Using mobile personalisation to enhance the user experience at large sporting events

Using Mobile Personalization to Enhance the User Experience at Large Sporting Events

by

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CERTIFICATE OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this thesis, that the original work is my own, except as specified in acknowledgements or in footnotes, and that neither the thesis nor the original work contained therein has been submitted to this or any other institution for a higher degree.

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ABSTRACT

At large sporting events (LSEs), e.g., football matches and athletics events, the user experience has been shown to be highly variable (Nilsson, 2004; Nilsson et al. 2004). Reported problems include a lack of social interaction with fellow spectators, and insufficient relevant information on the events or the sporting action taking place (Nilsson, 2004; Nilsson et al. 2004; Esbjornsson et al. 2006; Jacucci et al. 2005). A possible solution is personalization, making the mobile application adapt to the user, ensuring that only relevant information is retrieved and presented in a way that is suitable. This thesis is devoted to studying the user experience related to mobile personalization at LSEs. It aims to investigate how personalized mobile applications at LSEs can render the user experience more active and engaging in a contextually, socially and culturally relevant way.

The thesis reviews different theoretical approaches to help to understand the concepts of interest e.g. personalization and user experience (Chapter 2). Research methods are also discussed including the challenge of adapting user-centred methods into the Chinese culture (Chapter 3).

This thesis investigates the user experience of mobile personalization at LSEs by following the circle of user-centred research: It starts to consider user requirements and user experience at LSEs and derives the usage patterns that personalized mobile applications could usefully support (Chapter 4). Then it explores the relevant contextual factors at LSEs which could be used to prescribe the behaviour of a personalizable mobile application (Chapter 5). Next, it describes the user-centred process used to design personalizable interfaces for mobile applications used at LSEs. Four key elements of design are considered: content, conceptual, interaction and presentation design (Chapter 6). The final outputs of the design process were two personalized mobile prototypes for Chinese users at LSEs. These included versions based on either (1) user-initiated or (2) system-initiated personalisation. Finally it investigates the impact on user experience of mobile personalization at LSEs in two empirical studies (a field experiment and a lab-based experiment) with these prototypes (Chapters 7 and 8). Mobile personalization is shown to result in an enriched user experience across a range of activities that a spectator would undertake at a large sporting event.

The thesis discusses primarily the effective design of mobile personalization, the design implications at LSEs, user experience design, and research methods for Chinese users (Chapter 9). In conclusion (Chapter 10), specific contributions and avenues for future work are highlighted.

Keywords: Mobile Personalization, User Experience, Large Sporting Events, User-Centred Methods, Chinese Culture, Human Computer Interaction

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TABLE OF CONTENTS

LIST OF APPENDICES

1 INTRODUCTION

1.1 Introduction

At large sporting events (LSEs), a large group of individuals gather within a particular spatial distribution to co-experience a lively atmosphere and the momentary excitement of sports. The user experience has been shown to be highly variable (Nilsson, 2004), and earlier research has demonstrated that the current spectator experience at large sporting events can be improved. There is often an inability for the spectators to select from the information available to them, and to put the details observed into the broader context of the event at the stadium (Olsson and Nilsson, 2002; Nilsson et al. 2004; Hallberg et al. 2004; Esbjornsson et al. 2006). Moreover, much social interaction between spectators has been shown to be limited and inactive (Sun et al. 2005; Esbjornsson et al. 2006).

Technology enables a possible solution - mobile personalization - making the mobile application adapt to the user, ensuring that only relevant information is retrieved, and is presented in a suitable way. Newly built stadiums incorporate wireless infrastructures to allow for future technology implementation (Hayden, 2004), and the possibility of mobile applications being an additional source of information at these events.

Within the field of human computer interaction (HCI), the term ‘personalization’ describes the tailoring of content/services between a computing application and an individual, in order to optimise the outcomes that result within a particular context of use. Personalization is critical for the success of services for end users. ‘It is the difference between a usable application and an unusable application’ (Durlacher Research Ltd., 2001). Personalization will become increasingly important to every user of mobile applications. And it has the power to lower cognitive overheads, enable greater productivity with mobile applications, provide consistent experiences across applications and environments, and to allow users to optimally use many more applications and services. Ultimately, it will make for a more enjoyable user experience and lifestyle (Motorola, 2006).

This research was initiated to investigate how personalized mobile applications at LSEs can render the user experience more active and engaging in a contextually, socially and culturally relevant way. It discusses user experience issues with regard to personalization, design, and the evaluation of personalized mobile applications at LSEs, and the implications for HCI research.

LSEs are the context of use of the personalized mobile application within this research. LSEs are characterised by Jacucci et al. (2006) as a large group of spectators gathered in a large spatial distribution to co-experience the lively atmosphere and exciting moments of a sporting event. LSEs are particularly interesting from a HCI perspective for a number of reasons. First, the main focus of user attention will be on the sporting action, rather than the mobile application itself, but this will vary considerably. Second, there is a range of information sources available (e.g. real-time action, replays projected on boards, information posters, broadcast announcements, competitor and event details on boards). If a mobile application is acting as an information channel, then it must add value over and above these other sources. Third, the user base is potentially extremely diverse, including multinational. Fourth, there is potential for good connectivity due to the physical constraints around the user. Fifth, social interaction between individuals is important, but is limited due to the physical constraints of the stadium. Sixth, outcomes need to be measured in more than functional terms, i.e. traditional usability-based design and evaluation criteria are likely to be insufficient.

This research also considered a particular user group – Chinese users – because of the needs of this specific user group, the methodological challenges and market trends. First, Cha et al. (2005) indicated that Chinese users are highly keen on personal add-ons, such as the personalization of wallpaper and ring tones, compared with their western counterparts. The authors suggested that if various personalized options or simple ways of making changes to the settings are provided for mobile applications, it will lead to a better user experience for Chinese users. Second, methodological concerns for Chinese users present challenges for a user-centred design approach. Most existing user-centred research methods were generated based on the premise that participants will find it easy and comfortable to articulate their thoughts and feelings about what works for them and what does not (Edward, 1990). It is assumed that the methods which originated predominantly in the West are used and will work in the East. However this assumption is biased heavily in favour of certain cultures, and is not compatible with Chinese culture because of the language and traditional beliefs (Kim, 2002; Lin, 1977). Third, the booming Chinese economy means that mobile applications are becoming an integral part of daily life for many of the Chinese population. China is a vast market, with over 600 million mobile subscribers as of the end of July 2008 (ICT Statistics Newslog, 2008). Therefore, designing an optimal user experience for mobile applications that are targeted specifically at Chinese users has become increasingly important.

1.2 The call for mobile personalization research

The need for this research in mobile personalization is illustrated in terms of user experience at LSEs, Chinese users, usability, mobile HCI and its related research.

Related studies. During the last decade, personalization on the web services has already been extensively studied from various viewpoints (Manber et al. 2000; Bonnet, 2001; Blom et al. 2003; Venkatesh et al. 2003; Haym et al. 2000). Also, personalization has often been discussed in relation to mobile services (Thanh and Dustdar, 2004). The usefulness of mobile personalization has been shown in a number of scenarios, e.g. tourist guides (Abowd et al. 1997; Cheverst et al. 2000; Oertel et al. 2002), reminder systems (Lamming and Flynn, 1994; Rhodes, 1997), and office applications (Nabeth and Roda, 2002; Voida et al. 2002; Bergman et al. 2004). Those research studies demonstrated the importance of personalization. They mainly focused on technology development rather than perspectives of HCI, but some research has been conducted into trying to enrich user experience of media in different ways (Boll and Westermann, 2003; Olsson and Nilsson, 2002). However, there have been few studies of mobile user experience in sports, and there is relatively little research that provides guidance to HCI researchers and practitioners. There is little agreement on theoretical frameworks of user experience issues with personalization, a lack of empirical evidence to demonstrate the impact of personalization, and little direct support for designers of personalized content and services delivered to consumers over mobile applications. This research into the impact of mobile personalization for spectators in the LSE context is, therefore, a relatively new research domain.

User experience at LSEs. Previous research that has observed user experience at LSEs demonstrates the need for mobile personalization (Nilsson, 2004; Nilsson et al. 2004; Olsson and Nilsson, 2002; Hallberg et al. 2004; Esbjornsson et al. 2006). According to the observation, spectatorship is an active experience with lots of information. Spectators are overloaded with mass media information as well as the competition on the field (Sun et al. 2005). It has been pointed out that it is not easy for the spectators to determine what to read from the large amount of information available, since there was no support to filter the incoming data (Olsson and Nilsson, 2002; Nilsson et al. 2004). Spectators had no control to decide what and/or when information should be transferred (Sun et al. 2005). In addition, they lacked effective social interaction with fellow spectators at LSEs (Esbjornsson et al. 2006; Sun et al. 2005). Personalized mobile applications could reduce these problems by building up a virtual social community and providing users with the freedom to set what information they want to receive and when to receive it, supported in a personalized way, in comparison to traditional information resources.

Chinese users. China is a vast country with a population of over 1.3 billion. According to statistics published by ICT Statistics Newslog (2008), there were over 600 million mobile subscribers as of the end of July 2008, with the subscriber base more than tripling in the last five years. Research studies suggest that if various personalized options are provided for mobile applications, it will lead to a better user experience for Chinese users (Cha et al. 2005; UPA, 2006).

Usability. Personalization could embody universal usability. Usability defines whether the application solves the right problems from the user's point of view and whether the system solves the problems in the right way. It has multiple components and is defined by the International Organization for Standardization (ISO, 1998) as ‘the effectiveness, efficiency and satisfaction with which specified users could achieve specified goals in particular environments’. These definitions could mirror the characteristics of personalization, which puts users in a controlling role in the process of personalization and adjusts itself based on a model of users. The model is based on users’ interests, preferences, behaviours and contexts. Usability could be improved in a personalized approach by reducing redundancy and addressing relevance.

Personal needs. Personalization offers the possibility for users to meet their desire to be designers of their own lives. Norman (2004) suggests that personalization allows users to act as designers by organizing their thoughts, memories, and images that they find useful or pleasing, thus creating a more engaging user experience. He suggests that users inherently want to personalize: “we are all designers”. Christos et al. (2005) go even further, by suggesting that the majority of mobile users think of it as a declaratory part of their personality.

Mobile HCI. The nature of mobile applications and the limitations of the user place greater importance on the need of mobile personalization. The small screens of mobile applications limit the information that can be presented to the user and the number of ‘pages’ returned per request must be limited due to the limited mobile bandwidth. Mobile services are generally used ‘on the move’ and in an environment where users have neither the time nor the attention span to navigate through complicated menus or to interpret ambiguous results. Furthermore, limited battery life is still an issue for most mobile applications – the accessing of resource hungry applications, such as video and wireless networks, needs to be managed to maximise the availability of services to end-users. Such limitations could be addressed by personalization, which is to provide service/content tailored to the users’ interests, preferences, behaviours and contexts. Thus, personalization should make users more effective by helping them to reach their goals.

1.3 Research aims

This overall aim of thesis is to investigate if and how personalized mobile applications at LSEs can render user experience more active and engaging. The specific objectives are:

- to investigate the kind of support that personalized mobile applications could usefully provide at LSEs
- to investigate the key contextual factors which could be used to prescribe the behaviour of a personalizable mobile application

- to investigate how mobile applications can be personalized for end end-users so they can enhance user experience and be sensitive to contextual influences within the stadium
- to investigate the design of enhanced user experience of mobile personalization at LSEs
- to investigate how user experience at LSEs can be impacted by mobile personalization
- to highlight methodological and cultural implications

1.4 Research questions

To investigate how personalized mobile applications at LSEs can render user experience more active and engaging, the following should be made clear: the characteristics and requirements of the target users, the kind of support that personalization could usefully provide, the method by which that support is delivered, and proper methods to study its effects with Chinese users. Herein the research addressed the question:

How important is mobile personalization in enhancing user experience at Large Sporting Events?

This was further divided into the following four groups of questions:

RQ1: What is the potential for mobile personalization to contribute to the positive aspects of user experience at LSEs?

- What are the user group characteristics?
- What is the current spectator experience at LSEs?
- What are the user requirements of mobile personalization at LSEs?
- What are the usage implications of mobile personalization to enhance user experience at LSEs?
- What are the key cultural implications for user-centred research methods?

The first question group studies the target Chinese users, their characteristics, requirements and experience. This can be used to determine the usage implications of mobile personalization, which can be used to enhance the user experience at LSEs. It also investigates the implications of Chinese culture which can provide guidance to enable researchers and designers to incorporate the implications within a user-centred research.

RQ2: What are the key contextual factors to be used for mobile personalization at LSEs?

- What are the key contextual factors that affect the user experience at LSEs?
- How may the user experience at such events be enhanced by a mobile application that is sensitive to key contextual factors?

The second question group considers the aspects of the relevant context within the confines of LSEs. This can be used to maximise the relevance of information and communication services delivered to a spectator over the mobile personalization.

RQ3: How can personalized mobile applications be designed to optimize user experience at LSEs?

- How can mobile applications be designed to personalize their content according to the relevant contextual factors?
- What is the conceptual mode of the mobile personalization?
- How can the design of interaction enhance user experience in the LSE context?
- How can content be appropriately presented upon the user interface?

The third question group investigates approaches for the realization of mobile personalization based on the first two groups of questions. This can demonstrate how a range of user-centred design methods, and explicit considerations of user experience, can lead to mobile interface designs that enhance the user experience for spectators at sporting events.

RQ4: How does mobile personalization impact on user experience at LSEs?

- How can user experience of mobile personalization be evaluated in the LSE context?
- Which personalization approach is more appropriate to subject matter-user-initiated personalization or system-initiated personalization?

The fourth question group investigates the impact on user experience of mobile personalization for spectators at large sporting events. This can answer the overall research question of how mobile personalization enhances the user experience at the LSEs.

1.5 Research scope and outcomes

The thesis was undertaken from the perspective of HCI, rather than technological development. It embraces user-centred design principles for studying the impacts of mobile personalization on user experience at LSE. The outcomes of this thesis were related to product design as well as methodological contributions. Product design explored the implications for mobile personalization at LSEs and described how innovative products need to take the user experience into account. It helped practitioners design more effective personalization.

Methodological contributions were concerned with how to study the mobile user experience in a LSE context, and how to use culturally-sensitive methods to help ensure that services meet the needs of end users. Suggestions were proposed to help the HCI researchers to study, design and evaluate personalized mobile applications at LSEs. Another contribution was to take the Chinese culture into consideration, thereby supporting research and design for Chinese users.

1.6 Overview of thesis

The structure of this thesis uses a traditional research format (Figure1.1). It begins with a literature review, followed by a methods chapter reviewing all the research activities. Next, there are five chapters which describe the five main research activities respectively. The discussion and conclusion chapters make up the remainder of the thesis. A more detailed overview of each of the thesis chapters is provided below.

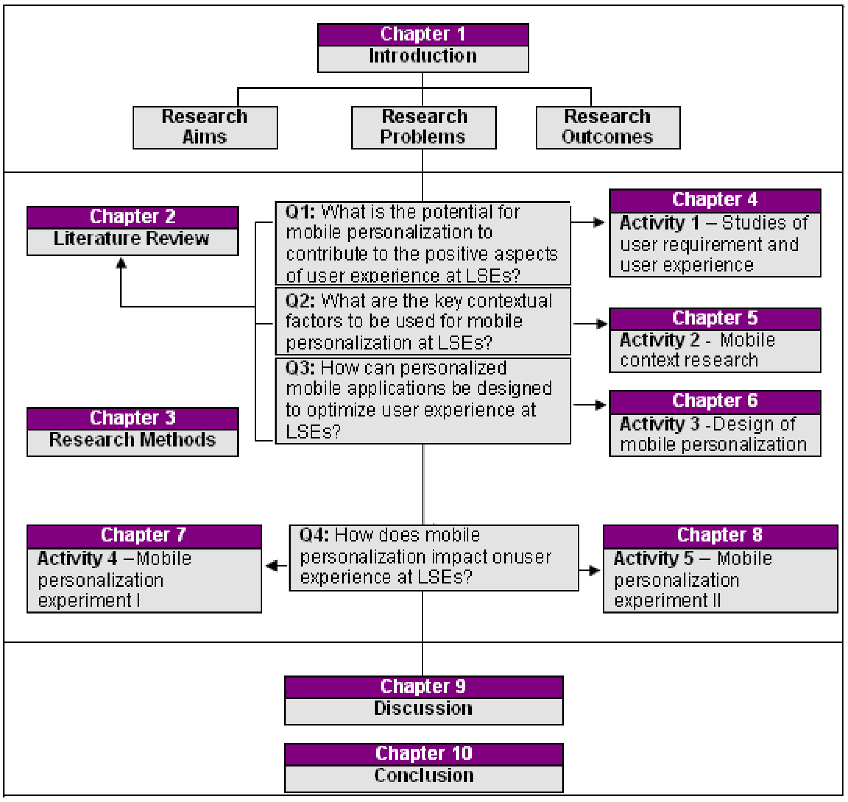

Figure 1.1 Thesis structure

Chapter 2 - Literature review: This chapter deals with three key concepts: mobile personalization, user experience and LSE context. It first looked at literature which helped to define the concepts, such as 2.2 mobile personalization, 2.3 user experience and 2.4 context of use - large sporting events. Next, user experience related literature was explored which helped to study, design and evaluate the research topic, including

2.5 mobile usability and 2.6 user culture. Finally, Section 2.7 discussed both the concepts and the novel parts of this research, and where the themes of mobile personalization and user experience overlap.

Chapter 3 - Research methods: The methodology started with an overview of the HCI research framework, followed by a consideration of the Chinese user culture and its influence on study methods. Finally, it introduced the methodology of this research and its adaption to the user culture, before finishing with a discussion of the validity and reliability of the methods used.

Chapter 4 - User requirement and user experience: This chapter described two user studies that included interviewing users in scenario-based workshops, and going out into the field to observe, interview and survey user experience (see Figure 1.2). Each study was conducted with the aim of understanding users, their requirements and their current experiences at LSEs. It discussed both the study methods and the results. In conclusion, the implications of how personalized mobile applications could usefully support user experience at LSEs were derived.

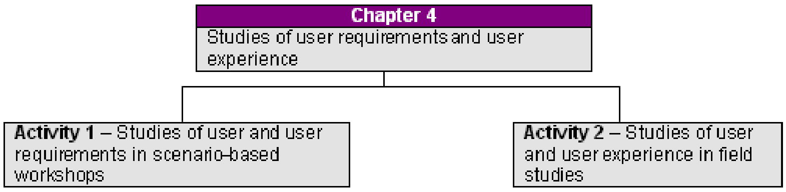

Figure 1.2 Research activities of user, user experience and user requirement study

Chapter 5 - Mobile context research: The mobile context research presented three field studies undertaken at large sporting events in the UK and China, with the aim of improving user experience at LSEs through the design of personally relevant mobile services (see Figure 1.3). These field studies were described separately, investigating which aspects of context were relevant to user experience within the confines of a large sporting event. Finally, the implications of how to use those contextual factors to prescribe the behaviour of the personalized mobile applications were presented.

Figure 1.3 Research activities for LSE context research

Chapter 6 - Design of mobile personalization: This chapter described the user-centred process used to design personalizable interfaces for mobile applications used at large sporting events. The design of mobile personalization addressed both user-initiated personalization and system-initiated personalization. It incorporated a design process including content, conceptual, interaction and presentation design in each separate section (see Figure 1.4). Each of these design aspects were accomplished with a user-centred view of product design and development, focusing on user experience, rather than technological innovation. The final outputs of the design process were two personalized mobile prototypes for Chinese users at a large sporting event.

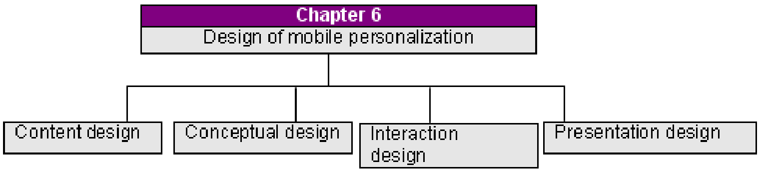

Figure 1.4 Research activities of the design of mobile personalization

Chapter 7 - Mobile personalization experiment I - The impact of mobile personalization at LSEs (see Figure 1.5): The first experiment focused on examining the overall role of mobile personalization at LSEs by comparing: (1) traditional user experience without a mobile application at LSEs, (2) user experience with a personalized mobile application and finally, (3) user experience with a non-personalized mobile application in the LSEs field setting with potential Chinese users. It dealt with its user-centred research methods, the experiment design, the set up and results. The study found that mobile personalization can play a positive role in enriching user experience at LSEs, although problems were also identified with user-initiated personalization.

Chapter 8 - Mobile personalization experiment II – Compare different approaches of mobile personalization at LSEs (see Figure 1.5): The second experiment focused on comparing different approaches of mobile personalization. It compared traditional user experience at LSEs, and user experience with both user-initiated and system-initiated personalization prototypes in a simulated, controlled lab with potential real users. The controlled lab experiment was set up to resemble a real life environment. This chapter described its methods, set up, and results. The studies confirmed that mobile personalization can play a positive role in enriching the user experience at LSEs. It also compared the two approaches - user-initiated personalization and system-initiated personalization - in the context of LSEs.

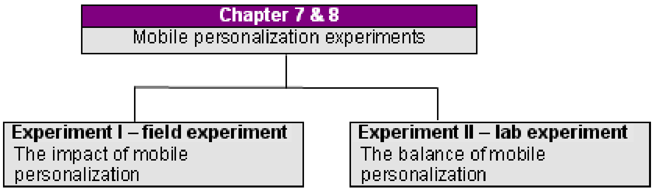

Figure 1.5 Research activities of the experiment of mobile personalization

Chapter 9 - Discussion: This chapter discussed the main findings of the thesis. These findings primarily pertained to the design implications at LSEs, the effective design of mobile personalization, user experience design, and research for Chinese users.

Chapter 10 - Conclusion: It drew a conclusion regarding the research questions and stated a range of potential avenues for further research that can be derived from this thesis.

2 LITERATURE REVIEW: MULTIDISCIPLINARY PERSPECTIVES

	Research questions addressed in this chapter:
1	**What is the potential for mobile personalization to contribute to the positive aspects of user experience at LSEs?**
2	**What are the key contextual factors to be used for mobile personalization at LSEs?**
3	**How can personalized mobile applications be designed to optimize user experience at LSEs?**
4	How does mobile personalization impact on user experience at LSEs?
5	What are the key gaps in user-centred research that arise from this thesis?

2.1 Introduction and aims

This thesis aimed to investigate how personalized mobile applications at LSEs can render user experience more active and engaging. The review of literature in this chapter mainly deals with two key themes: mobile personalization and user experience. To date, these two areas of research have had fairly little to do with one another: this chapter is about bridging the gap between these two topics.

The literature review contains seven sections which explore concepts from a variety of different theoretical perspectives and highlight the implications of this thesis (see Figure 2.1). It first looks at literature which can help define the concepts of research, such as 2.2 mobile personalization, 2.3 user experience and 2.4 large sporting events. It continues by examining user experience related literature which can help to study, design and evaluate the research topic, including 2.5 mobile HCI, and 2.6 user culture. Finally, Section 2.7 discusses the main concepts of the research, the novel part of this research, and where the themes of mobile personalization and user experience overlap.

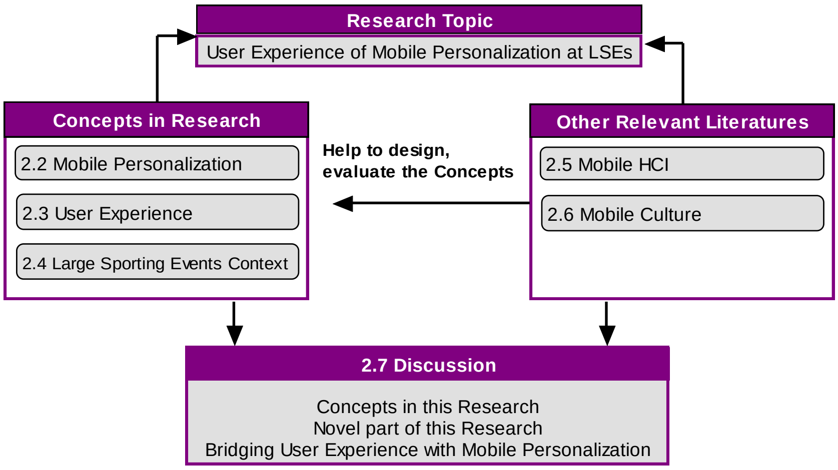

Figure 2.1 Literature overview

The overall aim of this chapter is to provide a relevant theoretical perspective that can be used to inform the research process. The specific objectives are:

1) to understand the research concepts;
2) to investigate related research;
3) to investigate different theoretical approaches to study, design and evaluate the research topic

2.2 Mobile personalization

This section introduces the concept of mobile personalization in this research. It first looks at its definition and categories, followed by a discussion of the different approaches to personalization, and finally, mobile personalization in various application fields is demonstrated in the discussion of related works.

2.2.1 Definition

There are various definitions of personalization in the context of HCI. Kramer et al. (2000) define personalization as a toolbox of technologies and application features used in the design of an end-user experience. Adomavicius and Tuzhilin (2001) state a simple definition which is that personalization is the ability to provide content and services, tailored to individuals, based on the basis of knowledge about their preferences and behaviour. Riecken (2000) further suggests that personalization is to understand the requirements of each individual and help to satisfy a goal that efficiently and effectively addresses each individual’s need in a certain context. It means to satisfy a user’s particular goal in a specific context. Kim (2002) defines personalization as optimizing the user experience by providing content and services based upon the user’s interests, preferences, behaviour and context, targeting the goal of the user. The user here has influence on the final presentation of information through a tailoring process, such as by changing certain settings. The user can be a single individual user as well as a group of users sharing a common interest.

To derive a comprehensive definition of mobile personalization from the different concepts related to personalization, the key elements were abstracted from these theories: the user plays a central role in the process of personalization; the mobile adjusts itself based on an understanding of the user; this understanding includes the user’s interests, preferences, behaviour and context; personalization should bring an enhanced experience for the user by helping him/her to achieve certain goals; and either the user can take the initiative to personalize the application or the mobile can initiate the personalization.

Various studies have already shown a number of positive psychological and somatic benefits resulting from personalization (Manber et al. 2000; Bonnet 2001; Blom et al. 2003; Venkatesh et al. 2003; Haym et al. 2000).

Bonnet (2001) states that from a marketing perspective the ultimate aim of personalization is user satisfaction. Norman (2004) suggests that personalization allows users to act as designers by organizing and designing thoughts, memories, and images that they find useful or pleasing, thus creating a more engaging user experience. He suggests that users inherently want to personalize: ‘we are all designers’. Christos et al. (2005) go even further by suggesting that the majority of mobile users think of it as a declaratory part of their personality. Blom et al. 2003 describe how personalization brings a sense of: ownership and identity; the desire to express personality in public forums; the availability of instant communication; and the personal appearance and feel of mobile applications.

These authors also describe how personalization helps users to increase social interaction by giving them the ability to be aware of and interact with others. Designing for social interaction implies encouraging communication, while personalization enhances social interaction by enabling users to incorporate artificial social actors into their social network as easily as real social actors.

Venkatesh et al. (2003) argue that personalization helps users feel more capable when using mobile services, thus increasing perceived usability. They highlight how this is especially important for mobile services, as many users face difficulties when using mobile applications, which in turn impact on their actual use of mobile services.

Personalization therefore provides an individual and managed interaction with a mobile application, taking advantage of ubiquitous access to digital media, while helping to mitigate the limitations of mobile interactions.

2.2.2 Categories of personalization

There are several basic categories of personalization which have been mentioned in the relevant literature (Schwabe and Rossi, 1998; Hjesvold et al. 2001; Georgiadis et al. 2005; Bonnie et al. 1999). The following lists some types of personalization that have been studied:

Link personalization involves selecting links that are the most relevant to the use, i.e. changing the navigation space in order to optimise the relationship between nodes. This approach is used widely by e-commerce applications in order to provide personalized recommendations to customers.

Content personalization provides tailored information within a node itself. This approach adapts the information, based on user needs and interests. By way of an example, a system may have information on athletes from different countries. If a user has specified that s/he prefers information on athletes from their home country, the personalized content system will display that athlete information. Context personalization is used when the same information (i.e. node) can be reached in different situations. For example, in a conference paper review application, it is possible to access papers, etc. One paper may appear in different sets, and different users may have different access restrictions, according to their role in the review application.

Authorized personalization refers to different users having different access authorizations to a system. It limits access to information and functions based on individuals or sets of users, and the role they play within the problem space. For example, in an academic application, instructors and students have different tasks to perform. Instructors want to access their class materials, perhaps to upload or edit their class syllabus or give students' grades, etc. Students, on the other hand, may access the interface to find out their enrolment status, and their course work status, etc.

Humanized personalization emphasizes the emotional dimension of the personalization elements, e.g. "hello John, how are you today?”. Bonnie et al. (1999) presented and studied an intelligent interactive telephone system which provided counselling about health behaviours. It demonstrated different emotions, such as love, hate, and guilt, with respect to users’ reactions to the system. This type of personalization still needs to be explored in the research area, since there remain many areas of ambiguity as well as technical obstacles.

This thesis is centred on the concept of content personalization, and is based on the key assumption that the optimal content for an individual is dependent on factors relating to the individual, their activities and their environment.

2.2.3 User-initiated personalization and system-initiated personalization

User-initiated personalization and system-initiated personalization are the major approaches to the design of personalization (Martinez et al. 2009). According to Dix et al. (1998) user-initiated personalization is the modification of the user interface by the user. Both Nielsen (2001) and Stephanidis et al. (1999) use the concept of user-initiated personalization differently, indicating that user-initiated personalization is under explicit user control. System-initiated personalization is a quite different concept, where the system, not the user, initiates the modifications (Browne et al., 1990).

The difference between user-initiated personalization and system-initiated personalization lies in the control of the adaptation process (Billsus, 2002; Nielsen, 1998). User-initiated personalization is a user-driven process, which uses adaptable system components that users can tailor to their specific needs. The systems use static profiles, which may be changed by the users. According to Trigg (1987), the need of user-initiated personalization systems stems from a common complaint of users that their systems do not fit the particular task they are doing, their style of working, or their personal sense of aesthetics. With the help of user-initiated personalization, users should be enabled to produce new systems behaviour without help from designers. Therefore, user-initiated personalization can be used in diverse task domains by users having diverse styles. By contrast, system-initiated personalization is system-driven and requires adaptive components. Moreover, system-initiated personalization behaves differentially depending on the current user of that system (Hjesvold et al. 2001; Finlater and McGrenere, 2004).

The difference between the two types of personalization is a question of active versus passive user-system behaviour. User-initiated personalization is described as adjustment initiated by the user to achieve a desired goal, while system-initiated personalization uses a user profile as a guide to provide content, based on what the user is believed to be interested in.

The two types of personalization are also related because they both eventually lead to the application interacting based on the user's profile. Both user- and system-initiated personalization require detailed information about the user. System-initiated personalization, however, additionally needs the system to monitor user behaviour in order to adapt automatically, and users are therefore unable to control how the system adjusts to their behaviour. System-initiated personalization offers the ability to change its own characteristics automatically (eventually after user consultations), thereby adapting itself to the user's needs. User-initiated personalization, in contrast, presents end users with tools that enable the users to change the system features and as such, the behaviour of the application. Therefore, user-initiated personalization is considered as the prerequisite to achieve system-initiated personalization. Conversely, system-initiated personalization is based on user-initiated personalization (Oppermann, 1994).

There are advantages and disadvantages of user- and system-initiated personalization respectively. Nielsen (1998) favours user-initiated personalization and its focus on the natural intelligence of the user, rather than attempting to use adaptation to guess user needs. His main idea is to allow users to decide their needs, instead of creating confusing inconsistencies and robbing the user of control. Norman (2004) suggests that users inherently want to personalize because people encounter success and failure, sadness and joy and they structure their own worlds to support them throughout life. The ease of user-initiated personalization is one essential characteristic for successful personalization.

While user-initiated personalization is considered important, it is evident that most users fail to personalize effectively (Weld et al. 2003). Few users are comfortable responding to requests to set personalization parameters, and users can spend time inputting data that actually turns out to have little impact on them (Nielsen, 1998). Thus, system-initiated personalization can save the user a lot of work, although s/he is not in full control of the system. Users and context should be researched in order not to lead the user into confusion. In addition, the use of system-initiated personalization appears to decrease levels of users' trust and some people feel it violates their privacy (Thomas and Krogsoeter, 1993).

There are very few empirical studies that focus on the impact of personalization (Ramnarayan, 2005). A few have pointed out that the effectiveness of personalization varies depending on the approach of the personalization used (Nunes and Kambil, 2001; Coner, 2003; Martinez et al. 2009).

Some empirical studies investigating personalized Websites have assessed what users prefer, in a comparison between user-initiated personalization and system-initiated personalization (Nunes and Kambil, 2001; Coner 2003). The authors found that user-initiated personalization is more effective in terms of satisfaction, relative to the system-initiated personalization. Users reported preferring a product over which they had control of preferences, rather than having the product personalize on their behalf, based on implicit preferences.

In contrast, the study conducted by Martinez et al. (2009) has compared how digital library users react to these approaches of personalization. The results show that users not only performed better in the system-initiated personalization, but also they reacted more positively to the system-initiated personalization. The authors suggested that it may be due to the fact that the system-initiated personalization automatically presents suitable functionality, whereas the user-initiated personalization requires users to choose functionality by themselves.

Several empirical evaluations of 'adaptive educational hypermedia' systems concluded that a mixed approach, where the system and the user share control, seems most promising (Dieterich et al. 1993; Bontcheva, 2002; Alpert et al. 2003; Papanikolaou et al. 2003). Those studies showed that users prefer to have control over personalization techniques and want to understand a system’s rationale for displaying particular content.

The real question is not only whether to use user-initiated personalization or system-initiated personalization, but how to meet the needs of users so that they will feel comfortable with the products.

2.2.4 Applications of mobile personalization

Applications of mobile personalization have often been discussed and shown in a number of scenarios, e.g. personal navigation (Rainio, 2001), tourist guides (Abowd et al. 1997; Cheverst et al. 2000; Oertel et al. 2002; Souffriau et al. 2008), reminder systems (Lamming and Flynn, 1994; Rhodes, 1997), office applications (Nabeth and Roda, 2002; Voida et al. 2002; Bergman et al. 2004), mobile commerce (Georgiadis et al. 2005), mobile entertainment (Mosmondor, M.2005) and mobile learning systems (Economides, 2009).

Table 2.1 Literature review of a range of personalization applications

Application	Meaning	Source
Personal Navigation	provides personalized guidance to individuals	Rainio, 2001
Tourist Guide system	presents visitors with personalized information	Abowd et al,1997; Oertel et al 2002; Cheverst, 2000; Souffriau et al. 2008
Reminder systems	personalized design of reminders to help with everyday memory problems	Lamming, 1994; Rhodes, 1997
Knowledge management system	supports organization by personalized knowledge management and exchange	Nabeth and Roada, 2002; Bergman, 2004
Kimura system	monitors a user's interactions in a personalized way considering user's current working context	Voida et al. 2002
LiveMail	allows mobile users to communicate using personalized 3D face models created from images taken by their phone cameras	Mosmondor, 2005
Mcommerce	delivers personalized information or service to each user	Georgiadis et al. 2005
Learning system	employs knowledge of each learner to provide direct customized instruction or feedback to learners	Economides, 2009

The above literature demonstrates mobile personalization applications in various fields, including tourism, office applications, commerce, and entertainment, always with the purpose of making mobile usage richer. However the focus was on the technological development of mobile personalization. Where user impact was assessed, this focused on the overall usability and user acceptance, rather than the more multidisciplinary concept of user experience. Moreover research on mobile personalization is not found in the application of sporting events.

2.3 User experience

User experience is another main theme which is investigated in this research, and this section presents different views on the subject.

In early studies, usability was one of the major technical areas within the field of HCI. Usability itself has been defined in many ways during the last decades (Miller, 1971; Shackel, 1991; ISO, 1998; Faulkner, 2000; Kukkonen and Kurkela, 2003). The International Organization for Standardization (ISO) defines usability in relation to the quality of the interaction between the user, who works with the product to achieve certain goals, and the product itself. It is 'the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in particular environments' (ISO, 1998), in which the effectiveness means the ability of the user to accomplish their goals while using the system; the efficiency is the resources consumed in order to achieve these goals, and satisfaction is how the user feels about working with the system.

Subjective motivations or contextual factors aren't given any attention in the definition of usability. Moreover, the meaning of the user's goals is essential to usability, but the goals of users have been vaguely defined. In the view of usability, user's pleasure is measured by satisfaction, or more precisely, by the lack of displeasure (Jordan, 1999), and experience related feelings such as 'happy' and 'sad' are missing.

Nowadays a much broader concept of user experience, including motivation and emotion, has gained increasing attention, in which the user is seen as a human being and the human's motivations or reactions to these experiences are studied. User experience is broader than simply the usability of a product, though it may include usability as poor usability of a product will affect user experience in a negative way (Koskinen et al. 2003). User experience also takes context of use and subjective motivation into consideration, because these aspects affect what kind of experiences an application evokes. In view of this, user experience has to be studied intensively considering all those affective aspects. As user experience affects the success of a product, studies of user experience should therefore be considered as an important part of the product development process (Dewey, 1980).

There are no cohesive theories of user experience, as user experience is associated with a wide range of meanings. However, there is lots of interest in this subject from design, business, philosophy, anthropology, cognitive science, social science, and other disciplines. Among these, there have been some initial efforts to create theories of user experience (Alben, 1996; Macdonald, 1998; Buchenau and Fulton, 2000; Mäkelä and Fulton 2001; UPA, 2006; Hassenzahl and Tractinsky, 2006; Nielsen-Norman Group, 2007; Desmet and Hekkert, 2007; Sward and MacArthur, 2007; UXnet, 2007). Some of them are described below:

Dewey (1980) describes experience as a totality, engaging oneself in relationship with the product;

Alben (1996) says experience is all the aspects of how people use an interactive product: the way it feels in their hands, how well they understand how it works, how they feel about it while they're using it, how well it serves their purposes, and how well it fits into the entire context in which they are using it;

Macdonald (1998) points out that experience is a dynamic, complex and subjective phenomenon, which depends upon reactions to multiple attributes of a design - for example, its behaviour, sound, look, and smell - that are interpreted through filters relating to personal, social and cultural significance;

Buchenau and Fulton (2000) refer to experience as the 'totality' of subjective experience of using an application or tool in a situation;

Mäkelä and Fulton (2001) regard experience as simple artifacts that don't happen in a vacuum but, rather, in dynamic relationship with other people, places and objects. Additionally, the quality of people's experience changes over time and it is influenced by variations in these multiple contextual factors;

The Usability Professionals' Association (UPA) (2006) considers user experience as every aspect of the user's interaction with a product, service, or company that makes up the user's perceptions of the whole;

Nielsen-Norman Group (2007) note user experience as all aspects of the end-user's interaction with the company, its services, and its products. The first requirement for an exemplary user experience is to meet the exact needs of the customer. Next is the simplicity and elegance that cause products to be a joy to use. True user experience goes far beyond giving customers what they say they want, or providing checklist features;

Desmet and Hekkert (2007) describe user experience as ‘the entire set of affects that is elicited by the interaction between a user and a product, including the degree to which all our senses are gratified (aesthetic experience), the meanings we attach to the product (experience of meaning), and the feelings and emotions that are elicited (emotional experience)’;

Sward and MacArthur (2007) consider user experience as the value derived from interaction or anticipated interaction with a product or service and the supporting cast in the context of use (e.g., time, location, and user disposition).

UXnet (2007) points out that user experience is the quality of experience a person has when interacting with a specific design. This can range from a specific artefact, such as a cup, toy or website, up to larger, integrated experiences, such as a museum or an airport;

Law et al. (2008) tried to come up with a shared definition, by assembling a set of existing definitions and viewpoints of user experience. As a result, they concluded that user experience is seen as subjective, dealing with psychological issues like affections, emotions, cognition and performance. It is about users and their interaction with products and services, and some would even like to see it extended to companies, brands and public environments. It is not restricted to the time of the actual interaction, but extends from before the interaction and beyond the interaction. It is affected by various factors, including user-related factors, product-related factors and the context in which the interaction takes place.

The approaches to defining user experience are various, given the complexity and richness of user experience. Rasmussen (2000) argues that as society becomes more dynamic and integrated with technology, there is a need for a greater multidisciplinary approach in tackling human factors problems. Arhippainen and Tähti (2003), in evaluating mobile application prototypes, describe five categories of influences on the user experience, evoked through interaction with an application. These are user factors, social factors, cultural factors, context of use, and product (i.e. application) related factors. They also list specific attributes for each category, such as the age, emotional state of the user, habits and norms as cultural factors; the pressure of success and failure as social factors, time and place as context of use factors; and usability and size as product factors. Similarly, Hassenzahl and Tractinsky (2006) define user experience as 'a consequence of a *user's internal state* (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed *system* (e.g. complexity, purpose, usability, functionality, etc.) and the *context* (or the environment) within which the interaction occurs (e.g. organizational/social setting, meaningfulness of the activity, voluntariness of use, etc.)'.

This research followed the approach of Arhippainen and Tähti (2003) and Hassenzahl and Tractinsky (2006) in considering user experience to come about as a result of multiple components. Based on a multidisciplinary review of the literature, user experience is assumed to be contingent on a number of quite distinctive components, summarised in the following: (Dewey, 1980; Shedroff, 2001; Sanders, 2001; Norman, 1998; Kankainen, 2003; Koskinen et al. 2003; Isomursu, 2004; Buchenau and Fulton, 2000; Forlizzi and Ford, 2000; Hassenzahl and Tractinsky, 2006; UPA, 2006; Arhippainen and Tähti, 2003; Kukkonen, 1999; Davis, 1986; Nielsen-Norman Group, 2007; Desmet and Hekkert, 2007; Sward and MacArthur, 2007; UXnet, 2007).

User aspects:

Emotions, past experiences, needs and expectations are considered as personal aspects of user experience. According to Dewey 'emotions are qualifications of a drama' and are things that occur in the mind and not in the 'objective' world. Makela et al. (2000) point out that from a psychological standpoint, emotion has three basic functions: to shape our plans and intentions, to organize the procedures related to the plans, and to evaluate outcomes. From a design standpoint, emotion shapes the gap that exists between people and products in the world. Battarbee, (2004) and Desmet and Hekkert, (2007) state that emotion affects how we plan to interact with products, how we actually interact with products, and the perceptions and outcomes that surround those interactions. Emotion itself serves as a resource for understanding and communicating about what we experience.

Sanders (2001) describes how present experiences are affected by past experience in general, and he indicates that experience is a 'subjective event' occurring in the 'context of time', including 'memories from experience already lived, experiences from the present moment, and dreams about future or imagined experience'.

Norman (1998) discusses how expectations regarding a product or service arise and how well the performance of a product/service satisfies the potential perceived experience. For example, a company or product logo can evoke a set of feelings and expectations for the value that a product will be expected to give someone. The product still has to provide the value, although often that value is not in terms of actual functionality, but rather in the emotional satisfaction that owning, using or being seen with a product brings. This component is the emotional value that the spectator perceives the product will deliver, and in that sense, it is the perceived affective quality of all of the products produced by an organization. Products that don't meet expectations can either disappoint or confuse users, but the performance of a product that meets or exceeds users' expectations should be a key part of product concept definition (Kankainen, 2003; Nielsen-Norman Group, 2007). Product performance which does not meet users' expectations leads to dissatisfaction and a negative user experience.

Social aspects:

Koskinen et al. (2003) emphasize that the 'social users' and creativity in use are issues in understanding the notion of user experience. 'Social users' means groups of people communicating and sharing information within the same social setting, and creativity in use refers to the ways in which people make things meaningful for others, and the way in which they use tools to create experiences. From the same perspective, Hassenzahl, and Tractinsky (2006) see the user not as one entity, but as a group of people creating and sharing experiences, using the product as a facilitator in the interaction process.

Battarbee (2003) also emphasized that user experience is very much linked to users' social groups and that a community may share an experience. People enjoy the company of each other more than their products, so it is important to design attractive, functional and usable products, but it is even more important to provide the opportunity for users to create relevant experiences with their family and friends, near and far.

Sanders (2001) criticizes the individualistically oriented approach of experience design and suggests that the focus should rather be on understanding collective creativity: the creativity of ordinary people in their everyday lives. Creativity, then, is not just the domain of the designers, and what is created is not necessarily a product or art form. Users create ways to make existing technologies and products work for them in supporting and enhancing social interaction.

