A Model-Driven Service Design Toolkit: From Co-Design to Implementation

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Abstract: This work presents a model-driven design process, by which our research team successfully developed a cross-platform system to support an innovative service in short time. Essentially based on co-design and agile development approaches, we applied methods and models developed in user experience design, marketing management and software engineering in our development process. This work presents how these models can play the roles as both communication tools and boundary objects to help practitioners, stakeholders, business analysts, designers and end users work together and participate in all stages of the iterative design process.

Key words: Service design, interaction design, emerging design methods, inter-discipline, usage-centered design

1. Introduction

For the rapid and complex IT product development, much research discusses what types of methods and frameworks are suitable to support participatory design and co-design for rapid and complex IT product development [1-3]. These design approaches generally emphasize the necessity for all stakeholders and development team members to understand end users and real usage contexts. However, the emerging domain of service design not only needs to develop useful systems and satisfying usage contexts, but enhance entire user experiences and create new values [4,5].

To gain insights for designing tangible artifacts and support intangible experiences, service system development therefore requires thorough investigations of interested activities, contexts, and target groups' emotional needs [5-7]. Other challenges emerging from the development of large-scale, social and entertaining service systems, include designing adaptive systems for diverse user types [8], supporting users' social and complex activities [5,9], and aligning experience and interaction design for cross-platform systems [8]. Due to the increasing complexity in service design practices, many scholars have highlighted the importance to integrate insights, methods and knowledge from a variety of disciplines (e.g. sociology, psychology, design, computer science, marketing and management) [10,11].

Beyond traditional multidisciplinary co-design and participatory design, we consider that a more integrative and inter-disciplinary approach is needed to reflect the complexity of service design in practices. Therefore, it is crucial not only to identify suitable tools and methods to enhance communication and knowledge exchange among all stakeholders, but also to support transitions between development process stages.

In this work, we present a case study, a development of a context-aware, social and entertaining service system in a rapid manner by applying–different methods and models developed in design, marketing and software

engineering. Based on the user testing and the evaluation of the project, we identified each model's role, strength and weakness in an interdisciplinary and agile development process. The benefits we found while applying them as communication and design tools will be presented, and the challenges to bridge the gaps between models will also be discussed.

2. Model-Based Analysis and Development Techniques

One of the main challenges of co-design and multi-disciplinary projects is to bridge different perspectives and knowledge of all domain experts, stakeholders and development team members. In the past decade, applying models for developing and demonstrating knowledge or for presenting ideas have been well accepted in IT projects, since these graphic representations offer a simple way to deliver complex concepts [1,12]. For instance, many model-based languages in software engineering have been developed to help both designers and engineers establish a system at a more conceptual level [12-14]. In experience design and interact design, various models have been used to identify and to illustrate domain problems [1,8,9]. Moreover, business analysts also apply modeling techniques to identify customer experiences drivers and values and to design a service [4,5,15]. This chapter will introduce the models used in this case study for business analysis, design research and software engineering.

2.1 Customer-Centric Service Design Tools

Different from traditional marketing survey, many scholars have highlighted the significance of gaining thorough understanding of customers' activities, perspectives and motives [5]. To bring these insights into service development, several service design techniques were crafted to help business analysts understand what a company may offer to support the desired customer experience [15]. In this section, we specially introduce the model-based service design tools, which have potential to be used and read by people with different backgrounds.

Customer Experience Modeling (CEM) is a model-based method to represent and systematize customer experience drivers (their requirements, activities and surrounding context), so it can guide service design efforts [5]. CEM has a multidisciplinary backbone, embedding contributions from human-computer interaction with Human Activity Modeling [16] concepts and notation, and from requirements engineering and service design using customer experience requirements [4,17] and a multilevel service design approach [15]. Previous research on customer experience focuses mostly on its separate drivers, such as the process of service delivery with service blueprinting [18] or the roles performed by people with personas and use cases [19]. CEM aims to encompass customer experience holistic nature [20] by portraying in a systematic manner the experience drivers, thus allowing service design teams to better understand and communicate current or envisioned experiences.

Customer Value Constellation [15] models the service concept as the value provided to the customer in the context of a broader set of service offerings. Normann and Ramirez [21] introduced the concept of value constellation, presenting it as the evolution from an industrial paradigm with a horizontal value chain, to a modern complex network of value creating relationships. Customer value constellation gives service designers an overview of the relevant value creation relationships, so that they can position the new service offering to capture or add the most value to the customer.

Service System Architecture defines the structure of the service offering for services provided in multiple interfaces/ devices [15]. In a matrix layout; columns indicating the defined set of activities or tasks performed by

the customer and rows showing the available service interfaces, the designers choose where each activity should be supported. This model helps design teams to structure and discuss how and where each service should be provided in order to obtain a seamless customer experience.

Service blueprinting [18] is a well-known service design technique introduced by Shostack [22] and systematizes the service delivery process. While being a graphic tool with a defined notation, it is less formal than other counterparts like Unified Modeling Language [19]. Its easily understandable structure and simplified concepts make it suitable for communicating with all the stakeholders of a service design effort. Also, unlike UML that is focused on systems, or BPMN that is focused on internal business processes, service blueprint is customer-centric. A service blueprint has a swimlane structure, dividing tasks in frontstage and backstage if, respectively, they are seen or not by the customer. Service experience blueprint [4] is a modified blueprint for multi-interface/device services, with added notation to deal with switching interfaces to accomplish a task.

2.2 User-Centered and Context-Centered Research Tools

The scope of design research in technology development has expanded from task analysis to more complex context analysis after 1990s. Based on traditional ethnographical techniques, many analytic frameworks and models have been developed to make user study more efficient, such as POSTA (person, objects, situation, time and activity), AEIOU (activity, environment, interaction, object, and user), POEMS (people, objects, environments, message, and services), and Ax4 (atmosphere, actors, activities, and artifacts) [23-26]. These frameworks provide clear guidelines and dimensions for investigating the entire activity context, such as practical space, behaviors, atmosphere and involved people.

Among these research frameworks, contextual design methodology [1] has its specific advantages for both system development and design practices. Contextual design methodology was developed based on research techniques of ethnography and was influenced by the development of participatory design techniques in the 1990's. It helps researchers and designers identify domain problems in rapid design cycles, especially for software and hardware redesign and usability evaluation [27,28]. To help researchers and designers convey their domain knowledge, thoughts and ideas, Beyer and Holtzblatt developed five work models as a tangible representation for issues in different dimensions. These models are designed to identify information flows, constraints and interactions among individuals, groups, objects and environments. In order to develop successful system, which can ‘fit with the customer's culture, make conforming to policy easy and reduce friction and irritation in the workplace,’ Beyer and Holtzblatt specially addressed the importance of understanding organizational culture. Their cultural model therefore highlights cultural influences among individuals, groups, and the organization and also helps researchers identify invisible power and individual preferences.

To deal with complex social activities, Multi Level Social Activity Model (MLSAM) [6,9] can be seen as an extension to contextual design. It mainly focuses on how individual motives, attitudes and socio-cultural context affect behaviors. There are two main concepts behind the model. First, social behaviors are deeply localized and historical on the account of cultural background. The social activity not only reflects norms and common values of the society, but also presents various inherent characteristics of the cultural context. Secondly, people have great agency and creativity to fulfill needs and achieve goals in a variety of ways [6]. Traditional field observations and user studies, which focus on a limited scope, settings and behaviors, can only reveal results of how people perform

to achieve their goals. Hence, the model emphasizes the necessity to identify people's motives and attitudes, which could be used in evaluate if a design is reasonable and valuable.

2.3 Design and Implementation Tools

The previous two sections introduce several analysis tools for understanding users, customers, activities and contexts. In the phase of developing design concepts, there are some techniques very useful to demonstrate target uses, such as user modeling, personas and user portraits [8]. In software engineering, user modeling has focused on having an internal representation of users, to explain and to predict the ways that users interact with systems based on their knowledge and preferences [8,29]. Beyond traditional user cognitive models, research has extended the modeling variables to cover users' previous computing experiences and personality traits [29,30]. Personas and user portraits on the other hand are used to create fictional characters for representing different user types. Traditional personas describe the uses' taste, perspectives and attitudes toward a certain product, a service, or a brand [31-33], and user portraits are used to demonstrate both static and dynamic features of users, including their socio-cultural perspectives, long-tern attitudes, urgent needs and technology use [8].

After having design concepts, customer journey maps and storyboards make visible important moments of experiences, and also help designers organize and present their design ideas from user perspectives and real contexts [34-36]. The customer journey map is a graph used to show different touchpoints within a journey, where a user may interact with and experience the service. Although the customer journey map does not present interaction sequences as detailed as a service blueprint [18], it offers a high-level overview of activity flows and involved physical contexts [34-36]. Storyboards are used to visualize the processes that take place during a service encounter [37]. With rich contextual information, storyboards make design concepts understandable and palpable; they help explain and evaluate the service design concept to all stakeholders and development team members, before actual implementation [38].

Many tools have been developed to support rapid prototyping for traditional website and interface design. However, these tools are either developed for supporting static graphic design with very limited interactivity such as page changes for website, or are based on conventional languages such as Javascript for professional programmers [39]. Designing system behaviors therefore requires tight collaboration with developers, and demonstrating interactions in prototyping phase become very time-consuming and limits many possibilities [39]. Since most designers need to use sketches and storyboards in the early stage of design, and state diagrams, sitemaps or screen transition diagrams, wireframes, flow charts and screen mockups are very common techniques to help explain system behaviors [39,40], we will present a way to combine sketches and transition diagrams together on the same paper for rapid low-fi prototyping.

It has been argued that models may improve software engineering as they have in traditional engineering disciplines due to their abstraction properties [41]. In software engineering, domain models are used to identify the relevant entities that populate the problem domain and allow project team members share common understandings with unambiguous terms. In addition, domain models also help bridge the gap between developers and other stakeholders, in particular making application domain experts active participants in development [12]. In this research, we applied a simplified version of UML Class Diagrams [14] as our domain model.

In the next section, we apply the above-mentioned models to conduct design research, develop ideas, make decisions and develop systems in a complex service design project. Each of these models has its unique functions to convey information and to enhance stakeholder collaboration in an iterative design process.

3. A Cross-Platform Service System Development

This case study was part of a three-year project, aimed to develop a systematic, model-based service design process to bridge the gaps between business perspectives, user-center design and technical concerns in software engineering. In this section, we present an application of the above-mentioned methods and models to a large-scale and complex design project, in which we develop a service to enhance football-watching experience for a large population of fans in Europe.

3.1 Process and Methods

The case study was conducted for a Portuguese multimedia company, and was split in two parts. The first part was a pilot study to understand people's entertainment activities and attitudes towards media consumption and to map customer behavior to the business goals of a media company [5]. The second half of the project aimed to develop an innovative service system to support one of the most popular entertainment activities, football watching. In this phase, we integrated the first study results, user experience research [1,2,8], agile development process [42,43], and several service design methods [4,15,18] into our design process.

Figure 1 presents how above-mentioned models and methods have been applied in our project. The models used in user experience design are marked in green, and the models developed in marketing and management are marked in purple. The other visual representations for supporting system development are marked in blue.

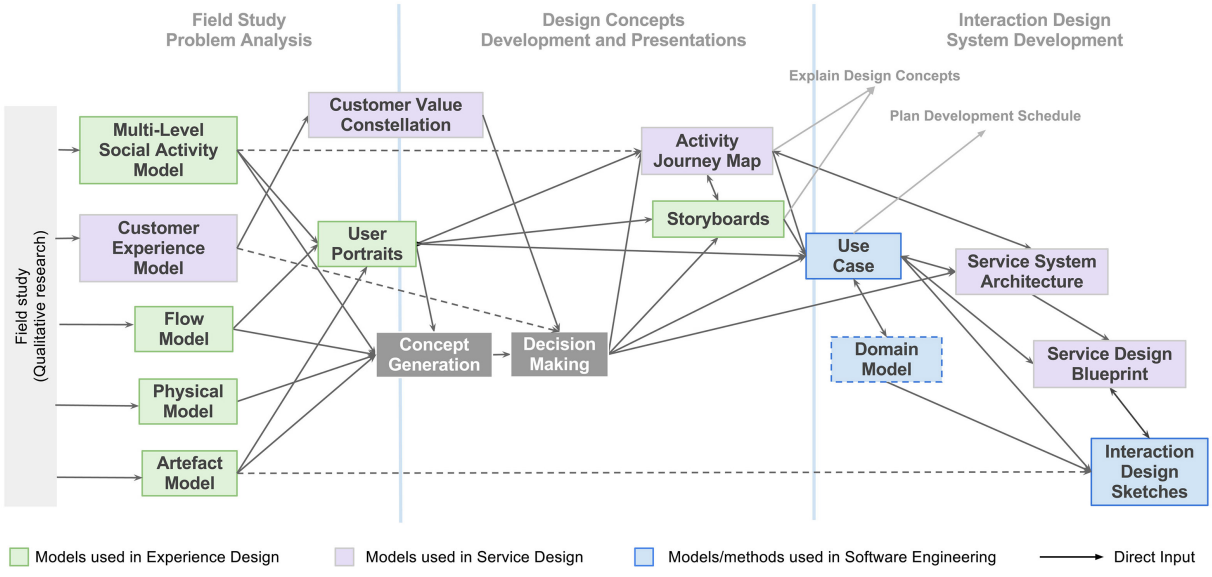


Figure 1. Model-Driven Service System Development

The design process began with the interviews and contextual inquiries with 20 active sports fans and people who had participated regularly in football watching activities, followed by modeling according to the work models of contextual design and the multi-level social activity model to understand people's experiences, motives and behaviors in sports watching (as shown in the first column of Figure 1). In a workshop, these models were used to

explain our research findings, including detailed football-watching contexts and people's perspectives. Three user portraits and 30 significant, wide-range concepts were then generated.

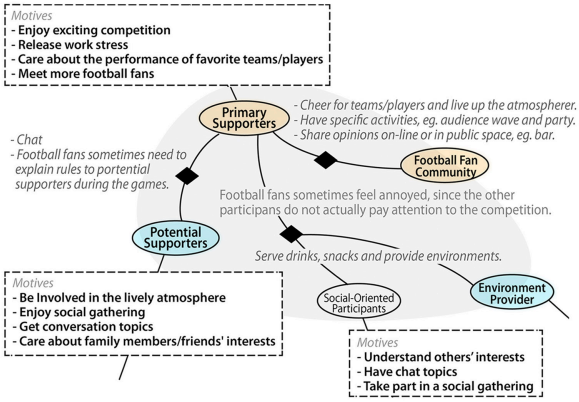
Later, eight external evaluators, including football fans, a marketing manager and business analyst, engineers, and seven of our development team members, were asked to do card sorting to rank all the design concepts. The top ranked concepts were compared with the customer value constellation map to help prioritize the most valuable design ideas to implement. After having defined a clear service concept, the customer journey map was drawn to show how customers would desirably experience our service. Scenarios and storyboards were also made to demonstrate our ideas to both external evaluators and our team members.

In the beginning of the implementation, another workshop was conducted to identify all use cases [19] associated with the customer journey map and the scenarios. The service system architecture was then built based on the uses cases, and defined the most suitable service delivery channels or devices to support them and the desired customer experience. This model also helped plan our development schedule [43]. Based on use cases, we were able to create a pipeline to process interaction design and coding in parallel; for each use case, the business analyst created service design blueprints to show the high-level interaction flow between users and devices, the interaction designers used interaction sketches to define detailed system behaviors and presentations, and the software engineers developed the systems based on the interaction sketches.

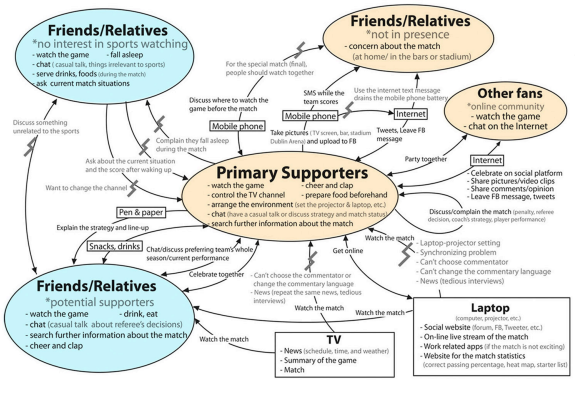
3.2 A Case of Service Design: Information of the Models

We used multi-level social activity model, customer experience model, and work models (flow model, artifact model and physical model), to present our field study findings. These models covered information in different levels, from detailed physical interactions and individual emotions to high-level phenomenon.

The social activity model (Figure 2a) highlighted football fans' behaviors, intentions of watching football matches (e.g. many participants consider watching football as an important social activity), and how socio-cultural situations, such as economic status and nationality, affected people's attitudes. The flow model (Figure 2b) presented football fans' detailed interactions with others (such as family members, friends, and online communities). The physical and artifact models revealed the information about the physical settings. Examples include accessing high quality streaming on a laptop, using a projector, getting more statistical information from websites and discussing referees and penalties with friends on the Internet.



(a) Multi-Level Social Activity Model

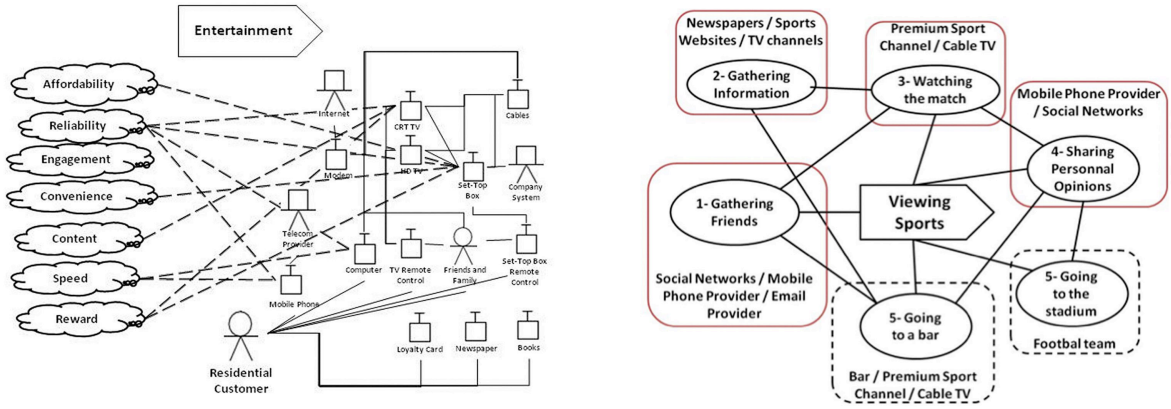


(b) Consolidated Flow Model (Home)

Figure 2. Models for User Experience Design

Based on field study, we identified two major types of people, primary football supporters and social-oriented supporters, according to their motives, life styles and technology use. Primary supporters enjoyed watching games, with strong interests in details of the game and high-quality game play. Social-oriented supporters considered football watching primarily as a social activity and their motives for participation were generally derived from primary supporters' interest (e.g. most of our male interviewees mentioned that their girlfriends, wives and children tried to understand the football rules so that they could be more involved in discussions of details during the game). Together with the other user experience models, user portraits were used to explain our findings to the participants in a brainstorming workshop.

