>
<tr>
<td>Context</td>
<td>Constant and timely update and placement of the distributed work planning based on location information through GPS + GIS application + GPRS connection</td>
</tr>
<tr>
<td>Solution</td>
<td>Track and trace pattern</td>
</tr>
<tr>
<td>Example</td>
<td>See section 4.2</td>
</tr>
</tbody>
</table>

Table 4 Mobile dispatching pattern

#### 4.2 An example of dispatching pattern

The dispatching pattern example is based on a real case of a leading patrol & response company (referred as company X in this paper) in the Netherlands, where mobile guards play an important role in company’s main business operation. There are mainly three parties involved in the company’s business operation. Their roles and relations are specified as fellows:

**Customer:** This is the end user who has contracted with company X for patrol and response service. In the customers’ building, alarms are installed by alarm utility company who also own the Alarm Receiving Center.

**Alarm Receiving Center (ARC):** In this case, we simply refer ARC to switchboards receiving signals sent by alarm systems installed on the premises of end users. After an alarm signal is received, these switchboards call the company X to conduct appropriate interventions on the customer site.

**Company X:** Within the company, there are mainly two types of actors can be distinguished by their functions: Dispatching Centre is responsible for planning action after receiving an alarm, assigning intervention tasks to mobile guards, and coordinating mobile guards during their intervention. Mobile Guards are the patrol workers who receive assignments from Dispatching Center to intervene the alarm at customer site.

The high level business process is summarized in Fig.3. The event is started when an alert is sent to alarm receiving center. The alarm receiving center then forwards the alarm to the dispatch center. The dispatch center responds by assigning a guard to intervene the alarm. The guard, who conducts patrol service, will drive to the alarm location and process the alarm.

![Fig. 3: High-level business process](image)

Mobile workforce solution is expected to enable time-critical planning through real-time location based services, so that the dynamic dispatching mechanism will increase the efficiency of company X’s business operation. We explore the dispatching pattern to formulate the first conceptual model in this case within a very short time scope.

The definition the dispatching pattern draws our attention to understanding the process in detail. We first conceptualize the dispatching process in UML activity diagram, see Fig. 4. When DispatchCenter receive an alert, it will ask for guard from GuardLocationServer (reflects a GIS system). GuardLocationServer updates location information of all mobile guards real timely, and the information is used by ShortestPathCalculation (reflects a software application) to find out the nearest mobile guard to the alarm site. Based on the result, DispatchingCenter will then assign task to the selected guard directly.
A simple object model (see Fig. 5) is constructed easily on the basis of the activity diagram. This object model represents our quick conceptualization of the dispatching process under investigation. The model serves as a first platform for discussions within project members, including business analysts, system integrators, software developers, and problem owner. It is proved as an efficient means to reach a common starting point among the team towards the final design of the workforce solution.

5. Conclusions
In this paper, we introduced the initial findings of our research work in progress. We suggested a problem solving based approach for designing mobile workforce solutions. We further argued for the use of business patterns in such an approach to improve the efficiency of conceptualizing the problem situation. We defined a set of business patterns, and explained one of them in a real case. The result shows that the dispatching pattern helps the designers in quickly understanding the problem domain, and conceptualizing the business processes. As a result, it supports the problem-solving approach of designing mobile workforce solutions.

References: