Design Principles of Web-based Services in Large-Scale e-Logistics Processes

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Abstract: E-logistics is defined to be the mechanism of automating the logistics processes and providing an integrated, end-to-end fulfillment and supply chain management service to the players of logistics processes. In this article, we take a look at the design of Web-based Services in the area of e-logistics. We describe our ongoing research investigations aimed at defining a user-centered design approach that uses the concept of persona to analyze and model the future users. It aims also at deriving a conceptual design and prototypes from the different persona. The approach has been applied to identify, define and design Web services in a large-scale complex logistics system used by a large food company.

Keywords: large-scale complex systems, complex organization, Human-Computer Interaction, logistics, e-logistics, web services, service-oriented architecture (SOA), business process, persona, modeling.

1. INTRODUCTION

The rapid evolution of technologies, hardware complexity, process automation development, and introduction of IT in all business functions, induced important changes in human activities in complex interactive systems. Faced with dynamic, complex and various situations that may be caused or triggered by the imperatives of production or market, the actors are forced to react and interact accordingly either inside or outside the company (subcontractors, suppliers, etc.). The organizations becoming more and more complex, the needs and attempts about interactive systems evaluate. Thanks to the support of new IT, different information supports are now more and more used or usable (mobile phones, PDA…) by the different actors; new services become conceivable. Therefore, taking into account the changing needs of different actors (Fig. 1) in the development cycle of these interactive systems becomes imperative. The technologies of Web services and the SOA model offer prospects for creating new interaction models for human actors in complex organizations (Idoughi and Kolski, 2006).

It is necessary to propose new human-centred and service-based approaches. A new concept, the persona, is particularly promising when considered in complex organizations. The persona is a fictitious person describing a target group of users. The description of a persona includes name, first name, gender, age, patterns of exploitation related to the target product, and many other attributes depending on the domain studied. In fact, the persona is a typical representative of a class of users, and aims to give a real existence through a character (often fictional) of the user class (Cooper, 1999; Seffah et al., 2009). We consider in this article the persona as a tool for analyzing the behavior of the final user: more precisely we integrate the persona in the development process of complex systems, to establish relationships with other data sets through artifacts, such as matrices of persona characteristics and task descriptions (Pruitt and Grudin, 2003).

Fig. 1 New interactions in large-scale complex systems

After a description of the foundations and motivations of a service-oriented approach for complex interactive applications (more detailed in Idoughi, 2008; Idoughi et al., in press), we explain the basic principles for analyzing and modelling complex systems based on web services. The approach proposed in this paper is original: indeed its particularity is to exploit the persona concept. We show its feasibility in interactive application design in logistics domain (implying e-logistics concepts); this study is extracted from a more global real case study in large agri-food Industry Company. A conclusion and perspectives end the paper.

2. SOA AND INTERACTIVE WEB SERVICES

2.1 Key notions and concepts

Service Oriented Architecture (SOA) is a methodological framework encompassing a set of concepts and techniques for building service-based. SOA is a development approach decomposing all in services (software components) (De Gama, 2003; Avignon, 2002). It addresses a specific need within reusability, simplicity and interoperability aims, and can hide the heterogeneity of the information system of the company. It is mainly based on the service notion. It is
also motivated and driven by: (1) the business, which requires the information system of a complex organization to evolve in response to constant and frequent changes of business requirements and (2) technologies, providing opportunities through the emergence of new needs due to changes in technology offer (internet, mobile phones...).

A service is a software component providing actors (human, equipment, software ...) involved in business processes of a complex organization with an access to one or more business functions through several operations. From an analytical perspective, a service is a loop of interaction between supplier and consumer of the service, while maintaining a service contract (Fig. 2).

When the target application is interactive, one need user-oriented web services to be deployed across multiple distribution channels; they allow applications, computers and business processes to interact, and provide an unified access to a set of remote services, adapting the information presentation to the distribution channel and user profiles (Kadima, 2003).

2.2 Methodological aspects related to service-oriented approach
The service-oriented approach is an organizational approach to computer applications based on the emergence of a services layer; this layer has to offer a logical view of data and treatments which exist or have to be developed. The key methodological issues, both conceptually and organizationally, related to SOA, include in particular: (1) service-oriented analysis and modelling, (2) business modelling. Our proposal in this regard is the subject of the third section.

The first motivation concerns the so-called applicative blocks (or silos). Indeed, the enterprise applications are usually grouped into blocks according to the organizational structure of the company. The company is often functionally organized, that is to say that there are relatively fragmented services such as planning department, Scheduling, Purchasing, Production, Sales, Administration, and so on. Such a configuration leads to a vertical division of the information system around application blocks; they can be isolated and autonomous and do not allow complete transverse tasks. More, it creates information redundancy and makes difficult the communication between applications. All this makes difficult the processes integration.

By cons, with the SOA (Fig. 3), one considers that business processes become cross-applicative or cross-organizational and could be better integrated in complex environments.

So companies should be organized around key business processes and provide all the means to drive them. In the implementation of that process-driven organization, it is important to map, control and optimize the business processes that can bring value to the company.

Fig. 2 Global services model

Fig. 3. Organization services Layered (Zimmerman, 2004)

3. THE PROPOSED METHODOLOGY

3.1 Description
For the service oriented interactive applications design, we aim to stay within an agile methodology (cf. www.agilemodeling.com) using the Unified Process (UP) instead of a purely bottom-up or top-down approach. UP suggests an iterative approach, use cases driven and architecture oriented. Moreover, the proposed approach takes its source from the user centered design approach as defined by (Norman, 1986; Shneiderman, 1987; Lepreux, 2003). Furthermore, it considers also the characteristic features of the development methodologies of web services such as those presented in (Poh Lee, 2006; Zimmerman, 2004). Its foundations, initially tackled in the domain of industrial supervision comes from (Idoughi et al., 2006; 2007). It proposes to split a project into four main phases where we find the main development activities conducted in an iterative and incremental manner (fig. 4).

Fig.4. Global methodological framework
In this paper, after the presentation of the main phases, we mainly focus on the first phases, preceding the design of interactive services.

3.2 The main phases

In the phase 1, a preliminary analysis of the complex organization is conducted through three types of analyses: (1) business analysis conducted from the service oriented objective, (2) task analysis to show up the global human-machine system decomposition into different sub systems and distinct processes simpler to consider or to deal with, (3) user analysis identifying the main business actors implied and the potential users of the future system.

In the phase 2, a second level of requirement analysis expressed in the phase 1 is necessary in order to express these requirements and needs in terms of web services and human actor’s mobility and cooperatives tasks.

The phase 3 aims to specify the complex system HMI exposing in forms of web services the system functionalities based on the results of the precedent phases.

3.2.1 Business analysis

This step aims to discover a first set of candidate business services. It consists of a hierarchical decomposition of the business domain in forms of functional domains (fig. 5), thus to highlight the whole business processes and corresponding use cases. These make good candidates for high level business services (Zimmerman, 2004).

Moreover, we also proceed to the decomposition of the existing applications within the complex system such as Manufacturing Execution System (MES), Enterprise Resources Planning (ERP), Client Relationships Management (CRM), etc., in a form of applicable modules that might realize the business services previously identified. It consists therefore to apply a bottom-up approach (from the existing system to business and processes services) (fig. 6).

3.2.2 User and task analyses

This is about identifying and analyzing all the user types implied in the business processes of the complex organization. This is done by using the user gathering techniques (usability tests, contextual and individual interviews, focus groups, card sort, etc.). Furthermore, tasks analysis is also conducted in order to complete and enrich the business use case model using models such as SADT/Petri (Abed et al., 2001), CTT (Paterno, 1999).

Using the information about the users and their tasks, we may identify the main users groups. Afterwards, we consider the most representative characteristics of the users groups that might be transformed into persona. It is then possible to identify the features and functionality that will make the complex system a success, and how the design can meet different goals and levels of skill. Persona can direct the vision and design of an acceptable solution (fig. 7).
3.2.3 Business services identification and categorization

This step consists of deducing the candidate business services from the use cases issued during the first phase; grouping and categorizing them into packages (a package reflects one business service category). These categories may be exploited in the services synchronization (Peltz, 2003) and composition (Claro, 2006) process (fig. 8).

![Fig. 8 Business services categorization](image)

3.2.4 Mock-up and prototyping

The mock-up and prototyping step starts by elaborating the mock-ups of the complex system HMI accordingly to the business scenarios along with the identified personas and their needs in terms of interactive services. Afterwards, from a set of mock-ups, we move towards developing a prototype that may offer a more or less view of the final services based HMI of the system. Meanwhile, it is necessary to have the feedbacks from the users so that to validate the different HMI components (fig. 9).

![Fig. 9 Use of personas in the mock-up and prototyping process](image)

4. CASE STUDY

4.1 Description of the case study

This section presents a complex and representative case study. It is about the logistics of an agro-alimentary multi-site organization. It uses many independent heterogeneous information systems which imply different categories of actors (human or not). The logistics dedicated system necessities to propose HMI for the different actors.

The information about the management, monitoring and execution of the logistics process may be issued from different sources and from different structures of the enterprise on one hand, and on the other hand from the partners’ structures as well. This happens in a dynamic and evolutive context. Moreover, there may be situations where some human actors interact with some others (human or not) in a cooperative work (services agency, transport, etc.). Thus, the human actors with their central role(s) in the logistics process may need some different computing tools to have the necessary information graphically displayed appropriately in order to accomplish their different tasks. These tools generally coupled to different types of modules describing and synthesizing the status of the logistic process help the actors during their respective tasks accomplishment.

4.2 Application of the approach

This section illustrates only the main steps of the phases.

4.2.1 Business analysis

Many processes have been identified: warehouse management, procurement, transport, distribution, documentation… (fig.10). Afterwards, we proceed to the business modeling of the processes which yields to extraction of functional definitions (potential functionalities) focusing mainly on well chosen and prioritized business scenarios.

![Fig. 10 Example of Logistics business processes](image)

4.2.2 User and task analysis

As an input of the organizational analysis, we identified several types of user actors including logistics assistant, logistic projects managers, manufacturing engineer, logistic department head, product line director, purchasing director, factory and production unit director, supply chain manager, etc. The organizational analysis leads also to the identification of several tasks. We distinguish between two types of tasks:

- Tasks such as the identification of potential supply partners from inside as well as from outside the company, transportation and custom operations for the shipping of products to a storage unit or the place where the product are package and prepared based on an issued invoice.
- Tasks such as storage, packaging, preparation of purchase, transportation, etc.

From such information about the different types of users and their tasks, we defined the main groups of uses by clustering the users with the same similarities in term of tasks and personal attributes. We represented each of these groups of users by a persona. A persona is an artifact that consists of a narrative relating to a desired class of user’s daily behavior patterns, using specific details, not generalities. Figure 1 is an example of persona using the format described in (seffah et al., 2009).
Tab. 1 Example of a persona

<table>
<thead>
<tr>
<th>Components</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Picture</strong></td>
<td><img src="image" alt="Picture" /></td>
</tr>
<tr>
<td><strong>Identity</strong></td>
<td>Peter Born is a logistic engineer specializing in automates for the main production chain, 42 years old, married, 3 kids</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td>Main user of the system</td>
</tr>
<tr>
<td><strong>Objectives</strong></td>
<td>Peter is in charge of managing the flow of goods (products, materials, etc.). He aims to streamline the interactions between purchase orders, production and delivery. This is done with the perspective to optimize the efficiency, reduce the costs and time while taking into account less commitments and the constraints of the organization. His responsibilities include both inside and outside activities.</td>
</tr>
<tr>
<td><strong>Knowledge and experience</strong></td>
<td>Peter has a bachelor degree in logistics and certificate in quality assurance. He was trained in production and mass distribution. Compared to his colleagues, he has a strong background in using computer in customer relationship management. He is the only manager of logistics during the last 10 years.</td>
</tr>
</tbody>
</table>
| **Activities or tasks** | • **Key tasks**
  - Develop the procedures and analyze the key performance indicators
  - Peter has to identify and develop all the procedures to manage the workflow, dashboard, update the databases to keep track of the different activities, production plans, develop and optimize the prediction tools, analyze the problems and suggest improvement and correctives solutions
  - **Secondary tasks**
  - Initiate and follow up of all operations
  - Define and process supply orders, supply chain management, select and manage contractors. |
| **Work relationships** | Peter has to interact with all the operational services including purchasing, production, distribution, marketing, etc. He has to participate in the relationship with suppliers, production, distribution, marketing, clients, etc, dealing with customs services, policy makers, etc. |
| **Cognitive Profile and needs** | It is not easy to work with Peter. His expectations are very high; he is never satisfied with the work done by others. He is never sure and needs to ask his boss always. He dislikes working under pressure, but likes to work with young employees while providing them with tips and hints. |

| Attitude and Motivations | Peter is a fast learner, he is up to date regarding new technologies in his area of expertise logistics, and he has a strong interest in the Internet and mobile computing. |
| Expectations | Peter wants that the system be like him: precise, strong and powerful. |

3.2.3 Business services identification and categorization

This stage consists of deducing the business services candidates from the use cases and scenarios that might be derived from the persona. For example, in the case of a scenario related the process of product delivery and the persona detailed in the previous section, we have been able to identify the interactions with the different participants. The potential human participants in the scenario are: the final customer, sales person, and transportation agent. The different required services are the management of service orders and transportation. Therefore, proceeding in a similar way, for the whole scenarios that might be driven from a persona and for all identified personas, we can highlight a whole set interacting web services including for clientele, authentication, personalized visualization panel, as well as a collaboration service.

3.2.4 Storyboarding and prototyping

To illustrate how a prototype can be derived from the persona and the scenarios, one can consider the logistics scenarios derived from the previous persona. The scenarios first are illustrated with different possible storyboards. These prototypes are then combined and refined in a unifying prototype. Such prototype features the key functionalities of the system, the interaction style as well as the usability properties of the future system. Figure 11 portrays an example of the prototype that can be derived from the previous persona.

![Fig. 11 An example of a storyboard](image)

6. CONCLUSIONS ET PERSPECTIVES

In this paper, we discussed the foundations of a persona-driven and service-oriented design approach while portraying how it can be applied in design of Web services in large complex e-logistics systems. We mainly show the link between persona, Web services and the development of a
conceptual design from persona. The proposed approach has been applied in the context of e-logistics processes in a large-scale and food industry. A focus on qualitative and quantitative attributes of the user persona is a central issue in our work. More investigations are needed to detail the information which is contained in their personas, how they are represented, and how they are mapped to actual design artifacts. Furthermore, it is unclear if and how precise interaction behavior is addressed in their personas.

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