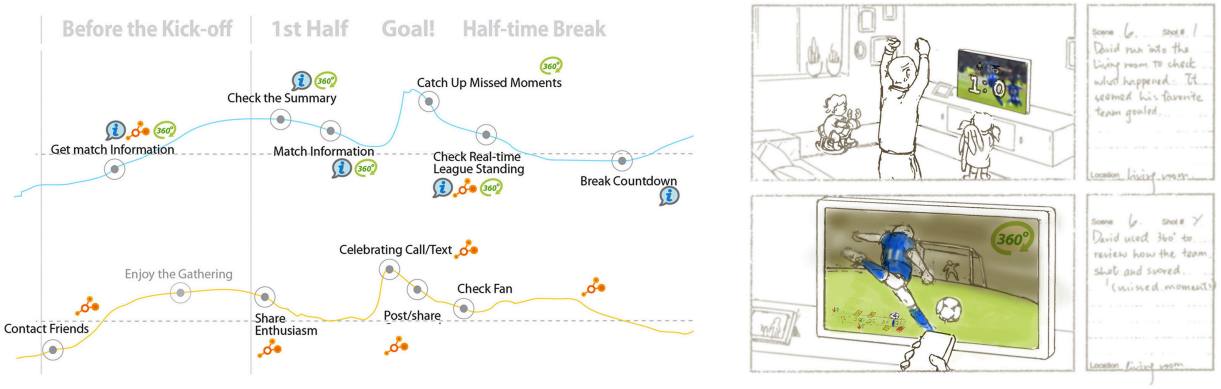
The customer experience model (Figure 3a), on the other hand, provided an overview of people's general activities, their context and requirements from a marketing perspective. More concrete than socio-cultural models, customer experience model is not as detailed as ethnographic studies. In our case, it allowed service providers to understand people's activities and general expectations and to lay out the process of service delivery. Together with customer value constellation map (Figure 3b), it also helped to define the service offering to add the most value for the potential users. For instance, through the customer experience model, a multimedia company can understand in detail customers' overall entertainment activities and needs (e.g. watching football at anywhere and at anytime). After comparing with the existent services and channels (e.g. cable TV and the Internet), a company may easily position their next product or service (e.g. webcasting football matches).



(a) Customer Experience Model **(b) Customer Value Constellation Map**

Figure 3. Models Stand for Marketing Perspectives

The thirty design concepts generated from the workshop had a very wide range, such as a customized channel which follows specific teams' activities, a travel package planned with a special league/team, or a way to interact stadium audience remotely while watching a match at home. Based on the ranking results, user portraits, and above-mentioned models, we decided to focus on enriching real-time match information and immersion, and supporting social interaction in our service. In Figure 4, the customer journey map presented important moments that people may experience before, during, and after a match into two dimensions; how people socially interact with friends and how people would like to access information. The detailed design ideas, including all the features, use contexts and situations, were presented in storyboards (Figure 4b). Both the storyboards and customer journey map provided all stakeholders and our development team with a clear image of the desired service, which helped us to gain quick feedbacks. In addition, we also used them to identify fifty use cases for the system development.

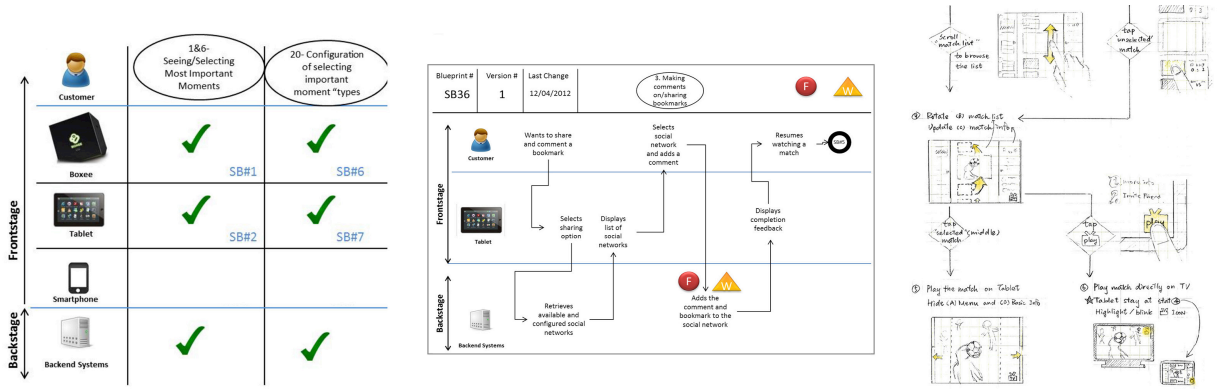


(a) Customer Journey Map

(b) Storyboards

Figure 4. Design Concept

Before the implementation phase, we located twenty important use cases on the service system architecture (the first row in Figure 5a), and assigned them the most suitable service delivery channels (e.g. TV set-top box, tablet, and smartphone). For instance, during a football game, sending a text message to friends via a TV was not the most likely and desirable situation (as it is difficult to use the TV remote for texting), but sending a message to friends through a tablet could be a desired function. Therefore, providing this feature on TV had a lower priority than on Tablet in the development schedule.