Usage context aspects:

As Isomursu et al. (2004) describe, experience doesn't happen in a vacuum. The quality of users' experience changes over time and it is influenced by variations in these multiple contextual factors (Sward and MacArthur, 2007). The contextual factors include both the physical context and the social context (Mäkelä and Fulton, 2001; Dewey, 1980). The physical context means everything that a user can see or feel: the tangible physical surroundings, location, temperature, rain or humidity, and lighting. The social context refers to the social environment surrounding the user that influences communication. It involves domains of knowledge, resources, the expectations and influences of others in relation to that user, and/or the support and willingness of the user to participate in a social situation. All of these influence the actions, thoughts and feelings of the user, and they are distinct from the *social aspects* of user experience (described above) which concern the phenomena of communication among a group, e.g. creating and sharing experiences.

***Cultural aspect*s:**

Buchenau and Fulton (2000), Forlizzi and Ford (2000) and Hassenzahl and Tractinsky (2006) discuss how the experience created by an event is heavily dependent on the culture a person is living in, the situational context, and a person's attitude towards the events. Lee et al. (2008) also argue that the quality of user experience is intricately related to the users' cultural characteristics, and these have been found to be important because a user's cultural profile shapes his/her perceptions of a system's features (Garfield et al. 1998). For example, a given cultural profile will cause a user to pay attention to certain information and to ignore the rest (Overby et al. 2004).

The UPA (2006) describes the function of user experience designers as 'cultural translators'. An effective user experience can be designed employing a strategic approach to handling the unique aspects of culture, such as language, traditions, values, religion, symbols etc. Successful design must accommodate the users' culture and fit in with the context of their tasks (Arhippainen and Tähti, 2003).

Product aspects:

The qualities of the product (i.e. functionality, aesthetics, purpose etc.) that are perceived by the user while interacting with the product itself influence the user's experience of it (Hassenzahl and Tractinsky, 2006), and the overall quality of a product includes the perception of instrumental and non-instrumental quality (Thüring and Mahlke, 2007). Instrumental quality refers to the perceived usefulness and usability of a product, while non-instrumental quality relates to the aesthetic, symbolic and motivational aspects of a product.

There have been a range of studies investigating the link between product attributes and end-user behaviour, and in one of these Kukkonen (1999) suggests that perceived usefulness and fluent navigation predict a positive use experience. Similarly, Davis (1986) also stresses that both perceived usefulness and ease of use are significantly correlated with self reported system use.

This section examined different attempts to define user experience and multiple components of user experience. It enables this research to form a framework for gathering user experience of mobile personalization in this research.

2.4 Context of use – large sporting events

Within general computing systems development, identifying the intended context of use is the starting point for tailoring the behaviour of the mobile application in a human-centred design process. This section defines context, describes the LSE context and presents its current applications.

2.4.1 Context definition

Context has been discussed widely within the HCI literature, where the term context has elicited numerous definitions, but none has yet gained the position of being considered the default one. In the following, some well-known attempts to define context are presented.

Schilit et al. (1994) introduce the term context as ‘location of use, the collection of nearby people and objects, as well as changes to those objects over time’. Schmidt (2000) proposes two general categories for structuring the concept of context: human factors and physical environment. These have three subcategories each: human factors divide into information on the user, social environment and tasks, while the physical environment distinguishes location, infrastructure, and physical conditions. Dey and Abowd (2001) define the context as 'any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves’. Dix et al. (2000) provide a taxonomy of context comprising 1) infrastructure, which refers to bandwidth, reliability and display resolution, 2) system, which means relationship with other applications, applications and users, 3) domain, which refers to the domain of application, style of use, and identification of users, and 4) resource, which is concerned with the physical nature of the application, environment and location.

Among the wide range of definitions, context has been developed including at least two different general perspectives (Dourish 2001). The first is the ‘physically based interaction and augmented environment’, and the second tries to understand the ‘generally operative social processes surrounding everyday interactions’.

The importance of context is highlighted by Dey et al. (2001) who describe how 'a goal of context acquisition is to determine what a user is trying to accomplish. Because the user's objective is difficult to determine directly, context cues can be used to help infer this information and to inform an application on how to best support the user.' Context acquisition therefore supports personalization, as described above. Similarly, Bradley and Dunlop (2002) highlight the need to understand contextual interactions in order to maximize usability of systems.

2.4.2 Detecting context

While context is considered important to design a product, numerous different kinds of information sources can be utilized in order to detect environmental context. Sensors are a commonly applied technology, and sensor data can be used to recognize the use situation, for instance from illumination, temperature, noise level, and application movements, as described for example in Gellersen et al., (2002) Mäntyjärvi and Seppänen, (2002) Hinckley et al. (2005).

Several different location detection techniques have been utilized in detecting context of location. The global positioning system (GPS) is a commonly used technology when outdoors and it is widely utilized in car navigation systems. The network Cellular ID can be used for location purposes with mobile phones, while Bluetooth and WLAN hotspots are frequently used techniques for both outdoors and indoors (Aalto et al. 2004; Burrell and Gay, 2002; Persson et al. 2003). Other methods used for indoor location detection include ultrasonic or infra-red (IR) based location detection (Borriello et al. 2005; Flanagan et al. 2002).

Determining the context with sufficient confidence requires advanced techniques, and numerous approaches have been proposed with which to analyse the data. Flanagan et al. (2002) use self-organizing maps to recognize the context, based on several input data types, and Korpipää et al. (2003) apply a Bayesian approach in order to recognize context based on sensor data. In addition, time series segmentation (Himberg et al. 2001) and hidden Markov models (Eronen et al. 2006) are techniques utilized in context-recognition problems. Although several papers report relatively good recognition results, the experiments are typically done in very limited environments and with simplified settings, and the identified problem of significant uncertainties in context recognition remains valid. Nevertheless, learning techniques can be employed, such as, for example, in the comMotion system (Marmasse and Schmandt, 2000) where the application observes the user's behaviour and learns to adapt in a manner that is perceived useful at a certain location. Pirttikangas et al. (2004) have used routine learning to automatically set mobile phone ring tones to general or silent mode based on users' context.

2.4.3 Large sporting events context

LSEs are the context of use of mobile personalization in this research. Their meaning and related works are described below.

Throughout history, large gatherings of people have been a constant aspect of social life, and today large-scale events are primarily social, economic, and media-based phenomena, ranging from sport events (e.g., the Olympics) to festival celebrations (Jacucci, 2006). At LSEs, large groups of spectators gather in a sports stadium to co-experience the lively atmosphere and exciting moments of the event.

Dewey (1980) introduces the concept of events as an aspect of experience. Events are often 'generating,' 'directing,' 'maintaining,' or 'terminating' a specific experience. They are often nodes that connect different experiences to form shared experiences. Events have no subjective experiential quality inherent in them, but they do evoke emotions to produce emotional conclusions.

This research is concerned with the physical context (Ciborra and Lanzara, 1994) of LSEs, which is used to support understanding of distributed events and their fundamental properties, as well as the social context (Schilit et al. 1994) which is employed to explain the practices and behaviour of the spectator.

The physical context of a LSE includes everything that can be seen or felt: the tangible physical surroundings and their movement, the temperature, the atmospheric conditions, and the lighting. In addition, the current location and the surrounding noises are also part of the physical context. Large crowds are part of a LSE’s physical context as they physically affect the use of the mobile, such as when avoiding bumping into other people in the crowd.

The social aspect of a LSE context refers to the expectations of other people and their influence on the user, and/or the willingness of the user to participate in a social situation. For example, people may want to follow other people in cheering or applauding during an event.

In this research, LSEs are confined by the geographical boundaries that constitute the arena as a whole. It is interpreted and used analytically as the opportunity for visitors, through their interaction in the physical surroundings, to bring social meaning and multiple capabilities to the situation at hand. A key point is that the LSE context is highly situation-specific, where all interaction is influenced by the setting within which it occurs – implying the need to undertake situated and individual – rather than simulated and generalized studies on context and its influence.

2.4.4 User experience at LSEs

The previously observed spectators' experience calls for the need to use personalized mobile applications at LSEs (Olsson and Nilsson, 2002; Nilsson et al. 2004; Sun et al. 2005; Jacucci et al. 2006; Esbjornsson et al. 2006).

Olsson and Nilsson (2002) and Nilsson et al. (2004) describe that spectatorship is an exciting experience with lots of information. However spectators find it difficult to be at the right spot at the right time, to catch the most exciting sporting moments and to be fully aware of what is happening. Spectators cannot influence what or when information is transmitted to them during the events. While being mobile and away from available announcements, it is difficult for the spectator to access relevant information at the right time. Spectators have to rely on information available through word of mouth from other spectators.

Similarly, Sun et al. (2005) point out spectators are overwhelmed with large amounts of information, but there is no support to filter the incoming data. Spectators are occupied not only with sports during the competition but also with the other related media via newspapers, magazines, broadcasts, etc. Such mass media sources simultaneously reach a large number of people with updates on the action, but they are unable to support interactivity, and information on demand.

Moreover, Esbjornsson et al. (2006) mention that there is often an inability for spectators to put the details observed into the broader context at the events – such as what a particular lap means for the overall race, or what a particular game means for a whole competition.

From the perspective of the social context at LSEs, Jacucci et al. (2006) state that spectators gather in groups to co-experience something exciting during the LSEs. Rather than being passive participants, they are actively engaged in staging their experiences, including navigating and selecting places, settling, and creating multimedia records of the events.

Esbjornsson et al. (2006) also emphasize that social communication is important at LSEs because being at the event is a social activity: visitors go there with their friends to enjoy the events together. However, their study showed the spectator experience itself is often dominated by long periods of waiting, with the 'action' only taking a small part of the time spent watching. This can lead to considerable boredom amongst spectators.

2.4.5 Related research

In the past, research has been conducted into trying to enrich users' interest, engagement, and experience of LSEs in different ways, such as in the following projects: Media Event Platform (Olsson and Nilsson, 2002), Situate System (Hallberg et al. 2004), the Arena project (2004), MELISA (Papaioannou et al. 2004), MySplitTime (Esbjörnsson et al. 2006) and Motoroa TuVista (2009). These studies aimed to enable visitors to have a better understanding of the events by providing timely information, and enhancing visitors' engagement with the proceedings. Besides these studies, the research of Voting Glove System (Beusekom et al. 2004), mGroup (Jacucci et al. 2005), LifeVibes™ (NXP Press, 2008), and DSBS (Lim et al. 2009) emphasized the interactivity between visitors and competitions, and among visitors themselves.

Table 2.2 Literature review of applications to enrich the user experience at LSEs

Application	Feature	Source
Promotes visitors' engagement with events through timely information provision		
Media Event Platform	enables a visitor to follow athletes of their choice by tracking their location, speed and pulse.	Olsson and Nilsson, 2002
Situate System	monitors athletes through sensors, which enables visitors to view events through several different camera angles and replays	Hallberg et al.,2004
Arena Project	tries to improve the experience at an event by transmitting sensor-based information	The Arena Project,2004
Melisa	aims to provide visual aids and enhancements for large sporting events	Papaioannou et al. 2004
Mysplittime	embeds the relevant race statistics within photographs of rally cars ,taken by spectators	Esbjörnsson et al. 2006
Motorola TuVista	delivers media bundlesto end-users,for example, the instant video replays.	Motorola, 2009
Supporting social interaction during events		
Voting Glove	aims to enhance the experience of being at arena sport events by encouraging interactivity in a stadium	Beusekom et al., 2004
mGroup Application	presents a novel application for mobile group media to move beyond person-to-person multimedia messaging and the passive receiver of multimedia content	Jacucci et al., 2006
LifeVibes™	allows users to share not only words, but also emotions, memorable sights and exciting (sports) moments	NXP Press, 2008
DSBS	a dynamic system, allows the formation of 'sides' within a sports stadiums; supporters of one team can chat on one screen while the supporters of the other team are able to chat on the other screen	Lim et al. 2009

These studies investigated how to enhance the experience of spectators by (1) providing a better understanding of the competition and (2) supporting interactivity. However, none of these studies have investigated the role that mobile personalization can play. In addition, there is no empirical study of user experience (studies to measure user experience aided with technology) during sporting events, so while these studies serve as good references to understand user experiences at LSEs, they also demonstrate the need to provide spectators with timely, detailed and dynamic information which further supports interactivity.

2.5 Mobile usability

Usability is important for any application, particularly for small mobile applications whose physical constraints make them even harder for users to interact with. Weiss (2002) remarks on the 'general lack of usability of most handheld applications' whilst Nielsen's discussion on mobile usability in 2003 stated that 'the latest mobile applications still lack key usability features required for mainstream use' (Nielsen, 2003).

Previous studies have identified several key usability problems of mobile applications (Kjeldskov, 2002; Kukkonen and Kurkela, 2003; Vetere et al. 2003) and these include: 1) the small visual display of mobile applications is the most obvious difference to personal computers and therefore limits the information that can be presented to the user, as well as input/output functionalities. 2) Limited bandwidth restricts the number of 'pages' (information) returned per request of the user. 3) Limited memory capacity restricts the use of mobile applications and application concepts developed for them. 4) Limited storage space constrains users' ability to store the information resources, such as PDF and media files, added software, games and music files. 5) Limited battery life is still an issue for most mobile applications – the accessing of resource-hungry applications, such as video and wireless networks, needs to be managed to maximize the availability of services to end users. 6) Mobile services are generally used 'on the move' and in varying contexts where users have neither the time nor the attention to navigate through complicated menus or to interpret ambiguous results. Mobility is regarded as the key concept to consider in relatioin to a user's capability to use a mobile application - ie being on the move and multitasking.

To address the usability problems of mobile applications, development has centred on interaction technology for small mobile applications (MacKenzie and Soukoreff, 2002). These include differently organized alphanumeric keypad layouts (Pavlovych and Stuerzlinger, 2003), and touch-screen based input (Isokoski and Raisamo, 2004). In addition to text entry, other interaction modalities have also been investigated, and ideas such as speech recognition and the use of styluses have been discussed to offer a more natural and efficient interaction mechanism for mobile applications (Hurtig, 2006). Gesture input methods employing either sensors (Hinckley et al. 2000) or an application integrated camera (Drab and Artner, 2005; Rohs and Zweifel, 2005) have also been demonstrated. Interacting with the physical world and smart environments with a mobile application has become an intense research area. Radio frequency identifier (RFID) and visual tags are the most common solutions for interacting with physical objects, and semantics of interaction have been investigated (Rukzio et al. 2006). Providing auditory cues (Brewster, 2002) and projection displays (Moizio et al. 2007) are other means which are being investigated to enhance the ability to present information on a small screen.

Moreover, recent development in mobile applications has seen an increasing awareness of contexts of use and how these might evolve. For example, Turel (2006) argues that the emergence of mobile value-added services has introduced a broad range of new use contexts, requiring a new conceptual model of mobile usability. Pehkonen and Turunen (2003) argue that in the case of mobile learning, user-centred design means not only planning learning goals and actions, but also specifying different contexts of use and the requirements of different 'actors', which might include teachers, students, and even parents.

Another approach to improving usability is to make the user interface or content adaptable to, or by, the user, and making information personally valuable in a given context, as suggested in mobile design guidelines (Malley et al., 2003). Jappinen et al. (2005) state that personalization, in the context of mobile learning, is very appealing as it can build a model of each user's characteristics and personalize its way of functioning. Malliou and Miliarakis (2005) put their faith in the personalization of the mobile system in the MoTFAL project, stating that 'it should adapt to the learners' evolving skills and knowledge' as part of a set of requirements that are specified to assure its usability.

There are a wide range of theories which are potentially applicable to mobile usability, such as user-centred research, ethnography, participatory design, action research and social network theory (Kjeldskov and Graham, 2003). They often influence which existing methods are selected. These theories are not actual physical procedures for conducting or designing a study, but instead they provide higher-level guidance about how to use methods or the broader intent of doing design in a certain way. No particular theory addresses all relevant issues and each emphasises different techniques and goals for design. This HCI research applies a user-centred research approach, which aims to improve design by linking an understanding of user experience to the design goals.

Studies of usability issues with mobile applications have helped in the design of mobile personalization in this research, and they have also formed the basis for choosing the research methods.

2.6 User culture

Culture is 'the collective programming of the mind that distinguishes the members of one group or category of people from another' (Hofstede, 1997). In any social system, culture serves as a perceptual framework that guides the interpretation of interactions and the construction of meanings (Cortazzi, 1990). Hence, an investigation of the Chinese culture provides an appropriate background to understand and design for Chinese users.

China is a vast country with a large population. It differs greatly from western countries in terms of economy, spoken language, and culture (China Internet Network Information Centre, 2004). Considering Hofstede's (1997) dimensions of culture, China is a country of significantly higher power distance (acceptance of unequal power distribution within society), high uncertainty avoidance (feeling threatened by uncertain situations), high collectivism (integration into cohesive groups in return for loyalty) and long-term orientation (perseverance with goals). The society distinguishes between different social roles, and a more collectivist nature, which emphasizes extended group relationships (Marcus and Gould, 2000).

The socio-cultural differences between Western and Chinese users highlight the issues of thinking, and while personal goals are more valuable in the West, the Chinese prefer to work as a group with a holistic world view (Peng and Nisbett, 1999).

The socio-cultural research also identifies a cultural difference between Western and Chinese people in communication, specifically noting that Chinese culture does not encourage talking in communication (Kim, 2002; Lin, 1977; Peng, 1997; Liu, 1988). The Chinese language is a non linear pictorial-based language that may not be as efficient as linear language for verbalizing thoughts (Kim, 2002). Preparing thoughts internally before verbalization for communication seems essential for Chinese people. Besides the language barrier, communication could be also influenced by the traditional Chinese value of discouraging speech, as quoted by Lao Tzu, who stated that 'he who knows does not speak, he who speaks does not know' (Lin, 1977). Moreover, Chinese high power distance may explain the predetermined hierarchical work structure. The discussions for group decision-making may not be common practice; instead decisions tend to be individually made by a higher authority and then are given to subordinates (Liu, 1988).

The Chinese emphasis on harmony may contribute to a lack of debate during communication (Peng, 1997), and one way of maintaining harmony is the preservation of face. Preserving face means maintaining one's dignity by not embarrassing or humiliating a person in front of others and by preserving one's face, inter-personal relations can be improved and harmony and respect can be sustained (Nakamura, 1985). Concepts and words place the emphasis on finding the middle way, in which truth can be found in each of two competing propositions (Liu, 1988). As 'the middle way' approach to overcoming conflicts is common for Chinese people, critical debates can be undesirable for group discussions for fear of losing harmony (Peng, 1997).

Some concrete studies regarding cultural difference have been found, such as Choong and Salvendy (1998) who analysed cultural differences between Chinese and American populations. They found two distinct cognitive styles. Chinese users have a relational cognitive style which is contextual, and the tendency is to classify things by inter-dependence within wholes and to reply to subjective experience without differentiating sharply between the self and others, or from facts and concepts. Conversely, American users tend to classify things by functions, to analyse components and to infer common features. Chinese users are collectivist, and as such they are more likely to value things that enhance their relationships with others within their social groups.

Evers and Day (1997) report an interesting study regarding Chinese users in the acceptance processes. They examined users' culturally specific design preferences, and evaluated the attitudinal and behavioural consequences of satisfying or not satisfying such preferences. Participants consisted of three groups of users: Chinese, Indonesian and Australian. Results indicated that design preferences did affect interface acceptance, but that the path of influence leading from preference to attitude and behaviour varied from culture to culture. Chinese users found usefulness a more discernible variable, and when preferences for design features are met, users will be satisfied with the interface. Somehow, when the Chinese's interface functionality is met, their demands for ease of use are also met. Evers and Day further discuss the fact that Chinese users do not separate interface satisfaction from system satisfaction, indicating that a system's external design features are not enough to satisfy the Chinese. Furthermore, certain functionality levels must be met, and they suggest putting emphasis on both the way an interface looks and the actual functionality.

Cha et al. (2005) indicate that Asian users are particularly keen on personalizing their interaction with mobile applications – for example, ringtones and wallpaper – suggesting that personalization is an effective way of enhancing the user experience for this particular group of people.

These previous studies have discussed the cultural differences between western and Chinese people in thinking, communication, and personal and social values. Such cultural characteristics and differences imply a distinction in designing and evaluating for Chinese users. The implications include 1) cultural issues must be considered in designing a suitable user interface for the mobile personalization application, 2) the importance of choosing proper research methods to effectively communicate with

Chinese users, and 3) the need for future work in method development (which is discussed in Chapter 10).

2.7 Discussion of literature

This section discusses the definition of the main concepts in this research, highlights its novel parts and explains where the themes of mobile personalization and user experience overlap.

2.7.1 Mobile personalization in this research

The key elements abstracted from previous theories that are used to define mobile personalization in this research are: the mobile application tailors content and functionality provided to a user based on an understanding of the user; this understanding includes the users and their context; personalization helps the user to achieve certain goals; the tailoring can be user-initiated or mobile application-initiated.

Here, personalization is centred on the concept of *content* personalization, and is based on the key assumption that the optimal content for an individual is dependent on factors relating to the individual, their activities and their situated context. In the context of a LSE, personalization involves the collection of information about users and their context in a sports stadium. It also includes adaptation to that information to recommend services or information to users.

Both user-initiated and system-initiated personalization approaches are studied in this thesis to examine how personalized mobile applications can enhance the user experience at LSEs. This research analyses and compares when it is appropriate to choose user-initiated personalization and when one should opt for system-initiated personalization. The balance of those two approaches is also discussed in relation to enhancing the user experience at LSEs.

This thesis takes an explicit user-centred approach to mobile service design, building on the key elements described within the personalization literature:

- The needs of the user play a central role in the process of personalization, and technology acts in a subservient role.

- Stable and more transient parameters provide input to the adaptation of services; these parameters describe the user's interests, preferences, behaviour and context.
- The user and/or an application can take the initiative to personalize services.
- Usability provides necessary, but insufficient design and evaluation criteria – a broader construct, such as user experience, is necessary for designing effective personalization.

2.7.2 User experience in this research

The existing theories of user experience are useful on a general level, however, they are too broad to be used as a practical tool in the product design or concept design context. A method of defining a meaningful subset of user experience is therefore required.

In this research, the user experience refers to the subjective experience that an individual encounters within a stadium. It is a broader concept than usability, reflecting the fact that mobile applications are personal applications used by individuals with particular social and cultural norms, within an external context defined by their environment. At sporting events, user experience is defined by the spatial bounds of the stadium, and arises as a result of the interactions that occur between the individual and other entities within the stadium. These interactions can be between the user and the sporting action, the user and other individuals (including the crowd), the user and other information sources, and the user and their mobile application.

Table 2.3 Influences on user experience

Component	Sub-component	Source
User aspect	expectations, needs, motivation, emotion, past experience	Dewey, 1980; Battarbee and Koskinen, 2004; Makela et al. 2000; Desmet and Hekkert, 2007; Sanders 2001; Norman, 1998; Kankainen, 2003; Nielsen-Norman Group, 2007
Social aspect	social user and creativity in use	Koskinen et al. 2003; Hassenzahl and Tractinsky, 2006; Battarbee and Koskinen, 2004; Sanders, 2001
Usage context aspect	physical context, social context	Isomursu et al. 2004; Sward and MacArthur, 2007; Mäkelä and Fulton, 2001; Dewey, 1980
Cultural aspect	values, traditions	Buchenau and Fulton, 2000; Forlizzi and Ford 2000; Hassenzahl and Tractinsky, 2006; UPA, 2006; Arhippainen and Tähti, 2003
Product aspect	usability, aesthetics, functionality	Nielsen, 2001; Davis, 1986; Kukkonen, 1999; Thüring and Mahlke, 2007

Multiple aspects of user experience based on the literature are: the user aspect, which refers to the mental and physical state of the individual who interacts with the system (e.g. expectations, needs, motivation, past experience and emotion); the social aspect is an aspect which is created by social interaction (e.g. social user and creativity in use); the usage context aspect defines the physical and social environmental factors for the experience (e.g. physical context and social context); the cultural aspect means the cultural background of the user group (e.g. value, traditions); and the product aspect is all services and infrastructures that are involved in the interaction when using the examined product (e.g. usability, functionality). These five levels of components are able to cover all aspects mentioned by the earlier definitions, although the lists of attributes for each component (shown in brackets) are still incomplete. This study examines user experience at LSEs from personal, social, contextual, functional and cultural perspectives.

2.7.3 Large sporting events as the context in this research

In this research, LSEs are confined by the geographical boundaries that constitute the arena as a whole. It studies both the physical (e.g. noise) and the social (e.g. visitors' willingness to communicate) elements of the events.

LSEs are the general context of use of mobile personalization. Based on broad definitions of context, in this research it is assumed to be all things that are relevant to the interaction between a user and a mobile application in a sporting stadium at a LSE. In general terms these include aspects of the user, what they are doing or intend to do, and the physical and social environment in a stadium (including objects, people and resources). This thesis takes a broad view of those situational factors that can influence how personalization, within a given situation, can influence the user experience.

For the purposes of this study, if the contextual factor can potentially influence the user experience, then the contextual factor is considered relevant. The literature review on context has also developed a toolkit for this research and design. See Table 2.4.

Table 2.4 Contextual factors summarized from the literature

1. User factors	2. Task	3. Environment	4. Social
gender/age	task type	weather	'with whom'
interest/preference	task goals	location	co-location of others
knowledge/ experience of sports	task importance	noise level	activities of other users
mood	task status	lighting	social atmosphere
attention	linked task	traffic	group dynamics
motivation	task duration	crowd density and behaviour	
5. Time	**6. Culture**	**7. Mobile Application**	**8. Events**
date	nationality	screen size	event type
time	language	Battery life	Event characteristics
		ease of use	

These contextual factors have commonly been used for two different kinds of application approaches: to capture context so that it can later be used as a cue for information retrieval, or, more commonly, to use context to adapt an application's behaviour to correspond to the manner of its usage (Dourish, 2001). In addition to these two cases, i.e. tagging context of later use and automatic execution of actions, contextual factors can be used for providing information to the user (Dey et al. 2001). Context acquisition therefore supports personalization, as described above.

By analyzing and attempting to understand the relationship between the user experience and context, it is possible to prescribe how a mobile application should adapt itself according to the relevant contextual factors.

2.7.4 Novel part of this research

The literature study highlights the gaps in the literature pertaining to mobile personalization, relevant work to this research, user culture, and these are outlined below:

Mobile personalization. User-initiated personalization and system-initiated personalization are the two major approaches for the design of mobile personalization, however, there are very few empirical studies that focus on the impacts of different approaches to personalization (Ramnarayan, 2005). Some research studies favour user-initiated personalization because of the human instinct to be a designer, but also because of its characteristics of allowing the user control to decide on their needs (Nielsen, 1998; Norman, 2004; Nunes and Kambil, 2001; Coner 2003). Other studies support the approach of system-initiated personalization, for the reason that it saves users' time and energy (Weld et al. 2003; Martinez et al. 2009). The real question is not only whether to use user-initiated personalization or system-initiated personalization, but how to meet the needs of users, so that those users will feel comfortable with the products. This research attempts to fill a gap in the above literature, by examining both user-initiated and system-initiated personalization and their impact on user experience.

Related research. During the last decade, the usefulness of mobile personalization has been shown in a number of scenarios (Rainio, 2001; Souffriau et al. 2008; Rhodes, 1997; Bergman et al. 2004; Voida et al. 2002; Mosmondor, 2005; Georgiadis et al. 2005) (See Table 2.1). These research studies did not consider the personalization application in the field of LSEs, rather they focus on technology development in mobile personalization, instead of its impact on user experience. Where user impact was assessed, this has focused on the overall usability and user acceptance, rather than the more multidisciplinary concept of user experience.

Only a few studies have been conducted on trying to enrich the user experience at LSEs in different ways (Arena Project, 2004; Hallberg et al. 2004; Nilsson et al. 2004; Mylonas et al. 2004; Olsson and Nilsson, 2002; Esbjörnsson et al. 2006; Jacucci et al. 2005; Beusekom et al. 2004). Related research in sports has tried to support visitors with an enhanced experience by providing better understanding of the competition, and supporting interactivity at LSEs (See Table 2.2). However, none of these studies have investigated the role that mobile personalization can play; instead they focused on providing detailed competition information or trying to encourage social interaction. In addition, there is no empirical study of user experience (studies to measure user experience aided with technology) during sporting events.

This research takes a new look on the impact of mobile personalization on user experience, investigating spectators' experience at LSEs, their requirements and context. It searches for ways to fulfil those requirements and to improve their experience in a contextually, socially, and culturally relevant way.

Culture. Another feature, which makes this research unique, is the cultural consideration. Studies of culture highlighted differences in thinking, communication, and values between Chinese culture and other cultures, and because there are significant differences among cultures, research should consider these differences in the design and evaluation of mobile personalization for Chinese users in a LSE context.

2.7.5 Bridging user experience with mobile personalization

Concerns related to the use of mobile personalization applications have been identified in the literature, but so far the discussion has focused mainly on technical and functional factors, and little attention has been devoted to user experience in mobile personalization applications. When the literature of mobile personalization applications is examined, it is found that studies lack the design perspective that pays full attention to user experience issues. Their functions are based on assumed, rather than examined, end-user needs, and no detailed attention has been devoted to the interaction flow or user interface design. Thus, reports focused on user experience are very rare.

User experience in a personalized mobile application at LSEs is important because it has been noticed that spectators face problems during LSEs, such as having insufficient relevant information on the events or the sporting action taking place. User experience is the centre of the mobile personalization research in this study, defining the scope of this thesis from a HCI perspective, rather than technology development.

2.8 Conclusion

The overall aim of this chapter was to provide a relevant theoretical perspective that can be used to inform the research process. Based on the literature reviewed in this thesis, the following main concepts are defined:

- The mobile application tailors content and functionality provided to a user based on an understanding of the user; this understanding includes the users and their context; personalization helps the user to achieve certain goals; the tailoring can be user-initiated or mobile application initiated.
- User experience in this research refers to the subjective experience that a spectator encounters within a stadium. At sporting events, user experience is defined by the spatial bounds of the stadium, and arises as a result of the interactions that occur between the individual and other entities within the stadium. These interactions can be between the user and the sporting action, the user and other individuals (including the crowd), the user and other information sources, and the user and their mobile application.
- LSEs are viewed as a large group of spectators gathered in a spatially defined environment to enjoy the excitement of sporting action within a large and stimulating social environment. It is the context of use of mobile personalization in this research where context is assumed to be all things that are relevant to the interaction between a user and a mobile application in a sporting stadium.

This literature review also brings two main methodological points which can be used to guide the approach taken in this thesis:

- To study user experience, HCI research presents an idea of user-centred research, which aims to improve design by linking an understanding of user experience to the design goals.
- The studies of Chinese cultural characteristics and differences imply a difference in designing personalization of a mobile application for Chinese users, including the research methods used.

Through investigating the related research, the novel parts of this research have been highlighted. The literature on mobile personalization has focused on technological development and where user impact has been assessed, this has emphasized overall usability and user acceptance, rather than the more multidisciplinary concept of user experience. Some studies have researched the user experience at LSEs, however, none of these studies have investigated the role that *mobile personalization* can play; instead they have focused on providing detailed competition information, or on trying to encourage social interaction. This thesis takes a new look at investigating the role of personalization at large sporting events using a multidisciplinary perspective on user experience. It examines both user-initiated and system-initiated personalization and their impact on user experience.

3 METHODOLOGY

3.1 Introduction and aims

The overall aim of this thesis is to study the role of mobile personalization in enhancing the user experience at LSEs. The previous chapter reviewed the literature which provides a relevant theoretical perspective that can be used to inform the research process.

The study of user experience is complex because user experience is formed in a dynamic relationship between the user and the application, and the application and the context of use; it cannot be studied in a vacuum (Mäkelä and Fulton, 2001; Isomursu et al. 2004).

HCI research presents the philosophy of user-centred research, which aims to improve design by linking understanding of user experience to the design goals (Kuniavsky, 2003).

This chapter discusses the user-centred approach that may be used within a research design and its applicability to this thesis.

The overall aim of this chapter is to provide a methodological perspective which can be applied in this research, and the specific objectives of this chapter are:

1) to outline the relevant methods of user-centred research;
2) to identify potential methodological concerns of user-centred research;
3) to describe the research methods to be applied within this research

3.2 User-centred research and its related methods

User-centred research emphasises that the real users and their experience, not just technology, should be the driving force behind the development of a product (Nielsen, 2001). Users take a central place and should be involved throughout the research process, so direct contact with users is an essential requirement. Its goal should be the understanding of the experience of users and technology to manage the risks of technology creation and to increase the chances of success.

User-centred research encompasses methods of examining, inferring, and managing a user's experience so that it is beneficial for product development. One aspect is the model of user experience, which includes artefacts, environments and their impact on what people think and do. The other important part is to understand the relationship between 'think', 'do' and 'use'. The following is an analysis of user-centred research methods related to this research (Kuniavsky, 2003; Kukkonenand Kurkela, 2003; Kjeldskov and Graham, 2003; Robson, 1993; Preece et al. 2002; Cooper and Reimann, 2003; Robertson and Robertson, 1999). These methods are discussed in separate sections in terms of their role in the user-centred circle of collecting user requirements, designing a product, and prototyping and evaluating a product.

3.2.1 Interview, questionnaire, observation

Interviews, questionnaires and observation are widely used methods for collecting user requirements in HCI, and their nature may vary depending on the case (Kuniavsky, 2003).

Interview is a method of asking users about their experience (Kuniavsky, 2003). It creates an easy way to get information about the user's background, such as their profile, prior experiences, expectations and motivation, etc. However, there are some challenges for the interviewers: firstly, interview questions should be formulated very carefully to make sure the users can understand them easily; secondly, it is easier for users to express what goes wrong with an application rather than to describe their feelings about the application. The user may not be aware of their experiences or be capable of expressing them verbally (Robson, 1993).

A ***contextual interview*** is an interview carried out in the context of use. It is a field data-gathering method, studying a few carefully selected individuals in depth, to arrive at a fuller understanding of the work practice across all users (Kuniavsky, 2003). It helps develop awareness of the real environment in which users live and work, and reveals users' needs within that environment. It uncovers what users really do and how they define what is actually valuable to them.

A ***questionnaire*** is a set of questions which creates a structured way to ask users to describe themselves, their needs, their interests and their preferences (Kuniavsky, 2003; Kukkonen and Kurkela, 2003). It investigates who users are and what their opinions are, and while it is quite easy to conduct, it can easily go wrong. If the questions are not designed carefully, the researcher can ask the wrong user the wrong questions, producing results that are inaccurate, uncertain, or even deceptive.

Observation is a method of gathering user requirements by listening to and watching users in relation to their experience (Kuniavsky, 2003; Kjeldskov and Graham, 2003). The basic approach of this method involves visiting users and observing them in context, based on the study of anthropology and ethnography. In watching them carefully, it is possible to comprehend what problems users have and how the product can contribute to their problems. However, researchers need to carefully interpret the users' facial expressions, body movements and gestures, because the personality of each user will affect how they behave.

3.2.2 Persona, scenario and card sorting

Persona, scenario and card sorting are methods commonly employed for designing a product in HCI.

The aim of a ***persona*** is to present a precise description of a user profile, and what a user wishes to accomplish, that can serve as a guide in the design process (Preece et al. 2002). The idea with personas is not to define one generic user, but instead it will give a short presentation of some typical users and their characters. The persona is used to answer questions about which pieces of information are required at what points, and why. It aims at a simple, but good enough description of the user to make it possible to develop a product.

A ***scenario*** is an informative description which is told in stories describing how a user behaves or thinks about a task or a situation (Bødker, 2000). They are created by role playing with the profiles that are created, by looking at their problems and the solutions through users' eyes. It can be used to communicate the motivations and goals of users and creates a realistic understanding of the context within which mobile products are likely to be used to meet these goals.

Scenarios can be characterised with a set of elements. A setting draws a picture of the environment; for instance a student is on the way to school, with a mobile phone in his pocket. The scenario includes actors who typically have goals or objectives, which are the changes the agent wants to accomplish in the circumstances of the settings. The scenario has a storyline or plot, which contain sequences of actions and events. Usually they are things the actors do or what happens to them, or changes in the circumstances of the settings (Carroll, 2000).

Although the scenario method serves well in evoking conversation and new ideas, one can argue that the given scenarios may be unrealistic and easily overlook things that would arise if the considered situation took place in real life. The successful use of scenarios requires ways of capturing user needs in relation to realistic contexts of use, taking into account the diversity of contexts within which mobile products are to be used (Fulton and Marsh, 2000).

Card sorting is a method which is sometimes used together with a scenario. It uncovers information on how users arrange information, and how they categorize and associate concepts in the design. For example, a researcher writes the names of the things to be organized on small cards and users sort the cards into their preferred order. It is a method used to study users' mental models and to decide interaction steps accordingly (Cooper and Reimann, 2003).

3.2.3 Low- and high-fidelity prototyping

Prototyping is a part of the iterative user-centred research process, following the design stage. The forms of prototypes are diverse, varying from the low-fidelity prototype to the high-fidelity prototype. Low-fidelity prototypes, such as paper mock-ups, are used in the early phase of the product development, whereas high-fidelity prototypes, such as computer simulation, are typically employed at a later stage.

The ***paper mock-up*** is a low-fidelity prototype which is widely used in design and testing phases of an application. It is a tool for capturing usability issues early in the product development process, before any code is written (Cooper and Reimann, 2003). Walking through the mock-ups with users allows people to visualize the design and to attempt different aspects of specific tasks. This process reveals at an early stage, the areas that users have difficulty with, and paper mock-ups enable alternative designs to be drawn, tested and refined. They can be hand drawn, a combination of photocopied templates with hand drawn components, or created online with drawing packages.

Simulation is a high-fidelity prototype for designing and testing the application. It is an imitation of the real user interface, where the act of simulation entails representing certain key characteristics of the user interface. Users are presented with the high-fidelity simulations to visualize the design and to attempt different aspects of specific tasks. If user testing is conducted in non-laboratory settings, a reasonably advanced high-fidelity prototype may be easier to handle (Cooper and Reimann, 2003). The experiences and feedback gained while using a high-fidelity demonstrator give valuable information of an application, taking it one step closer to a commercial product (Preece et al. 2002).

3.2.4 Lab-based experiments and field-based experiments

Evaluation is usually the final phase in a circle of user-centred research. Lab-based experiments and field-based experiments are the most discussed methods used to evaluate a mobile application.

A lab-based experiment is usually conducted in laboratories with test participants performing a pre-defined set of tasks, while data on performance measures are documented (Robson, 1993). It can quickly reveal a vast amount of information about how a user uses a prototype, whether with a paper-based mock-up or a computer designed simulation. A field-based experiment, on the other hand, is used to examine the user, work and environment. It produces a richer understanding of the relationships between preferences, behaviour, environment problems and values (Kuniavsky, 2003; Robson, 1993).

Field-based experiments produce insights into the total relationship between the associations of the user experience, as experienced and understood in the context of use, unlike the lab-based experiment which is used to remove people from their environments to focus on individual tasks or perspectives, or to aggregate responses from many people. However, field-based experiments are not easy to conduct (Brewster, 2002; Nielsen et al. 2004). Three fundamental difficulties are reported in the literature: Firstly, it can be complicated to establish realistic studies that capture the context of use of a system (Pasco et al. 2000; Rantanen et al. 2002). Secondly, it is far from trivial to apply established methods such as observation and think aloud when a study is conducted in a field setting (Sawhney and Schmandt, 2000). Thirdly, field-based evaluations complicate data collection and limits control, since users are physically moving in an environment with a number of unknown variables potentially affecting the set-up (Petrie et al. 1998).

For lab-based experiments, the difficulties in conducting and collecting data are significantly reduced when compared to field-based experiments, although such tests cannot address factors and issues that occur in the field. Research indicates some drawbacks in lab-based usability testing methods (LTA, 2004; Kjeldskov et al. 2004), and these drawbacks include limited relation to the real world and an unknown level of generalization of results outside of laboratory settings.

This research tries to employ new and different techniques for increasing the realism of lab-based experiments (Petrie et al. 1998; Pirhonen et al. 2002; Graham and Carter, 1999; Lai et al. 2001; Koppinen, 2000; Salvucci, 2001). There are two basic concerns, which are identified as mobility and divided attention. With regard to the question of mobility, test participants have been asked to use a treadmill, or to walk on a specifically defined track in a lab setting (Petrie et al. 1998; Pirhonen et al. 2002). To deal with the matter of divided attention, test participants have been asked to use a mobile system while driving a car simulator which facilitated the evaluation of a mobile system while simultaneously engaged in a demanding cognitive activity (Graham and Carter, 1999; Lai et al. 2001; Koppinen, 2000; Salvucci, 2001).

3.3 Concerns of user-centred methods

According to the relevant literature, user-centred methods are widely accepted and applied in most user-centred research that is carried out, and they are geared toward understanding user experience of a product (Robson, 1993). These methods are all different ways of examining and interpreting many of the same phenomena. For example, questionnaires allow users to express their experiences in a written form, and diaries enable users to organize and remember experiences and communicate experiences of different situations to the researcher. Although each method can be used alone, there is not a single all-purpose method (Kuniavsky, 2003). Each one has its strengths and weaknesses; for example, questionnaires can uncover what people feel is working and not working, but people's preferences are not good predictors of their behaviour (Kuniavsky, 2003). A context interview can reveal issues in the way people use the application, but can only be used with one person at a time.

Another concern is that these user-centred methods were generated and developed from western countries. Can such methods fit into a study of Chinese users? Any method is influenced by the culture from where it originates and hence can corrupt the data that is collected when applying that method in a completely different culture (Edward, 1990). The literature neglects to detail the efficacy of these user-centred methods when used in the Chinese culture because of the difference in language, cognitive style and personal and social values, details of which were introduced in Chapter 2 (Kim, 2002; Lin, 1977; Peng, 1997; Liu, 1988; Choong and Salvendy, 1998; Cha et al. 2005; Evers and Day, 1997).

Any assumption that the methods which predominantly originated from the West will work in the East does not take into Eastern culture into considerations (Kim, 2002; Lin, 1977). Some examples of inefficacies of Western user-centred methods were found in previous research studies (Kim, 2002; Fernandes, 1995; Herman, 1996; Yeo, 2001; Vatrapu and Pérez-Quiñones, 2004; Liu, 1988).

In Japan, the co-discovery technique was found to be problematic when people of differing status were employed; in particular, women when paired with men were found to talk very little (Fernandes, 1995). In Singapore, it is reported that a subject actually broke down and cried during usability testing, however, during the post-test interview, the subject was very positive about the software (Herman, 1996). Similarly, with Malaysians, giving frank negative opinions can undermine harmonious relationships and threaten group solidarity. Therefore participants who performed poorly in the usability testing session were positive in the interview (Yeo, 2001; Vatrapu and Pérez-Quiñones, 2004). Also, Malaysian and Chinese users have been observed to be less forthright in expressing views and opinions and are uncomfortable in criticising and evaluating peers and subordinates (Yeo, 2001). Research considers that this kind of inconsistent behaviour is due to the characteristics of Eastern culture whereby it is ‘considered culturally unacceptable to criticize the designer directly or openly, as this may cause the designer to lose face’ (Liu, 1988).

When applying the Western-developed methods to study Chinese users, the research may not take the cultural differences into consideration, such as the difference between Western and Chinese users in thinking and communicating, as mentioned in Chapter 2. The literature studies mentioned that Chinese users are not encouraged to talk during communication (Kim, 2002; Lin, 1977; Peng, 1997; Liu, 1988), because the Chinese language, as a non-linear pictorial-based language, may be not as efficient as linear language for verbalizing thoughts (Kim, 2002). Preparing thoughts internally before verbalization for communication seems essential for Chinese people. As well as language barriers, communication could be also influenced by the traditional Chinese value of discouraging speech, as quoted by Lao Tzu: 'he who knows does not speak, he who speaks does not know' (Lin, 1977). On the other hand, debate for Chinese users in works could be frustrating for them due to the cultural value of maintaining harmony (Peng, 1997). Concepts and words place the emphasis on finding the middle way in which truth can be found in each of two competing propositions (Liu, 1988; Nakamura, 1985).

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In light of these concerns, this research developed and adapted user-centred research methods which were more compatible with Chinese culture and values.

3.4 User-centred research methods in this research

This user-centred research involved the activities of literature research, user studies, context studies, design of mobile personalization prototypes, and experiments of mobile personalization at LSEs. A diagram (see Figure 3.1) is built up identifying this user-centred research as a holistic concept, depicting the research activities of user and mobile application, user and context, and user and researcher. The diagram advocates the process of designing for user experience including early and regular user involvement, and iterative research. The diagram is applied to develop a methodology for this study.

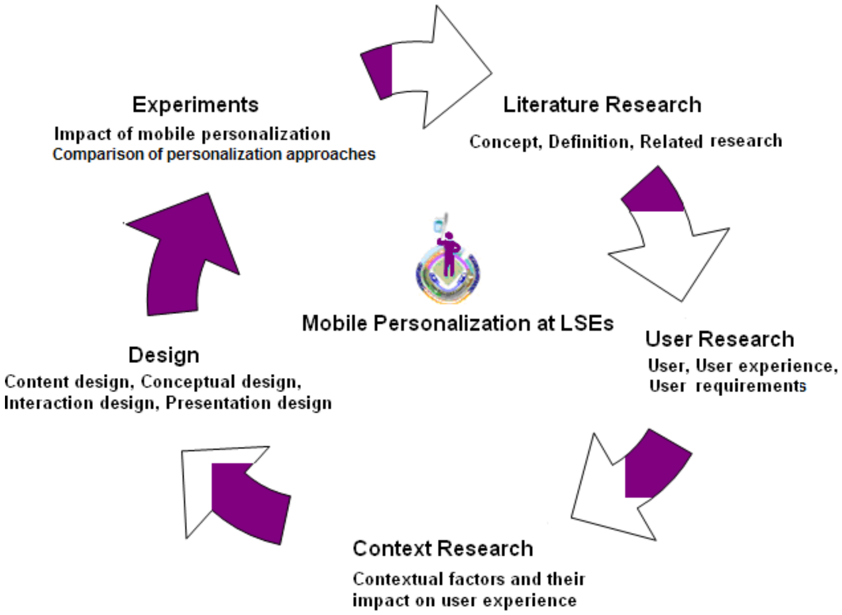

Figure 3.1 User-centred research diagram for mobile personalization at LSEs

3.4.1 Multiplicity of user-centred research methods

In view of the concern that no user-centred method is a single all-purpose method (Kuniavsky, 2003), this research applied multiple user-centred methods. Applying multiple user-centred methods helped to balance and complement each other. Every method described is designed to provide a different insight into people's perceptions, desires and abilities. For example, usability testing gives valuable information about people's interaction with the application; questionnaires broadly paint users' desires and hopes, while contextual interviews help to understand the full environment in which the experience happens. These methods work at specific times using a common method, however, there are also many situations that call for different approaches.

Each stage of the research activities employed a multiplicity of user-centred methods, and the overview of the research methods is given below in terms of the diagram introduced above. The detailed methods are explained for each chapter accordingly.

3.4.1.1 Methods applied in Chapter 4 – understanding users, user requirements and current user experience

The first activity in this research tried to tackle the first research question by understanding users, user requirements and their current experience at LSEs.

RQ1: What is the potential for mobile personalization to contribute to the positive aspects of user experience at LSEs?

To investigate the potential of mobile personalization, scenario-based interviews were chosen to gain an initial understanding of the user. The interviews created an easy way to get information about the user's background (Kuniavsky, 2003), such as profile, prior experiences of personalization, motivations for personalization and expectations at LSEs. Scenario-based interviews were conducted to understand how a user behaves or thinks about the LSE context.

To observe current users' experience and their requirements, field studies were conducted which combined the methods of self reporting, experimenter observation, and context interviews in the field. They examined which user needs within the stadium were, or were not being met at LSEs. The multiple methods employed in the field allowed the researcher to observe experience, which was difficult for the user to articulate, and then to obtain clarification and explanations regarding the experience observed.

3.4.1.2 Methods applied in Chapter 5 – LSE context research

The second research activity dealt with the second research question of understanding the contextual influences on the user experience encountered by individuals at LSEs.

RQ2: What are the key contextual factors to be used for mobile personalization at LSEs?

Field studies were applied again, based on the need to understand situated action (Dourish, 2001). Three field studies, which combined the methods of observation, and context interviews, were undertaken in the UK and China. Observation was used to identify user attention to the sporting action, their needs and their interactions with other individuals (either on a one-to-one basis or as part of the crowd), and interaction with other information sources within the stadium. Context interviews were carried out with participants after they had watched the event, in order to validate the direct observations.

3.4.1.3 Methods applied in Chapter 6 – design of mobile personalization at LSEs

The third research activity focused on actually designing an enhanced user experience for the personalized mobile application at LSEs. Four key elements of design were considered, which were content, conceptual, interaction and presentation design. The design process investigated how user- or system-initiated personalization can enable the delivery of easy to use and relevant services to end users. The design process applied multiple user-centred methods, including scenarios, paper mock-ups, simulations, card sorting, questionnaires and interviews.

RQ3: How can personalized mobile applications be designed to optimize user experience at LSEs?

During the design phase, scenarios helped to immerse users in the context of use, while paper mock-ups and simulations vividly demonstrated the conceptual ideas. With these methods used together, users could gain a good understanding of the design. The questionnaire revealed patterns in people's preference in different design ideas, and then causes for these preferences were investigated and verified with interviews. Card sorting was used to investigate how people organize information and how they categorized related content.

3.4.1.4 Methods applied in chapter 7 and 8 – experiments of mobile personalization at LSEs

The fourth research question was addressed by conducting experiments using mobile personalization prototypes in the LSE context with potential Chinese users.

RQ4: How does mobile personalization impact on user experience at LSEs?

As introduced above, the distinction between field and lab experiments has been a controversial topic for several years. Some argue that it is important that mobile applications are tested in realistic settings, since testing in a conventional usability laboratory is not likely to uncover all of the problems that would occur in real mobile usage (Nielsen et al. 2004). However, field experiments are time consuming, they complicate data collection and they reduce experimental control (Brewster, 2002;

Nielsen et al. 2004; Pascoe et al. 2000; Rantanen et al. 2002). It has been suggested that instead of going into the field, when evaluating the usability of mobile applications, adding contextual features, such as scenarios and context simulations to lab settings, can contribute to the outcome of the experiment while maintaining the benefits of a controlled setting (Duh et al. 2006; Petrie et al. 1998; Pirhonen et al. 2002; Graham and Carter, 1999). Despite these arguments, no individual approach to usability experiments with mobile systems can be held to be the definitive approach (Kjeldskov et al. 2004).

A mixed field- and lab-based methodology was used in order to assess the impact of personalization on the user experience at sporting events. An initial field-based experiment maximized the ecological validity of the study, and also helped to identify the key situational factors that influenced the user experience (and would need to be carried forward into more controlled settings). The field-based experiment included going into the field where the application would be used; carrying out scenario-based tasks; working with and comparing different mobile prototypes; and surveying user experience in the field setting as users interacted with the mobile prototypes. The second experiment was a lab-based study, where it was easier to control against confounding factors and to concentrate on the independent variable of interest (whilst accepting that there would be some loss in ecological validity). The lab-based study included setting up the lab to simulate a real life stadium, carrying out scenario-oriented usability testing, working with and comparing mobile personalization prototypes, and interviewing and surveying to test user experience as users interacted with the prototypes. A mixed approach also enabled a methodological comparison, and comments on their relative effectiveness for Chinese users.

This research applied a multiplicity of user-centred methods in a flexible, optimized combination through balancing and complementing each other. It obtained information from various methods which could leverage the strength/weakness of each user-centred method and sharpen understanding in a specific, targeted way. It also tried to understand user experience of mobile personalization by allowing triangulation on a problem from different perspectives and delving deeper into issues. It could be particularly powerful when the output of one method becomes the input of another. For example, problems found during observation were discussed and confirmed with users during interviews. The use of multiplicity of user-centred methods in this research aimed to reach a better, deeper understanding of user experience.

3.4.2 Adapted user-centred research methods

Most existing user-centred research methods are generated based on the premise that the methods which predominantly originated from the West are used, and will work, in the East (Edward, 1990). However this assumption is not necessarily compatible with Chinese culture (Kim, 2002; Lin, 1977; Peng, 1997; Liu, 1988). The user-centred methods were adapted based on Chinese cultural influences.

In light of the Chinese culture of discouraging speaking (Kim, 2002; Lin, 1977; Peng, 1997; Liu, 1988), the study employed Emotion Cards (Desmet, 2000) to facilitate the communication with Chinese users. Emotion Cards are a group of cards depicting cartoon faces with eight distinct emotional expressions.

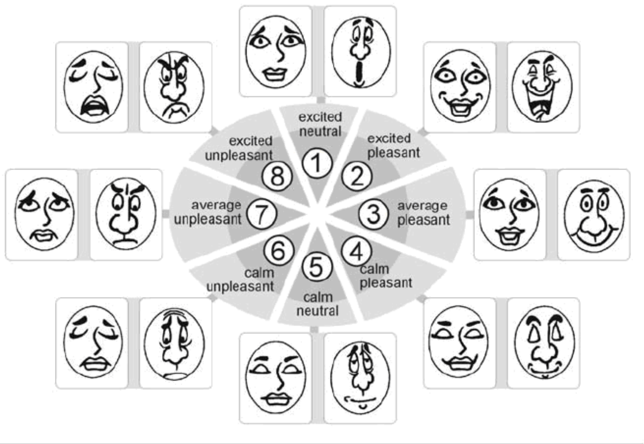

Figure 3.2 Emotion Cards (Desmet, 2000)

These expressions vary on the basis of 'pleasantness' and 'excitement' dimensions, because in psychology, these are the two most accepted dimensions of emotion (Schlosberg, 1952). Each emotion can be described in terms of the levels of pleasantness and arousal. Based on the two dimensions, Russell created a 'circumplex of emotions' (Russell, 1980), and in this model, each emotion has a specific location on the circumplex. Figure 3.2 shows that excited emotions are located on the upper part of the circle while the calm ones are on the lower part. Unpleasant emotions are located on the left side of the circle and the pleasant ones are on the right side. The Emotion Cards were used to help Chinese users objectify their experience and to serve as an aid for starting a conversation with the researcher.

Furthermore, in order to encourage users to think aloud, the research created a User Advisory Board that was employed throughout the whole series of design activities. This method was based on the idea that Chinese users work better with those familiar to them (Yeo, 2001), and the User Advisory Board is a way of achieving continuity of users throughout the design process. The advantage of applying this method is that everyone is familiar with each other and knows the ongoing issues with the product, meaning that the focus can therefore remain only on the new ideas being investigated.

Another concern is that Chinese users' emphasis on harmony may have contributed to a lack of negative feelings being expressed during the study. The middle way (Liu, 1988; Nakamura, 1985) approach of overcoming conflicts is common for Chinese people, whereby truth can be found in each of two competing propositions. The Chinese users' 'middle way approach' can be minimized by asking indirect questions - which are projective rather than personal - (Robert, 1993). For example, instead of asking: 'do you enjoy interacting with this mobile prototype?' (where a negative response would imply criticism of the researcher and hence a lack of harmony), an indirect question would elicit a response that was a truer reflection of the participant's real feelings. An example would be: 'would you like to use this mobile application for a longer period of time, and if so, why?' There is strong evidence of the link between positive attitudes, intention to use and actual usage (e.g. Venkatesh et al. 2003). Interestingly, this approach is using intentions as an indicator of attitudes, whereas technology acceptance models typically use attitudes as predictors of intentions and usage.

Another technique to counteract the Chinese tendency towards the 'middle way approach' is to design data collection methods that require participants to take a particular side with respect to an issue. Even-rating scales were used, which forced participants to commit to either side of a neutral response, as recommended by Rantanen (2008).

3.4.3 Reliability and validity

In general, reliability refers to whether a particular research method will yield the same results if applied repeatedly to the same object (Robson, 1993; Babbie, 1998). Threats to reliability can result from various sources (Robson 1993), such as participant error (where participant behaviour might fluctuate widely from occasion to occasion, irrespective of the conditions of the study), participant bias (resulting from the participant being aware of the nature of the study), observer error (due to inconsistent measurement), or observer bias (e.g. influenced by raters' beliefs concerning the effectiveness of a particular intervention).

The research tried to enhance reliability by the use of triangulation, which is the use of a combination of sources or methods to study the same phenomenon (Jick, 1979). This research triangulated data sources and methods (as suggested by Miles and Huberman, 1994) to study the impacts of mobile personalizaiton on user experience at LSEs. For example, using the methods of observations, interview and questionnaires, it studied the importance of mobile personalization which took place at different places, different times and with different users, which allowed the research to compare multiple measures. Triangulating on this dimension enhances reliability if results are consistent, because it demonstrates that the same data collection technique yields the same results, even from different informants or sources.

Moreover, the research tried to eliminate (as far as possible) confounding influences within experimental designs, to hide the nature of the studies from participants, where appropriate, and to use data collection protocols to maximize the consistency of measurement.

In contrast to reliability, as discussed above, validity refers to whether a particular indicator measures what it is intended to measure, rather than some other phenomenon (Robson, 1993; Carmines and Zeller, 1979). There are various distinctions between aspects of validity, as discussed in Robson (1993), such as content validity, construct validity, ecological validity, external validity and internal validity. Threats to qualitative research can include 1) generating inaccurate or incomplete data, 2) incorrect interpretation, 3) not considering alternative explanations or understandings of the phenomena being studied (Robson1993). Validity in this thesis was tackled chiefly by the use of standard methods and triangulation.

The overriding philosophy of the research described in this thesis is user-centred research which entails a variety of standard data collection and design methods, including questionnaires, interviews, scenario development, card sorting and so on. This research was conducted by applying these standard methods. It tried to ensure the scheme of observation, interview, and questionnaire by referring to the literature.

It also applied triangulation to improve the validity of the findings by using different data types (i.e. qualitative or quantitative) generated from different types of methods. The findings found in one method can be further validated in another method. For example, users' preferences were revealed in the questionnaire, which could then be further validated when talking with users in the interviews.

In addition, the research tried to improve the validity of the data by understanding the problem domain, allowing interpretations to emerge without preconceptions concerning cause and effect, and focusing on research within a real usage context (LSEs) in order to maximize the ecological validity of the research undertaken.

3.5 Conclusion

This chapter has outlined a range of user-centred research methods, which included methods to collect user requirements, design, prototyping and evaluation. It described the overall philosophy of the user-centred research in this work which involved identifying needs and establishing requirements, developing designs that meet those requirements, and building interactive versions so that they can be experimented on with users.

It also identified two main methodological concerns of user-centred research:

- No user-centred method is a single all-purpose method (Kuniavsky, 2003), although each method can be used alone. Each one has its strong and weak points. The different methods should be applied to complement and balance each other.
- Another concern is that the standard user-centred methods were generated and developed from western countries which may not fit with the target Chinese

culture. This research needs to adapt those methods for the Chinese user, based on their cultural influences.

In consideration of these concerns, this research has applied a multiplicity of user-centred methods in a flexible, optimized way through combining and balancing each method. The user-centred methods were also adapted to Chinese culture based on the differences between Chinese and Western users in language, thinking, communication and values. The adaptation included the use of Emotion Cards, a User Advisory Board, indirect questions, and an even number of items on a questionnaire scale.

4 UNDERSTANDING USERS, USER REQUIREMENTS, CURRENT USER EXPERIENCE

	Research questions addressed in this chapter:
1	**What is the potential for mobile personalization to contribute to the positive aspects of user experience at LSEs?** • **What are the user group characteristics?** • **What is the current spectator experience at LSEs?** • **What are the user requirements of mobile personalization at LSEs?** • **What are the usage implications of mobile personalization to enhance user experience at LSEs?** • **What are the key cultural implications for user-centred research methods?**
2	What are the key contextual factors to be used for mobile personalization at LSEs?
3	How can personalized mobile applications be designed to optimize user experience at LSEs?
4	How does mobile personalization impact on user experience at LSEs?
5	What are the key gaps in user-centred research that arise from this thesis?

4.1 Introduction and aims

LSEs are characterised by Jacucci et al. (2006) as a large group of spectators gathered in a large spatial distribution to co-experience the lively atmosphere and exciting moments of a sporting event. As a LSE is a large environment with lots of stimuli, visitors can be overloaded by the amount and diversity of information to which they are exposed, and can lose track of that which is relevant to them (Olsson and Nilsson, 2002; Esbjornsson et al. 2006). In order to avoid the overwhelming experience of a large and complex information environment, and to satisfy individual differences, personalization is recommended for the mobile application design to enhance the user experience at LSEs.

The previous chapter indentified a user-centred approach for this research, which advocates the process of designing for user experience, including early and regular user involvement, and iterative research. It included the principle of the circle of studying users, designing a product and testing the design.

The overall aim of this chapter is to investigate the usage implications of mobile personalization that can contribute to the positive aspects of user experience at LSEs. To explore this issue, it is important to first investigate the negative aspects of the existing experience during events in order to determine what elements are missing. In addition, it is essential to study the target Chinese users, their characteristics, requirements and experience. Thus, the objectives of this chapter are:

1) to investigate the nature of the user
2) to investigate current user experience and user requirements at LSEs
3) to investigate the usage implications for personalization of a mobile application in order to support user experience at LSEs

4.2 Understanding users in the context of LSEs

An initial user study was conducted to study the target Chinese users, their characteristics and requirements in the context of LSEs. This was used to derive the usage pattern of mobile personalization at LSE.

4.2.1 Participants

Fifteen potential Chinese users (university students, managers, researchers, engineers) were invited for the workshops. Their ages ranged from twenty to forty two, and the average age of the participants was 27 years. All the users have had experience of personalizing mobile application and had attended a LSE in an open stadium within the preceding six months.

4.2.2 Methods

To gain preliminary understandings of users in this study, typical users were first interviewed about their backgrounds, and then scenarios were developed to study their requirement at LSE. The results derived were used to create personas for this research. Specific methods are discussed below:

Scenario-based interviews were conducted to get information about the users' backgrounds, expectations and motivation toward mobile personalization at LSEs. Scenarios were then developed to illustrate a situation of usage (Bødker, 2000), bringing the LSE context to life, and making the study more contextually relevant. It was used, together with the interviews, to put Chinese users into role-play situations by looking at the problems and the solutions through users' eyes.

The scenarios contained a number of scenes that told a detailed story of watching the Olympic Games, and these were created to cover a wide of range of spectating, such as information flow and social interaction in context, based on the understanding of LSEs in the relevant literature (Nilsson, 2004; Nilsson et al. 2004; Jacucci et al. 2006; Esbjörnsson et al. 2006; Ciborra and Lanzara, 1994; Olsson and Nilsson, 2002). These scenarios were broken into a number of episodes, with each episode covering enough of the story to reach a describable outcome, and the scenarios were further developed in cooperation with the users. By going through this and other scenarios, users' characteristics and requirements were discovered. An example of a scenario is given below. Detailed description of scenarios are given in Appendix 4A.

Table 4.1 Example of the scenario

Scenario 1: Preparation before the event.
Episode 1: Mike just arrives at the athletics stadium.
Questions: * What kind of preference would Mike like to set for watching the athletics in the stadiums? * How could Mike set the preference list on the mobile application? * Which functions are missing in this scenario? Outcome: The preference list is set successfully on the mobile application.
Episode 2: ….

4.2.3 Procedure

Users were firstly interviewed to obtain basic user information, such as age, profile, their use of mobile applications, and past experience at LSEs. Then, each user was provided with four scenarios for watching a football match at the Olympic Games, and they were asked to answer the questions for each episode of the scenarios to discover their requirements for mobile personalization in a LSE context.

4.2.4 Analysis

After the interviews were conducted, an affinity diagram technique (Hackos and Redish, 1998) was used to extract further data. These types of diagrams are good for sifting through large volumes of data and for encouraging new patterns of thinking. Furthermore, they allow grouping of ideas based on their natural relationships before sorting through them and analyzing which kinds of requirements the data represents.

The process worked as follows: first, the qualitative data was reviewed to synthesize the key themes, and then those themes were recorded on small pieces of paper. Next, a priority for the theme was set according to number of times it was mentioned. Then, they were sorted into groups based on their natural affinity, and subsequently, headers for each group were created. During the analysis phase, patterns were found in the data, and the focus was on finding these key user requirements and prioritizing design opportunities.

Figure 4.1 Example of an affinity diagram

4.2.5 Results

It transpired that 13 out of the 15 invited participants were frequent users of personalized mobile applications, with self-identification, convenience and entertainment being their main motivations for personalization.

Identification. One of the most pervasive themes throughout the investigation (also widely recognized in the recent literature on user experience) is that of identity (Johanson et al. 2002). Personalization has an impact on a user's private identity in terms of how the user expresses himself/herself and also impacts on a user's public identity in terms of how others perceive him/her (Blom et al. 2003). For example, by personalizing a ring tone, users expressed their characteristics (e.g. interest) to the public and which in turn made them feel unique.

Convenience. Personalization improves the usage efficiency and effectiveness by enabling tasks with less interaction and more relevance with the mobile application (Venkatesh et al. 2003; Haym et al. 2000). For example, users liked to create personalized short-cut keys to perform quick operations.

Entertainment. Entertainment is one of the psychological drivers for personalization (Blom et al. 2003; Bonnet, 2001). For example, users wanted to personalize the mobile application according to their mood, so that users who are bored want to have exciting or arousing content, while those who are stressed are likely to prefer relaxing content.

Personas were employed to present a precise and descriptive model of the user (Preece et al. 2002). The idea with personas was not to define one generic user, but instead to give a short presentation of a pair of typical users. It provided a clear basis to understand users, and the persona was used to answer questions, such as which pieces of information were required at what points, and why.

Two personas were created based on the difference in users' motivations regarding personalization and requirements for mobile personalization at LSEs.

First User Group - Lance

Sports fan - Lance. He is a sports fan and wants to better enjoy watching competitions at LSEs. He would benefit greatly from personalized mobile applications because they can provide him with personalized events information or services and therefore keep him more involved in watching the events.

Name: Lance

Age: 30

Position: Marketing manager

Company: Shell

Sports habits: he loves playing sports and watching live sporting events.

Mobile habits: he usually uses a mobile phone for communication with his clients.

Social habits: he spends most of the time working but tries to get to know more people and build up a business network.

Frequency of personalization: frequently.

Experience of mobile personalization: creating short-cut keys and personal menus, customizing ring tones on the mobile phone.

Motivation for mobile personalization: identification and convenience.

Requirements at LSEs: since Lance is a sports fan, his highest priority in the stadium is to watch the competition, however, he requires personalized information to help him better to follow and understand the competition, such as personalized information on athletes and event schedules. The information is expected to be provided relevantly and upon request. He also prefers to have logistic support relevant to the stadium, for example, arranging transportation to and from the venue.

Second User Group - Nancy

Lover of social communication – Nancy. The second persona is a social communication fan. She enjoys company with friends and usually visits the LSEs with a group of people. Her needs are more focused on social interaction with friends.

Name: Nancy

Age: 21

Position: University student

University: Zhejiang University

Sports habits: she swims once every two weeks.

Mobile habits: she uses a mobile phone to communicate with friends.

Social habits: she is a very outgoing. She goes out with friends almost every evening.

Frequency of personalization: frequently.

Experience of mobile personalization: profiling ring tone and appearance (colour, layout of background) of her mobile phone.

Motivation for mobile personalization: identification and entertainment.

Requirements at LSEs: Nancy likes to visit LSEs mainly because of their lively atmospheres. She enjoys talking and taking pictures with friends during events in a stadium. She requires support for social interaction, such as discussing, cheering, sharing experiences, and making new friends with people with similar interests in the stadium.

These personas reflect two types of potential users with different requirements and focus, which are 1) Lance, who requires supports for information and logistic support in a stadium; 2) Nancy, who desires opportunities for social communication at LSEs.

4.3 Current user experience and user requirements at LSEs

After the initial study of users, user studies continued to investigate the current user experience in the field in order to further understand user requirements. It aimed to investigate 1) what the current user experience was at the stadium, 2) what was missing for users during the events (user requirements), and 3) what were the implications of mobile personalization at LSEs.

4.3.1 Methods

A field study was used for investigating user experience at the site of use (Robson, 1993). It can be summarized as, 'the study of people in naturally occurring settings, involving the researcher participating directly in the setting, in order to collect data, without meaning being imposed externally' (Kuniavsky, 2003). It combined methods of observation, context interviews and questionnaires.

Observation was a suitable method for gathering user experience data emanating from non-verbal expressions. It can capture information relating to their experience which the user may not be aware of, or is unable to express verbally, and furthermore, this method was compatible with the ethos of ethnography, where the researcher was immersed in the users' naturally occurring environment in order to collect data without meaning being imposed externally.

Contextual interviews were selected as a means of investigating a user's needs and expectations, which have been identified as central elements of user experience (Kuniavsky, 2003). They were also used to study user requirements in context. This kind of data cannot be observed directly.

A questionnaire was designed based on the Technology Acceptance Model (TAM) developed by Davis (1986), measuring a user's acceptance toward the concept of mobile personalization in the LSE context. The questionnaire is presented in Appendix 4B.

In view of the Chinese culture of not encouraging talking (Kim, 2002; Lin, 1977; Peng, 1997; Liu, 1988), Emotion Cards (Desmet, 2000) were used with the Chinese users to encourage them to speak during the study, because they served as an aid for starting a conversation with the researcher.

The methods employed in this research aimed to uncover more than simply what problems were experienced by Chinese users. They were intended to understand what users felt and what they required from mobile personalization in the LSE context, and why.

4.3.2 Field study

The field studies took place at four sporting events, comprising two swimming competitions and two football matches which were held at sports stadium in Shanghai, China. Eighteen Chinese participants, who are mobile users and have prior experience of watching sporting events, were involved in the study which lasted for 16 hours over four days. Their ages ranged from seventeen to thirty-seven and their gender was evenly distributed (9 male, 9 female). Their occupations varied from student to professional people, such as engineers, business officers, accountants, sales people and teachers. The composition of the subjects was well-balanced in terms of age, gender, and occupation. Among them, nine users represented the first user group (Lance) and the other nine were characterised by the second user group (Nancy), based on the difference in users' motivations regarding personalization and requirements for mobile personalization at LSEs.

Figure 4.2 Field studies in swimming and football stadiums

4.3.3 Procedure

Before the sporting events users were firstly informed of the research purpose and the concept of mobile personalization. . During the events, the observer sat behind them, observing and recording their user experience in a relatively unobtrusive way. Each participant involved in the evaluation had a mobile phone that prompted them by SMS to fill in the 'wish list' during the breaks – this reminded them to write down their requirements for improving the spectator experience. The lists were collected and recorded for later analysis. This method is referred to as a 'beeper study' (Dey, 2001) which tends to be relatively intrusive and may encourage participants to be more expressive than when being simply interviewed.

Follow-up context interviews were carried out immediately after the events to investigate users' levels of anticipation and their expectations. It was conducted while the participants' memory of the event was still fresh, in order to promote recall of relevant detail. During the interview, users acted as informants as well as co-designers. The interviews covered questions regarding their spectator experience and user requirements at LSEs. Summative user experience at LSEs and user acceptance toward mobile personalization concepts were measured at the end of the interview using the questionnaires. As a first attempt, a questionnaire applied the widely used five-point scale to observe if there was a trend towards the Chinese 'middle way' approach, which was discussed in Chapter 2.

Observers were placed among the users to record the observable multiple factors of user experience, which included factors of users, culture, event context and social experience (as described in Section 2.7.2, Chapter 2).

4.3.4 Data collection

Based on the literature studies of user experience, this study gathered data mainly on the multiple aspects of user experience. They are: 1) user (expectations, motivation, and emotion); the usage context (e.g. physical and social environment) and the social interaction occurring at LSEs (e.g. social interaction); the culture (e.g. values), 2) user requirements at LSEs. This was done to provide an overview of what the current spectator experience was, what kinds of information resources were predominantly used, and the relevance to mobile personalization. It was also a means of capturing the types of information that the users were interested in, or were unable to access.

4.3.5 Analysis

Both qualitative and quantitative methods were used to analyse the data. For qualitative data captured during field observation and interview, the affinity diagram technique (Hackos and Redish, 1998) was applied to group findings, based on their natural relationship, before sorting through them and analyzing which kind of requirements they represented. The process worked similarly to that described in Section 4.2.4.

For quantitative data, users' scores on the TAM-based questionnaire were analysed using statistical methods (Siegel and Castellan, 1988).

4.3.6 Results

The results of the studies were analysed from three viewpoints:

1) current user experience at LSEs;
2) user acceptance toward the concept of mobile personalization;
3) user requirements at LSEs

4.3.6.1 Current user experience at LSEs

Table 4.2 describes the multiple aspects of user experience observed during the four field studies, relating to: user, social, cultural, LSEs context and mobile product.

Table 4.2 User experience captured during studies and the methods used

Interviews (I), observation (O) and user questionnaire (Q).

Factors	I	O	Q	Analysis
User				
Behaviour		Y		watch, navigate, talk, taking pictures, cheering
Emotion	Y	Y		excited (peak movement), distracted, bored
Expectation	Y			understand the competition, enjoy live atmosphere
Motivation	Y			sports, social interaction
Culture				
Value	Y	Y		emphasis on group image, interactions happen in groups
Social interaction				
With events	Y	Y		cheering , create multimedia records
With friends	Y	Y		talk to friends nearby, take photograph
With strangers	Y	Y		glance at each other
Usage context				
Stadium layout		Y		round stadium, stages were centered for competition, seats were closely related to each other; spectators could not easily move around.
Physical Objects		Y		two outdoor 15x17-foot video stadium displays hanging on the front and rear of stadium
Social Environment		Y		easy to get separated from friends, difficult to move and locate friends in the stadium
Audio Information		Y		at the beginning/end of each competition, audio presented information of who was competing, and who scored afterwards.
Visual Information		Y		public screen displayed information of score, time, and replay of scoring moments. (not visible from a distance)
Paper-based Information		Y		program list is available from the Internet or prepared in advance. (few users had it and looked at it).
Mobile Device				
Use of mobile media		Y		moment: take photograph, video recording break: sending messages, take photograph
Interaction with device		Y		move around trying to get a good view when creating multimedia records, one hand to send message, put in pocket after using
User acceptance	Y		Y	average user acceptance score of all users was 4.52 on a 1~5 point scale.

Information overload. There was an overload of competition information which was published/distributed in several ways, including audio, visual and paper ‘channels’ at both football and swimming stadiums, consistent with Sun et al. (2005). The events were watched by spectators, but the significance of the events within the wider competition was often not known by the spectators until later. For example, users did not understand the meaning of the scores of one event of the swimming competition in relation to the overall scores of the event. Within the overall LSEs atmosphere, the detailed competition information can easily be lost, as also found by Nilsson et al. (2004). For example, some users missed the moment that a football player scored a goal.

The spectators were limited in their ability to select from a variety of different information sources (e.g. audio, visual and paper-based information in the stadiums), to assimilate the content and to control their interaction with information during the observed swimming and football events.

Social interaction. There was limited social interaction formed at the events. Spectators were seldom involved in other activities besides quietly watching the competition, and they rarely directed their attention to social interaction. The social interaction happened infrequently and included asking questions, discussion among friends and cheering at peak sporting moments (e.g. scoring). It took place in a less explicit way with passers-by through the exchanging of glances. The experience itself was often dominated by long periods of watching in the sports stadiums, with the social interactions only comprising a small portion of the time spent actually watching the swimming and football events. An interesting finding was that Chinese spectators demonstrated their distinctive group image by wearing specific uniforms or using particular accessories (e.g. flags) when cheering in the stadiums. Interactions happened by taking pictures, talking to group members, or chanting group slogans during the climaxes of the studied events.

Use of mobile devices. The mobile devices, which were their own personal phones, were inconvenient to use. In both swimming and football stadiums, it was not possible to perform complicated mobile tasks, except by simple clicking. For example, some users struggled to take photographs using the mobile application while clapping their hands and cheering.

Personal activities. Personal activities were somewhat constrained in the sports stadiums. For example, it was not easy to locate seats among the spectators, especially when arriving late in the swimming stadium; it took one and a half hours to watch the football matches, during which it was inconvenient to obtain refreshments because of the crowds in the stadium; after the events, crowds caused difficulties in meeting friends in the stadiums, as indicated by Olofsson et al. (2006).

4.3.6.2 User acceptance toward mobile personalization

To consider the availability of mobile personalization, the questionnaire based on TAM (Davis, 1986) was to provide an explanation of the determinants of user acceptance. The questionnaire, comprised of tailored measurement scales, was rated after the context interview. The measurement scales were on a 1-5 point range, and dialog boxes were included in the questionnaire to elicit user feedback regarding perceived usefulness, and attitudes toward using and intention behaviour.

The average acceptance score of all users was 4.52 in a 1~5 point scale. Consistent with literature research, Chinese users are very keen on mobile personalization (Cha et al. 2005; UPA, 2006). A summary diagram is given to show the mean user acceptance rating over all participants according to the user acceptance category. The ratings shown are aggregated scores on ‘strongly agree’ (5) to ‘strongly disagree’ (1) scales. The error bars represent +/- 1 standard deviation (SD) of the mean in all cases.

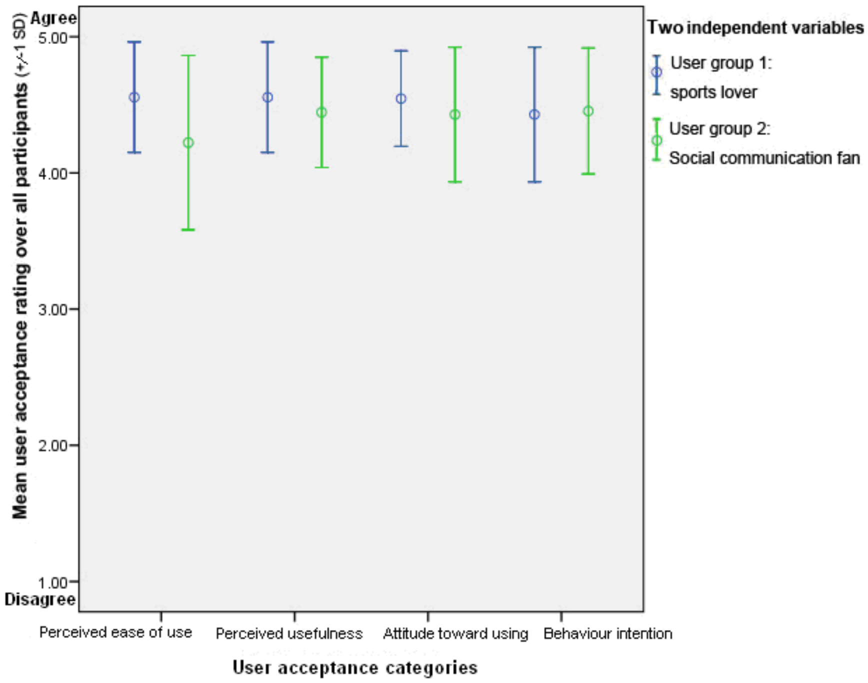

Figure 4.3 User acceptance rating toward the concept of mobile personalization at LSEs

A Mann-Whitney test showed no significant difference for perceived ease of use (n=15, df= 17, Z= -.830, P= .489, P>.05), perceived usefulness (n=15, df=17, z=-.458, p=.730, P>.05), attitude toward using (n=15,df=17,z=-.458, p=.724, P>.05) , intention behavior (n=15, df =17, z=-.255, p=.86, P>.05) between the two persona groups.

Based on users' comments, users showed high levels of acceptance toward the concept of mobile personalization at LSEs. Although there was no significant difference in acceptance categories between the two groups of users, the first user group (sports lover) underlined the importance of less interaction which required providing related information/services on demand with minimum attention at LSEs. On the other hand, the second user group which enjoys social communication, placed emphasis on relevance, which demanded the enhanced social interaction tailored to users' interest and preference in a stadium and the presentation of relevant event information/services.

4.3.6.3 User requirements of mobile personalization at LSEs

The studies also generated a list of 55 requirements that were further reduced to 46 core requirements by combining related issues, which were later divided into 4 groups of user requirements: functional requirements, information, social, and usability requirements. A detailed description is provided below.

Priority was set to required, important or less important. The condition was set as required when 50% or more users asked for it, as important when 25%-49% of users asked for it and others were ranked as less important requirements.

Functional requirement. Personalization should provide information/services in line with the event context, such as updated information/services according to the event progress. It should also provide location-sensitive event broadcasts, replays and notification of competition times on the mobile application.

Table 4.3 Functional requirements

Required	event broadcast; event replay; provide information/services according to relevant context; notification of competition time
Important	order food; different viewing angles; professional analysis; buy tickets; reminders before events; guidance to seats in the stadium; bet and predict before events; video chat; make a picture-diary; block redundant information; play music via the mobile application
Less important	provide advanced gaming; send messages to a group; automatically find friends; translate different languages; chatting system like MSN; estimate of the time to go to the stadium

Information requirement. It should supply personalized information on athletes, event schedules, results and event background information (such as competition rules).

Table 4.4 Information requirements

Required	personalized information on athletes, event schedules, event results and event background information, such as competition rules
Important	personalized information on tickets, entertainment, and traffic; location of food, toilets, emergency exits, police, ATMs, supporters’ products such as flags, etc; event news
Less important	Rank of matches and players; number of available and sold tickets; number of fans of different players; weather information

Social requirement. It should support social interaction by building up virtual communities, especially enhancing interactions within/with groups of people who share something in common, such as discussing and sharing experiences.

Table 4.5 Social requirements

Required	build up a\virtual community with people sharing something in common; share experience in groups; discuss with groups of users
Important	locate friends; make recommendations to friends; get celebration information after events; share pictures with friends
Less important	find new friends during matches; support the feeling of not being alone in the stadium

Usability requirement. Information/services should be timely and relevant, and personalized to users' context. Interaction with the application should be intuitive and simple, allowing easy interaction and minimizing a user's commitment and saving their time. Information/services presented should cater for user needs at different times and support different activities.

Table 4.6 Usability requirements

Required	present timely, relevant, event information; provide context for information and services which makes information useful; be easy, quick to interact with
Important	easy to carry
Less important	easy to remember the control keys

4.4 Discussion

4.4.1 Understanding users in this research

The study found that self-identification (Johanson et al. 2002), convenience (Haym et al. 2000) and entertainment (Blom et al. 2003) were the main motivations for mobile personalization in users' daily life.

It further identified two groups of users in this research according to the difference in users' motivations and requirements for mobile personalization at LSEs. The two groups of users were: 1) users who love sports, who underlined the importance of less interaction with a mobile application at LSEs; 2) users, who love social communication, placed greater emphasis on enhancing social interaction tailored to their interests and preferences in the LSE context. These two groups of users served as a good basis to understand the typical users in this research.

The study also revealed that users have a high level of acceptance toward mobile personalization concepts at LSEs. It reflected that Chinese mobile users welcomed the characteristics of various personalized options of mobile applications, which is proposed to lead to a better user experience for Chinese users (Cha et al. 2005; UPA, 2006)

4.4.2 Use of personas

The research created two personas, based on the difference in users' motivations for going to the LSEs, and requirements for mobile personalization at LSEs. The purpose of generating the personas was to present a clear description of user profiles and what a user wishes to accomplish, that can serve as a guide in the design process (Preece et al. 2002). For example, it can help to determine if the design of different interfaces of a product is needed for different personas.

When comparing levels of user acceptance, there was no statistically significant difference between the two personas, although there were different focuses in considering user experience and their requirements based on the users' comments. However, as their experiences and requirements at LSEs often overlapped each other, instead of considering users in two separate groups (based on the personas), the research regarded the users as a whole group when designing the mobile personalization in later research activities. The personas were referred to when considering user profiles in recruiting participants throughout the user studies in this research, in order to cover a representative range of user types.

4.4.3 Current user experience at LSEs

Usage context. The LSEs were conceptualized as a large group of individuals within a particular spatial distribution who co-experience a lively atmosphere and the momentary excitement of sports (Sun et al. 2005). The field studies discovered that the

LSE context influenced the user experience in relation to the flow of information and the stadium environment of which they were a part.

It was important to realize that the main experiences for users at LSEs related to the competitions in the field; the general event information became of secondary interest. There was an overloading of competition information published/distributed in several ways, including audio, visual and paper 'channels' at stadiums. As highlighted by Olsson and Nilsson (2002) and Esbjornsson et al. (2006), it was not easy for the spectators to search or assimilate the large amount of information while experiencing the events. The spectators were therefore cognitively overloaded and often failed to notice information which was potentially relevant (e.g. in the swimming stadium, most users missed the introduction to a new athlete, who turned out to be the winner).

It is evident that detailed information can easily be lost at a LSE. Unlike watching TV, watching at a LSE meant missing detailed ongoing information, such as that usually provided on television. The information broadcast in the stadium (via the stadium loudspeaker system and large screens) was used to inform the spectator of the competitions. This information was located at the hot spots of the events where some spectators were located. However, many spectators were not at the critical locations and therefore they missed event information. The event was watched by spectators, but the significance of the events within the wider competition was often not known until later. Within the overall LSEs atmosphere, detailed competition information can be lost, which is an observation consistent with the finding of Nilsson et al. (2004).

The characteristics of the published information at LSEs were not under the users' control, and were only partly relevant, as shown by Olsson and Nilsson (2002). The spectators' interest in information varied. For example, at particular moments, some spectators were interested in athlete information, while others were interested in information relating to the competitions taking place. Currently, the diversity of the spectators' interests is not satisfied by the information provided, because the host publishes/broadcasts the information, while the spectator has no influence on what, when or how information is received during the ongoing events.

The stadium environment also influenced the user experience (Olofsson et al. 2006). Due to a large number of spectators and limited stadium space, the use of a mobile application and related personal activities were constrained in the stadium environment. Examples included locating stadium seats, or going to the toilet, which occurred during the break or before or after the competition.

Social interaction. One of the characteristics of being a LSE spectator was that their experience of the event was socially constructed by seeing people go there to enjoy the company of others. However, the social interaction between spectators only played a small role during events, leading to considerable boredom amongst the spectators, consistent with Esbjornsson et al. 2006. Spectators were seldom involved in other activities besides quietly watching the competition; they seldom directed attention to social interaction. The experience itself was often dominated by long periods of watching, with the social interactions only comprising a small proportion of the time spent watching the event. The lack of social interaction could promote spectators' experience at a shared level of attention – this becomes part of a social interpretation process that can influence what the experience means to individuals and others.

User. Users staged their experiences mainly by watching, and moving around the stadium to optimize their viewing angles. Other activities were undertaken occasionally, such as creating multimedia records, and interacting with each other. Being in a sports stadium, users expected to experience the events in a more dynamic fashion, and such a dynamic experience would consist of a better understanding of the competition, more active social interaction, and engagement in their local environment (i.e. the stadium). This was not supported in the current sporting events which were studied.

Culture. An interesting finding was that most social interactions arose within specific groups. For example, the Chinese spectators demonstrated their distinctive group image by wearing specific uniforms or using particular accessories (e.g. flags) when cheering. Interactions happened by taking pictures, talking to group members, or chanting group slogans during the climaxes of the events. Interviewing the users highlighted their anticipation of a greater level of interaction within their group, such as discussing what they had just seen, and sharing their experiences at LSEs. This finding highlights the collective orientation of Chinese culture, which emphasizes extended group relationships (Peng and Nisbett, 1999; Marcus, 2003; Marcus and Gould, 2000).

4.4.4 Implications of mobile personalization at LSEs

The user studies discussed a new design space for personalized mobile applications that could render the user experience more active and engaging in a contextually, socially and culturally relevant way based on the studies of current user experience and user requirements.

Personalized mobile applications could contribute value by supporting a user's control over the information, facilitating their actions within a stadium environment, and enhancing social interactions of spectators in a LSE context. Those implications for how personalized mobile applications could supplement the user experience are discussed in the following section.

Support information flow. To address current problems of overload due to general and only partially relevant information, spectators should be provided with information in a personalized way - letting them decide what information is desired, and applying a user's requests as an information filter. It is also important to allow users to decide when the information should be sent. Information should by no means constrain the viewing of the LSEs, as the primary interest of the user in this context is the competition taking place. Users' control over information should be supported by allowing them to specify their requests, including interests, preferences and relevant context.

Reduce environmental constraints. The environment is a major influence on the user experience, especially in terms of the usability of the mobile application (Robson, 1993). Means of facilitating users in the stadium environment are proposed with the aim of mobile personalization. A clear finding from the field studies was that interaction with the mobile application needs to be simple: interaction should be personalized for the stadium environment to allow impromptu interaction with the application with a low level of commitment from the user.

Support of other personal services. To avoid the embarrassment involved in locating seats, ordering food and trying to meet up with friends, a mobile application should provide users with personal guidance. Users could get personalized guidance to their stadium seat according to their location, with seat identification integrated into an e-ticket function; food and refreshments could be ordered based on individual and group preferences; meeting points can be arranged on request according to users' locations.

Enhance social interaction. Social interaction is important to a fulfilling user experience at LSEs (Jacucci et al. 2005; Esbjornsson et al. 2006), as demonstrated by the enjoyment derived from being a member of a group of people who support the same team. A personalized mobile application can help to create and maintain a relationship in a virtual social network - this supports the group's co-experiencing of the event, and caters to the Chinese culture of underpinning group relationships (Peng and Nisbett, 1999; Marcus, 2003; Marcus and Gould, 2000). For example, personalized mobile applications can help generate virtual groups with people sharing common interests and profiles, and by doing so, interaction opportunities can be proposed based on users' interests, and greater social interaction can be promoted.

Design for Chinese users who showed a high level of acceptance toward the concept of mobile personalization and a high preference for group relationships during the field studies. Personalized mobile applications, besides being able to assign each individual to a virtual group to promote a sense of group belonging, can help to emphasise a group image by presenting personalized group information and creating personalized features, such as group chants and anthems.

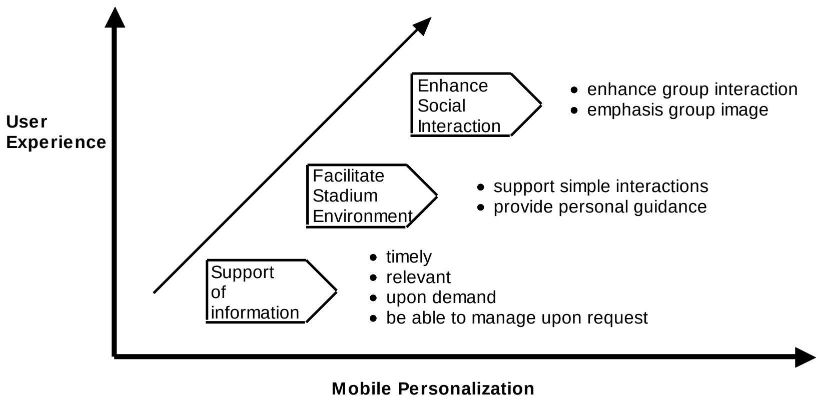

Figure 4.4 Design themes of mobile personalization at LSEs

The implications derived from this study demonstrate that personalized mobile applications can contribute value in enriching the user experience by providing timely, relevant information, creating a supportive environment and enhancing social interaction. Figure 4.4 illustrates these themes.

4.5 Conclusion

Discovering the problems that a large group of spectators faced today during LSEs, this research suggested a potential solution - mobile personalization. It employed user-centred research which emphasised real users and their experience. The goal of this chapter was to understand users, their requirements and their current experience at LSEs.

Two types of users were classified during the user studies. They were ‘Lance’ who loves sports and requires support for events information and stadium services which are subject to the LSE context; and ‘Nancy’ who is a social fan who needs relevant event information/services and especially encouragement for social communication during the events.

Current user experience was observed in the four sports stadiums, and it indicated that, for the participants studied within this research, user experience needed to be improved in large sports stadiums. This finding originated from multiple perspectives relating to the LSE context, social interaction, user-centred issues and the wider culture of this particular group of users. In summary, the spectators were limited in their ability to select from a variety of different information sources, assimilate the content and control their interaction with information in the LSE context. The social interaction between spectators only played a small role during events, which caused considerable boredom amongst the spectators; mobile applications were not convenient to use due to the LSE context. For Chinese users, sporting events were important not just in themselves but also as a means for social interaction amongst groups. Users expressed a high expectation of greater group interaction within the stadium: the user experience should be enhanced since spectating is a rich, social experience.

A total list of 55 requirements (see Tables 4.3, 4.4, 4.5 and 4.6) were discovered which were further reduced to 46 core requirements by combining related issues. Those requirements were later divided into 4 groups of user requirements which were functional requirements, information requirements, social and usability requirements.

The findings derived the usage implications of mobile personalization to render the user experience more active and engaging in a contextually, socially and culturally relevant way. The usage implications were proposed in support of human-information interaction, the stadium environment, user culture and social interaction within the LSE context.

With regard to studying Chinese users in the LSE context, user-centred methods were adopted and developed. Interviews worked well as a method to get information about the users' backgrounds and to generate their profiles. However, it was a challenge to make users respond to questions about user requirements. For example, when asking 'what functions do you feel are missing?' most users responded with 'nothing'. Provided with a scenario, users found it easier to express their opinions in a context, because it helped users to understand the imagined applications and services of the personalization technologies. For Chinese users, scenarios served as a way for them put themselves into the persona described. This helped reduce tension as they did not feel they were being examined directly. The Emotion Cards were found to be amusing and were helpful to open a conversation and facilitate the discussion. For example, when interviewing Chinese users about how they felt, generally they would state that 'it was okay'. However, when presented with the Emotion Cards, they picked up one emotion face and started to talk more.

5 STUDYING LARGE SPORTING EVENTS CONTEXT

	Research questions addressed in this chapter:
1	What is the potential for mobile personalization to contribute to the positive aspects of user experience at LSEs?
2	**What are the key contextual factors to be used for mobile personalization at LSEs?** • **What are the key contextual factors that affect the user experience at LSE?** • **How may the user experience at such events be enhanced by a mobile application that is sensitive to key contextual factors?**
3	How can personalized mobile applications be designed to optimize user experience at LSEs?
4	How does mobile personalization impact on user experience at LSEs?
5	What are the key gaps in user-centred research that arise from this thesis?

5.1 Introduction and aims

In recent years, the concept of mobile context has been brought to attention as a result of the growing role of mobile applications in daily life. Besides making phone calls, mobile applications are used for arranging meetings with friends, finding locations, playing music, even receiving TV broadcasts, etc. While the technology enables these more complicated functions and services, it also presents problems for users in understanding and managing the ever increasing number of functions. Mobile personalization is a potential solution (Cha et al. 2005). It deploys different preferred features of the application according to the particular context, and aims to use information of the usage context to tailor the behaviour of the application as appropriate.

The previous chapter suggested that mobile personalization was a potential solution to enhancing the user experience at LSEs. While personalization is considered important, providing context for information and services is vital to make the information useful (Robson, 1993; Johanson et al. 2002). From a HCI point of view, there is a tendency to forget about the context when considering an application or product (Maguire, 2001). The products are often simply divided into those which are usable and those which are not. In fact, it is incorrect to describe a product as usable, without also describing the context in which the product will be used. It is necessary to understand the context for the product, i.e. the main user, task and environmental characteristics of the situation in which it will be operated (Häkkilä, 2006).

Therefore, this chapter examines the main contextual factors which would influence how mobile personalization should be incorporated into the design of mobile products, based on the literature studies (in Chapter 2). The overall aim of this study is to study users within the situated context of a LSE in order to understand the context for the design of personalized mobile applications within a user-centred research philosophy and practice. The specific objectives are:

1) to identify the key contextual factors that affect the user experience at LSEs;
2) to investigate the influence of the type of sporting event and the user language/culture on the relative importance of these contextual factors;
3) to identify the implications for personalized services for end users that promote the user experience and are sensitive to contextual influences within the stadium

5.2 Mobile personalization and its context of use

The definitions of the context of use were introduced and discussed in the literature (Schilit et al. 1994; Schmidt, 2000; Dey and Abowd, 2001; Dix et al. 2000; Dey et al. 2001; Cheverst et al. 2000; Bradley and Dunlop, 2002), where the definition of context was interlinked with concepts for mobile personalization. The context of use can be considered as the inputs or triggers for the mobile personalization application, which will influence the output presented to the user (Norros et al. 2003). Personalized mobile applications aim to adapt to the different contextual factors, in order to optimize the provision of information/services to the user.

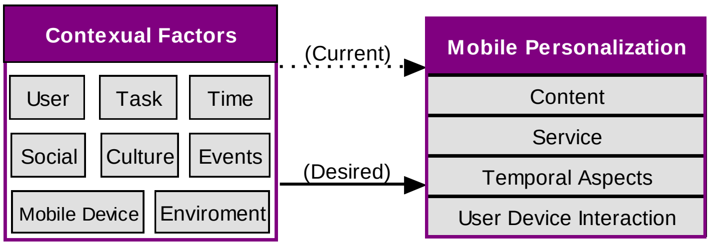

Figure 5.1 Relationship of contextual factors and mobile personalization

The analysis of the context of use helps to specify, in a systematic way, the characteristics of the users, the tasks they will carry out and the particular usage circumstances. It can provide an understanding of the situations in which the personalized mobile applications will be used; help to further identify user requirements (and how they vary) during a LSE

5.3 Methods

In order to understand the relevant contextual factors in mobile personalization situations and user activities at LSEs from the user's point of viewing, users were invited to join three context studies at real events. During the events, users self-reported and were interviewed about how/what contextual factors influenced their experience/requirement at LSE. The detailed methods are discussed below:

A field-based research approach was chosen, based on the need to understand situated action (Dourish, 2001), the degree to which user needs within the stadium were, or were not, being met and the contextual influences on the user experience encountered by individuals. Rather than being passive subjects, participants were considered to be informants and co-designers during the event (Olsson, 2004). A combination of self-report, experimenter observation, and co-enquiry was used, as described below.

During the event, each participant had a simple proforma to record unmet user needs during the sporting event. 'Unmet user needs' was interpreted widely to mean a gap between the desired and realized user experience, and therefore included the multiple aspects of user experience shown in Table 2.3. These unmet user needs were then synthesized and discussed with participants during the semi-structured interviews, described below.

Based on the literature review in Chapter 2, an assumption was made regarding the contextual factors that were relevant in influencing the user experience (Schilit et al. 1994; Schmidt, 2000; Dey and Abowd, 2001; Dix et al. 2000; Dey et al. 2001; Cheverst et al. 2000; Bradley and Dunlop, 2002). See Table 5.1. These factors formed the basis of a prompt sheet for semi-structured interviews with the users. These interviews were carried out to discuss the requirements recorded by the participants, and investigate how the contextual factors existing within the stadium would influence how a personalized mobile application could meet their needs. These interviews specifically investigated the impact of varying context (in relation to those factors shown in Table 5.1) on the personalization of services to meet user needs. For example, participants expressed varying level of interests in sporting action occurring at different locations within the stadium. Interviews, therefore, discussed how dynamic personalization of mobile applications could take into account relative locations of spectators and the sporting action, and how this would depend on the type of sporting action that was taking place. A sample of the contextual study sheet is provided in Appendix 5A.

Table 5.1 Contextual factors summarized from the literature

1. User factors	2 . Task	3 . Environment	4 . Social
gender/age	task type	weather	'with whom'
interest/preference	task goals	location	co-location of others
knowledge/ experience of sports	task importance	noise level	activities of other users
mood	task status	lighting	social atmosphere
attention	linked task	traffic	group dynamics
motivation	task duration	crowd density and behaviour	
5 . Time	**6 . Culture**	**7 . Mobile Device**	**8. Events**
date	nationality	screen size	event types
time	language	battery	events characteristics
		ease of use	

Observation was also used to gather data on user behaviour and visible evidence of whether user needs were being met during the sports. This direct observation identified user attention to the sporting action, their interactions with other individuals (either on a one-to-one basis or as part of the crowd), and interaction with other information sources within the stadium. Although participants were aware that this observation was taking place, it was discreet by being outside of the normal line of sight of the spectator. As well as enabling limited triangulation of data, direct observation was also able to capture overt user behaviours that were highly temporal in nature. An example was identifying periods of boredom during events, and then, during the structured interviews, being able to probe the participant about the factors that caused this. As far as possible, the direct observation was compatible with the ethos of ethnography (Dix et al. 1998), where the researcher is immersed in the user's naturally occurring environment in order to collect data without imposing meaning from an external perspective.

5.4 Three field studies of LSE context

5.4.1 First athletics field study

The first field study took place at an athletics sporting event in UK, namely the Accenture Loughborough International Athletics 2007 (refer to Figure 5.2). It is an annual large-scale international athletics sporting event, bringing together athletics teams from Loughborough University, the Great Britain under-20 and Student squads, and international athletes representing England, Wales and Scotland. It was a one day event running from 11:00 am until 6:00 pm.

Figure 5.2 User study at an athletic event in the UK

During the event, there were more than one thousand spectators. The stadium is an arena which has been used for many international athletics events, and its facilities include an elevated grass spectator area, athletics pavilion with changing facilities, press area and other ancillary services.

Eight subjects participated in this study. They all are mobile application users and familiar with the idea of personalization. Their ages ranged from eighteen to thirty five, and the average age of the participants was 22 years. Their gender was evenly distributed (4 male, 4 female). They also had diverse occupations ranging from student to professional occupations, such as financial analysis, engineering, computer programming, social work, and teaching. The composition of the participant pool was therefore well balanced in terms of age, gender, and occupation.

5.4.2 Second athletics field study

The second field study was conducted at the fifteenth international amateur athletics competition in Changsha, China (refer to Figure 5.3). The event was chosen to be similar to the UK athletics event (Study 1), but situated in China in order to observe the different influence of the language and culture of the host country. It is an annual large-scale international athletics sporting event which attracts athletics teams from Asia, including Thailand, Japan, Korea, and thirty four provinces of China. It was a one day event starting at 8:00 in the morning and finishing at 6:00 in the afternoon.

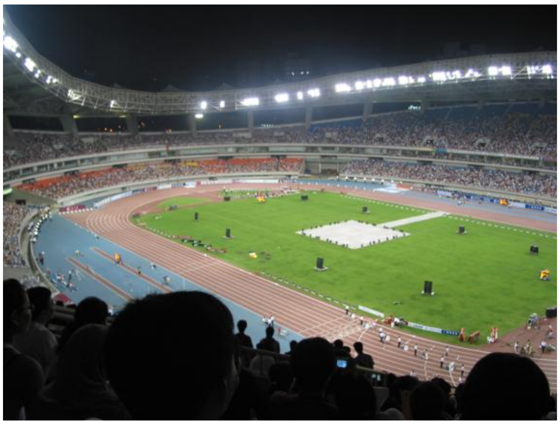

Figure 5.3 User study at an athletic event in China

The event took place at the HeLong stadium, which is an old sports stadium with a newly repaired race track and 5000 seats. More than a thousand spectators attended the event.

Eight users, who are mobile application users and have experience of using mobile personalization, were invited for the study. Their ages ranged from sixteen to thirty-three, and the average age of the participants was 25 years. Their gender was evenly distributed (4 male, 4 female). Their occupations varied from student to professional occupations, such as news reporter, business officer, mechanical engineer, and accountant.

5.4.3 Football field study

The third study was carried out at a football event at Shandong, in China. (See Figure 5.4) This was chosen because, although the language/cultural aspects were the same as for study two, the event (and the nature of the action taking place) was different to the previous two studies. The event was an international football tournament, which featured an all-star team from Shandong and two teams from the Spanish professional league, namely, FC Sevilla, and Real Zaragoza. There were two matches taking place during the event, one in the afternoon, and the other in the evening.

Figure 5.4 User study at a football event in China

The event was held in the 45,000-seat capacity Jinan Stadium in Shandong province, which is a stadium that has been used for professional football competitions. There were nearly one thousand spectators during the events.

There were also eight subjects who participated in this study. All of them are mobile application users, and they have personalized their mobile application. Their ages varied from nineteen to thirty two, and the average age of the participants was 24 years. Their gender was equally distributed (4 male, 4 female), and they also had diverse occupations ranging from student to professional occupations, such as business man, technical assistant, teacher, secretary and researcher.

5.5 Procedure

Users were firstly informed of the research purpose and the concepts of mobile personalization and its context of use. This was done before the sporting events. They attended the sporting events with groups of friends as per normal, but during the event, each participant used the proforma to record where user needs were unmet, or only partially met, and where the spectator experience could be improved.

Each individual was observed for approximately an hour; after this time, the requirements identified by them were grouped into information requirements, functional requirements and social requirements. These were discussed with the participant using the semi-structured interview with contextual prompts. For example, in terms of user factors components, participants were asked if the attributes of gender/age, interest/preference/habit, knowledge/experience, mood, attention to events, and motivation, would influence the how personalized mobile applications could meet their stated requirements. If a participant thought that time (e.g. time of day, progress of the event) would influence the desired behaviour of the mobile application, he or she was probed more deeply about how this factor could make a difference. On the other hand, if the participant did not think that particular factor was important for them in their situation, the researcher would move on to the next one. During the interview, users acted as informants as well as co-designers to co-discover the influence of contextual factors at LSEs. This process was completed for each participant that took part, to complete the data collection for that event. The test session with each subject lasted for around one hour.

5.6 Analysis

The affinity diagram technique (Hackos and Redish, 1998) was used for the qualitative data analysis. It was used to create groups of attributes under each contextual factor. For example, social factors included the friends present, and their location. As a result, the components of context were extended, as illustrated in Table 5.2.

Table 5.2 Extended contextual factors summarized from the use study

1. User Factors	Gender -male -female Age -young -middle age -old	Interest -stable interest -instant interest -strong interest	Knowledge -rich -familiar -new Experience -professional -amateur	Mood -happy -sad -excited -neutral	Attention to events -focused on events -diverted to other things	Motivation -relaxation -sports -social interaction -atmosphere
2. Task	Task type -watching -socializing -rest -waiting	Task goals -relaxation -social engagement -enjoy sports	Task importance -important -not important	Task status -busy -relaxed	Linked task - related - not related	Task duration - long - quick - frequent
3. Environ-ment (stadium)	Weather - sunny - rainy - windy	Location -near to stage -far from stage -near to public media	Noise Level - high - low	Light - High - Low	Crowds - heavy - light	
4. Social	Who with -with friends - alone	Co-location of other users - nearby - far away	Other tasks - watching - socializing - rest - waiting	Social atmosp-here - active - passive	Group Dynamics - friendly - active - inactive - unfriendly	
5. Time	Date - special date - not special date - holiday		Time - before vents - calm moment - climax moment - break – reflecting – after events			
6. Culture	Nationality - China - Other countries		Language - native (Chinese) - non-native (other languages)			
7. Mobile Application	Screen size - big (like PDA) - small		Battery - long - short		Usability - ease of use - useful functions - difficult to use	
8. Others	Event types - team sports - individual sports		Events characteristics - single sport - multiple sports - distributed sports - not distributed sports			

In summary, each of the eight contextual factors was sub-coded to produce a total set of 91 unique contextual factors. The results of each context study were recorded and coded in a context sheet.

5.7 Results and discussion

5.7.1 Results from the first athletics field study

The first user study identified that the following contextual factors were influential: preference/interest in sports, event progress, language, stadium location, with whom, mobile screen, event types, task status, attention to event, knowledge, weather, media in stadium, social atmosphere, mood, and crowds. They were assigned to different importance levels, according to the numbers of users identifying that requirement. See Figure 5.5.

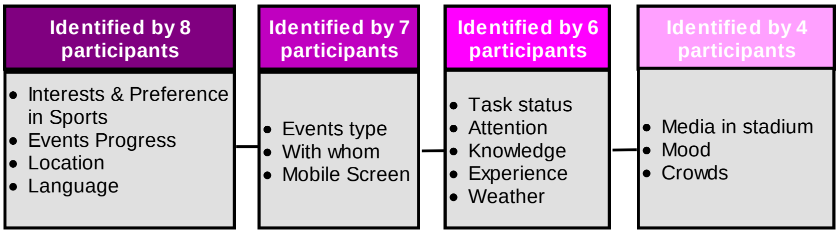

Figure 5.5 Contextual factors found during the first athletics field study

1) High significance (context attributes identified by 100% of participants)

Preference and interest in sports. This included interest in particular sports, specific athletes and current or historical information, such as record holders. Preferences and interests can be used to characterize a user (Schmidt et al. 1998); however interests and preferences are also influenced by contextual factors. For example, action happening near to the user in the athletic stadium can arouse new and unanticipated interest from a spectator. During the athletics event, information that directly addressed stable or transient spectator interests was prioritized by individuals over other information.

Event progress. This was regarded as a critical temporal influence (Tamminen et al. 2004) on the user experience and the need for information. The temporal distinctions within this study related to periods of 'pre-event', 'quiet periods in the sporting action', 'climaxes of sports', break and 'post-event' based on users' comments. The individuals' willingness to receive event-related information was related to whether they were actually watching the event, and whether they were either willing to, or wanted to divert their attention away from the event. For example, most users wanted to receive event information during the break and calm moments of the athletics event. In contrast, they did not prefer mass information during the climaxes of the athletics event. A guide that was sensitive to the progress of events could more closely integrate real and virtual user experience.

Language. This factor was used to describe the terminology which was employed during the athletics event as well as the native language of the spectators. This factor influenced the need for translation of information. Users required translation of the English event information into Chinese (the native language of users) at the athletic event. In addition, the complexity of the terminology used within the athletic event led to a need for simple, non-technical descriptions of the key aspects of an event, including an introduction to the rules of competition.

Location. In contrast to typical mobile applications, such as tourist guides (Abowd et al. 1997; Oertel et al. 2002), the users' location within this study was relatively static. It included both the orientation and distance of users to the events. Users described how location in the athletics stadium played a key role in the quality of their user experience. For example, users could often only watch the athletics competitions from a particular viewing angle. Users expected to be able to view the live events from a suitable viewing angle according to their location – they wanted the benefits of real and 'armchair' spectatorship, with information tailored according to the spatial relationship between them and the sporting action.

2) Medium-high significance (context attributes identified by 87.5% of participants)

With whom. This factor referred to who the user is with (Schilit et al. 1994). It influenced users' information requirements as well as social interaction during the athletics event. For example, this study's participants described the need for identifying topics of mutual interest, in order to help initiate conversion with other fellow spectators in the athletics stadium.

Mobile screen. This physical factor meant the potential screen size of a mobile application. Screen size influenced the desired organization of content as well as information presentation to the end user. For example, users expected picture in picture effects to broadcast the athletics events on a big mobile screen (e.g. screen size of a PDA).

Event types. Sporting events were classified according to their temporal and spatial characteristics and the number of events involved. Athletics events consisted of multiple shorter events, many of which occurred at discrete geographical locations. By contrast, football was classified as a single with a moving focus of action. There were specific information needs during the athletics events, which were not present during the football competition. For example, participants expressed frustration at not being able to follow the action from multiple events occurring simultaneously. In addition, the scheduling of multiple events during the athletics programme produced the 'temporal tensions' described by Tamminen et al. (2004) which were not so apparent with continuous events, such as football.

3) Medium significance (context attributes identified by 75% of participants)

Task status. The division between 'watching events' and 'resting' was also a function of time and content. For a researcher, it is not always easy to discern whether the user is watching the event. Watching events can take place at irregular times and places (Olofsson et al. 2006). Whether the user felt that he or she was watching matches reflected on his or her willingness to receive event-related information. For example, when the users were watching the athletics event, only important information was requested.

Attention to events. Similar to task status, users' attention to events influenced what, and when, information should be provided in the athletics stadium. With limited attention to events, only important information should be notified in an unobtrusive way, such as vibration. The users' definition of 'important' was information that was relevant to the things they were watching, tailored to their interest in sports and the event progress.

Knowledge/Experience in Sports. Spectators' degree of knowledge and experience were important context factors for delivering relevant content. For example, when a spectator has detailed knowledge/experience of the athletics event, deeper, more detailed information can be delivered to that user. When a spectator is not familiar with the sport event, simple and general information should be presented, such as an overview of the competition rules. Also the technical terms should be explained.

Weather. Weather is an environmental context and it influences users' requirements for different services, and interaction. The design of mobile applications should vary according to the weather. For example, a strong level of contrast of screen displays was requested when watching the athletics event in bright sunlight. Also, how users preferred to interact with the mobile application was influenced by the weather. For example, users preferred to interact with the mobile application using voice during wet weather in the athletic stadium.

4) Low significance (context attributes identified by 50% or less of participants)

Media in Public. Depending on users' interests in sports and their location in a stadium, the users wanted either the options for synchronization of the public media to the mobile application, or the opportunities for receiving information which the public media did not broadcast, such as more personalized information. For example, users preferred synchronized information for information of interest, or events which were out of view because of their location at the athletics stadium; for other general information, users liked to have personalized information which can be different from the public media.

Social Atmosphere. The social atmosphere was a context influencing social communications (Jacucci et al. 2005). When there was little social interaction occurring during the athletics event, opportunities for communication were expected to be proposed, such as developing a virtual community and suggesting community activities.

Mood. Mood is a context unlikely to be recognized by a mobile application (Kankainen, 2003). Affective contexts such as being 'happy' may not be related consistently to a certain place or time. For example, when users were 'happy' (as they described during the athletics event), they tended to be more active in communication with friends; when users were less happy, they were more likely to expect services which can cheer them up, such as event-based videos or interactive activities, such as voting.

Crowds. When there are a large number of spectators at events, a stadium should have more entrances open, in order to reduce heavy traffic as well as to improve security. The interaction with mobile applications can also be tailored to the crowds, such as, notification of information by vibration, which was appreciated among crowds because audio rings may not be audible during the athletics event.

5.7.2 Results from the second athletics field study

The second user study was analysed to find a general view on the relevant use of contexts for the mobile application to personalize its behaviour accordingly. As a result, the following contextual factors were found influential: preference/interest in sports, event progress/time, location, nationality, event types, with whom, mobile screen, task status/attention to events, language, media in stadium, mood, weather, knowledge/experience, and social atmosphere. According to the numbers of users identifying each requirement, the contextual factors were rated into different levels. (See Figure 5.6).

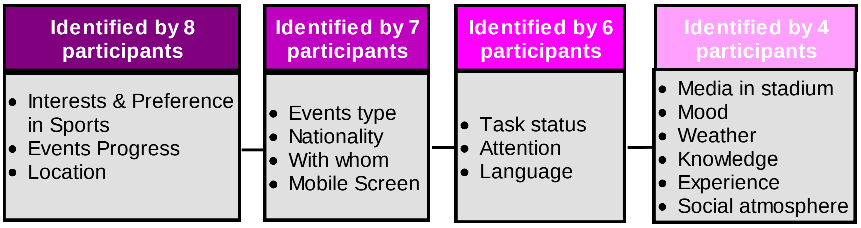

Figure 5.6 Contextual factors found during the second athletics field study

1) High significance (context attributes identified by 100% of participants)

Preference and interest in sports. The attribute of preferences and interests in sports was also regarded as very important by all participants. For example, all the participants in the athletics event described how information tailored to their preferences and interests can make them feel that the mobile application is personal. Preferences and interests can also be used to characterize information. The information of interest should be provided in detail, while the general information can be briefly presented.

Event progress. Event progress was also regarded as very important to serve as a temporal influence on providing information. With current 'services' (e.g. broadcast announcements and posters in the athletics stadium), information was not adapted to temporal demands. A time-sensitive guide could afford a seamless user-experience. Information provided should be closely adapted to the progress of events. For example, winnner information (e.g. who won, how he/she won) should be presented should be presented immediately after the completion of an event. More detailed information (e.g. an interview with an athlete) can be presented during breaks in the action.

Location. Location was an obvious choice to describe a context, and users described how location-based information was very useful. A key concern for spectators was finding a good location from which to watch (Esbjornsson et al. 2006). There were different parts of the competitions occurring at the same time in the athletics stadium; however a spectator sat at the event stadium with certain viewing angles. As a result, users could only watch some competitions and other parts of the events which were far away from users' locations were simply out of view. Another concern was that the display of a user's location should be limited to friends. There was little interest in viewing the status of unknown visitors, unless it concerned the number of visitors at a location, for example how to indicate how busy a location was.

2) Medium-high significance (context attributes identified by 87.5% of participants)

Nationality. This context referred to the nationality of the spectators, and the link with that of the athletes/teams. It was regarded as one of the criteria to select information, and any information about the user's own country was of higher priority than that of a foreign country. For example, most users required detailed information about the Chinese athletes in the stadium. The information which was indirectly linked to the user's own country was also regarded as important, for example, information on the strong competitors. If the information is of great importance, such as the record holders, it is useful regardless of the country.

Event types. Similar to the first result, the event type was found to be influential in relation to the time of information delivery. For longer running events (where final results have not yet been decided) it is useful to provide ongoing updates to keep spectators informed. However, for shorter running events (athletics), it is better to minimise the information because there is little time for users to check information. The structure of information presentation should be very clear and logical for users to find and read. Also, the individual athlete's information was required for *individual* events; however, for *team* events, users required group information as well as individual information.

With whom. 'With whom' again impacted on what kind of information users needed within a certain social context. For example, when users are with friends in the athletics stadium, information can be more flexible, because they can communicate openly with a friend; if users are with strangers, information of common interest is useful to serve as an 'icebreaker' for a conversation.

Mobile screen. The size of the mobile screen is always an issue for usability (Gong and Tarasewich, 2005). It influenced how users want to interact with the mobile application. For small mobile screens, the information should be presented in text or voice; conversely, the content of information can be displayed in pictures and videos on a larger mobile screen. Also, the information can be structured and delivered using different levels of information hierarchy for small screen applications, in order to have 'top-down' user interaction (Gong and Tarasewich, 2005). The first levels of information will be more general; subsequent levels can be more detailed according to the user's selection.

3) Medium significance (context attributes identified by 75% of participants)

Attention to events and task status. Users' attention to events was considered together with users' task status in the athletics event in China. These two context factors can take place at irregular times and places, and it was not always easy to discern which status the user was in (Olofsson et al. 2006). Whether a user was watching the event was reflected in their willingness to receive information. For example, when users were heavily engaged in the athletics stadium, only important information was required to be notified in a less obtrusive way; when users had more spare attention, they preferred to take the initiative to search for information by themselves.

Language. All information needed to be adapted to the native language of the users (i.e. Chinese). Another way of considering language relates to the sports terminology. For example, when participants were not familiar with the rules of a particular athletics event (e.g. discus), general information was required, such as an introduction of the competition rules. The technical sports terms should be avoided for inexperienced spectators.

4) Low significance (context attributes identified by 50% or less of participants)

Media in Stadium. Either the option of synchronizing the public media to the mobile application, or the opportunity for receiving different information, was again mentioned by users in the athletics stadium. Users sitting far away from the public media wanted synchronized information; users sitting nearby preferred different information, such as more personalized content, because they would like to get more information of interest in addition to that from the public screen, which they can view clearly.

Mood. Consistent with Shedroff (2001), mood was also a factor which influenced the usage of the mobile application. For example, when users were 'happy' (as they described during the athletics event in China), they tended to be more active in using the mobile services to enrich their spectator experience. When users were unhappy, they did not use the application to the same extent. It was suggested by the users that mobile services, such as interactive activities, could be used to cheer them up.

Weather. A users' preferred interaction with the mobile applications varied according to the weather, e.g. voice control was expected in rainy weather and normal key operation was the choice in sunny weather. Also, strong contrast of screen displays was requested when watching the athletics event under the bright sunshine.

Knowledge/ Experience. Similarly, the user's knowledge and experience of the athletics event influenced requirements relating to information content and information presentation. For an inexperienced spectator at the athletics event, general information is useful, such as an overview of the competition rules. That information should be presented in a simple, well-structured way. For an experienced spectator, who knows the rules and technical terms of the athletics event, broader information should be presented.

Social atmosphere. The social atmosphere was also regarded as influential to the usage of the application in the athletics event in China. For example, when there was an inactive social atmosphere in the athletics stadium, users expected the mobile service to help and encourage more social communication, (such as building up a virtual community and suggesting community activities). When participants were involved in a very active social atmosphere, the likelihood of using the application is less. In these instances, the application should be less obtrusive when presenting information.

5.7.3 Results from the football field study

The third field study results were analysed to obtain a common view on what kinds of contextual factors were relevant for users, and how the mobile application should personalize its behaviour according to those contexts. As a result, the following contextual factors were identified as relevant: preferences/interests in sports, nationality, location, event progress, event types, language, attention to event and task status, media in stadium, social atmosphere, 'with whom', mobile screen and knowledge/experience of the spectator. The contextual factors were sorted into different levels of importance, based on the numbers of users identifying that requirement.

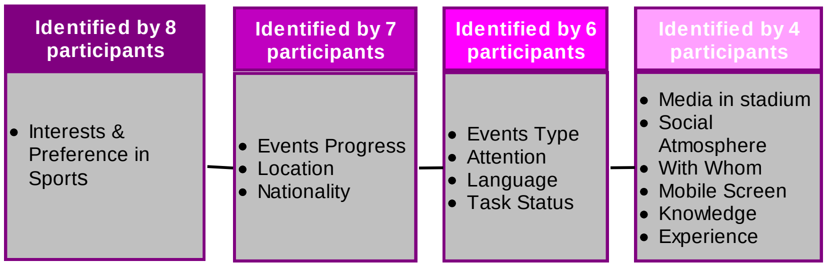

Figure 5.7 Contextual factors found during the third (football) field study

1) High significance (context attributes identified by 100% of participants)

Preferences and interest in Sports. The attribute of preferences and interest was confirmed as very important by all participants in the football event. Similarly, information that directly addresses stable or transient spectator interests was prioritized over other information by individuals.

2) Medium-high significance (context attributes identified by 87.5% of participants)

Nationality. Nationality was a cultural attribute which was also found to be an important criteria to filter information. Any information about a user's own country was of higher priority than that relating to a foreign country. For example, during the football events, spectators specifically requested detailed information on the Chinese football teams.

Location. The user's location influenced how much a spectator can see within a stadium. Different viewing angles tailored to a user's location were expected by the participants. However, this attribute was found to be less critical during this single football event than during a multi-sport event (i.e. athletics).

Event progress. Consistent with the previous results, the progress of the event served as a temporal influence on providing information in the football event. The information was valued according to the time of the information delivery. For example, users may choose to read some information (e.g. a player's information after he scored) the effects of which may be lost if not processed immediately.

3) Medium significance (context attributes identified by 75% of participants)

Event types. Similar to the previous two studies, the event type influenced the time of information delivery and information content, which were described in the above sections.

Language. It was interesting to find out that language was also a concern during the football event in China. Barriers occurred when information was not provided in a spector's native language. For example, users pointed out the confusion of information about one player from Taiwan. This player's information was provided in complicated Chinese instead of simplified Chinese (which was the native language of participants). Users demonstrated the need to support the native language of individual spectators at the event.

Attention to events and task status. Consistent with the first two athletics events, users' attention to events and task status of the users influenced what, and how, information should be provided in the football stadium. For example, only important information should be delivered to a user in an unobtrusive way when the user is busy watching the events. Other information, which was tailored to their interest, could be sent via SMS.

4) Low significance (context attributes identified by 50% or less of participants)

Media in stadium. As for the previous two studies, users who were sitting far away from the public media wanted their mobile application synchronized to the stadium media, while users near to the public media preferred information tailored to their interests in sports.

Social atmosphere. The social atmosphere influenced social communications at the event. There was little social interaction occurring in the football event: greater opportunities for communications were expected, such as generating a virtual community.

With whom. 'With whom' also impacted on the information users requested during the event. Users expected that support for this attribute could be used for making new friends, for example, to propose a topic of interest to talk about with a stranger sitting nearby.

Mobile screen. Similarly, the mobile screen influenced how information can be presented to the user, as described above.

Knowledge/Experience. The users' knowledge and experience of the football event were again regarded as important for information delivery, as discussed above.

5.7.4 Comparison between the three field studies

5.7.4.1 Differences due to culture/nationality and language

One aim of the three field studies was to specifically investigate the impact of participant culture/nationality and language on the user experience within a LSE. The study included two matched events held in the UK and China, with the same event (athletics) held within similar stadiums, and with similar participants in terms of key demographics.

Table 5.3 Layout of the use studies

Sports \ Country	China	UK
	Athletics	Athletics
	Football	

The native language of the participants in both studies was Mandarin Chinese. Language was identified by participants as a more important contextual factor at the event held in the UK, due to the mismatch between the native language of the participants and the host language. During the study in China, language was not perceived as so important: it was therefore identified as a barrier to understanding (especially during complex events) but not as an enabler. The study demonstrated the need to support the native language of individual spectators at events such as athletics, with this being less important for football matches.

The role of culture, meaning which country (and home town or province) a user came from, also varied. During the UK study, users watched and socialized during the events as one group of Chinese spectators, without preferences for particular athletes based on their nationality. However, for the study in China, users exhibited distinct preferences for particular Chinese athletes, and specifically for athletes from their home town or province. In this case, the participants formed themselves into three distinct, separated groups, based on home provinces, with discussion and interaction largely contained within those groups. This role of culture can be explained in relation to the users' sense of belonging and group interaction (Liu, 1988; Marcus, 2003) and the important role these factors play within Chinese culture.

5.7.4.2 Differences due to the type of sporting event

The study also investigated the impact of the sporting event on the role of contextual factors in enhancing the user experience. The users' location in the stadium was regarded as less important at the football event than at the athletics event. Unlike other location aware applications (Abowd et al. 1997; Oertel et al. 2002), the spatial relationship of interest is the movement of the sporting action in relation to a fixed viewing point within the stadium. Since athletics meetings have several simultaneous events occurring at different locations in the stadium, spectators were often only actively participating in those events close to where they were sitting. In contrast, during football matches, although the focus of action moves, the movement of all players on the field mirrors the movement of the ball, and action is rarely contained within one location for long. Spectators at the football event were able to engage in the event irrespective of their physical location.

Similarly, event progress was a more significant contextual factor during the athletics event due to the intermittent scheduling of these events. In contrast, football was perceived as a continuous event. Windows of opportunity (May, 2001) arose during the athletics event, with quick, simple and timely information needed to satisfy user needs. In contrast, during the football event, the temporal factor was less influential, with spectators willing to interact with a mobile application during most stages of the event, with the exception of goal scoring opportunities.

Two final major differences due to the type of sporting event were the factors of 'with whom' and screen size. 'With whom' was regarded as less important during the football event as greater social interaction occurred naturally during the football event. This may have been because of the single focus of attention of the spectators, irrespective of where they were physically located. In contrast, the spatially distributed action within the athletics event resulted in less focus of spectators on common action. Regarding physical application factors, unsurprisingly, users preferred larger screens over smaller screens (but this simple judgment did not take into account the more complex trade-offs involved). However, the larger screen was seen as more important at the athletics event due to the spatially distributed action, and the potential for simultaneous display of information relating to different spatial locations within the stadium.

5.8 Implications for mobile personalization

5.8.1 Design for information content

A problem with the current user experience at large sporting events was that spectators can either be lacking information that was relevant, or can be overloaded with information aimed at a general spectator. To address this problem, key influencing contextual factors can be used as attributes to filter and supplement the mass of event information available when designing information content.

A mobile application should personalize the content based on users' interests and preferences in sports (interest and preference in sports factor). It can adapt the content to a user's location, for example, displaying different viewing angles according to a user's current seat in a stadium (location factor). It can tailor the content dependent on whom the user is with. If a user is with a stranger, it could offer information of common interest as a conversation topic (social environment factor). The information content can also be adjusted to the users' attention to events, with only important information being presented when the user is heavily engaged in the events (attention to events factor). An application can deliver the content depending on how much sports knowledge the user has. For example, it can present broader information to a more experienced spectator, but display basic information to an inexperienced spectator (knowledge/experience factor). Specific content can also vary according to different types of events - users require team information for team events and individual athlete's information for individual sport events; users can accept more information for long, single sport events, but less information for short, multi-sport event (event type factor).

The collection and sharing of the above contextual factors introduces potential privacy issues. Some systems balance personalization and privacy concerns by only tracking information about peoples' preferences. Most users are comfortable giving this information, as long as it remains disconnected from their physical selves (Sheehan, 2002). This does reduce the potential for preferences to be used to form temporary, spatially defined social networks. Alternatively, a solution is to allow users to easily manage the information they are willing to share with others (Hawkey and Inkpen, 2006).

5.8.2 Temporal considerations

A mobile application needs to take into account the 'temporal tensions' described by Tamminen et al. (2004), and to provide information according to relevant time windows. As highlighted by May (2001), windows of opportunity open and then close again, and information delivery must take these windows into account, as they influence benefits, and the effort that people are willing to spend.

Temporal influences (and hence the need for timely delivery) are highly dependent on the type of sporting event. Windows for information delivery occur after individual events, or heats, within athletics meetings, and it is likely that such information has a relatively steep decay curve. In contrast, information windows occur *within* longer, more continuous events, such as football matches, and information delivery needs to be integrated within the ongoing action. Some information has a short-term value, for example the finishing times within an athletics race. A simple test of temporal influences on information value is to ask whether the usefulness of, or potential interest in, information will change if it is delivered one minute later, five minutes later, or 30 minutes later, etc.

5.8.3 Design for information interaction

Personalized mobile applications can include changes in the interaction mode and the user interface, as a result of key contextual factors. This reflects the contextual adaptation described by Dey et al. (1999) based on Pascoe (1998). Depending on the user's attention to events (which will in turn be influenced by the spatial relationships within the stadium), interaction can be overt or unobtrusive. If a user is actively engaged in an event, information can be *made available*, rather than pushed to the user.

Information presentation also needs to take into account the type of event, the extent to which it is geographically distributed, and the physical characteristics of any application. Where events have multiple, distributed sources of action, coding or multiple 'windows' are needed to group information and minimize cognitive load. Videos and stills will enhance the user experience where screens are large enough to accommodate them. Picture-in-picture images will enable a degree of parallel processing of events or incidents that are spatially distributed.

5.8.4 Design for social interaction

Social interaction is the key to a fulfilling user experience at a LSE. Design for social interaction implies the need to encourage people to communicate and share experiences with other people within a stadium (Olofsson et al. 2006), and mobile personalization needs to support this aspect. Personalized mobile applications can create opportunities for interaction with fellow spectators who sit together, by providing conversation topics of common interest, and supporting real, geographically defined temporary communities. However, a key requirement is to understand how and when to use a mobile application for this purpose (Weilenmann, 2001), since most individuals at large sporting event will be strangers.

Nationality (including the home town or province) is an important context attribute which can be harnessed for designing social interaction among Chinese users in particular. The studies showed how Chinese users displayed interest in information relating to where they came from, reflecting their desire for group interaction and social belonging (Liu, 1988; Marcus, 2003). Personalization of mobile interactions can help assign individuals, who are from the same place and share common interest, to a virtual group to promote a sense of group belonging. It can help to emphasise group image (another important cultural characteristic of Chinese users) by presenting personalized group information and creating personalized features, such as group chants and anthems.

5.9 Conclusion

This chapter aimed to understand how context awareness can lead to the design of mobile applications that can optimize the user experience at LSEs. The study of mobile context was based on the *user's perception* of context, and whatever is a relevant contextual factor for the user is considered important within this research. Three field studies were conducted in the UK and in China, to investigate the user experience and determine important contextual factors. There were 11 common contextual factors identified by participants as influencing their user experience across the three user studies. These were: preferences and interest in sports, progress of events, location in the stadium, event types, language, 'with whom', mobile screen, nationality, public media channels present in the stadium, knowledge/experience of the user in relation to the particular sporting event, and the social atmosphere present in the stadium.

The study also investigated the significant characteristics of the types of sporting events and the user language/culture at LSEs. Different types of events result in differing influences of contextual factors such as location, event progress, of 'with whom' and screen size. The influence of user language/culture can be explained in relation to the users' sense of belonging and group interaction (Liu, 1988; Marcus, 2003 ;) and the important role these play within Chinese culture.

The design implications (carried forward into the next chapter) were derived, based on the role that user- or system-initiated personalization can play in enhancing the user experience. At a basic level, personalization can maximize the relevance of information to the end user by taking into account the situational needs of the spectator, and by adding value over and above other information and communication channels within a stadium.

There were several limitations to the study. Although participants and events were chosen carefully for comparison and external validity, these results are only based on a sample of 24 Chinese spectators. However, duplicity of results emerged after five to six users out of a total of eight from each of the three studies and it would be useful to extend the study to other demographic groups, and a greater variety of sporting events.

6 DESIGN OF MOBILE PERSONALIZATION

Research questions addressed in this chapter:	
1	What is the potential for mobile personalization to contribute to the positive aspects of user experience at LSEs?
2	What are the key contextual factors to be used for mobile personalization at LSEs?
3	**How can personalized mobile applications be designed to optimize user experience at LSEs?** • **How can mobile applications be designed to personalize their content according to the relevant contextual factors?** • **What is the conceptual mode of the mobile personalization?** • **How can the design of interaction enhance user experience in the LSE context?** • **How can content be appropriately presented upon the user interface?**
4	How does mobile personalization impact on user experience at LSEs?
5	What are the key gaps in user-centred research that arise from this thesis?

6.1 Introduction and aims

As the functionality of mobile applications increases, it can contribute to multiple aspects of people's work and play, and one such example is at LSEs. With ever-increasing mobile functionality, it has been shown that users are not willing to deal with complex functionality or complicated user interfaces (Gartner, 2004). Designing mobile applications and services that optimize the user experience has become a new challenge. One way of tackling this challenge is to conduct a user-centred design process to enable the iterative design and testing of the mobile applications.

Previous chapters derived the design requirements of the personalized mobile application in terms of its functions (in Chapter 4) as well as the influential contexts at LSEs (in Chapter 5). These studies made it possible to decide how the mobile application should function and adapt itself according to relevant contextual factors.

This chapter describes the design of a mobile user interface that enabled the personalization of functionality and content based on previous studies. The design process considered four main aspects which are considered most important in the HCI literature (Cooper and Reimann, 2003; Preece et al. 2002):

- Content design – the information (including functionality) that is presented or made available to the user.
- Conceptual design – the physical nature of the application including the basic way in which it works.
- Interaction design – the way in which a user works with the application.
- Presentation design – how content is actually presented to the user.

Each of these design aspects can be accomplished with a user-centred view of product design and development, focusing on user needs, rather than technological innovation.

The overall aim of this chapter is to describe the design of a user interface for a personalized mobile application which can bring enhanced user experience and promote a user-centred perspective for mobile service design. The specific objectives are:

1) to design the interface of mobile personalization that enables certain functions (based on the user studies in Chapter 4) and adapts to the relevant contextual factors (based on the context studies in Chapter 5);
2) to build prototypes of the interface to test the design in the final stages of this thesis;
3) to investigate the implications of design for Chinese users

6.2 A general introduction to how mobile personalization works

As stated before, mobile personalization refers to mobile applications that provide information and services tailored to a particular user, and their context of use, in order to provide an enhanced user experience. This tailoring can be done either by the user, or the system, or a combination of both. For example, a service provider can provide information via the mobile application on a particular athlete, based on users' settings, or suggest a stadium map automatically, according to a user's current location at a LSE.

A personalized mobile application contains four modules, which cooperate to perform the functions of classification of information, to collect relevant contextual factors, and to personalize itself accordingly (Riecken, 2000; Kim, 2002; Adomavicius and Tuzhilin, 2001; Billsus et al. 2002; Trigg et al. 1987). See Figure 6.1.

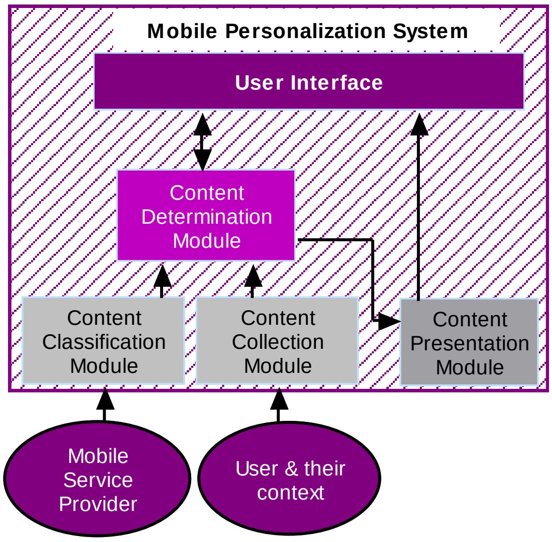

Figure 6.1 Modules forming a mobile personalization application

Content classification module. The content classification module includes services/information provided by the mobile service provider. The classification involves analyzing the information/services, dividing it into elements and creating and storing metadata, which describes the information and the elements.

Context collection module. This module contains relevant information about the user and their context, which has been defined during previous studies. For example, it can collect user's location information by GPS. All the gathered information is sent to the content determination module for analysis. The context collection module also keeps monitoring context changes during the process, including for example, users' locations. These changes are sent to the content determination module, which then makes a real-time analysis to determine if there are content changes necessary. This context collection process can be user-initiated, or system-initiated, or a combination of both approaches, as discussed in the literature.

A user-initiated approach is under explicit user control (Dix et al. 1998). The user may set his/her context information in the profile and then this setting will be used for all subsequent usage of mobile services, although the user can change the setting when there is a need.

A system-initiated approach refers to where an application automatically analyses and classifies the context of the user, and updates the information automatically (Billsus et al. 2002), without user intervention.

Content determination module. The content determination module involves deciding the relevant data on the basis of the metadata and the context collection module. This module undertakes analysis of data according to some algorithms and deduces the information tailored to each individual (Trigg et al. 1987). It determines the content for the user, but when the setting is incorrect, the user should be able to change it. The content determination module can also learn from itself and improve its algorithms.

Content presentation module. On receiving the content information from the content determination module during a service initialization stage, this module presents the content according to some pre-defined schemes in the user interface.

Mobile personalization user interface. The user interface is the gateway between a person and a system. The user interface provides a means of input, which allows the users to manipulate the system, and a means of output which allows the system to produce the results of the users' manipulation (Johnson, 2000). The user interface of an application does not only refer to how it looks; it is how easy it is to learn, how well it recedes into the sub-consciousness of experienced users, and how well it supports users' tasks (Preece et al. 2002).

This chapter focused on designing a user interface for mobile personalization that can enable certain functions based on user requirements (in Chapter 4) and personalize itself according to the relevant LSE contextual factors (in Chapter 5). Instead of building up a whole working system, the design was developed into high-fidelity prototypes in order to reduce the time and cost of development, and to maximise flexibility in conducting experiments early in the development process.

6.3 Methodology

6.3.1 User-centred design

As the overriding philosophy of this research is one of user-centred research (Preece et al. 2002), the design also placed the user at the centre of the design effort, and undertook an iterative process to design and test a mobile prototype. The design applied multiple user-centred methods, and below is a short description of the methods used for the mobile personalization design, including methods particularly suitable for Chinese users.

Questionnaires were used to reveal patterns in peoples' behaviour and preferences for the design ideas which were developed based on previous studies. They ranged from very structured, with a series of categorical responses, to having very open questions where free responses were given. The questionnaires generally answered the 'what' questions about users.

Scenario-based interviews were used to explore with users the reasons for their preferences (as revealed in the questionnaires) and how they would behave in certain situations. Scenarios were generated to describe the functions and context of use, based on previous studies (in Chapter 4 and Chapter 5). Successful use of scenarios requires ways of capturing user needs, and taking into account contexts of use of a system (Fulton and Marsh, 2000). Combined with the scenarios, the interviews were more effective than traditional interviews because they were based on immersion of the user within a (simulated) context, and led more directly to a definition of solutions.

Card sorting was employed in the interaction design phase for increasing the application's usability. The process involved sorting a series of cards, each labelled with a piece of content or functionality, into groups that made sense to the participant. It provided insights into users' mental models, showing how users tacitly group, sort and label tasks and content within their minds (Preece et al. 2002).

Paper mock-ups are low-fidelity prototypes which were designed to visualize the design concept in the early design process, before any code is written (Cooper and Reimann, 2003). Walking through the mock-ups with users allowed people to picture the design and to attempt different aspects of specific tasks. Early in the design stage, this process revealed the areas with which users had difficulty.

Simulations are high-fidelity prototypes which were generated to imitate the real user interface (Cooper and Reimann, 2003). The act of simulation involved representing certain key characteristics of the user interface. During the final design phases, the user interface was programmed on a PC and installed on a mobile application to allow users to work with the simulation.

Emotion Cards (Desmet, 2000) were applied to facilitate the communication with Chinese users, in light of the Chinese culture of discouraging speech (Kim, 2002; Lin, 1977; Peng, 1997; Liu, 1988). The Emotion Cards helped Chinese users objectify their experience and to serve as an aid for starting a conversation with the researcher, and this approach helped Chinese users to overcome their reserve about verbalizing their feelings. Typically, a participant would select a card that best expressed his or her experience in relation to an aspect of design, and this would initiate a deeper conversation with the researcher.

A User Advisory Board. Chinese users work better with those who are familiar to them (Yeo, 2001). The research created a User Advisory Board that was involved throughout the whole design cycle. The board consisted of a group of four users who had experience of personalizing mobile applications (e.g. mobile phones, mp3 players) and had watched a LSE in an open stadium within the previous six months. They were aged between 26 and 31 and split equally between males and females.

6.3.2 Design phases

The design process in this research considered four main design aspects (content, conceptual, interaction, presentation). These are regarded as the most important in the HCI literature (Cooper and Reimann, 2003; Preece et al. 2002) and impact differently on the five components of user experience (UE). The links between design components and main UE impact are shown in Table 6.1 below:

Table 6.1 Impact of design aspects on user experience

Design aspect	Meaning	Main user experience impact
Content design	The information (including functionality) that is presented or made available to the user	User, social and usage context factors
Conceptual design	The physical nature of the application including the basic way in which it works	Product and usage context factors
Interaction design	The way in which a user works with the application	Product and usage context factors
Presentation design	How content is actually presented to the user	Product and cultural factors

The four design stages are described in the sections below. Since they are sequential (and also iterative), later design stages will incorporate the findings from earlier stages. Consequently, later stages will also take into account the UE components that are more relevant to the early design phases.

6.4 Stage 1 - content design

Content analysis of the personalized mobile application investigated the functionality and information that should be presented or made available to the user, and the personalization required to satisfy individuals' needs at a large sporting event. Content design considers user experience by supplementing information (user UE factor) and enhancing the social environment (social UE factor) at a large sporting event (event UE factor).

To help optimize the user experience, the content must be organized logically and predictably (Lif, 1998), keeping it as context sensitive as possible. A matrix of possible content was created by listing the system functions, based on previous user requirement studies (in Chapter 4) in the left column of Table 6.2, and the relevant contextual factors at LSEs which personalization needs to adapt to, derived from previous mobile context studies (in Chapter 5) in the upper row of Table 6.2.

Table 6.2 Design possibilities

Context / User requirements	Preference & Interest in sports	Event Progress	Location inStadium	Event Types	Language	With Whom	Mobile Screen	Nationality	Public Media	Knowledge Experience	Social Atmosphere
Event broadcast			Yes	Yes			Yes				
Event schedule	Yes				Yes			Yes			
Athletes information	Yes			Yes	Yes			Yes	Yes		
Event results	Yes	Yes			Yes					Yes	
Community generation	Yes		Yes			Yes		Yes			Yes
Community activity	Yes		Yes			Yes		Yes			Yes
Event replay	Yes	Yes	Yes				Yes		Yes		
Order food		Yes			Yes	Yes					
Notification of time	Yes	Yes		Yes	Yes				Yes		
Event news	Yes	Yes			Yes	Yes				Yes	Yes

By analyzing the interplay between user requirements and contextual factors, it is possible to recommend how the mobile application should function and adapt itself according to relevant contextual factors. In order to develop and then test a mobile design, the scope was narrowed down to six representative functions, and the three most influential contextual factors, based on a frequency analysis of user studies data in Chapters 4 and 5. These are shown in the highlighted portion of Table 6.3.

Table 6.3 Design content

Context / User requirements	Preference & Interest in sports	Event Progress	Location inStadium	Event Types	Language	With Whom	Mobile Screen	Nationality	Public Media	Knowledge Experience	Social Atmosphere
Event broadcast			Yes	Yes			Yes				
Event schedule	Yes				Yes			Yes			
Athletes information	Yes			Yes	Yes			Yes	Yes		
Event results	Yes	Yes			Yes					Yes	
Community generation	Yes		Yes			Yes		Yes			Yes
Community activity	Yes		Yes			Yes		Yes			Yes
Event replay	Yes	Yes	Yes				Yes		Yes		
Order food		Yes			Yes	Yes					
Notification of time	Yes	Yes		Yes	Yes				Yes		
Event news	Yes	Yes			Yes	Yes				Yes	Yes

The chosen functions of event broadcast, event schedule, athlete information, event results and community were the representative functions derived from the user requirements studies in Chapter 4. It included the functional, information, social and usability requirement of users.

The selected contexts of: (1) preference and interest in sports, (2) event progress, and (3) location, were the three most influential contextual factors, according to the frequency by which they were identified by users during previous context studies in

Chapter 5. They were considered as the inputs for the personalized mobile applications which influenced the output presented to the user.

> User's *preferences and interest in sports* refer to what type of sport a user is interested, for example, football or athletics and also particular athletes of interest, for example, Liu Xiang in 110m hurdles, etc. The personalized mobile application can collect that information based on user's settings or through the user' history record on the mobile application.
>
> Event progress refers to periods within the event defined (by the user) as: 'pre-event', 'quiet periods in the action', 'sporting climaxes', 'breaks' and 'post-event'. It is regarded as a critical temporal influence (Tamminen et al. 2004) on the user experience and the need for information.There are various options to collect real-time categorization of event progress, for example: directly from the sporting action based on athlete and environment sensors or video image recognition; based on the nature and location of crowd reaction; automatic analysis of sports commentaries; manual categorization by commentators.
>
> Context of location refers to the spatial relationship between the spectators, the sporting action, and other entities in the stadium. It includes spectator location, but is a broader term encompassing aspects of an HCI definition of context, such as that given in Dey et al. (2001). This factor can be collected by GPS, local network sensing, or simply by seat number with an electronic ticket.

Analysis of user requirements and key contextual factors can indicate how system functions (e.g. athlete information, event schedule and results) can be best delivered, based on internal and external contextual factors, such as user preference, event progress and location in the stadium. By way of example, personalization can result in a tailored viewing angle of an event, which is broadcast according to a user's location in a stadium. Location in this respect encompasses the distance of the spectator from the sporting action, and their orientation within the stadium.

The design of personalized content (whether this is user- *or* system-initiated) emphasises that basic system functions have a differential impact on the components of UE. This is illustrated in Figure 6.2. By way of example, specific information requirements of the end user are influenced by the progress of the event being watched (a key usage context factor of user experience). The degree to which those information needs are met by a personal mobile application influences the user factor of user experience. Similarly, satisfying the desire to be a member of a community can lead to an enhanced social factor component of the user experience. However, the extent to which a personal mobile application is able to promote a sense of community depends on contextual factors relating to the user's location in the stadium, and the preferences and interests of those spectators near to them.

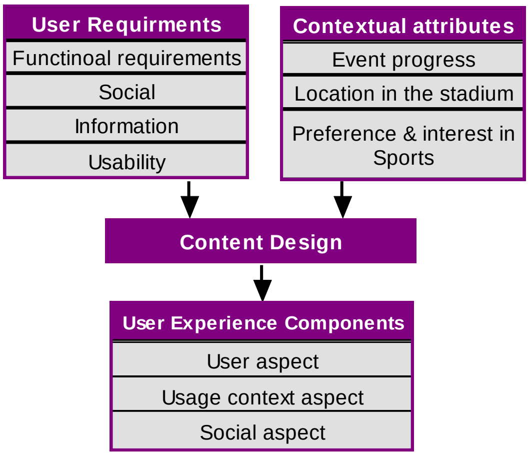

Figure 6.2 Design content and its influences on user experience

6.5 Stage 2 - conceptual design

The conceptual design phase investigated what the mobile application comprises required by its users (product UE factor) and how it fits into the broad context of use (event UE factor). This design phase was based on the premise that there are multiple forms that a mobile application can take, and that appropriate concepts are (at least in part) dependent on the content and functionality that is being made available to the user.

The focus of conceptual design was to determine: (1) how users personalize/interact with the application, (2) how users receive information notification, (3) how to display information to a user, and (4) how to carry the application in the context of LSEs.

6.5.1 Generating options for concept design

The first stage of the conceptual design phase was a brainstorm of different design solutions by a small team of HCI researchers. A range of different options was generated, based on technological feasibility (Oquist et al. 2004; Kostakos and Neill 2003; Brewster, 2002; Moizio et al. 2007; Rukzio et al. 2006).

6.5.1.1 Personalizing information

Personalizing an application refers to how a user personalizes his/her personal information on the mobile application. It can become a complex process (Nielsen, 1998), as some instances of use may be very specific to a particular individual or usage situation. Different options for user-initiated personalization are: (1) direct manipulation; (2) keyboard or keypad interaction; (3) gesture control; (4) eye movement control (which can be very unobtrusive); (5) finger control using muscle sensors in the form of rings or other applications; (6) foot control using sensors; (7) voice control using voice recognition software; (8) remote computer based setting, performed prior to an event.

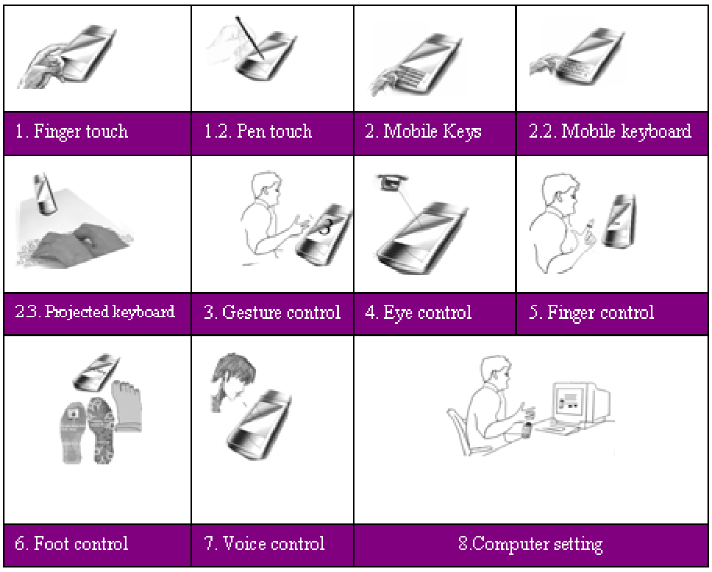

Figure 6.3 Modes of personalizing personal information

6.5.1.2 Personalizing information

Notification information means the mobile application notifies a user with available information and services upon the personalization. (See Figure 6.4) There are various options for being notified of the presentation of personalized information, whether this is user- or system-initiated. This has to be effective, but also unobtrusive. Although users do not want their mobile applications to 'beep' continuously, it is also impractical (and detracts from the sporting event) to keep checking the screen for visual notifications in a stadium. Five different ways of notifying information were generated: (1) *mobile application notification* in the form of sound, lighting modes and vibration from the mobile application; (2) *wireless ear plug* notification, which alerts user by means of a small and inconspicuous wireless ear plug; (3) *wearable notification*, which notifies the user relatively unobtrusively by means of a wearable application, such as a ring, bracelet, watch, necklace or glove; (4) *glasses notification*, which alerts users by means of glasses they wear; (5) *small display notification*, based on a separate display in the form of a badge, brooch or key ring, using light, sound, vibration or text alerts.

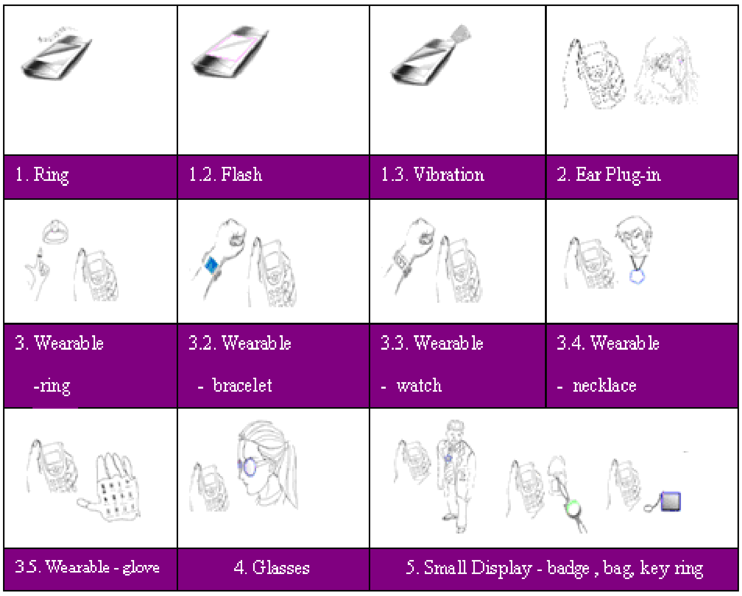

Figure 6.4 Modes of providing notification of personalized information

6.5.1.3 Displaying information

Displaying information is to present user with available personalized information and services. (See Figure 6.5) The required personalized event information needs to be displayed to the user in an effective manner, whether this is user- or system-initiated. Information display modes must take into account that the user may be visually engaged in the sporting event. Six different ways of displaying information were generated: (1) a *mobile application* with a certain size of screen (e.g. the size of a normal PDA), which displays the information directly on the mobile application without the need for carrying an extra screen or display; (2) *information projection*, which projects the information onto stadium seats, floor, legs, hands or spectators' clothes from a mobile application; (3) *ear plug* for auditory information, enabling hands-free and eye-free interaction; (4) *wearable display*, for example, in the form of a ring, necklace, watch, bracelet or glove, excluding the need to hold the mobile application; (5) *virtual displays* via glasses, removing physical space limitations, and ensuring privacy; (6) *public display* via wireless connection to the mobile application – most appropriate in particular semi-private environments.

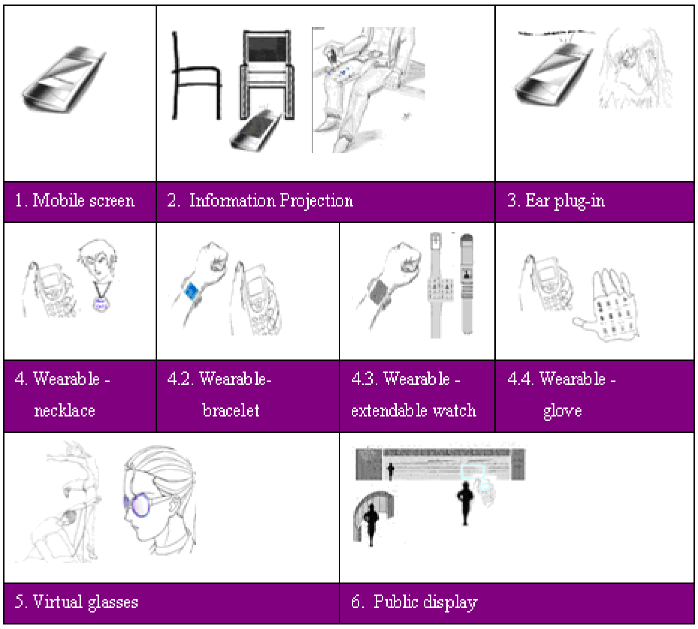

Figure 6.5 Modes of displaying the personalized information

6.5.1.4 Interaction with the application

Interaction with the application relates to how a user interacts with incoming information and how a user inputs outgoing information.

A user must be able to interact with information sent to them (for example, being able to distribute it or adapt it). The main options for achieving this are similar to those for personalising the application. (See Figure 6.3)

6.5.1.5 Carry the application

It is essential to have an easy way of carrying a mobile application in a stadium, (See Figure 6.6). It should fit the context of large sporting events during which there may be crowds of people moving, watching and cheering. There are two main ways of carrying a mobile application: (1) *wearable application* attached to the body, such as on the wrists, around the neck or waist; (2) *attachable application* – fastened to something the user always carries such as a key-ring, a wallet, a pocket or bag, or to the stadium seats.

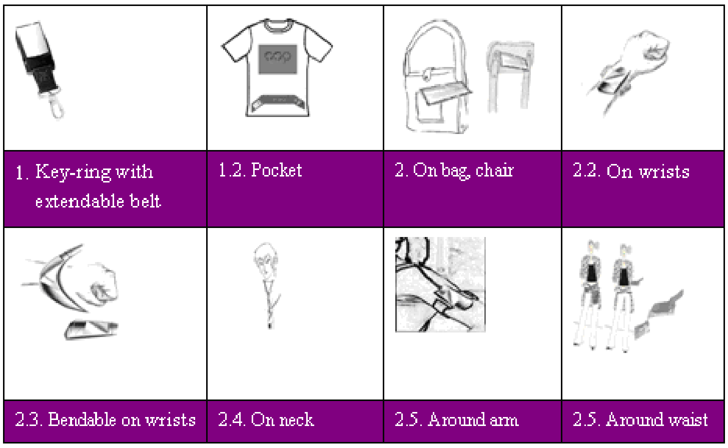

Figure 6.6 Modes of carrying the personalized application

6.5.2 Selecting appropriate design concepts

The concept generation phase produced a number of potential design options, as outlined above. User-centred design methods were then used with participants to select appropriate design solutions for: information notification; information display; personalization and interaction; how to carry the application in a stadium environment.

Participants

Ten users, including the User Advisory Board, were invited to take part in the study. All the participants had experience of personalising mobile applications and had watched at least one large sporting event in an open stadium within the preceding six months.

Methods

Scenarios, paper mock-ups, questionnaires and scenario-based interviews were used during this phase. It also involved the User Advisory Board during this phase, to ensure that the methods and their communication to Chinese users were effective.

Scenarios were generated to describe the chosen design functions and relevant contextual factors, a brief example of which is given below. The use of scenarios constructed additional meaning from the contextual information contained within them, and provides greater information on those situations within a stadium where personalization of a mobile application could result in the tailoring of services.

Table 6.4 Example of a scenario

Scenario 1: Watching the event
Episode 1: Mike is watching the athletics in the stadium. However he cannot see everything clearly from his seat position. Mike uses the personalized mobile application to get different viewing angles, based on his location.
Episode 2: Mike gets an alert that an athlete of interest is running the 3000 metres. He uses the personalized mobile application to view the detailed progress. ...

Paper mock-ups were used to walk-through conceptual ideas with users. At this early stage, concepts were hand drawn on paper to allow users to visualize the design and complete aspects of tasks.

A questionnaire was used to reveal users' preferences in relation to aspects of design ideas based on the paper mock-ups they had just experienced. An interview was then conducted to allow users to expand on, and explain their preferences.

The Emotion Cards were used during interviews as an aid for starting a conversation between the participant and the researcher. Typically, a participant would select a card that best expressed his or her feelings in relation to the design ideas; this would then initiate a deeper conversation with the researcher, which was also able to cover wider topics if desired.

By interleaving the methods, and being flexible in their application, it was possible to use one technique to answer questions raised by other techniques. The scenarios introduced the context of use; the paper mock-ups demonstrated the conceptual ideas. The questionnaire revealed users' preferences toward the different concept ideas, and the reasons for these preferences were explained during the interviews.

Procedure

Each participant was first introduced to the study and the concepts of personalization of mobile services within a LSE. Scenarios were then presented to participants. In each scenario, pre-generated conceptual ideas were provided in paper mock-up form, and these helped users to visualize both the context of use, and potential solutions. Users' preferences were collected via a short questionnaire, which was followed by a longer semi-structured interview to determine whether the user understands the concepts and the reasons for their preferences. The process lasted about one hour for each participant.

Results

The final conceptual design was chosen based on the results of the user studies described in this section. Personalising the mobile application by means of direct touch on a touch-screen was considered the most convenient method because of the sense of direct manipulation. The best way to provide notification of services in a stadium was via vibration of the mobile application, because although users do not want their mobile applications to 'beep' continuously, it is also impractical (and detracts from the sporting event) to keep checking the screen for visual notifications during an event. Most users were very interested in the concept of image projection from the mobile application (e.g. onto the seat in front) to display information, because this provided flexibility with relatively large displays. However due to technology constraints, the second preference of a screen-based display of information was chosen. Users preferred to have only one mobile application with integrated phone functions, which was light enough to not restrict hand movement.

The conceptual design helped to decide the form factor of the system, as shown in Figure 6.7.

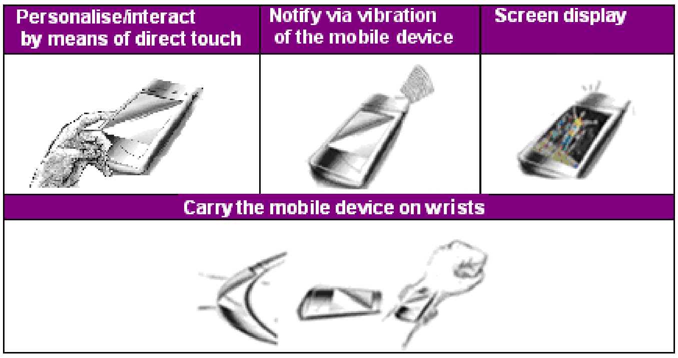

Figure 6.7 The overall concept for the personalized mobile system

The conceptual design stage generated an outline for how the mobile application should look, and the basic way it should operate. This stage focussed specifically on the type of application that would work well (product UE factor) within a large sports environment (usage context UE factor). However, it also took into account the prior content definition stage (and hence also incorporated indirectly the user, social and usage context factors). (See Figure 6.8)

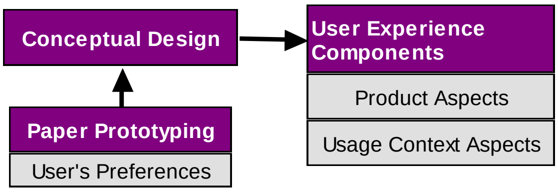

Figure 6.8 Conceptual design and its influence on user experience

6.6 Stage 3 - interaction design

Interaction design tried to optimise the UE by matching the information architecture of the ‘system’ with the users’ mental model of how information and functions are organised in the LSE context. A user’s mental model is an internal theory of the causal behaviour of a system, or the basic way in which it works (see e.g. Cooper and Reimann, 2003). Understanding the users’ mental model of a ‘system’ can help lead to a user interface design based on simple interaction requiring minimal user attention - therefore helping to maximise the product and event components of UE.

User studies were undertaken to analyse the users' underlying mental models by using the scenario-based tasks. The scenario-based tasks were designed by considering the service functions as well as its context based on previous user requirement studies (in Chapter 4) as well as the mobile context studies (in Chapter 5). The information gleaned from this study established the foundation for user interface design, with the ultimate goal being simple interaction requiring minimal user attention.

6.6.1 User study of interaction design

A series of scenario-based workshops were conducted to create an early 'top down' vision of the users' mental model within a large sporting event context. These scenarios were based on previous studies analysing user requirements (Chapter 4) and the impact of context on the user experience (Chapter 5); they are described in more detail below.

Participants

Twelve users, including the User Advisory Board, took part in the interaction design phase. They were divided into four groups, and as before, all participants had experience of personalising mobile applications and had watched a large sporting event in an open stadium within the preceding six months.

Methods

Five scenarios were developed which incorporated a series of *tasks* based on specific application functions, derived from user requirements studies (Chapter 4). They also incorporated one or more of the key contextual variables which had been identified during the studies into mobile context (Chapter 5). These contextual variables allowed the investigation of both user-initiated and system-initiated personalization. For both of these personalization approaches, the scenarios were used to prompt user discussion of how the system might behave, how they might interact with it, and the benefits/drawbacks of each approach.

Table 6.5 Example of the Scenarios

User-initiated personalization - Scenario 1: Check the event schedule.
Mike arrives at the athletics stadium. Immediately, he gets a notification from his mobile application, with a timetable introducing the athletics event schedule. He personalizes the service by entering the sports that interest him. Immediately, the system shows him a personalized event schedule based on his preferences.
System-initiated personalization - Scenario 1: Check the event schedule.
Mike arrives at the athletics stadium. Immediately, he gets a notification from his mobile application, with an automatically created personalized event schedule.

Card sorting was then used. The chosen design content was written on small cards according to each scenario, and the cards were presented to the users without any pre-established groupings. Users were asked to sort cards into groups that they felt were appropriate, and then describe each group in terms most relevant to them.

Figure 6.9 Card sorting during the workshop

Analysis

Patterns arising from the card sorts were initially created by mounting the cards onto a whiteboard (see Figure 6.9). An affinity diagram technique (Hackos and Redish, 1998) was then used to enable further groupings and sub-groupings to emerge. The patterns that arose represented sensible structures for the users. It is important to note that areas of difference (as opposed to agreement) also provided useful insights. These can help to identify: content that participants haven't understood well; content that could belong to more than one area; alternative paths to content; and how different types of participants attach meaning and groupings to information.

6.6.2 Results

The interaction design stage produced task diagrams of how content information should be arranged and presented clearly, in order to match users' mental models of the 'system' (i.e. mobile application within a sports context), and the way in which it should personalise content. For the user-initiated personalization, the results showed that the user can either pre-set personalization parameters (Figure 6.10) before the delivery of a service via the personalization menu page, or can do this in real-time as services are delivered to them (Figure 6.11). The interaction of system-initiated personalization is shown in Figure 6.12.

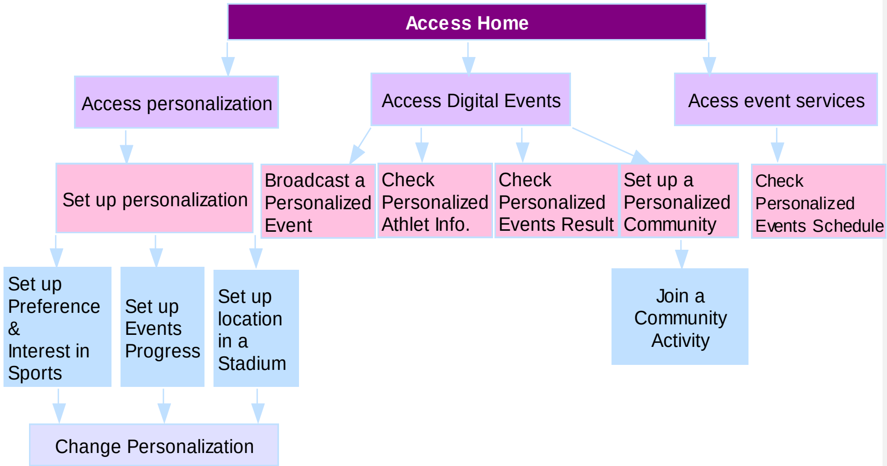

Figure 6.10 Task diagram of user-initiated personalization (pre-set personalization)

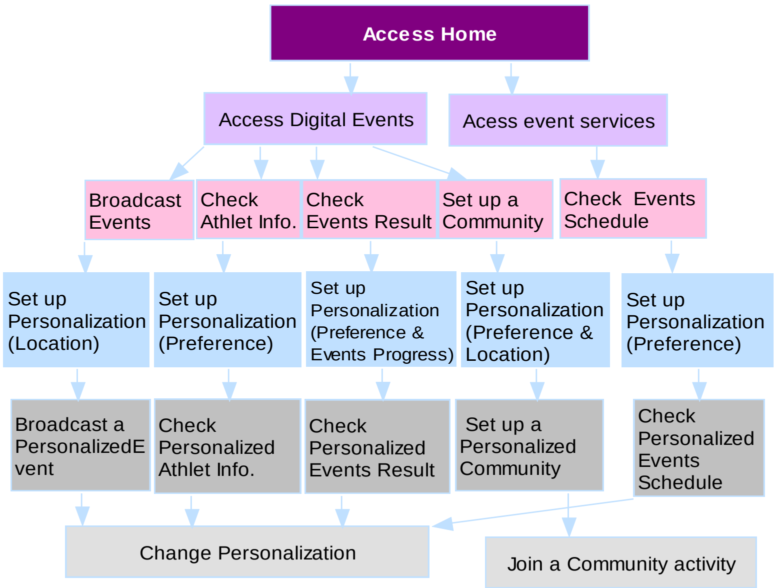

Figure 6.11 Task diagram of user-initiated personalization (instant-setting)

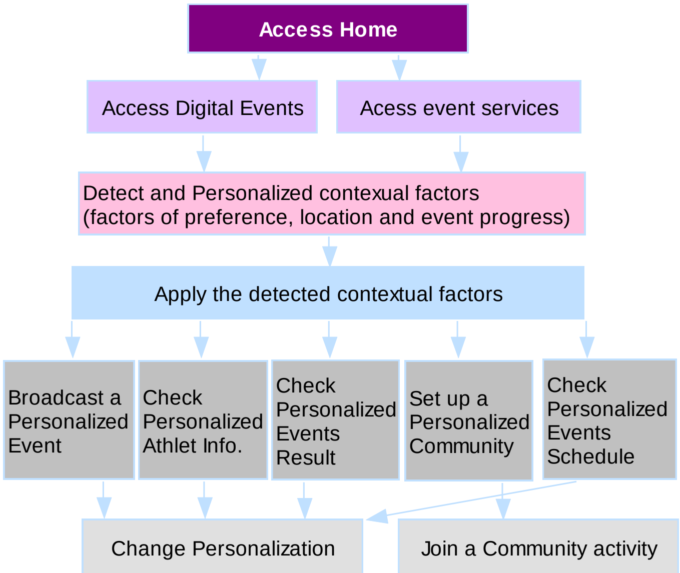

Figure 6.12 Task diagram of system-initiated personalization

The task diagrams led to a structure for the information/services presented to users at a large sporting event, grouped under four main categories – 'home', 'personalization', 'digital event' and 'event service'. The 'home' provides access to all the functions in the system. The term 'digital event' means information which should be provided when users are watching the events in a stadium. 'Event service' refers to information that can be provided anytime, e.g. before or after the events. The 'personalization' function allows the user to set the three main contextual factors of relevance. This is shown in Figure 6.13.

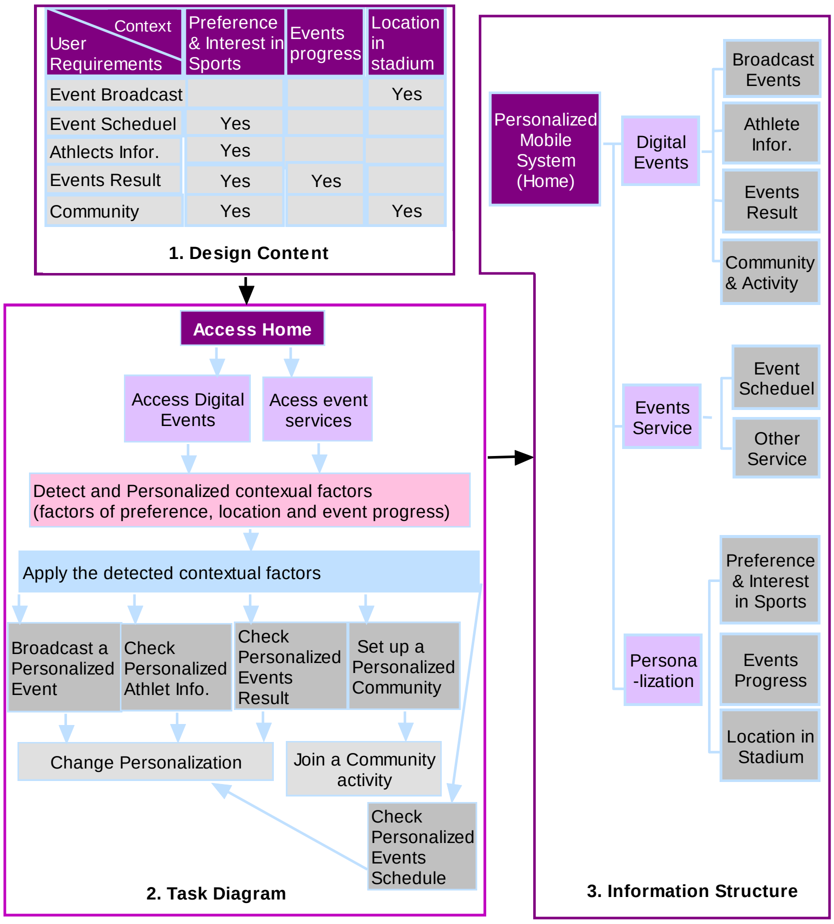

Figure 6.13 Information structure

Figure 6.13 also shows the relationship between *interaction* and *content* design. Design *content* was incorporated into the user tasks that were used during the users' mental model studies, and developed into task diagrams. These task diagrams were then used to partition content into sets of 'pages' and to describe how 'pages' were linked within a given structure.

The interaction design phase generated information architecture for the design. The design originating from the workshops also reflected the relational-contextual style of Chinese users (Kim, 2004; Choong and Salvendy, 1998). This describes how individuals classify information according to the natural relationships between objects; participants understood and classified information according to this type of relationship. User needs were expressed in terms of the multiple, concurrent requirements relating to a particular sporting event. In particular, users wanted to access broadcasts, view athlete information, check event results and interact with a community – all in relation to a specific event. To support this through design, these needs were then incorporated within a single group under a 'digital event' button.

The interaction design tried to match the information architecture of the 'system' with the users' mental model, based on user requirements and aspects of usage context, as outlined in the content design. (See Figure 6.14) This then led to the final stage, the presentation design of the content actually presented to the spectators, described below.

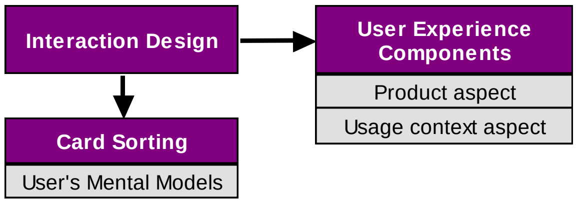

Figure 6.14 Interaction design and its influences on user experience

6.7 Stage 4 - presentation design

Presentation design impacts directly on the product factor of UE, but also builds on conceptual design, content analysis and interaction design to maximise the other components of UE. This phase took into account (1) previous studies of user culture to enhance cultural aspects of UE (Gong and Tarasewich, 2005; Kim, 2004) and (2) current mobile design guidelines (e.g. Shneiderman and Plaisant, 2005; Weiss, 2002).

The presentation design phase generated designs of both user-initiated and system-initiated personalization which were used during the experimental studies in this thesis (described in Chapters 7 and 8). The key design criteria for both user- and system-initiated presentation are given below.

6.7.1 General design features

Highly structured menus. The design content was partitioned into mutually exclusive menu groups with distinctive identifiers, based on the prior content analysis and interaction design stages. This highly structured approach is compatible with the Chinese culture of 'high power distance' (the acceptance of unequal power distribution within society) which enables users to handle highly structured information (Kim, 2004). Based on the interaction design, there were four menu groups – home page, digital event page, digital service page and personalization, as illustrated below.

Figure 6.15 Visual design of the four main menu groups

Principle of grouping was used, whereby proximate objects that 'belong' together were enclosed by lines or boxes within menus. This is based on humans looking for patterns in data that can be used to identify one from the other, simplify the interaction with the world, and make it more understandable (Weiss, 2002).

Top down interaction. The 'top-down' interaction design guideline (Shneiderman and Plaisant, 2005) was followed, by presenting high level information first, and then giving user the option of retrieving more detailed information. This is shown in Figure 6.16, relating to event and athlete information.

Figure 6.16 Top-down interaction

Task-oriented navigation. Mobile design guidelines recommend against using breadcrumb navigation, noting that breadcrumb navigation 'adds visual clutter and extra clicks in the mobile environment' (Goto, 2006). The design only included links back to the homepage and back to the last important, relevant point along the path users have taken on menu pages. The navigation was kept task-oriented, where all related function buttons were laid out, based on the task flow for users to jump through other functions on one page. It helped simplify the interaction and direct the end user towards task completion.

6.7.2 Design considerations for user-initiated personalization

Depending on whether personalization of services at an event is user- or system-initiated, a range of key design considerations will help to optimise the user experience when using a mobile application. Particular design aspects are relevant to user-initiated personalization, and these are summarized below. The user-initiated personalization user interface is presented in Appendix 6A.

Easy personalization. In a sporting context, any mobile service should require minimal attention of the user when accessing personalized content. Spectators don't go to a sporting event to play with their mobile phones! A user can either pre-set personalization parameters before the delivery of a service via the personalization page, or can do this in real-time as services are delivered to them. (See Figure 6.17)

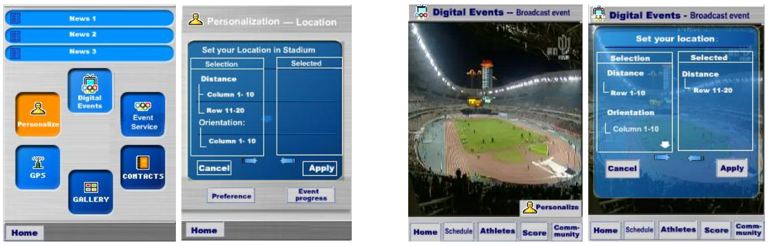

Figure 6.17 Pre-setting personalization and Instant-setting personalization

Personalization parameters suitable for small screen displays. To overcome conflicting requirements of large-scale visual presentation on a small mobile application, extended tree structures (e.g. Figure 6.18) were used to segment information according to the interaction design findings and the available screen space. These enabled user-selected personalization according to the ‘high power distance’ characteristics of Chinese users. A few studies which investigated the effect of content structures found that hierarchical tree-like structures led to higher user performance (Shin et al. 1994, Pollock et al. 2002). A trade-off was necessary between providing a single view of information, and enabling a user to access more detailed information as required.

Figure 6.18 Semi-transparent menu

The extended tree menus also reduced the interaction steps for users, since they did not have to access multiple screens in order to perform their personalization choices. It helped to lessen users’ cognitive loads by presenting all personalization choices on one page. Design guidelines (Shneiderman and Plaisant, 2005) recommend providing a list of options from which the user can select, rather than having the user key in values from memory – this is based on the principle of recognition being easier than recall.

A ***semi-transparent menu*** was used to overlay the main body of content. This made most use of a small screen by promoting parallel processing of visual information, helping to integrate function and content within a single view (Kamba et al. 1996). It means a small screen does not have to set aside a large portion of its space for infrequently used features, and so allows the user to access more content. This is also shown in Figure 6.18.

Privacy. Privacy is a major issue for all users of mobile applications, particularly where they support virtual communities (Gong and Tarasewich, 2005). From a Chinese users' point of view, a key component of Chinese culture is collectivism (Kim, 2004) – this describes how within Chinese society, individuals are integrated into strong cohesive groups. These groups provide protection throughout an individual's lifetime, in exchange for unquestioning loyalty. Chinese users are reticent to stand out from their groups. For this reason, the sharing of group information with other groups is acceptable, while sharing of individual information outside of the group is less acceptable. The design therefore considered the privacy issue by allowing sharing of group information instead of individual information. Personal data (spectators' preference and location) were shared only within the users' own group. In addition, the design allows users to select whether their personalization attribute is accessible to other users within the group or other groups.

Figure 6.19 Menu to manage privacy

6.7.3 Design considerations for system-initiated personalization

Unlike interfaces for *user-initiated* personalization (described above), users do not have to set anything before receiving system personalized content or functions – this is done automatically by the application. As for user-initiated personalization, content was grouped to support highly structured information presentation and interaction. Highly structured content, extended tree structures and semi-transparent menus, privacy issue were all considered, as above. Several other factors become important with system-initiated personalization. The system-initiated personalization user interface is presented in Appendix 6B.

Visibility system status. Since system-initiated personalization results in an application acting semi-autonomously, a status indicator is needed to understand the behaviour of the application. If greater potential uncertainty is likely, then the visibility of the system status needs to be increased. An icon was used to indicate that system-initiated personalization is taking place.

Figure 6.20 System-initiated personalization icon

Dealing with contextual ambiguity. Several authors highlight how some aspects of context are unlikely to be accurately measurable or computational (e.g. Bellotti and Edwards, 2001). To compensate for inherent difficulties in context measuring, several principles can be applied, including the defensive use of context, system-driven behaviours being visible and recoverable, and users being easily able to regain control over application behaviour. In the context of a large sporting event, the most obvious implication is that users need to be able to 'switch off' any system-initiated personalization.

Consistency and predictability. A consistent and predictable interface is another key way to avoid the uncertainties of system-initiated personalization. It is also particularly important for Chinese users (Kim, 2004) because of the cultural influences relating to uncertainty avoidance - the extent to which members of a culture feel threatened by uncertain or unknown situations. The design therefore emphasised consistency for navigation through content and menu options.

Changes to personalization requirements. As long as basic principles for employing context are followed, system-initiated personalization can result in an application being better able to meet individual needs at a particular point in time. However, a user's preferences may change over either a short or a long timescale (Ciborra and Lanzara, 1994). An application needs to be able to take into account how personalization preferences may change over time, either implicitly by 'learning' based on interaction patterns, or explicitly via user input. In the design, users were allowed to change the personalization parameters by clicking the icon  . After clicking of this icon, a user can choose 

to edit, then the personalization parameters are extended in a semi-transparent menu, which allows the user to edit the attributes.

The presentation design stage tried to optimize the presentation of content for maximum efficiency (e.g. to reduce the number of navigation steps), minimize the memory load on the user and therefore enhance user experience during interaction. The design was based on analysis of user requirements and underlying contextual influences, whilst following mobile design guidelines and taking into account the specific cultural implications of Chinese users. Of particular relevance were the Chinese culture of 'high power distance' and the relational-contextual style of Chinese users. (See Figure 6.21)

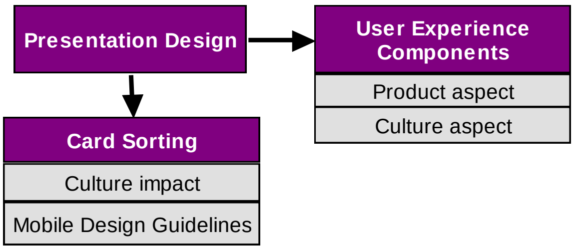

Figure 6.21 Presentation design and its influences on user experience

6.8 Discussion

The aim of this design was to demonstrate an approach to optimising the UE for a specific mobile design challenge. The effectiveness of the design process is discussed below.

6.8.1 The user experience focused design

This thesis considered user experience to be a formative concept that is tackled in terms of its components, rather than being a concept that is tackled directly (Lin et al. 2005). It considered user experience to comprise multiple components – user, product, usage context, social and cultural.

The design included four roughly sequential stages of design, namely: content, conceptual, interaction and presentation design. Each components of UE was tackled separately during its each design stages. Figure 6.22 shows how specific design stages relate directly to discrete UE components.

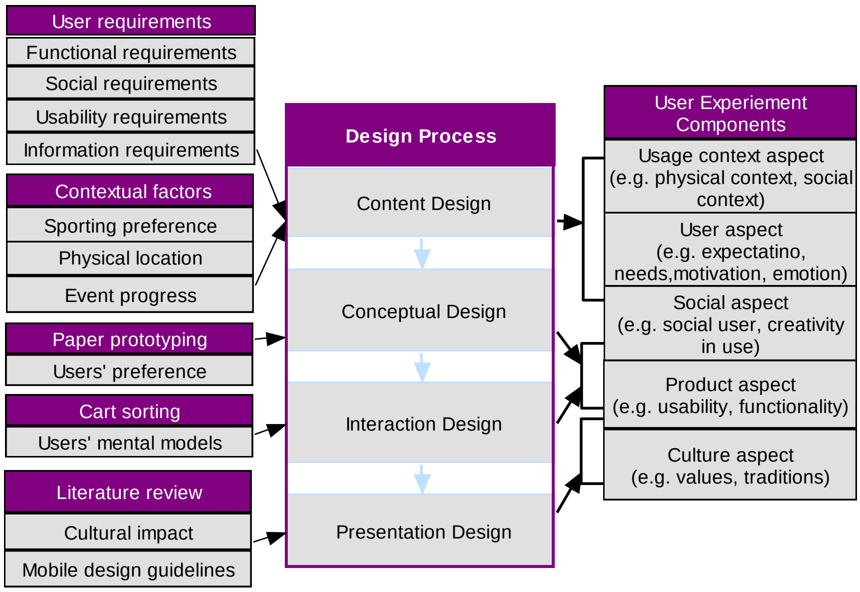

Figure 6.22 Relationship between the design content and user experience

The content design stage determined the basic system functions based on the results of user requirement studies (Chapter 4) and contextual impact analysis (Chapter 5).

Required functions and information were selected according to identified needs. In addition, the required variation of these functions/information according to changes in context was established, focusing on where contextual influences impacted on one or more aspects of user experience. The content design tried to maximise the UE of the mobile 'system' for a specific individual within a particular usage environment by personalising content according to key contextual factors (Dey et al. 1999).

The conceptual design envisioned the physical form factor of the personalized mobile application based on the previous studies of user requirements and contextual factors at large sporting events. A conflict worth noting was users' requirements for large-scale visual presentation on a small mobile application. To deal with the conflict, one possible solution is personalized information presentation which can maximise relevance and reduce user interation. Another design solution is to provide a structured menu format which is compatible with Chinese culture of 'high power distance' - enables users to deal effectively with highly structured information (Kim, 2004). The conceptual design allows users to choose among a range of different conceptual options which has two benefits: 1) promote an enhanced user experience by designing understandable system in a certain context; 2) discover further product development opportunities.

Interaction design determined the way a user works with the content presented. It underlined the importance of less interaction with minimum user attention in the large sporting event context. By incorporating the chosen content into scenario-based tasks, user studies were undertaken that established users' mental models of the 'system'. It tried to match the information architecture of the mobile 'system' with the users' mental model that controls the immediate user experience (Kuniavsky, 2003).

Presentation design described how the content could actually be presented to the user. It was undertaken based on having completed the previous design stages, and explicitly taking into account mobile design guidelines and the impact of the specific culture of the end users within this research. It was carried out based on understanding the limitations of user interface and interactions of a mobile application, such as a small screen, the usage environment whereby users have neither the time nor the attention to navigate through complicated menus or to interpret confusing results

(Weiss, 2002). Such limitations were addressed in the design, including, the considerations of extended tree menus, visibility system status and support of user control.

Each of these design aspects can be accomplished with a user-centred view of product design and development, focusing on user experience, rather than technological innovation. It took into account the human psychology and the physiology of the users. Figure 6.22 shows how specific design stages relate directly to discrete user experience components. However, as each design stage builds on the outcomes of previous stages, it is important that each design stage is tackled explicitly.

6.8.2 User-centred design methods

The user-centred design applied multiple methods, including scenarios, paper mock-ups, card sorting, interviews, questionnaires, Emotion Cards, and a user advisory panel.

Using multiple methods promoted validation of the design outputs by enabling triangulation of data and deeper exploration of issues than would be possible with single methods. For example, the conceptual design applied multiple methods of scenarios, paper mock-ups, questionnaires and interviews. The scenarios helped to bring users to the LSE context of use, while paper mock-ups vividly demonstrated the conceptual ideas. With these two methods used together, users could get a good understanding of the design and its actual state. The questionnaire then revealed patterns in people’s preference for different design ideas, while the causes for these preferences were then investigated and verified with interviews.

Within this design process, two methods were adopted (and adapted) which had specific relevance for the user group of interest (i.e. Chinese users) based on their cultural influences. Emotion Cards were used to visually represent aspects of user emotions, and these helped the Chinese users to verbalize their views and engage in a dialogue with the researcher. As an example, when Chinese users were interviewed concerning their reaction to a personalized mobile service at large sporting events, they would generally reply with a response equivalent to ‘it was okay’. However, when presented with the Emotion Cards, they would typically pick up one of the cards representing a particular emotion, and talk about aspects of the design in relation to that emotion.

In addition, a User Advisory Board was recruited which consisted of a group of users who were engaged by the researcher throughout the design process. Members of this team quickly became familiar with the researcher, and were able to have an ongoing dialogue with them in relation to aspects of design. The method was based on the premise that Chinese users work better with those familiar to them, as highlighted by Yeo (2001).

However, as the User Advisory Board became more familiar with the researcher and the emerging design, they started to contribute more as designer/developers, rather than as impartial end-users. As a consequence, they became less able to focus on meeting user needs and providing user-focused input, without being constrained or directed by technological issues. To overcome this, additional potential end users were recruited to take part in the user studies, in order to contribute a purer ‘end-user’ perspective. The presence of the User Advisory Board created a free and open atmosphere; this encouraged the users then to verbalize their thoughts and discuss aspects of the design, hence overcoming the traditional Chinese value of discouraging speech.

6.8.3 Cultural implications for Chinese users

The research focused on the design of mobile services suitable for Chinese users at LSEs. This enabled a detailed analysis of specific design requirements, and whilst it promoted external validity within the design boundaries, it potentially limited the ability to generalise to a wider usage situation. The study highlighted several cultural design impacts which the design should take into account:

- To design the information architecture, it reflected the relational-contextual style of Chinese users (Kim, 2004; Choong and Salvendy, 1998) with users understanding and classifying information according to this type of relationship.

- To design the content, the highly structured information was compatible with the Chinese culture of ‘high power distance’ which enabled users to handle highly structured information (Fu, 2007; Kim, 2004).
- To design the presentation, consistency and predictability were particularly important for Chinese users because of the cultural influences relating to uncertainty avoidance - the extent to which members of a culture feel threatened by uncertain or unknown situations (Fu, 2007; Han et al. 2007; Kim, 2004).
- In the design of personalized mobile applications, privacy is a major issue for Chinese users (Gong and Tarasewich, 2005). A key component of Chinese culture is collectivism (Kim, 2004) – this describes how within Chinese society, individuals are integrated into strong cohesive groups. These groups provide protection throughout an individual’s lifetime, in exchange for unquestioning loyalty. For this reason, the sharing of group information with other groups is acceptable, while sharing of individual information outside of the group is less acceptable.

6.9 Conclusion

This chapter has considered four key elements of design: content, conceptual, interaction and presentation design. The design of each element focused on maximizing five aspects of user experience. The final outputs of the design were prototypes for personalized mobile services which can be evaluated by potential Chinese users in the LSE context in the coming stages of this thesis.

The research also concerned the cultural influences within the design process. Two methods were adapted to have specific relevance for the Chinese user group, which were the use of Emotion Cards and the creation of a User Advisory Board. The design also drew attention to several cultural design impacts on Chinese users, such as designing the information architecture by classifying information according to their relationship, designing highly structured content, designing consistent presentation and addressing the issue of privacy.

The design developed two interfaces, incorporating both user-initiated and system-initiated personalization. They shared the same functionality, based on user needs at LSEs, and the same interface look and feel. The user-initiated interface incorporated menus that allowed the prior setting of preferences in relation to a LSE. This could occur at any stage prior to the sporting action, or during the event. In contrast, the system-initiated personalized interface did not require explicit actions from the user, and was designed to let users experience the feeling of automatic detection on the relevant context attributes, including (1) location, (2) user preferences and (3) event progress. The design did not consider the system detection accuracy; instead it assumed that on these three attributes, the system would have a level of accuracy equivalent to that achievable through manual setting. The design of the interfaces allowed the research to continue with experimental testing of those interfaces in order to examine the role of mobile personalization at LSEs. This testing is described in Chapters 7 and 8.

7 EXPERIMENT I – THE IMPACT OF MOBILE PERSONALIZATION AT LARGE SPORTING EVENTS

	Research questions addressed in this chapter:
1	What is the potential for mobile personalization to contribute to the positive aspects of user experience at LSEs?
2	What are the key contextual factors to be used for mobile personalization at LSEs?
3	How can personalized mobile applications be designed to optimize user experience at LSEs?
4	**How does mobile personalization impact on user experience at LSEs?** • **Keeping the user in the centre of attention, how can user experience of mobile personalization be evaluated in LSE context?** • Which personalization approach is more appropriate to subject matter-user-initiated personalization or system-initiated personalization?
5	What are the key gaps in user-centred research that arise from this thesis?

7.1 Introduction and aims

Mobile personalization is suggested in this research to avoid the overwhelming experience of a large and complex real/virtual information environment, and to satisfy individual difference at LSEs. However the impact of mobile personalization at LSEs is still not clear. Whether it can effectively tackle the problems of a lack of social interaction with fellow spectators, and insufficient relevant information on the events, is still to be investigated.

Previous studies investigated the user requirements (in Chapter 4) and the LSE context (in Chapter 5), which therefore derived the design requirements of personalized mobile applications. These requirements were designed (in Chapter 6) to support different aspects of user experience in a stadium, such as maintaining awareness and engagement in the event (enhancing event presence) and maintaining relations with a social network (the group's co-experiencing of the event). The research continued with experiments of the mobile personalization concept, in terms of user experience, by working with potential Chinese users.

Two experiments followed the design phase in Chapter 6: the first one examined the mobile personalization concept in the LSE context; the second one investigated the balance of user-initiated personalization and system-initiated personalization at LSEs. This chapter reports on the first experiment of mobile personalization with potential Chinese users in the LSE context.

The overall aim of this chapter is to examine the impact of mobile personalization in terms of user experience at LSEs. The specific objectives are:

- to compare the user experience at a sporting event under three different conditions: 1) using a traditional paper-based source of information; 2) using a mobile application that provides event-based features, but no ability to personalize it; and 3) using a mobile prototype that provides features that can be personalized by the end user;
- to examine the role of mobile personalization at LSEs for enhancing user experience;
- to investigate the methods of evaluate user experience of mobile personalization in LSE context;

7.2 Methods

7.2.1 Lab experiment or field experiment

Usability analysis of systems involving stationary computers has grown to be an established discipline within human-computer interaction. Established concepts, methodologies and approaches in HCI are being challenged by the increasing focus on mobile applications. Researchers and practitioners are encouraged to investigate further the criteria, methods and data collection techniques for usability evaluation of mobile applications (Johnson, 1998). Lab experiments and field experiments are the methods most discussed in relation to evaluating a mobile application.

The distinction between field and lab experiment has been a controversial topic for several years. Some argue that it is important that mobile applications are tested in realistic settings, since testing in a conventional usability lab is not likely to find all problems that would occur in real mobile usage (Johnson, 1998). It also seems to be an implicit assumption that the usability of a mobile application can only be properly evaluated in the field, (e.g. Brewster, 2002; Abowd and Mynatt, 2000). However, field experiments are time-consuming, they complicate data collection and they reduce experimental control (Kjeldskov and Stage, 2004; Baillie, 2003; Bohnenberger et al. 2002; Kjeldskov et al. 2004). Others argue that lab experiments are not burdened with the problems that arise in field experiments. In a lab, the conditions for the experiment can be controlled, and it is possible to employ facilities for collection of high-quality data (Kjeldskov and Stage, 2004; Baillie, 2003; Salvucci, 2001). However, lab experiments do not adequately simulate the context in which mobile applications are used, and they also lack the desired ecological validity (Esbjörnsson et al. 2003; Graham and Carter, 1999; Pascoe et al. 2000; Rantanen, 2002). It has been suggested that instead of going into the field when evaluating the usability of mobile applications, adding contextual features, such as scenarios and context simulations, to lab settings can contribute to the outcome of the experiment, while maintaining the benefits of a controlled setting (Kjeldskov and Stage, 2004; Bohnenberger et al. 2002; Kjeldskov et al. 2004; Salvucci, 2001; Lai et al. 2001; Pirhonen et al. 2002). How much the simulated scenario of usability testing can represent a real life situation is one critical factor in terms of the validity of the usability experiment (Duh et al. 2007). Despite these arguments, no individual approach to the usability experiment of a mobile system can be held to be the definitive approach (Kjeldskov et al. 2004).

In view of this, a mixed field- and lab-based methodology was used, in order to assess the impact of personalization on the user experience at sporting events. An initial field-based experiment (this Chapter) maximized the ecological validity of the study, and also helped identify the key situational factors that influenced the user experience (and would need to be carried forward into more controlled settings). The second experiment (described in Chapter 8) was a lab-based study, where it was easier to control for confounding factors, and to concentrate on the independent variable of interest (whilst accepting that there would be some loss in ecological validity). A mixed approach also enabled a methodological comparison, and comment on their relative effectiveness for Chinese users.

7.2.2 Methods used during the field experiment

User-centred research methods were employed during the field experiment, as appropriate for the mobile application and Chinese user culture. This included: first going to the field where the application would be used; then asking participants to solve the scenario-based tasks with different mobile prototypes; and then interviewing about the user experience in the field setting as users interacted with the mobile prototypes. It applied a multiplicity of methods, namely: field experiments, scenario-based tasks, questionnaires and context interviews.

Field experiments were first chosen to take the LSE context of use into consideration. A field experiment is characterised by the manipulation of a number of independent variables to observe the influence on dependent variables in a natural setting (Robson, 1993). This experiment involved three independent conditions, which were 1) traditional user experience without a mobile application at LSEs, 2) user experience with a non-personalized mobile prototype and 3) user experience of a personalized mobile prototype. The major advantages of field experiments are the increased realism and control in comparison to ethnographic field studies, and support for studying complex situated interactions and processes (Nielsen et al. 2004).

Scenario-based tasks were developed as a script providing a concrete example of a task the user would perform with the prototypes. The scenario-based tasks were derived from the previous user requirement and context studies which is presented in Appendix 7 and 8E. It was ensured that scenario-based tasks covered and resembled a real-life situation (Fulton and Marsh, 2000). Under this method, one user at a time was asked to perform scenario-based tasks in an effort to measure the three different conditions on the user experience.

Questionnaires were used after each task as well as at the end of all tasks to collect users' opinion of "what", such as what they felt about using the mobile prototypes in context. To examine the user experience of mobile personalization, the questionnaire was designed based on the literature review described in Chapter 2: user (e.g. expectations, needs, motivation, past experience and emotion); the characteristics of the designed mobile application (e.g. usability, functionality); the usage context (e.g. physical context and social context); social interactions occurring within context (e.g. interactions); the culture (e.g. values, beliefs). These five levels of components were able to cover user experience aspects mentioned by the earlier definitions (in Chapter 2), although the lists of attributes for each component (in brackets) were still incomplete.

To consider the Chinese users 'middle way' approach (Liu, 1988; Nakamura, 1985), data collection methods were designed to require participants to take a particular stance with respect to an issue. The questionnaire employed an even number of points which force participants to commit to either side of a neutral response, as recommended by Ramscar (2008).

Context interviews were used to explain which issue users considered problematic (and why), by interacting with the researchers, in addition to the quantitative data from the questionnaires. It provided insights into the five aspects of user experience during the experiment.

In light of the Chinese culture of discouraging speaking (Kim, 2002; Lin, 1977; Peng, 1997; Liu, 1988), the experiment applied the ***Emotion Cards*** (Desmet, 2000) to facilitate communication with Chinese users. Usually, a participant would select a card that best expressed his or her experience in relation to mobile personalization, which would start a more in-depth conversation with the researcher.

Chinese peoples' emphasis on harmony can be minimized by asking ***indirect questions*** during the interview. For example, instead of asking 'do you enjoy interacting with this mobile prototype?' a researcher can ask 'would you like to use this mobile prototype for a longer period of time? And why?' Users who have had a positive experience with the mobile application are more likely to consider using it for a longer time than those who had a negative experience.

7.3 Experiment set-up

7.3.1 Field set-up

The user study took place in a sport stadium at Shanghai University in China. There were football competitions organized by the football clubs in this stadium during the experiments. These generated a typical LSE user experience, and enabled a contextually realistic study of how a personalized mobile application could impact on the user experience at LSEs. During the field experiment, participants sat far away from the playing area where the football competition took place. There was audio information (loudspeaker) and visual information (a display in a corner far away from where users sat) available in the stadium. Participants sat with other non-known spectators in the stadium (see Figure 7.1).

Figure 7.1 User studies at the sport stadium at Shanghai University, China

7.3.2 Participants

Eighteen participants, with different genders, ages and professions, were invited to take part in the study. Typical users were chosen based on previous user studies, as discussed in Chapter 4. The test users in the experiment were aged from 18 to 45 years old. Their average age was 28.5 years with a standard deviation of 3.5 years. An equal number of men and women took part in the tests. Their occupations were salespeople, journalists, engineers, teachers, secretaries, accountants and university students. All the participants had experience of personalizing mobile applications (e.g. mobile phones, MP3s) and had watched a LSE in an open stadium within the preceding six months. The recruiting of the users was done by an agency which was responsible for finding the right number of users according to a predetermined profile. See Figure 7.2 for a demographic summary.

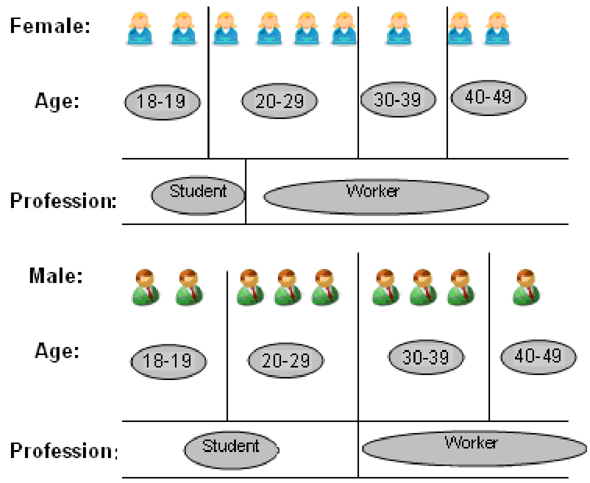

Figure 7.2 User demographics

7.3.3 Experimental scenarios

Four scenarios were developed to enable empirical assessment of the impact of personalization on a range of typical spectator activities at sporting events. The successful use of scenarios (i.e. capturing information on user needs) must take into account the diversity of contexts within which the system is likely to be used (Fulton and Marsh, 2000). Each scenario included a spectator task based on the requirements and contextual analysis described in Chapters 4 and 5.

The four tasks within each scenario were: (1) checking the schedule of matches and finding one of particular interest; 2) finding out information on a particular player of interest; 3) reading information relating to the real-time progress of the match; 4) joining a community and participating in community-based activities in the stadium.

7.3.4 Prototypes of the experiment

Based on the design process described in Chapter 6, two mobile prototypes were developed that provided content and functionality to support the experimental scenarios outlined above. The prototypes were built up with the computer programming language of Actionscript: one was the non-personalized mobile prototype; the other was the personalized (user-initiated) mobile prototype. Both mobile prototypes were identical in terms of their functionality and visual design (see

Figure 7.3). Four specific functions were implemented for the experimental scenarios: information on match schedules, including timetables and match locations for specific teams; information on the players participating in the event; real time match results, e.g. details of goal scorers; online chat and media sharing within a virtual community.

Figure 7.3 Screenshots of non-personalized and personalized mobile prototypes sharing a similar UI look and feel

The difference between these two mobile prototypes was that the personalized mobile prototype asked users to set their personalization parameters of preference, location and event progress. For example, users were asked to set their preferences in the sports types and athletes (Figure 7.4) from an extended tree menu structure. As a result, the event information (e.g. information of athletes and event schedules) was presented based on the users' settings (Figure 7.5, Figure 7.7). In contrast, the non-personalized mobile prototype did not require the user to set their preferences, and as a result presented more general information and services applicable for a general spectator (Figure 7.6, Figure 7.8).

Figure 7.4 Screenshot of personalized mobile prototype

Figure 7.5 Screenshot of personalized mobile prototype – athlete information

Figure 7.6 Screenshot of non-personalized mobile prototype – athlete information

Figure 7.7 Screenshots of personalized mobile prototype – event schedule

Figure 7.8 Screenshots of non-personalized mobile prototype – event schedule

In addition, a paper leaflet was prepared that was based on the information that a spectator would traditionally get during a real event from posters and programmes. It provided information on event schedules, and athletes' profiles (Figures 7.9 and 7.10).

The event schedule leaflet shows the date, day, place (host place, guest place), city, stadium, time plan of this event and other football events (from left to right).

轮次	日期	星期	场序	主场	客场	城市	体育场	时间
1	3-29	六	1	上海申花	深圳上清饮	上海	虹口足球场	19:45
1	3-30	日	2	天津泰达	浙江巴贝绿城	天津	泰达足球场	15:35
1	3-30	日	3	大连海昌国际	青岛盛文中能	大连	金州体育场	15:35
1	3-30	日	4	长沙金德	长春亚泰	长沙	贺龙体育场	15:35
1	3-29	六	5	成都谢菲联	辽宁宏运	成都	成都市体育中心	15:45
1	3-30	日	6	北京国安	河南四五老窖	北京	丰台体育场	19:30
1	3-30	日	7	山东鲁能泰山	陕西中新	济南	山东省体育中心	15:35
1	3-30	日	8	武汉光谷南益	广州医药中一	武汉	新华路体育场	15:35
2	4-6	日	9	深圳上清饮	广州医药中一	深圳	深圳市体育场	15:35
2	4-5	六	10	陕西中新	武汉光谷南益	宝鸡	宝鸡市体育场	15:35
2	4-5	六	11	北京国安	山东鲁能泰山	北京	丰台体育场	16:00
2	4-5	六	12	河南四五老窖	辽宁宏运	郑州	航海体育场	19:30
2	4-5	六	13	长春亚泰	成都谢菲联	长春	长春市体育场	15:35
2	4-6	日	14	大连海昌国际	长沙金德	大连	金州体育场	15:00
2	4-5	六	15	浙江巴贝绿城	青岛盛文中能	杭州	黄龙体育场	19:30
2	4-5	六	16	上海申花	天津泰达	上海	虹口足球场	19:45
4	4-9	三	25	深圳上清饮	陕西中新	深圳	深圳市体育场	19:30
4	7-16	三	26	北京国安	广州医药中一	北京	丰台体育场	19:30
4	4-9	三	27	辽宁宏运	武汉光谷南益	锦州	锦州市体育场	16:00
4	7-20	日	28	长春亚泰	山东鲁能泰山	长春	长春市体育场	19:30
4	4-9	三	29	大连海昌国际	河南四五老窖	大连	金州体育场	15:00
4	4-9	三	30	浙江巴贝绿城	成都谢菲联	杭州	黄龙体育场	19:30
4	4-9	三	31	上海申花	长沙金德	上海	虹口足球场	19:45

Figure 7.9 Screenshot of traditional paper leaflet – event schedule

The player information leaflet described the football team, player number, name, date of birth, height, weight, position, nationality and player ID (from left to right).

序号	姓名	号码	出生年-月-日	身高(cm)	体重(Kg)	场上位置	外籍国籍	参赛证号
1	陈东	1	1978-5-3	190	90	守门员		MP0223
2	唐田	2	1977-3-3	185	79	后卫		MP0969
3	孙峰	3	1978-9-11	181	72	后卫		MP0316
4	卡拉兹诺夫	4	1977-1-25	194	83	前卫	保加利亚	MP01989
5	冯潇霆	5	1985-10-22	186	78	后卫		MA13279
6	张耀坤	6	1981-4-17	183	84	后卫		MA00325
7	赵旭日	7	1985-12-3	185	85	前卫		MA13281
8	朱挺	8	1985-7-15	182	75	前锋		MA13300
9		9						
10	胡兆军	10	1981-3-1	181	80	前卫		MP0213
11		11						
12	杜龙泉	12	1988-5-29	182	78	后卫		MA35560
13	权磊	13	1985-1-13	180	84	前卫		MA13271
14	王选宏	14	1989-7-24	182	78	前卫		MA30820
15	赵明剑	15	1987-11-22	181	81	前卫		MA13253
16	闫世鹏	16	1987-9-8	180	74	后卫		MA30741
17	邹捷	17	1981-1-17	184	77	前锋		MP0210
18	马帅	18	1985-2-16	189	79	前锋		MA13284
19	基利科夫	19	1978-8-23	194	88	前锋	保加利亚	MP01990

Figure 7.10 Screenshot of traditional paper leaflet – athlete information

The general description of the three conditions in this experiment was summarized in Table 7.1.

Table 7.1 Description of experiment conditions during the field study

	Control	Non-personalized prototype	Personalized prototype
What were the experiment conditions:			
Platform	paper-based prototype	mobile device prototype	mobile device prototype
Information content	match schedules; football players information	match schedules; football players information ; real time match results; virtual community discussion	match schedules; football players information ; real time match results; virtual community discussion
Visual design	font: Chinese character 10 colour: white-grey navigation: left-right	font: Chinese character 10 colour: blue-grey navigation: menu bar at the bottom of a page	font: Chinese character 10 colour: blue-grey navigation: menu bar at the bottom of a page
What did the participants do with the prototype:			
Number of participants	18	18	18
Interaction	1. read the information provided via the paper prototype	1. click the function buttons on the mobile prototype 2. read the information provided via the mobile prototype	1. click the personalization button on the mobile prototype 2. set their personalization parameters of preference, location and event progress 3. click the function buttons on the mobile prototype 4. read the personalized information via the mobile prototype

Table 7.1 continues…

Table 7.1 continued

Results of interaction	receive general match information including match schedules; football players information	receive general, updated match information including match schedules; football players information; real time match results; virtual community discussion	receive updated, personalized match information based on user's setting including personalized match schedules; personalized football players information; personalized real time match results; personalized virtual community discussion
Information validity	match schedule and players information are the same to the field football match	match schedule and players information are the same to the field football match; match results are different from the field match.	match schedule and players information are the same to the field football match and are based on users' setting; match results are different from the field match.
What data were collected and how:			
User experience	multiple aspects of user experience: user aspect, social, usage context, culture, product aspects	multiple aspects of user experience: user aspect, social, usage context, culture, product aspects	multiple aspects of user experience: user aspect, social, usage context, culture, product aspects
Data collection methods	questionnaire, interview, observation	questionnaire, interview, observation	questionnaire, interview, observation

7.3.5 Experimental design

The experimental design was a 3 way (personalization) within subjects design. 'Personalization' represented the source of content/functionality provided to the participant: a control condition representing the typical environment in a stadium (paper-based information, tannoy broadcasts, a large screen display and no mobile support); a mobile application that did not enable any form of personalization; and a mobile application that allowed the user to personalize the output via the application's graphical user interface. Each user undertook four tasks within separate scenarios (Section 7.3.3). The order of presentation of the personalization factor was balanced across the participants for each task.

The key dependent variable was the user experience that resulted from using the prototypes. The five user experience factors (namely, user factor, social factor, usage context factor, cultural factor and mobile product factor) were derived from the multidisciplinary literature review in Chapter 2 (see Table 2.3). The user factor refers to the mental and physical state of the individual who interacts with the system. The social factor describes that aspect which is created by social interaction. The usage context factor defines the physical and social environmental factors for the experience. The cultural aspect experience refers to the underlying beliefs and values that the spectator holds, and the product factor of user experience includes all applications, systems, services and infrastructures that are involved in the interaction with the product.

Having previously completed a total of seven investigative field trials with participants at large sporting events (in Chapters 4 and 5), it was clear that many of the subcomponents identified in the literature were not relevant in the context of this study (e.g. Arhippainen and Tähti, 2003). Consequently, the *user factor* was measured using agree-disagree scales relating to users' emotions, motivations, and expectations in relation to their needs. The *usage context factor* was assessed according to the extent to which the stadium environment supports spectator activities, such as watching the sporting action and enabling social interaction. The *social factor* was assessed according to the users' perception of their social engagement in the large sporting event, and the sense of creating and sharing experiences at large sporting events. The *cultural factor* was measured in relation to the key relevant values and traditions of the user group – these being group image, group belonging and group interaction for the Chinese spectators. The *mobile product factor* was measured in relation to perceived ease of use, and perceived usefulness.

7.3.6 Data collection

During the study, a multiplicity of data collection methods was used to enable triangulation of data. There was a video camera mounted behind the user to record their interactions with the prototypes in the field. Users' comments and ratings toward their experience with the prototypes were recorded on the paper-based questionnaires, while interviews were taped for later analysis. All the video and audio recordings were taken with the authorization of the participants, and were used only for the purpose of this research.

7.3.7 Pilot test

The pilot studies were conducted with the purpose of improving the technical set-up during the LSEs environment, to estimate the time it takes participants to complete certain parts and to improve the quality of the questionnaire by eliminating ambiguities. It took place in an empty sports stadium, and the pilot participants were one male and one female, with a mean age of 29.

The pilot test revealed several ambiguities in the questionnaires, which were subsequently addressed. Furthermore, the questionnaire structure was found to be rather complex to use, and as a result, the questionnaires were refined by going through them word by word with potential users. Pilot tests showed that participants needed about 45 minutes to complete the whole experiment including the completion time for the questionnaires (approx 15 minutes). This was considered an underestimate of the time needed because of the lack of LSE context. Therefore another 15 minutes were added to the estimation time of experiment for the final experiment.

7.3.8 Procedure

At the beginning of the study, subjects were introduced to the mobile personalization concept and given a brief instruction on how to operate the mobile prototypes. The experiment was then structured by scenario-based task assignments. The within group required each user to work with the paper leaflets and two different mobile prototypes. Users were counterbalanced apportioned to complete a task using either of the prototypes first, and once the user had finished, the alternative conditions were used to solve the same task.

After each task, subjects were presented with the Emotion Cards to encourage them to rate and think aloud about their user experience in relation to the three different conditions in the LSE context. A sample of the user experience questionnaire administered after each task is given in Appendix 7and 8A.

At the end of the tasks, users were given a questionnaire, which was designed based on the five aspects of user experience. They completed questions relating to their experience of multiple perspectives of the product, user, culture, LSE context and social experience with the prototypes. A sample of the user experience questionnaire administered at the end of all task is given in Appendix 7and 8B.

Finally, they were interviewed to discuss their attitudes toward the mobile personalization concept and its functions. Overall, the study lasted around 60 minutes for each user.

7.4 Analysis and results

The results were analysed and processed from three viewpoints:

1) the comparison of user experience under the three conditions
2) the usability of the personalized user interface
3) the user requirements for mobile personalization at LSEs

Both quantitative data (users' ratings) and qualitative data (users' comments) were gathered during the study. For quantitative analysis, data was aggregated over the five user experience factors, and differentiated according to the main within subjects factor. This showed how overall user experience varied according to the personalization approach. Friedman statistics for non-parametric data were calculated for the main within-subjects factors, while multiple paired comparisons were undertaken using the technique described in Siegel and Castellan (1988).

The qualitative data (interviews and concurrent verbal reports) were analysed using an affinity diagram technique (Hackos and Redish, 1998) to prioritise and categorise the verbal reports and observational data from the experiment. The presentation of qualitative data includes some participant quotes; these are attributed to individuals thus: #, and have been preserved as a literal translation from Chinese to English in order to retain the subtleties of meaning.

7.4.1 Impact of personalization on user experience (post-task)

User experience was assessed after each task scenario. A summary diagram is shown in Figure 7.11 to present the mean overall user experience assessment for each task, based on whether the participant was undertaking the control condition, or using a mobile prototype that had no personalization capability or a mobile prototype that enabled personalization by the user. The overall user experience ratings shown for each task are a mean, equally weighted score across the five dimensions. The ratings shown are aggregated scores on 'strongly agree' (6) to 'strongly disagree' (1) scales. The error bars represent +/- 1 SD of the mean in all cases

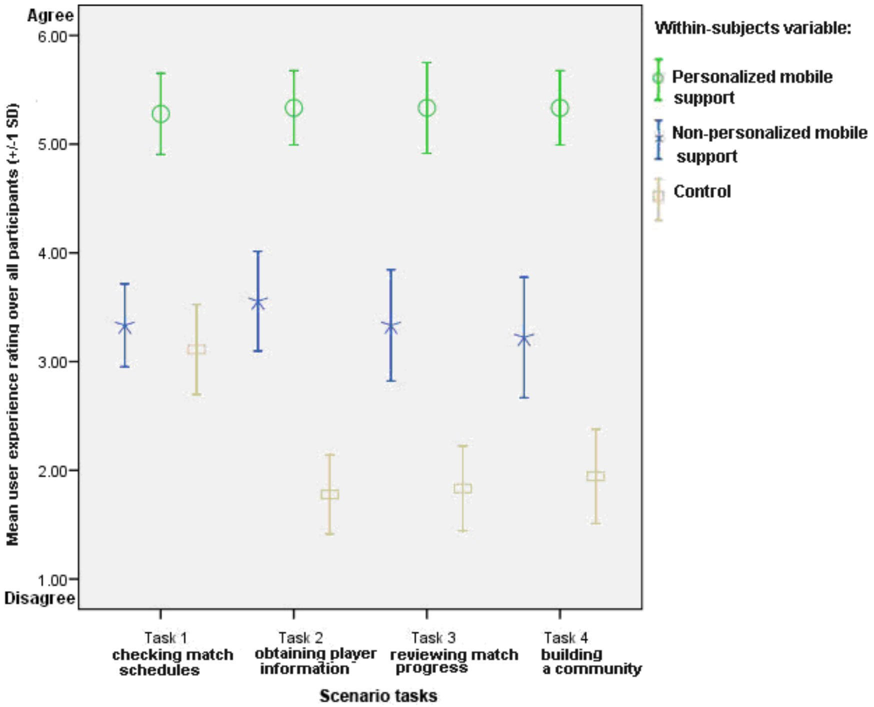

Figure 7.11 The impact of personalization on user experience

7.4.1.1 Task 1 - checking match schedule

During task 1, participants were asked to check the match schedule for a team of interest (including times and venues). Quantitatively, a Friedman test (Gibbons, 1992) for three dependent samples showed significant differences in the overall user experience, according to whether they were using a paper-based sheet, a non-personalized mobile application, or an application that was personalized by the user ($N = 18$, $\chi 2(2) = 31.3$, $p < .05$).

The multiple dependent sample paired comparison (Siegel and Castellan, 1998) further showed that user experience when using a mobile application with user-initiated personalization was higher than that achieved with a non-personalized application ($N = 18$, $|R_{Personalized} - R_{Non-Personalized}| = 21.5, > Z = 14.36$), and was higher than the control condition ($N = 18$, $|R_{Personalized} - R_{Paper}| = 29.5, > Z = 14.36$), and that there was no difference between the non-personalized application and the control condition (N = 18, $| R_{Non-personalized} - R_{Paper} | = 8, < Z = 14$).

Qualitative analysis was conducted based on users' comments that the personalized mobile prototype provided a quick and relevant match schedule based on users' sporting preferences, and therefore, it allowed users to better engage with the football competition. For example, it presented a schedule of other football events which was related to this field event. Spectators appreciated having schedules that highlighted particular players of interest:

#7 - 'I have enjoyed this event; especially I am interested in one player. I am very glad the prototype provides me with the coming match schedule in which this player will participate. I am definitely going to be there!'

In the control condition, and when using the non-personalized prototype, participants found information on matches harder to find, slower to retrieve or less personally relevant.

#14 - 'It's a pity I did not get a schedule relating to this one [team]. Maybe I have to go home to check it online.'

Comparing other tasks described below, using a mobile application to check event schedules appeared to offer no benefits when compared to traditional sources of information, including the paper-based programmes (see Figure 7.11). Schedule information is relatively static, and therefore does not need to be updated in real time. In addition, users' comments indicated that checking of match schedules takes place before travelling to the stadium, or during breaks in the sporting action. Therefore advantage is gained through personalization of content where information is mass broadcast, rather than the provision of content on a mobile phone just for the sake of it.

7.4.1.2 Task 2 – obtaining player information

For task 2, participants were asked to obtain information on particular players, including age, nationality and competition history. Statistically, significant differences in the overall user experience were shown in the Friedman test (Gibbons, 1992) for three dependent samples (N = 18, $\chi 2$ (2) = 34, $p < .05$).

The multiple dependent sample paired comparison (Siegel and Castellan, 1998) showed that the user experience with *user-initiated* personalization was significantly higher than with a *non-personalized* prototype (N = 18, $|R_{Personalized} - R_{Non-Personalized}| = 17 > Z = 14.36$) and higher than the control condition (N = 18, $|R_{Personalized} - R_{Paper}| = 34, > Z = 14.36$), and the user experience with the *non-personalized* prototype was also higher than the control condition (N = 18, $|R_{Non-personalized} - R_{Paper}| = 17, > Z = 14.36$).

Qualitatively, users' comments showed that the personalized mobile prototype seemed to have a 'memory' to keep interacting with users' preference and meet users' expectations by providing relevant and timely information. For example, users set their preference to football players who performed well on the field and got their detailed demographic and performance related data on those players (e.g. their name, history record, current performance).

#3 - 'It is amazing that the application keeps providing me information on this player. I can even know his current playing strategies from the application.'

The non-personalized mobile prototype also presented the updated information, but it did not create a sense of personal attention for the user. Also users took too much time reading and finding information of interest:

#12 - 'If I keep on looking for information via the application, I will miss the event on the field!'

Using the non-personalized application resulted in users sometimes finding items of *unexpected* interest during the process of searching for information (e.g. a new interest in an unknown football player). However users preferred the personalized mobile prototype in order to gain a quick overview of information of interest – this helped to reduce users' cognitive load when watching the football event.

In the control condition, user experience was poor as shown in Figure 7.11, and with comments such as:

#14 - 'Who scored just now?'

7.4.1.3 Task 3 – reviewing match scores

Within this task, participants were asked to review the progress of the match they were watching. A Friedman test (Gibbons, 1992) for three dependent samples showed significant differences in the overall user experience (N = 18, $\chi 2$ (2) = 34, p < .05).

The multiple dependent sample paired comparison (Siegel and Castellan, 1998) showed that the user experience with *user-initiated* personalization was significantly higher than with a *non-personalized* prototype (N = 18, $|R_{Personalized} - R_{Non-Personalized}| = 17 > Z = 14.36$) and higher than the control condition (N = 18, $|R_{Personalized} - R_{Paper}| = 34, > Z = 14.36$), and the user experience with the *non-personalized* prototype was also higher than the control condition (N = 18, $|R_{Non-personalized} - R_{Paper}| = 17, > Z = 14.36$).

From the users' comments, the personalized mobile prototype produced the best user experience by presenting dynamic information that took into account both the action on the field and the spectator interests. Several users commented that it provided *exactly* the information that they were looking for at that moment. *All users* described the information provided by the personalized prototype as 'nice and to the point'. For example, it presented users with the most important information (e.g. current score and who scored) during the scoring moments in the football competition. It presented more detailed information (based on spectator preferences) during lulls in the sporting action. However, the study also revealed that the personalization of a mobile application required time and effort:

#11 - 'I can only set personalization in a very short time, because I do not want to miss the scoring moment on the field.'

The non-personalized mobile prototype also displayed update information (e.g. current score, who scored). However it failed to take into account the temporal variations in the sporting action, and all information was presented at the same level of detail and it required a more active search. It should be remembered that users' main concern was the sporting action, rather than their mobile application, especially during periods of intense activity.

#5 - 'It is a pity that I missed the scoring moment!'

The control condition, including the paper leaflet, was poor. It neither matched personal preferences, nor provided detailed dynamic information, which is a limitation also noted by Nilsson et al (2004) in their field observations of sporting events.

7.4.1.4 Task 4 – building a community

Within this task, participants were asked to join a community in the stadium. It catered for an important component of Chinese culture, i.e. 'collectivism' (Kim, 2004) – this describes how within Chinese society, individuals are integrated into strong cohesive groups. Indeed, feeling part of a community (with a strong group image) is an important aspect of attendance at sporting events. The mobile application enabled the participant to feel part of, and interact with, a larger community at the football match, via media sharing and mobile 'chat'.

Statistically, significant differences in the overall user experience were found in the Friedman test (Gibbons, 1992) ($N = 18$, $\chi2\ (2) = 30.6$, $p < .05$).

The multiple dependent sample paired comparison (Siegel and Castellan, 1998) further showed that the user experience with *user-initiated* personalization was significantly higher than with a *non-personalized* prototype ($N = 18$, $|R_{Personalized} - R_{Non-Personalized}| = 16.5 > Z = 14.36$) and higher than the control condition ($N = 18$, $|R_{Personalized} - R_{Paper}| = 33, > Z = 14.36$), and the user experience with the *non-personalized* prototype was also higher than the control condition ($N = 18$, $|R_{Non-personalized} - R_{Paper}| = 16.5, > Z = 14.36$).

Based on users' comments, the personalized mobile prototype enhanced the social interaction between spectators by identifying those with common interests. For example, users were grouped in one community according to which football team they supported during the competition. In particular, it helped to emphasise the group image by developing a virtual community with a group image under a single logo. It clearly helped social interaction within the group, and to overcome some of the reticence to interact with strangers and generally support teams as a group:

#6 - 'It's so clever to help me find something interesting to talk about.'

However some participants, who did not realize that they can manage the information they are willing to share with others on the interface, were concerned about their privacy:

#6- 'Is my personal information available to everyone in the stadium?'

The non-personalized mobile prototype also enhanced social interaction by building up a virtual community in a stadium. However there was no way of differentiating between individuals according to their interests and location in the stadium. The virtual communities formed were therefore large and diverse, and not based on shared interests and values.

The traditional user experience without a mobile application did not encourage the social interactions and therefore it lacked the sense of entertainment. In this control condition, there was no direct help of social interaction and community building. Users felt they may feel 'forced' to talk to others because they were nearby, not because they had shared interests and common values within a social grouping.

7.4.2 Impact of personalization on user experience components

User experience was measured at the end of the experiment according to the five aspects of user experience, which included factors of product, users, culture, usage context and social experience, as described in section 7.3.5. A summary diagram is given in Figure 7.12 to show the mean user experience rating over all participants across the three independent variables according to the user experience category.

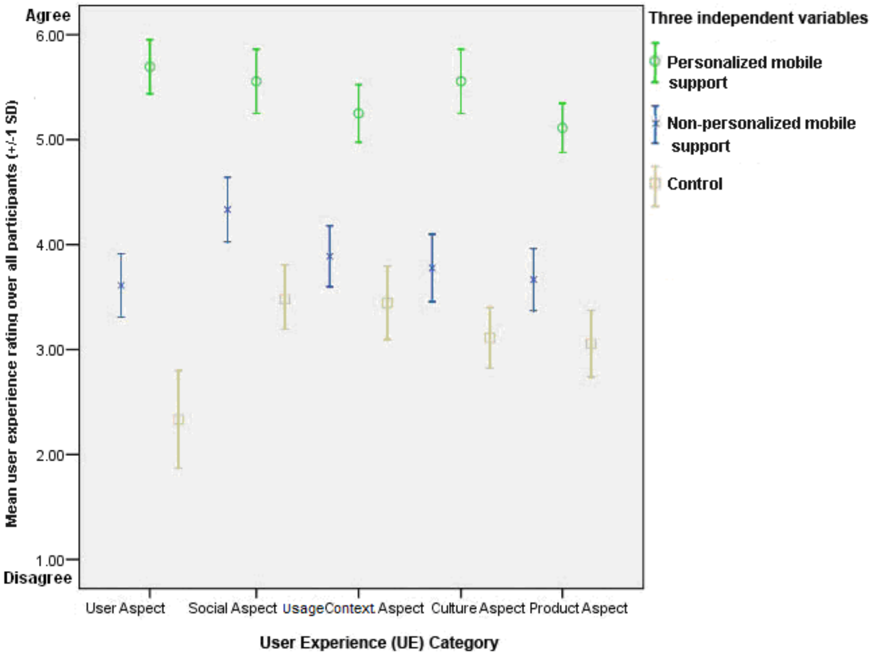

Figure 7.12 Impact of personalization on user experience components

The ratings shown are aggregated scores on 'strongly agree' (6) to 'strongly disagree' (1) scales. The error bars represent +/- 1 SD of the mean in all cases. All the ratings were treated equally in the analysis. The detailed explanations of the results are given below.

7.4.2.1 User aspect

The Friedman test showed significant differences in the 'user factor' user experience (Gibbons, 1992) N = 18, $\chi 2$ (2) = 33.7, $p < .05$

The multiple dependent sample paired comparison (Siegel and Castellan, 1988) further showed that this aspect of user experience when using a mobile application with user-initiated personalization was higher than that achieved with a non-personalized application (N = 18, $|R_{Personalized} - R_{Non-Personalized}| = 19.5 > Z = 14.36$), and was higher than the control condition (N = 18, $|R_{Personalized} - R_{Paper}| = 39.5, > Z = 14.36$), and the user experience with the *non-personalized* prototype was also higher than the control condition (N = 18, $|R_{Non-personalized} - R_{Paper}| = 20, > Z = 14.36$).

The user aspect refers to the mental and physical state of the person who interacts with the system, such as their needs, expectations, motivation and mood. What participants wanted during the football competitions was to understand the events and to be able to share their experiences. The personalized mobile prototype helped users to understand the events by presenting relevant, timely and personal information, which in turn generated a good user experience such as:

#12 - 'It knows what I want.'

The personalized mobile prototype also enhanced social interaction in the crowd, such as building a community for users who support the same football team. Moreover, it provided users with the sense of being in control by presenting information based on users' settings. By accepting and understanding users' interests and preferences, the prototype made an application feel more personal to a user (Blom et al. 2003). However, participants recognized a potential drawback, which is that the personalized mobile prototype required users' time and effort to set their preferences in a stadium.

The non-personalized mobile prototype lacked a sense of entertainment. Also, it took too much time and attention to interact with the mobile application during the event. Some participants were concerned they would miss the event by performing tasks on this prototype. Therefore this aspect of experience was judged lower than other user experience aspects. However, by providing a wider range of information to the user, a non-personalized application was able to bring a sense of freshness and breadth of coverage in comparison to the personalized application. For example, two users discovered unexpected items of interest (e.g. player information) during the process of searching for information with the non-personalized application.

During the control condition, the *user* component of user experience was rated lower than all other user experience components. This is because users' expectations at the LSE were not met: it was difficult to obtain relevant information and engage in social interaction. Participants considered the *user* component was most influential when assessing user experience in this study.

The information participants received at the event was not timely, dynamic and personal:

#15 - 'The players on the field changed, but there is no information about it'.

7.4.2.2 Social aspect

The Friedman test showed significant differences in the ‘social factor’ user experience (Gibbons, 1992) N = 18, $\chi 2$ (2) = 28, $p < .05$.

The multiple dependent sample paired comparison (Siegel and Castellan ,1988) further showed that this aspect of user experience, when using a mobile application with user-initiated personalization, was higher than that achieved with a non-personalized application (N = 18, $|R_{Personalized} - R_{Non-Personalized}| = 20 > Z = 14.36$), and was higher than the control condition (N = 18, $|R_{Personalized} - R_{Paper}| = 35, > Z = 14.36$), and the user experience with the *non-personalized* prototype was also higher than the control condition (N = 18, $|R_{Non-personalized} - R_{Paper}| = 15, > Z = 14.36$).

The social factor refers to experience, which is created through social interaction. The personalized mobile prototype supported participants’ social engagement and the sense of sharing experiences during the event by building up a personalized virtual community in the stadium. Users felt they were recognized and accepted by others.

#7 - ‘I really enjoyed forming my group according to which football team I supported in the event’.

#10 - ‘I love to be able to share my experience with my group.’

#13 - ‘I feel recognized and accepted by assigning and identifying myself into a group of users sharing something in common.’

The personalized mobile prototype can serve as an ice breaker with fellow spectators by providing a topic of common interest, such as detailed information on a football player who had just scored.

#4 - ‘It is not interesting to talk with someone who does not share common interests and values with me’.

The non-personalized mobile prototype also enhanced social interaction by allowing users to communicate virtually; however, it did not promote effective communication by helping users to find groups of users sharing common interests.

#9 - ‘I seldom communicate with other fellow spectators in the stadium.’

7.4.2.3 Usage context aspect

The Friedman test showed significant differences in the 'usage context factor' user experience (Gibbons, 1992) N = 18, $\chi 2$ (2) = 32.5, $p < .05$.

The multiple dependent sample paired comparison (Siegel and Castellan,1988) further showed that this aspect of user experience, when using a mobile application with user-initiated personalization, was higher than that achieved with a non-personalized application (N = 18, $| R_{Personalized} - R_{Non-Personalized} | = 30 > Z = 14.36$), and was higher than the control condition (N = 18, $| R_{Personalized} - R_{Paper} | = 37.5, > Z = 14.36$), and there was no difference between the non-personalized application and the control condition (N = 18, $| R_{Non-personalized} - R_{Paper} | = 7.5 < Z = 14.36$).

To consider the usage context factor, both the physical environment (e.g. noise, location) and the social environment at the event (e.g. a spectator's willingness to communicate) can influence user experience, as also mentioned by several other authors (e.g. Dewey, 1980; Mäkelä and Fulton, 2001; Schilit et al. 1994).

The personalized mobile prototype helped users in the football stadium environment by delivering dynamic, relevant, personal event information. It influenced how much a user could understand the event, irrespective of the physical environment (e.g. location in the stadium). In addition, it helped the social environment by finding groups of similar individuals who were willing to communicate and share experiences.

#6 - 'I do not have to spend more money on a good seat in the stadium, because the prototype can provide me with the right information'.

#2 - 'It is definitely helpful for me to form a community with fans of Fanzhi Yi (a famous football player in China).'

The non-personalized mobile prototype provided mass, general event information. Participants found it was difficult to search for the right information during the event environment, as also highlighted by Olsson and Nilsson (2002).

3 'If I use the application too much, I will miss the sports and exciting event environment'.

Although the non-personalized mobile prototype promoted an interactive social environment by finding opportunities for participants to communicate, participants were concerned about the quality of the communication:

#5 - 'It is difficult to find an interesting topic in the community without knowing common interests.'

In the control condition (without a mobile application), user experience was dependent on their location in the football stadium. For example, during the experiment participants sat far away from the football field, and the details of some events (e.g. who got hurt, and how, during the competition) were hardly seen. Moreover, participants did not find opportunities to share their experiences in the stadium.

7.4.2.4 Culture aspect

The Friedman test presented significant differences in the 'culture factor' user experience (Gibbons, 1992) N = 18, $\chi 2$ (2) = 31.6, $p < .05$.

The multiple dependent sample paired comparison (Siegel and Castellan,1988) further displayed that this aspect of user experience, when using a mobile application with user-initiated personalization, was higher than that achieved with a non-personalized application (N = 18, $|R_{Personalized} - R_{Non-Personalized}| = 21 > Z = 14.36$), and was higher than the control condition (N = 18, $|R_{Personalized} - R_{Paper}| = 30, > Z = 14.36$), and there was no difference between the non-personalized application and the control condition (N = 18, $|R_{Non-personalized} - R_{Paper}| = 9, < Z = 14.36$).

The culture factor in the football events refers both to the sense of belonging to a group and the group interaction (Liu, 1988; Marcus, 2003). The personalized mobile prototype allowed the formation of groups with the emphasis on group image, such as a personalized group logo and a group slogan. It also helped to express aspects of group identity by creating a mutual, shared concept, a factor binding a group of users together, such as supporting the same football team. Moreover, it promoted group interactions by organizing community activities. To users, knowing others who share the same interests or opinion brings the sense of 'togetherness' or 'companionship'; knowing others supporting the same athletes brought a sense of group belonging and the feeling of being approved and supported by the group.

#8 - 'Team A is probably going to win. But I still support team B. I don't feel alone and am encouraged by knowing that there are others people supporting team B with me.'

Although the non-personalized mobile prototype provided chances to communicate with others via the mobile application at the football event, it did not support the Chinese users' emphasis on group image and interactions with/within groups.

In the control condition, there was no support for group interaction or group image, and although the football competition formed the whole spectator naturally into one group, participants did not feel the sense of belong to this group.

7.4.2.5 Product Aspect

The Friedman test presented significant differences in the 'product factor' user experience (Gibbons, 1992) N = 18, $\chi 2$ (2) = 31.4, $p < .05$.

The multiple dependent sample paired comparison (Siegel and Castellan,1988) further showed that this aspect of user experience, when using a mobile application with user-initiated personalization, was higher than that achieved with a non-personalized application (N = 18, $|R_{Personalized} - R_{Non-Personalized}| = 22.5 > Z = 14.36$), and was higher than the control condition (N = 18, $|R_{Personalized} - R_{Paper}| = 31.5, > Z = 14.36$), and there was no difference between the non-personalized application and the control condition (N = 18, N = 18, $|R_{Non-personalized} - R_{Paper}| = 9, < Z = 14.36$).

The product factor includes all services and infrastructures that are involved in the interaction when using the examined product. Perceived ease of use and perceived usefulness are the measurable attributes. Users considered the personalized prototype easy to use, and in particular, participants appreciated the use of extended tree menus to organize content into groups according to their natural relationships. Personalization brought a sense of familiarly by making part of the system more recognizable, as highlighted by Blom et al. 2003. The changes on the prototype that were made by the participants implied that they focused attention on various features of the system. Personalized services and the information provided were considered useful, however, it required users' time and effort to set the personalization when watching the football competition.

#18 - 'The user interface is user-friendly – easy to recognize.'

#9 - 'By setting the personalization, I get a feeling for the interface'.

#3 - 'Even though it is easy to use, I would not like to use it during a scoring moment.'

Although the non-personalized mobile prototype did not require users' settings, participants noticed the ineffectiveness of the information/services provided. It was difficult to find information of interest (e.g. football players' scoring records); therefore, it resulted in a poorer user experience in terms of perceived ease of use and usefulness.

#4 - 'I won't use it to search for information like this during the event.'

During the control condition (without a mobile application), participants regarded the experience negatively when considering the perceived usefulness of the information available.

7.4.3 User interface of the personalized mobile prototype

To make sure that the user interface itself (rather than the personalization approach) was not majorly influencing the experiment outcome, the user-initiated interface was evaluated by calculating the percentage of tasks completed by participants and analyzing user comments.

The experiment recorded approximately 18 hours of video capturing the 18 subjects' interaction steps while completing each task. In summary, 95.5% of the tasks were completed successfully. For the 4.5% of unfinished tasks, 35 usability problems with the personalized mobile prototype were reported.

As a result, participants considered that the user interface of the personalized mobile prototype was easy to use. Several usability problems of the interface were indentified; however participants did not consider them as major influences on their experience. Users' detailed comments are explained in Appendix 7 and 8C.

7.4.4 User requirements for mobile personalization at LSEs

At the end of each task, users talked about the mobile personalization functions in terms of their requirement at LSEs. These requirements were examined to validate the requirements derived from the studies described in Chapter 4. In addition, it is interesting to see how user requirements changed in the field experiment setting (during which users worked with the personalized prototype while watching the event). The detailed results were described in the Appendix 7and 8C. Results showed that the user requirements gathered during this experiment covered the entire ‘required’ user requirement category listed in Chapter 4.

7.5 Discussion

The aim of this experiment was to determine the impact of mobile personalization on the user experience at LSEs. The results from this experiment are discussed in terms of user experience under the three test conditions, the overall influence of mobile personalization at LSEs and the experiment methods.

7.5.1 User experience under three test conditions

The field experiment examined the effects of user experience under three categories: 1) without a mobile application (control condition); 2) user experience with the user-initiated personalized mobile prototype; 3) a mobile prototype that did not provide any capability for personalization. This experiment focused on assessing the differences in user experience under the three conditions of the field study (see Table 7.2).

Table 7.2 Summary of participants' comments on user experience under the three test conditions

UE Factors	Personalized Prototype	Non-Personalized Prototype	Paper leaflet prototype
User factor	It was enjoyable to have an application which can interact with users' preferences and interests. However it required too many settings.	It did not response to personal preferences and interests. However, it sometimes presented new and broader information.	Users' expectations and needs were not fully supported.
Social factor	It greatly enhanced social interaction by building up a virtual community with groups of users sharing something in common.	It enhanced social interaction by building up a virtual community in the stadium.	Users only interacted with others nearby. It lacked a sense of entertainment.
Usage context factor	It provided location related information. It also helped to find groups of users who are willing to communicate in the stadium.	Information presented was general without focus, which can distract users' attention in the stadium.	Users were not supported with the update, detailed event information.
Culture factor	It helped to assign users to a common group and emphasized the group image during the events.	It did not consider the cultural emphasis on group relationships and image.	It did not support the group interactions.
Product factor	It provided relevant information with fewer interaction steps. It also made the application more recognizable.	It required more interactions to find information of interest in the LSE context.	It did not provide the cognitive perception of perceived usefulness.

A personalized mobile application can enrich the user experience in the stadium by presenting personal, relevant event information with few interaction steps. It can also help to enhance social interaction, especially opportunities for group interaction amongst people sharing a common interest. This is consistent with the Chinese culture that emphasizes group relationships (Peng and Nisbett, 1999; Marcus, 2003; Marcus and Gould, 2000). However, a potential problem, which was recognized during the experiment, was that the personalization of a mobile application requires considerable time and energy from a user whilst in the stadium.

A non-personalized mobile application was not able to minimize interactions between the user and application, and it cannot support the group interactions emphasised by cultural consideration of Chinese users. In addition, it lacks the sense of entertainment. However, by providing a wider range of information to the user, a non-personalized mobile application was able to bring a sense of freshness and a wider breadth of coverage in comparison to the personalized application. This was demonstrated by two users who discovered unexpected items of interest (including football player information) during the process of searching for information with the non-personalized application.

User experience without a mobile application was poor because of insufficient event information and the lack of social interaction during the event. It was not easy for the spectators to search for the relevant information while experiencing the events, a finding consistent with Olsson and Nilsson (2002) and Esbjornsson et al. (2006). The spectators were often cognitively overloaded, and failed to notice information which was potentially relevant (e.g. who scored and how), as highlighted by Sun et al. (2005). The information provided in the stadium (via the paper leaflet prototype and the stadium display board) was not updated in time. Within the overall LSE atmosphere, the detailed competition information can be lost, for example, the scoring details. The spectators had no influence on what, when or how information was received during the events as they progressed. The social interaction between spectators was not encouraged, and users expressed a high level of expectation of greater group interaction within the stadium.

7.5.2 The role of mobile personalization at LSEs

The study investigated user outcomes in relation to the user experience of a spectator at large sporting events. The study found that mobile personalization could play a role in enriching the user experience from five aspects of user experience:

The *user* perspective refers to the needs of the spectators, including their affective and motivational aspects. The impact of personalization on user aspects were fulfilled expectations, a sense of being in control, a feeling of personalization, and fun. Mobile personalization provided users with relevant, filtered information and created opportunities for social communication which met users' expectations when watching a LSE. Personalization presented information based on users' settings, which generated the users' sense of being in control by knowing what the system was doing. Personalization made an application feel more personal to a user by accepting and understanding their personal interests and preferences, as shown by Blom et al. (2003).

Fun also resulted from allowing users to play around with the application to obtain the desired results (Blom et al. 2003; Bonnet, 2001).

The *social* aspect describes experience which is created by social interaction. The effects of personalization on social aspect were improved communication, acting as an ice breaker, improved social interaction, and the reflection of personal identity. Personalization helped with social communication by assigning people to a virtual community with those who have common interests, resulting in common topics of conversation (e.g. supporting the same football team). It also served as an ice breaker with fellow spectators by providing a common topic of interest (e.g. detailed information about the current score). By allowing users to talk, share, and cheer with a group of related users, social interaction in the stadium was encouraged and improved, as highlighted by Maule (1997). Furthermore, personalization was used to distinguish individuals from others, while users felt recognized and accepted by being able to assign and identify themselves in a particular group of users.

The *usage context* aspect refers to the physical and social environmental factors impacting on experience. Personalization helped users to cope with the physical event environment by delivering updated, personal information in a stadium. This influenced the extent to which a user can understand the event. It also encouraged a social environment in a stadium by finding and generating groups of users who were willing to communicate and share something in common. It reduced 'ineffective communication' i.e. communicating with people nearby in a stadium without having a common topic of interest.

The *cultural* aspect of user experience refers to the underlying beliefs and values that the spectator holds. The cultural aspects were usually related to the social effects which personalization can influence. It can be further explained as the reflection of a group identity, the sense of belonging and fun. Personalization took place in order to express aspects of group identity by creating a mutual, shared concept, a factor binding a group of users together (e.g. forming a group of users who support a particular team and generating a personalized logo for the group). Users' comments relating to this were often associated with improving group cohesion (Schachter et al. 1951) by incorporating personalization as a shared activity. It improved group image, shared values and enhanced group interaction, all of which are consistent with the Chinese culture of the emphasis on group image and group interaction (Liu, 1988; Marcus, 2003). Finally, personalization acted as a way of having fun. For example, through the use of information which was circulated among group members, it enabled individuals to engage with each other, thus increasing their sense of fun. This strong group membership element associated with the application is supported by similar findings regarding the mobile phone SMS culture (Kasesniemi and Rautianen, 2002).

From a *mobile product* (application) aspect, personalization increased the perceived usefulness and ease of use of services delivered to the end user. It was found that the personalization was effective in terms of the ability to evoke cognitive effects of the perceived usefulness. It corresponded to the needs and preference of the users at LSEs. The perceived ease of use of an application can affect an individual's willingness to personalize it, as indicated by Venkatesh et al. (2003) and Haym et al. (2000). The design of the interface was undertaken by putting the users at the centre of attention in order to observe, discuss, and experiment with those users. In addition, the perception of ease of use was related to making parts of the system more recognizable with the help of personalization. The personalization steps that were undertaken by the user implied that the user focuses attention on various features of the system. It was expected that this attention resulted in a higher degree of familiarity with the system. Despite these advantages relating to the personalized mobile application, users' concerns about too many settings during the event were also raised, and these are investigated in the next chapter.

7.5.3 Field experiment

A field experiment is characterised by taking place in 'the real world' in which a number of independent variables are manipulated (Kjeldskov et al. 2004). This experiment took participants into a more real LSE context to compare user experience under three conditions: (1) traditional user experience without a mobile application, (2) user experience with non-personalized mobile application and (3) user experience with a personalized mobile application. Data was gathered through observations, subjective ratings, and interviews, and the phenomena studied were placed in a social and cultural context (Cheverst et al. 2001).

The major advantages of field experiments are the generation of large amounts of rich and grounded data in relatively short time, the increased realism for the participant (Duh et al. 2006) and a relaxed atmosphere for communication between participants and the researcher (Kaikkonen et al. 2005).

User experience was measured from the five aspects derived from the literature where 34 requirements were identified which were consistent with the user requirements gathered during previous studies (in Chapter 4). 35 usability problems were also reported.

The field experiment stressed problems of mobile ‘use’ rather than simply application ‘usability’, and typically those problems were expressed in the language of the situation (Duh et al. 2006). For example, users concerned about spending too much time personalizing the application during the event (detracting from the event itself) and the font on the interface being too small to read in an open stadium under bright sunlight.

It also identified issues of validity and precision of the data presented by the application. For example, users were concerned about the reliability of information provided by the prototypes after they found that some player information presented on the mobile devide did not match with the real events.

To the participants the field experiment seemed to be more casual, and the users talked more freely about the use of the application and their feelings, as also demonstrated by Kaikkonen et al. (2005). For Chinese users (typically reticent to communicate their thoughts), the field experiment allowed them to feel more relaxed and more able to communicate with the researcher. Users generally held broader views and were able to give more information during the experiment, such as expressing contextually related requirements.

Using a field experiment approach, it may be possible to obtain a higher level of ‘realism’, however, this method is not easy to undertake (Brewster, 2002; Nielsen, 1998). Experiments in the field are influenced by external factors, such as the weather, and moreover, it is more difficult to collect data. Users were impacted by things happening in the field, such as noise and other disturbances. For example, some users were distracted from the field experiment by focusing their attention on the competition happening in the stadium. A researcher should be flexible enough to handle such conditions and to ensure that the experiments can still continue successfully.

7.6 Conclusion

This chapter compared the user experience under three conditions at LSEs. It confirmed the need for mobile personalization to help with the information control and encourage social interaction (discussed in Chapter 4).

According to the results from the experiment, spectators were overwhelmed with mass media information as well as the competition itself. Participants pointed out that it was not easy for spectators to determine what to read from the large amount of information available, since there was no support to filter this information. In addition, spectators had no control over what and when information should be presented. Personalized mobile applications can address these problems by providing users with the freedom to set what information they wanted and when, supported in a personalized way, in comparison to the traditional information resources.

Social interaction is another major concern for a fulfilling user experience at a LSE, as demonstrated by the enjoyment derived from being a member of a group of people who support the same team. Personalized mobile applications can help to create and maintain a relationship in a virtual social network - this supports the group's co-experiencing of the event and caters to the Chinese culture of underpinning group relationships.

The role of mobile personalization at LSEs can be further explained in relation to the five aspects of user experience: (1) its effects on the *user aspect* were the fulfilled expectations, the sense of being in control, the feeling of personal attention, and having fun; (2) its impact on the *social aspect* were the improved social interaction, acting as an ice breaker, the reflection of personal identity and promoting a feeling of acceptance within a group; (3) its influences on the *usage context aspect* were the enhanced event environment as well as interactive social environment; (4) its effects in relation to the *culture aspect* were the reflection of group identity, and a sense of belonging; and finally (5) its impact of personalization on the *product aspect* were the increase in the perception of usefulness as well as the ease of use. It can be concluded that mobile personalization plays a positive role in enhancing the user experience at LSEs.

The field experiment increased the realism of the research by taking the users into real sporting events. The experiment provided rich information: a list of 34 user requirements was generated during the experiment which were consistent with the user requirements discovered during the previous studies (in Chapter 4); the usability problems which were indentified addressed the problems of mobile 'use' rather than simply application usability, and typically such problems were expressed in the language of the situation. Moreover, the field experiment seemed more relaxed and the users discussed the use of the application and their feelings more freely. However, the field experiment was not easy to set up and conduct, because users were sometime influenced by external factors during the study, such as noise and other disturbances. Experiments could be delayed because of unexpected factors such as the weather. Research should be flexible in dealing with those situations.

The study concluded by drawing attention to the concerns of the ease use of personalization in the LSE context. Participants in the experiment pointed out the problem of too many settings in the user-initiated personalized prototype and the balance of personalization approaches is the next focus within this research. Further research continued to examine the differences between user-initiated personalization and system-initiated personalization applications in terms of user experience at LSEs.

8 EXPERIMENT II – COMPARISON OF PERSONALIZATION APPROACHES IN THE CONTEXT OF LARGE SPORTING EVENTS

	Research questions addressed in this chapter:
1	What is the potential for mobile personalization to contribute to the positive aspects of user experience at LSEs?
2	What are the key contextual factors to be used for mobile personalization at LSEs?
3	How can personalized mobile applications be designed to optimize user experience at LSEs?
4	**How does mobile personalization impact on user experience at LSEs?** • **Keeping the user in the centre of attention, how can user experience of mobile personalization be evaluated in LSE context?** • **Which personalization approach is more appropriate to subject matter- user-initiated personalization or system-initiated personalization?**
5	What are the key gaps in user-centred research that arise from this thesis?

8.1 Introduction and aims

This thesis has investigated different approaches for personalization and their impact on the user experience for spectators at a sporting event. There are two different approaches of personalization: user-initiated personalization and system-initiated personalization. These two approaches are the only scalable approaches to the design of personalization (Kim, 2002). User-initiated personalization is described as the adjustment of a system, initiated by the user to achieve a desired goal (Stephanidis et al. 1999). By contrast, system-initiated personalization refers to the adjustment initiated by a system, based on a user profile, as a guide to provide content based on what the user is believed to be interested in (Hjesvold et al. 2001). They are different by definition, but they are also related because they eventually mean that the system interacts based on a user's profile, as discussed in the literature (Chapter 2). The balance of user-initiated and system personalization is essential for personalization to work effectively.

The previous field experiment found that a mobile application that provides personalized functions can play a positive role in enriching the user experience at LSEs. Users recognized the advantages of receiving personalized information and services, however they also pointed out the problems of spending too much time and effort on personalization tasks. Therefore system-initiated personalization in the LSE context is investigated in this chapter and serves as the basis of this experiment. This chapter describes a second experiment, which compared the user experience of user-initiated personalization with that of system-initiated personalization prototypes.

The overall aim of this experiment is to examine how to balance the different approaches of personalization (user-initiated personalization and system-initiated personalization) at LSEs. The specific objectives of this chapter are:

- to use a more controlled experimental setup to compare the user experience for a spectator at a large sporting event under three conditions: (1) using paper-based (not mobile) content; (2) using a mobile prototype where personalization parameters were set by the user; and (3) using a similar prototype where parameters were set automatically;
- to examine the role that mobile personalization plays in enhancing the user experience at LSEs;
- to investigate methods for evaluating user experience resulting from mobile personalization at LSEs;

8.2 Methods

A lab study was chosen for this second experiment, which applied multiple user-centred research methods. It included first setting up a lab to simulate a real life stadium, then inviting participants to carry out scenario-oriented tasks with two kinds of prototypes (user-initated and system-initiated personalization); and interviewing to understand user experience as they interacted with the prototypes. This study also considered the Chinese culture by adapting user-centred methods to ensure that they were appropriate. The specific methods are discussed below.

A lab experiment. As discussed before, there has been much debate on whether mobile applications should be evaluated in the field or in the more traditional laboratory environment. A literature study showed that most mobile HCI research projects employed lab based evaluations (Kjeldskov et al. 2004). Lab experiments can increase the degree of experimental control in terms of manipulation of variables before and during the experiment (Kjeldskov and Graham, 2003). However, they are limited in relation to the real world and may produce an unknown level of generalization of results outside of laboratory settings (Petrie et al. 1998; Pirhonen et al. 2002; Graham and Carter, 1999). Some studies explored how to improve the realism of lab experiments (Kjeldskov and Stage, 2004; Bohnenberger et al. 2002; Kjeldskov et al. 2004; Salvucci, 2001; Lai et al. 2001; Pirhonen et al. 2002). It has been suggested that instead of going into the field when evaluating the mobile applications, adding contextual features, such as scenarios and context simulations, to lab settings can contribute to the outcome of the evaluation, while maintaining the benefits of a controlled setting (Duh et al. 2006).

For this experiment, the lab study was chosen based on a good understanding of the context of LSEs. There were three previous field studies conducted to indentify the context at LSEs in different sporting events. This experiment tried to address the problems of conventional lab usability testing by recreating or imitating the real context of use in the laboratory. It also tried to involve potential users who were familiar with the real LSE context, in order to increase the realism of the lab experiment.

Scenarios. The scenarios were developed to introduce the usage contexts, as well as providing a concrete example of a task the user would perform with the prototypes. How much the simulated scenario of usability testing can represent a real life situation is a critical factor in terms of the validity of the usability test (Duh et al. 2006). The scenarios were designed to represent the real events by considering the LSE context and the service functions, based on previous context studies and user requirement studies (see Appendix 7 and 8E). Within this study, one user at a time was asked to perform scenario-based tasks with the prototypes, in an effort to measure the user experience.

Questionnaire. To evaluate the user experience, questionnaires were applied after each task as well as at the end of all the tasks. The constructs within the questionnaires consisted of multiple aspects of user experience summarized from the literature in Chapter 2. To avoid the Chinese user's 'middle way' approach (Liu, 1988; Nakamura, 1985), the questionnaire employed an even number of points in order to force people to make a decision that commits them to one side of the scale or another (Rantanen, 2008).

Context interviews were used to explain users' ratings on the questionnaire as well as to determine what problems users encountered, and why particular issues were problematic. The interview helped to validate the quantitative data from the questionnaire and discover more about users' experience, in addition to the usability problems described by them when working with the mobile prototypes.

Emotion Cards. To cope with the Chinese culture of discouraging speaking (Kim, 2002; Lin, 1977; Peng, 1997; Liu, 1988), the study used Emotion Cards (Desmet, 2000) during the interviews to encourage the communication with Chinese users. They were used to help Chinese users objectify their experience and to serve as an aid for starting a conversation with the researcher.

Indirect questions were asked during the interview in order to minimize the effect of the emphasis on harmony among Chinese users (Peng, 1997). The indirect questions may reduce the desire of the Chinese participants to project a desirable and pleasant image to others (Peng, 1997). For example, instead of asking 'do you enjoy interacting with this mobile prototype?' a researcher can ask 'would you like to use this mobile prototype for a longer period of time? And why?' Users who have had a positive experience with the mobile application are more likely to consider using it for a longer time than those who have had a negative experience.

8.3 Experiment set-up

8.3.1 Lab set-up

Previous literature tried to employ a range of techniques for increasing the realism of the lab evaluation situation (Petrie et al. 1998; Pirhonen et al. 2002; Graham and Carter, 1999; Lai et al. 2001; Koppinen, 2000; Salvucci, 2001). There are two specific concerns with mobile evaluation: mobility and divided attention. With regard to mobility, test subjects have been required to walk while using the mobile application being evaluated. This would either take place on a treadmill or on a specifically defined track in a lab setup (Petrie et al. 1998; Pirhonen et al. 2002). To deal with divided attention, test subjects were required to use a mobile application while performing a primary task, such as driving a car simulator. The type of car simulator used ranged from low-fidelity personal computer-based simulations (Graham and Carter, 1999) to high-fidelity simulators with large projection screens involving real dashboards (Lai et al. 2001).

To consider the realism of this lab experiment situation, it addressed the users' divided attention by requiring subjects to watch a sport event video, which was projected on the front wall of the lab room, while performing the scenario-based tasks with the mobile prototypes. The aspect of mobility was not specifically taken into account in this experiment, because, in contrast to typical personalized mobile applications, such as tourist guides (Abowd et al. 1997; Oertel et al. 2002), the users' location within this study was relatively static. Therefore, the experiment emphasized testing the user experience within the boundary of a stadium where users would usually sit.

This experiment took place in a usability laboratory at Loughborough University. It tried to bring the LSE context into the lab, which is something that is considered a critical factor in terms of the validity of the usability test (Robson, 1993). The usability lab was set up to resemble a part of a sports stadium, and the lab set-up was based on the most influential eleven contexts identified during previous context studies (in Chapter 5). See Table 8.1.

Table 8.1 Lab set-up according to the identified influential contextual factors

Most influential contexts	Lab set-up
1) sporting preferences of the spectator	incorporated in prototypes
2) spectator location in the stadium	incorporated in prototypes
3) event progress	incorporated in prototypes
4) event types	athletics events
5) language	Chinese
6) with whom	with a spectator (the researcher)
7) mobile screen	screen of a pocket PC
8) nationality of the spectators	Chinese
9) public media channels	recorded audio
10) spectators' knowledge/experience in sports	basic knowledge only
11) social atmosphere	videos of groups of spectators projected on the walls; recorded noise of the spectators during events

A recorded athletics event was projected on the front wall of the lab room to recreate the direct view of the sporting action. The two side walls were furnished with stadium posters/video to recreate a social atmosphere to the users. A video camera was set behind to record users' interaction with the prototypes. See Figure 8.1.

Figure 8.1 User studies in a controlled lab

8.3.2 Participants

Eighteen Chinese users were invited to take part in the study. Users were chosen according to a typical user profile predetermined in Chapter 4. They were aged between 18 and 38, varied in professions and split equally between male and female. Their occupations were engineers, researchers, housewives, and university students. See Figure 8.2 for a demographic summary. All the participants had experience of personalizing mobile applications (e.g. mobile phones, mp3s) and had watched a LSE in an open stadium within the preceding six months.

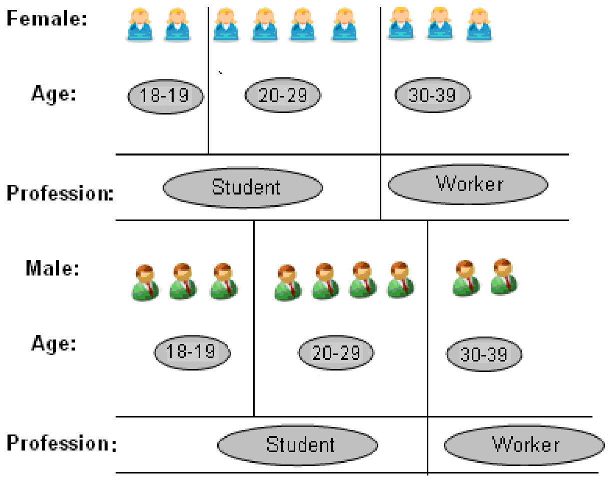

Figure 8.2 User demographics

8.3.3 Experimental scenarios

Five scenarios were developed that incorporated tasks and key contextual influences determined from previous user requirements studies (Chapters 4 and 5). Four of the experimental tasks were the same as those employed in the field experiment which were: (1) checking the schedule of matches and finding one of particular interest; 2) finding out information on a particular player of interest; 3) reading information relating to the real-time progress of the match; 4) joining a community and participating in community-based activities in the stadium. This lab-based study also employed a fifth task which required the participant to select a suitable viewing angle for a live action broadcast, based on their location in the stadium.

8.3.4 Prototypes used

Two mobile prototypes were developed, sharing the same look and feel, and similar in form to those used in the field study described previously (Figure 8.3). Five functions were implemented for the experimental scenarios: to enable the viewing of a live video on the mobile application of one of the events occurring in the stadium; information on match schedules, including timetables and match locations for specific teams; information on the players participating in the event; real time match results, e.g. details of goal scorers; online chat and media sharing within a virtual community.

Figure 8.3 Screenshots of the user-initiated personalized prototype and the system-initiated personalized prototype

The *user-initiated* personalized prototype asked users to input settings in relation to their sporting preferences (the sports types and athletes) from an extended menu (Figure 8.4). As a result, the prototype presented event information, such as athlete information (Figure 8.5), and event schedules (Figure 8.6) based on the users' settings. In the same way, users were asked to set their location in the stadium for receiving live continuous broadcast of sporting events on the application, categorise the event progress (e.g. quiet periods in the sporting action, breaks, sporting climax) for presenting event results, and their preference (e.g. types of sports) for building up virtual communities. The user setting could take place both before the events or as an event was taking place in a stadium.

Figure 8.4 Screenshot of user-initiated personalized user interface

Figure 8.5 Screenshot of user-initiated personalized prototype - athlete information

Figure 8.6 Screenshot of user-initiated personalized prototype - event schedule

In contrast, the *system-initiated* personalized prototype did not require a user to set any parameters. The system mimicked the automatic adaptation of content to key personalization parameters (spectator location, individual interests and preferences, and the progress of the event being watched). Personalized content/functions were then presented automatically to the participant. For example, a live video was automatically shown to the participant, based on their preferences and taking into account which events they were able to see clearly, according to their location in the stadium.

These factors can be measured directly, or inferred by a mobile application within a sports stadium, and the desired behaviour of an application can be identified and designed to match this. Location within a stadium could be determined by GPS, local network sensing, or simply by the seat number with an electronic ticket. This information, together with the location of different athletics events within a stadium would determine which events were clearly visible to the spectator, and which additional views of the sporting action could supplement the spectators' direct views.

Personal preferences (based on individual interests) could be derived from other real events or video broadcast viewing habits. This would assume that viewing habits derived from one consumption environment are transferable to the current one, which is a point discussed by Mercer (2009). Historical viewing interests can be used to present event-based information that is likely to interest the spectator.

Event progress indicates the level of likely engagement that the spectator will have in the sporting action, including their level of attention to events. Various differentiations can be employed, e.g. event build up, quiet periods in the action, climaxes, breaks and post-event analysis. These can be measured in a number of ways: directly from the sporting action, based on athlete and environment sensors, or video image recognition; based on the nature and location of crowd reaction; automatic analysis of sports commentaries; manual categorization by commentators. The event progress influences the content, the interaction, and the type of personalization that is most appropriate at that moment.

For this experiment, the system-initiated prototype was not implemented as a working prototype because of the time and technology constraints. Instead it was designed to let users feel how it can present personalized information/service based on automatic detection. This prototype was configured as follows: (1) the day before the study, users completed a form on which they indicated their sporting interests. It was not indicated to participants that this would be used to configure the application; (2) the users' interests and preferences were then input manually into the system-initiated prototype to ensure that relevant content was presented during the trial; (3) personalization according to the location attribute was based on the participant's position in the lab, relative to the projected scene; (4) event progress was based on the action occurring within the scene projected within the laboratory, and included content relevant to the line up before a race, or the finish order. (See Figures 8.7, 8.8, and 8.9).

Figure 8.7 Screenshot of system-initiated personalized user interface

Figure 8.8 Screenshot of system-initiated personalized prototype - athlete information

Figure 8.9 Screenshot of system-initiated personalized prototype - event schedule

This study, therefore, used two prototypes. The differences between these two personalized prototypes were the users' interaction as well as its effects. The *user-initiated* interface required users' setting of personalization parameters and it responded exactly according to a user's settings (including a user's sudden interest). On the other hand, the system-initiated personalization prototype did not require the user interactions for setting parameters, but it could not react to users' sudden changes in interest. For example, during the experiment, a user could set one new, sudden interest ('canoe') in the preference list on the user-initiated personalized prototype (Figure 8.10) and the prototype could respond to this new interest by displaying when the canoeing is on (Figure 8.11). In contrast, the system-initiated prototype could not detect this sudden interest (Figure 8.12).

Figure 8.10 Screenshot of system-initiated personalized user interface

Figure 8.11 Screenshot of user-initiated personalized prototype - taking account of a user's sudden interest

Figure 8.12 Screenshot of system-initiated personalized prototype - did not take account of a user's sudden interest

The paper leaflet was designed at the level of what a user could usually obtain during a real event. It provided information on event schedules, and athletes' profiles (See Figures 8.13 and 8.14).

The event schedule introduced the competition time, date, and order of different sport types in this event (from left to right).

热身场地			检录区	入场准备	正式比赛	项目
第一次点名	第二次点名	第三次点名				
16:45	16:50	16:52	16:55	17:05	17:45	女子跳远
16:45	16:50	16:52	16:55	17:05	17:45	男子三级跳远
18:25	18:30	18:32	18:35	18:45	19:00	女子100米
18:35	18:40	18:42	18:45	18:55	19:10	男子100米
18:43	18:48	18:50	18:53	19:03	19:18	女子1000米
18:50	18:55	18:57	19:00	19:10	19:25	男子1000米
19:00	19:05	19:07	19:10	19:20	19:35	女子400米
主赛场就绪			18:00	18:10	19:40	女子撑杆跳
19:10	19:15	19:17	19:20	19:30	19:45	男子400米
19:00	19:05	19:07	19:10	19:20	20:00	男子跳高
19:00	19:05	19:07	19:10	19:20	20:00	女子跳高
19:00	19:05	19:07	19:10	19:20	20:00	男子跳远
19:25	19:30	19:32	19:35	19:45	20:05	女子400米栏
19:40	19:45	19:47	19:50	20:00	20:15	男子100米
19:50	19:55	19:57	20:00	20:10	20:25	女子400米
19:58	20:03	20:05	20:08	20:18	20:33	男子1500米
20:05	20:10	20:12	20:15	20:25	20:45	女子100米栏
20:20	20:25	20:27	20:30	20:40	20:55	男子400米
20:30	20:35	20:37	20:40	20:50	21:05	女子100米
20:40	20:45	20:47	20:50	21:00	21:15	男子200米
20:45	20:50	20:52	20:55	21:05	21:25	男子110米栏
21:00	21:05	21:07	21:10	21:20	21:35	女子5000米

Figure 8.13 Screenshot of traditional paper leaflet – event schedule

The athlete information described the sports type, player name, nationality, and history (from left to right).

运动员	国籍	历史
男子 100 米(九人)		
Justin Gatlin 贾斯汀·加特林	美国	奥运冠军：2004 雅典
Aziz Zakari 阿齐兹·扎卡里	加纳	国际田联男子 100 米世界排名第三
Francis Obikwelu 弗朗西斯·奥比克维鲁	波多黎各	国际田联男子 100 米世界排名第四
Leonard Scott 莱奥纳德·斯科特	美国/	国际田联男子 100 米世界排名第六
男子 200 米(九人)		
Tyson Gay 泰森·格伊	美国	国际田联男子 200 米世界排名第三
Christopher Williams 克里斯托弗·威廉姆斯	牙买加	国际田联男子 200 米世界排名十一
Marlon Devonish 马龙·德沃尼什	英国	国际田联男子 200 米世界排名十八

Figure 8.14 Screenshot of traditional paper leaflet –athlete information

The general description of the three conditions in this experiment was summarized in Table 8.2.