(a) Service System Architecture

(b) Service Design Blueprint

(c) Interaction Design Sketch

Figure 5. Models Used for Implementation

According to the service system architecture, we developed service design blueprints and interaction design sketches for each use case (Figure 5). Service design blueprints presented the abstract interaction flow between users and devices, and interaction design sketches detailed the system states, transitions, interactions and possible presentations. However, one use case may have more than one interaction designs, in order to make the service system more adaptive and flexible toward different use situations. The whole implementation process was a pipeline; the business analyst firstly planned the blueprint for a use case, the designers then developed interaction sketches, which were forwarded to software engineers for implementation. We followed agile use cases process, and all members focused on delivering a certain amount of features. Having design and implementation in parallel allowed us to develop and implement the main features within three months.

3.3 User Feedbacks

To gain overall feedbacks and to improve the systems, we had two rounds of evaluation. The first one was conducted after we had the first release of the service, where most features of enriching information access were

implemented (Figure 6). At the moment, the service could be delivered through set-top boxes, tablets, and computers. Five active football fans, who have never participated in our research before, were asked to do cognitive walkthrough [44]. Two of the fans also attended a session of collaborative usability inspection [45] with our development team. In the first round, we identified more than fifty usability issues, which were directly used to improve the system. In addition, all five participates were impressed by our service concepts, most of them agreed that the features met their needs and could solve the problems in football watching.

Figure 6. The Cross-Platform Service System

In the second round, we had developed most the features for supporting social interaction. Firstly, we had three heuristic evaluations to identify major usability problems [44]. We then recruited twelve participants, including two middle-age football coaches, eight active football fans with different technology background, and two usability experts to test the system and to evaluate the design concepts. Among all participants, only three people had used tablets and four people had used smartTV, but the general feedbacks of the cross-platform system was very positive. About the design concepts, the features of enriching information access, such as match summary/highlights, interactive timeline, and commentary switch, were highly appreciated by all participants. Several participants described our system with expressions such as "love it" and "really nice". The access of social network and real-time interactions also received positive feedbacks.

4. Benefits and Issues

There were two main benefits of the model-driven approach. Firstly, the models help us share knowledge and communicate efficiently. These models offer simple graphic representations, which allow multidisciplinary team members and user participants to understand different domain issues. Although these models stand for different perspectives, we found they are very simple for everyone to follow. Secondly, models support well agile and iterative development. Unlike traditional design process, models make design process and design reasons transparent and easy to be traced. In the implementation phase, use cases allow designers and engineers to work on service design blueprints, interaction design sketches and programming in parallel, which shortens the time from idea to service delivery.

In this research, we also identified several significant issues of applying these models. The first issue is the information redundancy. For example, both customer experience models and flow models contain information about stakeholders' relationships, similar to role maps or stakeholder maps. Both customer experience models and multi-level social activity models discuss people' needs and motives. However, since these models stand for different domains, it is difficult to use one to replace another. Secondly, in this project we have noticed that some important information is missing. While developing interaction for a certain use case, it is important to know the initial system status. Therefore, we should have a suitable method, such as navigation map, to provide the pre-conditions for interaction design. Furthermore, we have noticed that current notations of service system architectures, blueprints and interaction design sketches are not enough to support adaptive and context-aware systems. It is very difficult to design interactions for a certain use case on different devices at the same time. Our suggestion is using blueprints as high-level guidelines to align interaction designs.

5. Conclusion

This work presents a model-driven service design process. We consider that to develop a large-scare and complex service requires supports from different domains experts, and therefore we need better communication tools to share knowledge and to work together. This research has shown that many well-accepted models can support a service design process; they reveal detailed contextual information and user needs, others helped make and document design decisions, and improve the traceability from conceptual designs to final products or services. In addition, following a use case agile process, we successfully developed a cross-platform system in six months. For future research, we will focus on the identified issues, and improve the connections between each model.

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