Table 8.2 Description of experiment conditions during the lab study

	Control	User-initiated personalized prototype	System-initiated personalized prototype
What were the experiment conditions:			
Platform	paper-based prototype	mobile device prototype	mobile device prototype
Information content	event schedules, athletes' information	event schedules, athletes' information, real time event results; community discussion	event schedules, athletes' information, real time event results; community discussion
Visual design	font: Chinese character 10 colour: red-yellow navigation: left-right	font: Chinese character 10 colour: blue-grey navigation: menu bar at the bottom of a page	font: Chinese character 10 colour: blue-grey navigation: menu bar at the bottom of a page
What did the participants do with the prototype:			
Number of participants	18	18	18
Interaction	1. read the information provided via the paper prototype	1. click the personalization button on the mobile prototype 2. set their personalization parameters of preference, location and event progress 3. click the function buttons on the mobile prototype 4. read the personalized information via the mobile prototype	1. click the function buttons on the mobile prototype 2. read the personalized information via the mobile prototype

Table 8.2 continues…

Table 8.2 continued

Results of interaction	receive general event information including event schedules, athletes' information	receive updated personalized information based on users' setting (including users' transient interest): personalized event schedules, personalized athletes' information, personalized real time event results; personalized community discussion	receive updated personalized information based on users' setting (do NOT include users' transient interest): personalized event schedules, personalized athletes' information, personalized real time event results; personalized community discussion
Information validity	information provided is the same to the events projected in the lab.	information provided is the same to the events projected in the lab.	information provided is the same to the events projected in the lab.
What data were collected and how:			
User experience	multiple aspects of user experience: user aspect, social, usage context, culture, product aspects	multiple aspects of user experience: user aspect, social, usage context, culture, product aspects	multiple aspects of user experience: user aspect, social, usage context, culture, product aspects
Data collection methods	questionnaire, interview, observation	questionnaire, interview, observation	questionnaire, interview, observation

8.3.5 Experimental design

The experimental design for the lab-based study was a 3 way (personalization) within subjects design, similar to that used for the field study (Chapter 7). In this case, the main 'personalization' factor comprised: the control condition (typical stadium environment without any mobile support); a mobile application that enabled the user to personalize the output; the system-initiated mobile application which did not require the user to personalize it. As before, the order of presentation of the personalization factor was counter balanced across the participants for each task. The dependent variable was user experience, described in more detail in the field experiment in Chapter 7.

8.3.6 Data collection

Both qualitative and quantitative data were collected. A video camera was mounted behind the user to record their interactions with the mobile prototypes in the experiment. Users' comments and ratings toward their experience with the prototypes were recorded on the paper-based questionnaires, and interviews were taped for later analysis. All the video and audio recordings were taken with the authorization of the participants and were used only for the purpose of this research.

8.3.7 Pilot test

A pilot study was used to maximize the realism of the simulation, and to ensure that the data collection methods that were used during the field trial were effective within a laboratory setting. The pilot test revealed several limitations with the lab set-up. Originally, two loudspeakers were placed in front of the users to simulate crowd noise in the LSE stadium, but it was pointed out that this was distracting during the pilot test, and as a result it was decided to use one loudspeaker behind the users during the final experiment. The two side walls of the lab were projected with an animated spectator video with the purpose of bringing a closer social atmosphere into the lab. However this video was also found to be visually distracting. Instead of video, the experiment used a combination of static images (poster and image) of the stadium, placed on two walls of the lab.

8.3.8 Procedure

Participants were firstly informed of the research purpose and the concept of mobile personalization, and they were also given instructions on how to operate both mobile prototypes. The experiment was then structured by the scenario-based tasks. Participants were randomly appointed to complete a task using either of the prototypes first. After they finished, the alternative conditions were used to complete the same scenario.

After each task, subjects rated their experiences and were interviewed (with the help of the Emotion Cards) in relation to their experiences with the different prototypes. After completing all tasks, participants were given the final questionnaire, in which they completed questions relating to multiple perspectives of product, user, culture, usage context and social experiences with the prototypes.

Finally, they were interviewed in more general terms to discuss their attitudes towards the mobile personalization concepts and the differences in both personalization approaches (user-initiated personalization or system-initiated personalization). The study lasted around 60 minutes for each participant.

8.4 Analysis and results

Both quantitative data (users' ratings) and qualitative data (users' comments) were gathered during the study. Non-parametric statistics (Gibbons, 1992; Robson, 1993) were used to analyse the quantitative data, while qualitative data was coded using an affinity diagram (Hackos and Redish, 1998). The analysis was processed from three viewpoints:

- the comparison of user experience under three conditions
- the usability of personalized user interfaces
- the user requirement for mobile personalization at LSEs

8.4.1 Impact of personalization on user experience (post-task)

An overview of the results is summarized in Figure 8.15. It shows the mean overall user experience assessment for each task, based on whether the participant was undertaking the control condition, or using a mobile prototype incorporating user-initiated or system-initiated personalization. The figure shows overall, aggregated user experience ratings, based on agree/disagree scales. The error bars represent +/- 1 SD of the mean in all cases. The ratings shown are aggregated scores on 'strongly agree' (6) to 'strongly disagree' (1) scales. The error bars represent +/- 1 SD of the mean in all cases.

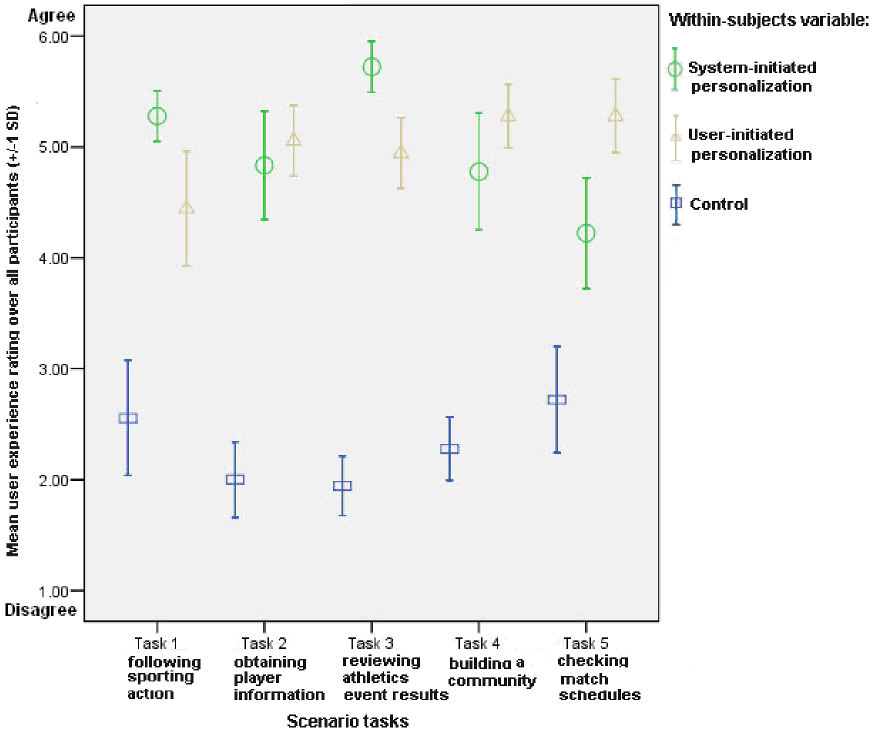

Figure 8.15 The impact of system or user-initiated personalization on user experience

8.4.1.1 Task 1 – following sporting action

Task 1 required the participants to optimize their view of the sporting action based on their location in the stadium. They did this by selecting a mobile video of an event occurring in the stadium that could be used to supplement their direct view of the sporting action. Quantitatively, the Friedman test (Gibbons, 1992) for three dependent samples showed significant differences in the overall user experience, according to whether they were using a mobile application incorporating (1) the system or (2) user-initiated personalization or the control condition (direct view only of the sporting action), (N = 18, $\chi2(2) = 27.5$, $p < .05$).

The multiple dependent sample paired comparison (Siegel and Castellan,1988) showed that the user experience with *system-initiated* personalization was significantly higher than with *user-initiated* personalization (N = 18, $|R_{system-initiated} - R_{use-initiated}|$ = 15, > Z = 14.36), and both *system-initiated* personalization (N = 18, $|R_{system-initiated} - R_{paper}|$ = 49 > Z = 14.36), and *user-initiated* personalization (N = 18, $|R_{user-initiated} - R_{paper}|$ = 34, > Z = 14.36) were higher than the control condition respectively.

Participants stated a desire to receive a live broadcast view on their mobile application as soon as they entered into the athletics stadium. Athletics meetings often have multiple events occurring simultaneously at various locations within a stadium, and spectators will typically have a limited view of many of these. System-initiated personalization (where a video feed was automatically selected for the participant) was preferred because of its ability to automatically increase the relevance of services and its potential for time saving (Perkowitz and Etzioni 2000). In addition, system-initiated personalization served as a 'friend' which enabled users to feel like they were being understood by the application:

#1 - 'There are too many things to see here. I am really glad the application knows where I am and can provide me with related viewing angles.'

However a potential drawback was that system-initiated personalization would narrow the scope of interest within the event and provide only limited types of live broadcasts. It was recognized by participants that it may discourage a diversity of interests within the event, such as those provoked by the comments of other spectators sitting nearby.

#13 - 'It's nice to trace my location. But my interest is on one athlete because my friend is now talking about him. The application does not provide me with this information.'

As regard to the user-initiated personalization, it gave the user full control of which live video feeds were presented, and it considered the transient nature of spectator interests (e.g. an interest in a new athlete). However, it took a user's time and attention to set their preferences, and this was particularly the case in large unfamiliar environments:

#4 - ‘I won’t be happy to set the personalization as soon as I enter the stadium’.

The research further revealed that the average tolerance of users on the settings procedure was 3~5 seconds, and within 3 interaction steps.

Without personalization, users can not view the whole athletic events clearly, due to there being more than one event going on simultaneously. The users’ viewing angle was largely dependent on where they sat. In addition, they missed the more detailed views of the event which the personalized prototypes can provide, such as, the athletics events happening in other corners of the stadium.

During the control condition, no additional support was provided for live broadcast feeds. Participants said that they were unable to view the whole athletics events clearly, because of their location in the stadium. Without a supplementary mobile video broadcast, there were events in the stadium that were not clearly visible, and in this case the only way of following the action was via the auditory broadcasts and results board:

#7 - ‘I know I missed a lot. I cannot see clearly sitting here’.

8.4.1.2 Task 2 – obtaining athlete information

This task involved obtaining detailed information on particular athletes. Statistically, significant differences in the overall user experience were shown in the Friedman test (Gibbons, 1992) ($N = 18$, $\chi 2(2) = 29.4$, $p < .05$).

The multiple dependent sample paired comparison (Siegel and Castellan,1988) illustrated that there was no significant difference in the user experience between system-initiated or user-initiated personalization ($N = 18$, $|R_{system-initiated} - R_{use-initiated}| = 2, < Z = 14.36$), but both system-initiated personalization ($N = 18$, $|R_{system-initiated} - R_{paper}| = 16 > Z = 14.36$) and user-initiated personalization ($N = 18$, $|R_{user-initiated} - R_{paper}| = 18, > Z = 14.36$) were higher than the control condition.

From users’ comments, participants preferred user-initiated personalization in this task because they could obtain athletes’ information during the many natural pauses in the sporting action (e.g. during warm-ups, or after events had finished), and for this reason, user-initiated personalization was relatively effective. It also engendered a strong sense of control:

#5 - ‘There is nothing important happening in the stadium. I would like to take my time to choose what I want to read [about the athletes]’.

Users compared the experience to using Google to search for information, which could also include a user’s sudden interest. In addition, participants highlighted the fact that the process of setting user preferences could result in finding new, unexpected content of interest relating to athletes. The main concern was that user-initiated personalization should not require excessive effort from the user. This issue was specifically investigated within this task; results were that the average tolerance of the user was between three to five seconds, and with not more than three interaction steps. The current tree interface, organizing the content into groups according to their nature relationship, was appreciated. Content organization appeared to be very important when watching the multiple athletics events where a user’s interest can be significant (e.g. interests in different types of athletics and different athletes, accordingly).

The obvious advantage of system-initiated personalization were the features of speed and time saving (Perkowitz and Etzioni, 2000), while the disadvantage was that it could not react to more transient changes in a user’s interests. A spectator’s attention to an event will vary considerably depending on the situation on the field (Ciborra and Lanzara, 1994). For example, a user’s interest in particular athletes being generated by seemingly trivial factors such as how they were dressed.

In the control condition, users did not have the help to understand the updated event details (e.g. dynamic or detailed information). It was difficult for spectators to find out relevant information on the athletes, such as background information relating to the winner of certain events, or information on a specific athlete:

#12 - ‘How is Liu Xiang [a famous Chinese athlete] performing now?’

8.4.1.3 Task 3 – review athletics event results

This task involved reviewing the results of athletics events in the stadium. A Friedman test showed significant differences in the overall user experience (Gibbons, 1992) ($N = 18$, $\chi 2\ (2) = 35.5$, $p < .05$).

The multiple dependent sample paired comparison (Siegel and Castellan,1988) further showed that the user experience with *system-initiated* personalization was significantly higher than with *user-initiated* personalization (N = 18, $|R_{system-initiated} - R_{use-initiated}|=$ 17.5, > Z = 14.36), and both system-initiated personalization (N = 18, $|R_{system-initiated} - R_{paper}|= 35$ > Z = 14.36) and user-initiated personalization (N = 18, $|R_{user-initiated} - R_{paper}|= 17.5$, > Z = 14.36) were higher than the control condition.

Qualitatively, this task was to present competition results personalized to the event progress. Users required the ability to view the results instantly when watching the athletics event. Generally the temporal influence (Tamminen et al. 2004) was the most influential in promoting a good user experience. For some athletics events, the window of opportunity for spectators was very short, e.g. the 100m. Users preferred the system-initiated personalization, particularly during multiple and short events, because it provided relevant information quickly at critical moments. Users were able to quickly understand what was needed, and then divert their attention back to the sporting action.

#9 - ‘Winner information and results is only what I care about now’.

User-initiated personalization here did not fully meet users’ needs. They were unwilling to invest time and effort to set personalization parameters at the critical time e.g. scoring moments during the multi athletic events. It may be used for single events where there is less intense competition going on at the same time, such as at a football match. In this case, the longer windows of opportunity, and the decrease in visual demand altered the trade-off between effectiveness of personalization and the perceived ease of use.

Without a mobile application (the control condition) users only received the event results from the audio broadcasts and the electronic display board in the stadium. However, these were not always clearly discernable, and did not include extra levels of detail of interest to the spectator. In addition, it was easy to miss information broadcasts in the stadium, since there were several athletics events running concurrently.

8.4.1.4 Task 4 – building a community

This task involved the participant joining a virtual community within the stadium in order to share media and take part in mobile chat. Statistically, significant differences in the overall user experience were shown in the Friedman test (Gibbons, 1992) (N = 18, $\chi 2$ (2) = 29.6, p < .05).

The multiple dependent sample paired comparison (Siegel and Castellan,1988) showed that there was no significant difference in the user experience between system-initiated or user-initiated personalization (N = 18, $|R_{system-initiated} - R_{use-initiated}| =$ 6, < Z = 14.36), but both system-initiated personalization (N = 18, $|R_{system-initiated} - R_{paper}| = 24$ > Z = 14.36) and user-initiated personalization (N = 18, $|R_{user-initiated} - R_{paper}| = 30$, > Z = 14.36) were higher than the control condition.

Based on users' comments, the virtual community was a social function which helped to increase the interactions in the stadium. Users were keen on this function when they were not busy actually watching the athletics event. Both personalization prototypes helped to create a sense of belonging by creating and then assigning users to a certain group. It was noticed that there was a natural tension between looking at the application and talking face-to-face to someone near to them.

The user-initiated prototype allowed participants to decide which community they formed part of. It also provided the options for participants to manage the information they are willing to share with others. Participants liked it for the reasons of privacy and remaining in control when finding potential 'friends'. In addition, there was a sense of engagement and satisfaction when their requests were met in the user-initiated prototype. It also enabled the easy transfer of information between groups who were interested in different athletics events in the stadium, which provided additional stimulus.

#4 - 'I like to choose my own friends to talk to.'

#8 - 'I want to make sure I am talking to someone who can understand me.'

#12 - 'I feel comfortable that I can decide how to share my information.'

#11 - 'I spend time in choosing friends, so I should be able to find someone interesting to talk to.'

The system-initiated personalization prototype recommended a community for a user based on a common sporting interest. It enabled quick communication which added to the excitement of the social interaction:

#3 - 'I would like to share my thoughts instantly now, but I do not care who I am talking to. The point is sharing, not to reaching an understanding.'

However, some users did not like always joining one community by default. In this respect they felt that system-initiated personalization may reduce the sense of freshness and excitement in the social communication. In addition, the privacy was also a concern, particularly in relation to others outside of the social groups having access to their information:

#17 - 'My information should be only shared within the *group*, not outside my group.'

Without a mobile application, the user experience in relation to community building was poor, especially when they were alone in the stadium. Most users did not feel like talking to strangers without a common topic of conversation or confidence that they were both focusing on the same aspect of the event:

#1- 'I am talking about this [player] and he/she can be watching something different.'

8.4.1.5 Task 5 – checking the event schedule

This task involved checking the schedules of forthcoming events involving athletes of interest. The Friedman test showed significant differences in the overall user experience (Gibbons, 1992) (N = 18, $\chi 2$ (2) = 34.5, $p < .05$).

The multiple dependent sample paired comparison (Siegel and Castellan,1988) further showed that the user experience with *user-initiated* personalization was significantly higher than with *system-initiated* personalization (N = 18, $|R_{system-initiated} - R_{use-initiated}| =$ 16.5, > Z = 14.36), and both *user-initiated* personalization (N = 18, $|R_{system-initiated} - R_{paper}| = 34.5$ > Z = 14.36) and *system-initiated* personalization (N = 18, $|R_{user-initiated} - R_{paper}| = 18$, > Z = 14.36) were higher than the control condition.

Users felt that they would normally check the event schedule during breaks or after individual athletics events had finished. Both personalization prototypes helped to filter the information available in order to obtain relevant event schedules.

The user-initiated personalization was more effective for users. The non-real time nature of schedule information meant that individuals were willing to trade-off time and efforts against a better match to their preferences and hence more relevant schedule information. It also allowed flexibility when setting preferences which can vary, as also highlighted by Ciborra and Lanzara (1994).

#11 – 'When I have time, I love to choose the event schedule myself.'

The system-initiated personalization allowed the convenience for users to view multiple athletics events of interest at a glance. However it did not provide the strong sense of control over the information. Users appreciated the quick provision of information with system-initiated personalization, however they wanted to be able to tailor schedules based on short-term variations in their interests, and to retain control over this process.

In the control condition, users had very little support for acquiring information on event schedules, especially queries that were related to the dynamics of what had occurred. Participants wanted to know related events schedules after having an exciting experience at the stadium.

8.4.2 Impact of personalization on user experience components

After the task scenarios, user experience was measured with an overall rating being the aggregated total of the five user experience components. A summary diagram is given in Figure 8.16 to show the mean user experience rating over all participants across the three independent variables, according to the user experience components. The ratings shown are aggregated scores on 'strongly agree' (6) to 'strongly disagree' (1) scales. The error bars represent +/- 1 SD of the mean in all cases.

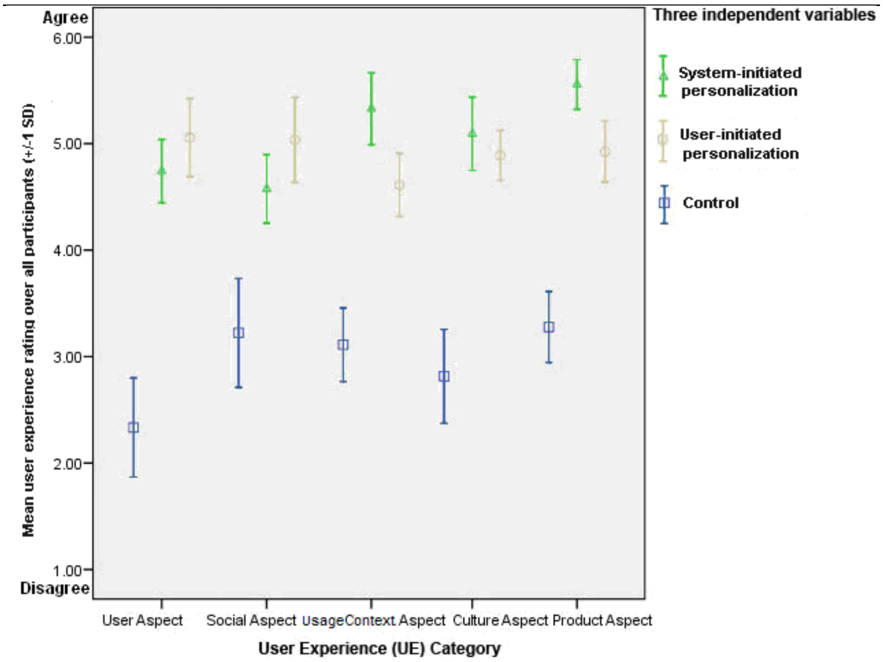

Figure 8.16 Impact of personalization on user experience components

For each of the user experience categories, Friedman statistics (Gibbons, 1992) and multiple paired comparisons (Siegel and Castellan, 1988) were undertaken as before. The results are discussed below.

8.4.2.1 User aspect

There were significant differences in the 'user factor' of user experience (N = 18, $\chi 2$ (2) = 27.9, p < .05). There was no significant difference in this aspect of user experience between system-initiated or user-initiated personalization (N = 18, $|R_{system-initiated} - R_{use-initiated}| = 7.5 < Z = 14.36$), but both system-initiated personalization (N = 18, $|R_{system-initiated} - R_{paper}| = 21.5 > Z = 14.36$) and user-initiated personalization (N = 18, $|R_{user-initiated} - R_{paper}| = 29, > Z = 14.36$) were higher than the control condition.

The user aspect refers to the user's needs, expectations, motivation and mood. Both ways of personalization helped to meet users' expectations and needs by providing dynamic, relevant event information (e.g. suitable viewing angles of the athletics events) as well as encouraging social interaction in the athletics stadium. Personalization also generated a sense of individual attention to a user's needs by understanding their personal requests, in line with Blom and Monk (2003) and as a result, was also seen as more fun (Bonnet 2001).

There was no clear winner regarding the approach of personalization for maximising the user component of user experience. There were clear pros and cons for both system- and user-initiated personalization. The user-initiated personalization considered users' needs for a sense of control, as highlighted by Nielsen (1998), and participants in this study:

#4 - 'I want the feeling of being in control by setting the preferences and getting the results of what I have set'

It provided more flexibility and freedom for participants accessing information/services. However, it took time and effort to set or change a personalization parameter when watching the athletics event.

System personalization, on the other hand, responded to users' expectations of quick, effortless and relevant information during the event. It appeared to be an "intelligent facilitator", especially during climaxes in the sporting action.

#7 - 'It is just as I expected, providing me with the right information at the right time'

However it could not react to more transient changes in a user's interests (e.g. a sudden interest in a new athlete during the event).

In the control condition, there was little support to help spectators to follow the events. There was a major concern among participants that they could not follow the overall multiple athletics events.

#11 - 'I am afraid that I am not able to follow all of the events.'

Social interactions in the stadium were not encouraged and supported, as highlighted by users:

#1 - 'It is a pity if I have nobody to talk to during the event.'

#12 - 'I need to find a better way to share my experience while watching the event.'

8.4.2.2 Social aspect

The social aspect of user experience describes that aspect which is created by social interaction. There were significant differences in the ‘social factor’ user experience (N = 18, $\chi2$ (2) = 22.8, p < .05). There was no significant difference in this aspect of user experience between system-initiated or user-initiated personalization (N = 18, $|R_{system-initiated} - R_{use-initiated}|$ = 4.5, < Z = 14.36), but both system-initiated personalization (N = 18, $|R_{system-initiated} - R_{paper}|$ = 21 > Z = 14.36) and user-initiated personalization (N = 18, $|R_{user-initiated} - R_{paper}|$ = 25.5, > Z = 14.36) were higher than the control condition.

To examine the experience created through social interaction, both personalization approaches helped to create opportunities to socialize with groups of users sharing something in common (e.g. supporting the same athlete) and therefore supported the sense of engagement and sharing. In addition, both approaches allowed sharing of group information instead of individual information, which mitigates the privacy issue. It was noticed that users did not want to only communicate with others in the stadium environment using a mobile application; instead, they wanted to have a facilitator to create and promote the face-to-face communication, as also discussed in Chapter 7:

#13 - ‘I like it if the personalization can propose a communication topic of common interest to fellow spectators nearby.’

There were clear pros and cons for both system- and user-initiated personalization during this task. The user-initiated personalization allowed more freedom for choosing who to interact with, because it gave participants full control over finding potential ‘friends’ according to their preferences at the athletics events (including being able to deal with a user’s transient interests). However, this personalization was not appropriate during sporting climaxes when a user’s focus was heavily on the sporting event.

#7 - ‘Except the scoring moments, I like to choose whom I share my experience with’.

The system-initiated approach did not support the participants’ sense of being in control. However it allowed participants to instantly share their feelings by automatically assigning them to a group of users sharing something in common. It also promoted communication when a user was not paying attention to the social interaction in the stadium.

#5 - 'It's good that I can share my exciting experience using the prototype'.

#8 - 'It builds an interesting community for me and raised my interest to communicate with the community members'.

Socializing in the control condition (without a mobile application) was much less exciting for participants because of physical constraints in the stadium, as well as limited interaction between spectators. Participants felt less engaged with the event. Also some users felt 'forced' to talk to others because they were nearby.

8.4.2.3 Usage context aspect

The usage context factor defines the physical and social environmental factors for the experience. There were significant differences in the 'usage context factor' user experience (N = 18, $\chi 2$ (2) = 30.8, p < .05). This aspect of user experience with *system-initiated* personalization was significantly higher than with *user-initiated* personalization (N = 18, $| R_{system-initiated} - R_{use-initiated} | =$ 15, Z = 14.36), and both system-initiated personalization (N = 18, $| R_{system-initiated} - R_{paper} | =$ 21.5 > Z = 14.36) and user-initiated personalization (N = 18, $| R_{user-initiated} - R_{paper} | =$ 15.5, > Z = 14.36) were higher than the control condition.

For the usage context aspect of user experience, participants considered the event-related physical and social environment which influenced their user experience in the stadium. Both personalization approaches helped participants to become familiar with the physical environment (e.g. broadcasting different viewing angles according to users' locations in the athletics stadium) and to build up the social environment (e.g. finding groups of spectators who are willing to communicate in the stadium).

The system-initiated personalization was preferred because it quickly and effortlessly enabled users to become familiar with the athletics stadium environment. This speedy approach was considered very useful in a large, unfamiliar and multi-zoned stadium environment. Participants liked to be automatically guided through the events in the stadium.

#11 - 'I need to quickly understand what's going on in the environment. Therefore I will choose the system-initiated personalization prototype'.

#6 - 'It is very useful to allow me to quickly become familiar with the environment and get ready for the exciting events.'

User-initiated personalization also provided environmentally sensitive information/services. It could also deal with a participant's transient interests during the athletics event (e.g. different athletics events and individual athletes). However it was less effective because it required users' time and effort to set their parameters during the event.

#9 - 'I first prefer to be guided automatically till I understand the overall environment.'

In the control condition, the user experience was largely influenced by their locations in the athletics stadium. Participants emphasized this point more during this athletics event than during the field experiment at the football competition. Participants complained that they often missed events of interest, e.g. the athletics events taking place at the other corners of the stadium. Also there was no support for social interaction during the event.

#15 - 'Sitting here it is not possible to view the high-jump competition, which I really like'

8.4.2.4 Culture aspect

There were significant differences in the 'culture factor' user experience (N = 18, $\chi 2$ (2) = 29, $p < .05$). There was no significant difference in this aspect of user experience between system-initiated or user-initiated personalization (N = 18, $|R_{system-initiated} - R_{use-initiated}| = 1$, < Z = 14.36), but both system-initiated personalization (N = 18, $|R_{system-initiated} - R_{paper}| = 26.5$ > Z = 14.36) and user-initiated personalization (N = 18, $|R_{user-initiated} - R_{paper}| = 25.5$, > Z = 14.36) were higher than the control condition.

The cultural factor referred to the factors specific to the particular user group being studied; in this case the sense of belonging to a group and the group interaction, as highlighted by Liu (1988) and Marcus (2003). Both personalization approaches allowed the forming of groups with an emphasized group image (e.g. incorporating group logos and slogans) by bringing the sense of 'togetherness' or 'companionship' and a sense of group belonging.

Both system and user-initiated personalization had their advantages. User-initiated personalization allowed participants to select their preferred community which brought a sense of control and engagement. Some participants preferred to form the community with a group of users sitting nearby, and the prototype helped users to find common interests among those spectators in the athletics stadium.

#17 - 'I enjoy choosing the group to socialize with'.

System-initiated personalization allowed a quick way of sharing experiences in the stadium. Some participants felt their group was special because it was 'chosen' intelligently by the IT technology:

#12 - 'I like my group: we share common values and it was chosen by 'fate'!'

In the control condition, participants lacked a sense of group belonging and group interaction. However, they were not willing to communicate with this general group for a number of reasons:

#1 - 'We may watch something different in the stadium.'

#11 - 'We may be interested in something different.'

#4 - 'I do not know what others like or dislike.'

#13 - 'There is no shared understanding of the group.'

The diversity of interests in the stadium hindered group communication.

8.4.2.5 Product aspect

There were significant differences in the 'product factor' user experience (N = 18, $\chi 2$ (2) = 36, $p < .05$). This aspect of user experience with *system-initiated* personalization was significantly higher than with *user-initiated* personalization (N = 18, $|R_{system-initiated} - R_{use-initiated}|$ = 18, > Z = 14.36), and both system-initiated personalization (N = 18, $|R_{system-initiated} - R_{paper}| = 36 > Z = 14.36$) and user-initiated personalization (N = 18, $|R_{user-initiated} - R_{paper}|$= 18, > Z = 14.36) were higher than the control condition.

When studying the product factor, the perceived ease of use and usefulness were considered by participants. Users preferred the system-initiated personalization approach because it was quick and effortless. However the result of personalization could be confusing when the information presented did not match with users' actual interests, such as when users had transient interests. Participants required a means of keeping them informed of the personalization parameters and editing the parameters if needed.

#8 - 'It provides me the right information instantly!'

#15 - 'I would like to know the personalization parameters and to be able to change them whenever I like'

Although user-initiated personalization required users' time and effort to acquire personalized information/services, it had perceived usefulness because it could provide users with a sense of control and could respond to a user's interests, even if transient. Participants expressed their desire to set the personalization when time/attention allowed.

#10 'I would like to specify my desired event information when I have time.'

In the control condition, user experience was poor in relation to the perceived ease of use and usefulness of the product. The event information was not always clearly discernable through the available channels (including loudspeakers and paper leaflets), and did not include extra levels of detail of interest to the spectator. In addition, it was easy to miss information broadcasts in the stadium, since there were several athletics events running concurrently.

8.4.3 User interface of both personalized prototypes

Similar to the field experiment (in Chapter 7), the user interface of both personalized prototypes were examined by calculating the percentage of tasks completed by participants and analyzing user comments. This is to check that the user interfaces were not significantly influencing the experiment outcome. Moreover, the examinations of user interfaces enabled a comparison of field experiment and lab experiment. Based on users' comments, users considered the user interface of both personalized mobile prototypes easy to use. A comparison of the usability problems found between the field and lab experiments, shows that there was no significant difference in terms of the number of problems identified, consistent with the findings of Kjeldskov et al. (2004). Users' detailed comments are explained in Appendix 7 and 8D.

8.4.4 User requirements for mobile personalization at LSEs

User requirements were also discussed at the end of the experiment to enable a comparison of field experiment and lab experiments. The results showed that that field experiment discovered ten more requirements than the number of requirements obtained from this lab study. Moreover, there were more context-related requirements (e.g. requests of services about location in the stadium and weather) identified during the field experiment than during the lab experiment. The detailed results are described in Appendix 7 and 8 D.

8.5 Discussion

The major aim of this lab experiment was to investigate the impact of different approaches for personalization, in relation to user experience at LSEs. The results from this experiment are discussed in terms of 1) the user experience under different testing conditions; 2) the overall influence of mobile personalization at LSEs; 3) how to balance user and system personalization approaches; and 4) experimental methods used in this study.

8.5.1 User experience under three experimental conditions

This chapter examined the impact on user experience without a mobile application (the control condition), with the user-initiated personalized mobile prototype, and with a system-initiated prototype in the LSE context. The study used scenario-based usability testing, with prototypes within a controlled lab study (see Table 8.3).

Table 8.3 Summary of participants comments on user experience under the three test conditions

UE Factors	User-initiated Personalized Prototype	System-initiated Personalized Prototype	Paper Leaflet Prototype
User factor	It gave user full control over the information. It provided flexibility and information variety. However, it required too many settings.	It was quick and effortless to use during the event, yet it sometimes missed the actual interest of a user.	Users' needs for information control and the expectation of more social interaction were not supported.
Social factor	It encouraged social interaction by allowing control and freedom of choosing whom to interact with.	It enhanced social interaction by assigning users to a certain group without effort and providing rapid communication.	Users were forced to communicate with others nearby, who may lack a common language.
Usage context factor	It provided relevant information, no matter a user's physical environment. It could accomodate users' instantaneous interest during an event	It provided relevant information in good time. It was quick to help users to become familiar with the environment.	User experience was largely influenced by their location in the stadium. The information they got was not updated and sometimes irrelevant.
Culture factor	It allowed users to choose a group of people in common and emphasized the group image during the events. It brought a greater sense of control and satisfaction.	It assigned users to a group of people with common interests and emphasized the group image during the events.	It did not support the group interaction and values.
Product factor	It needed some time and effort to set up, but it can consider users' actual interest and brought a sense of familiarity with the mobile product.	It was quick and effortless to operate. However it could be confusing when it did not match a user's actual interest.	It did not provide the cognitive perception of perceived usefulness.

User-initiated personalization helped to meet users' expectations by providing dynamic relevant information (e.g. athlete information of interest, suitable viewing angles, and event results) and encouraging social interaction in the stadium. Moreover it supported users' needs to be in control and to retain freedom over the system, which is something that is regarded as critical in mobile HCI (Nielsen 1998; Nunes and Kambil, 2001; Coner, 2003). Users were given freedom to form their own groups and decide what information to share, and with whom. This provided satisfaction and addressed privacy issues during social communication. It also allowed for information variety by considering users' transient interests. However, the potential problem was that the user-initiated personalization required time and effort from a user in the stadium, something which was as also highlighted by Ramnarayan (2005), as well as in the previous field experiment (in Chapter 7).

The system-initiated personalization was quick and effortless to use, consistent with Perkowitz and Etzioni (2000); Martinez et al. (2009). It appeared to be a more intelligent facilitator in certain aspects, such as helping users to quickly become familiar with a new environment, and it provided updated, relevant information without user effort during sporting climaxes. It also helped to enhance social interaction by assigning users into groups, which in turn provided an easy, quick way for users to share information. However it failed to bring users the sense of being in control. Moreover, system-initiated personalization could not cope with users' transient interests during the events, because users' levels of attention varied over time, depending on the situation in the field (Ciborra and Lanzara, 1994). This also influenced their interest in particular events. A good example is that several users' interests changed because of even seemingly trivial factors, such as how athletes nearby were dressed.

The user experience in the control condition was inadequate, as highlighted by Olsson and Nilsson (2002). The information obtained from the paper leaflets and other media sources in the stadium was neither personal nor dynamic. Moreover, additional detailed was missing, such as close ups of finishes. The spectators had no influence over what, when or how information was received during the ongoing events. Social interaction among spectators was not encouraged, and communication was restricted within the physical boundary of users' locations in the stadium. In the control condition, there was no support for designing a shared common interest among spectators.

8.5.2 The role of mobile personalization at LSEs

The experiment showed that mobile personalization could play a role in enriching the user experience in the context of LSEs. The influences on user experience were discussed from the following five aspects:

The *user* aspect means the needs of the spectators, including their affective and motivational aspects. Both personalization approaches brought the impact of fulfilled expectation, feeling of personal. Personalization fulfilled users' expectations by delivering relevant information and creating opportunities for social communication. It generated a sense of individual attention to users' needs by understanding their personal interests, in line with Blom et al. (2003).

In relation to the social aspects of user experience, both approaches of personalization provided improved communication and social interaction, as also demonstrated by Maule (1997) in virtual environments. Personalization helped social communication by promoting common topics in a created community, something which is particularly important for Chinese users, due to their natural reluctance to talk to strangers, and the desire to feel part of a larger group (Marcus, 2003).

The usage context aspect refers to the physical and social environmental factors impacting on experience. Personalization helped users to cope with the physical event environment by delivering location-sensitive information/services which influenced how much a user can understand an event. It also encouraged an active social environment by assigning users to groups and promoting interaction between spectators in the stadium.

The *cultural* aspect of user experience refers to the underlying beliefs and values that the spectator holds. Personalization can directly support these cultural aspects. It emphasized group identity by creating a mutual, shared concept, a factor binding a group of users together (e.g. forming a group with users who support the same athlete). It acted as a mechanism for creating the mutual values described by Schachter (1951). The improved group image, value and interaction within the group supports a user's feeling of group belonging, which is in line with the fundamental cultural beliefs and values of Chinese users (Liu, 1988; Marcus, 2003).

From the product aspect, personalization increased the perceived usefulness and ease of use of services delivered to the end user. The perception of ease of use was also influenced by the provision of relevant information with less interaction effort, resulting in users feeling more *capable* (Venkatesh et al. 2003) – ease of use and usefulness are, therefore, related, rather than being separate constructs. An unexpected result was that where users themselves set up personalization parameters, this interaction itself increased the familiarity with the services on offer, as indicated by Blom et al. (2003).

8.5.3 Comparison of user- and system-initiated personalization prototypes

This lab study indicates that in terms of the impact on user experience, neither user- nor system-initiated personalization emerged as a single best approach across the range of spectator activities analysed.

User-initiated personalization engendered in the participants a sense of control, freedom and flexibility (Nielsen, 1998; Nunes and Kambil, 2001; Coner, 2003). However, this approach required time and effort while they were in the stadium, as also indicated by Ramnarayan, 2005. System-initiated personalization, in comparison, was quick and effortless to use during events, as highlighted by Perkowitz and Etzioni, (2000); Martinez et al. (2009). Participants perceived it to be ‘intelligent’, serving as a ‘friendly helper’, but the drawback of system-initiated personalization was that it could not react to transient changes in participants’ interests.

System-initiated personalization was more effective for those tasks where: (1) the information environment is more diverse (e.g. athletics events), (2) a quick real-time response was needed, and (3) the benefits of relevant services would be outweighed to some extent by the costs of user interaction with the application. User-initiated personalization is more effective in less distributed environments (e.g. football events), and where the interaction costs are low in relation to variance in the possible outcomes. In effect, this refers to situations where it doesn’t matter to the end user whether they interact now or later with an application.

There are four key factors to consider which can help prescribe whether a mobile application uses system-initiated or user-initiated personalization.

The *progress of the event* was regarded as a critical temporal influence (Tamminen et al. 2004) on the user experience and the need for information. The temporal influence within this study is related to the progress of different events (e.g. 'pre-event', 'lulls', 'climaxes', 'pauses' and 'post-event', based on users' comments). Whether a system uses system- or user-initiated personalization can be determined by the temporal influence categorization. System-initiated personalization should be set on to detect the temporal tensions (Tamminen et al. 2004). For example, when a user is experiencing a busy period of action, the approach of system-initiated personalization is needed in order to provide tailored information without the need for user input. At other times, user-initiated personalization provides more control and flexibility over content/functionality provision. There are various options for the requisite real-time categorization of the temporal influence, for example: directly from the user and environment sensors or video image recognition; based on the reaction and location of other people nearby.

The *event environment* refers to the physical surroundings, the spectator's location and the activities taking place (i.e. equivalent to an HCI definition of context such as Dey et al. 2001). It is an attribute that can be used by the mobile personalization application to decide whether to use the user- or system-initiated personalization. If the environment is large and unfamiliar, system-initiated personalization is required to offer quick, overview information about the users' surroundings. This factor can be detected by comparing users' location history and current location, for which several different location detection techniques can be utilized. Global positioning system (GPS) is the technology used when outdoors ,most commonly in car navigation systems, while Bluetooth and WLAN hotspots are frequently used techniques for both outdoors and indoors (Aalto et al. 2004; Burrell and Gay, 2002; Persson et al. 2003). Other methods used for indoor location detection include ultrasonic or infrared -based location detection (Borriello et al. 2005; Flanagan et al. 2002).

Users' personal preference can also be used to consider the approaches of personalization by the mobile application. If preferences are strong and stable, (e.g.

users' interest in a particular sports item), system-initiated personalization can be employed to deliver the relevant information/service tailored to this preference. Where preferences are weaker, user-initiated personalization allows individuals to make their own selections, and also caters for the increased likelihood of them being transient. Preferences are the hardest factor to determine automatically. These could be derived based on the assumption that the history of habits derived from one environment of consumption is transferable to the current one.

Typies of events are classified according to their temporal and spatial characteristics, and the number of events involved. For example, football was classified as a single event with a moving focus of action, while athletics consisted of multiple events, many of which occurred simultaneously at discrete geographical locations. System-initiated personalization has a greater influence on the provision of location-sensitive services to the end user at the multiple, distributed events (e.g. athletics event). Because multiple, distributed events have several simultaneous events occurring at different locations in the stadium, spectators can have limited time to actively participate in all the events. System-initiated personalization is able to effortlessly provide broadcasts of additional views to help overcome some location-based constraints. In contrast, during single events (e.g. football matches), the focus of attention moves and is rarely contained within one location for long. Spectators at the football event were better able to engage in the event, irrespective of their physical location. On the other hand, user-initiated personalization is more important for social communities during multi-distributed events than during single events. Spectators have more diverse attention and interests during the multi-distributed events, while, social interaction occurs more naturally during single events because of single focus of attention of the spectators.

8.5.4 Lab experiment

This study recreated the context of a sporting event within a lab setting which examined the impact of mobile personalization in the context of LSEs and compared different approaches of personalization in a controlled lab.

The major advantage of a lab experiment is that it is relatively easy and quick to conduct and collect data, as indicated by Brewster, 2002 and Baillie, 2003. During the lab experiment, participants quickly revealed a large amount of information about how a user worked with the prototypes.

The lab experiment also offered more control over the conditions for the experiment, as shown by a number of authors such as Kjeldskov and Stage, 2004; Baillie, 2003; Salvucci, 2001. Participants were more focused on the experiment and were not influenced by external factors, such as weather, noise, or outsider disturbance.

There were some drawbacks to the lab experiment, as described in Chapter 3 (See 3.2.4), including the limited relation to the real world and an unknown level of generalization of results outside laboratory settings. This lab study tried to bring the LSEs into the experiment by carefully setting up the lab to resemble a stadium, designing scenarios based on previous contexts studies and involving users who were familiar with the context. It also addressed the issue of users' divided attention by requiring subjects to watch a sport event video which was projected on the front wall of the lab room while performing the scenario-based tasks with the mobile prototypes. As a result, participants were able to indentify some context related problems (e.g. the font was too small to read in an open stadium) during the lab experiment. Also participants expressed their concerns of using the personalized prototypes from contextual and social perspectives, including users' concerns over spending too much time in personalizing the device during the event.

For Chinese users (typically reluctant to communicate their thoughts), the lab experiment did not allow them to feel relaxed. Participants acted politely during the study, and they were uncomfortable about expressing negative feelings about the applications. However the Emotion Cards were found to be useful in overcoming these inhibitions. In one example, when interviewing a participant about aspects of his user experience, he generally stated that it was 'fine'. However, when presented with the Emotion Cards, he tended to pick up one emotion face and would talk about his concerns over the time and effort required to manually personalize the application, without feeling that he was being overly critical.

8.6 Conclusion

This chapter aimed to examine the impacts of mobile personalization in terms of user experience at LSEs, and compare the different approaches to personalization at LSEs. The impacts of mobile personalization at LSEs can be described in terms of the five components of user experience. These impacts can be summarised as fulfilled expectations, feelings of personal attention (user aspect); improved communication and social interaction (social aspect); the environmentally sensitive information and services (usage context aspect); an emphasised group identity and relationship (culture aspect); and increased perceived usefulness and ease of use (product aspect).

The study concluded that either personalization approach was a solution to enhancing user experience. System-initiated personalization is quick and effortless to use, however it failed to satisfy a user's desire to remain in control and to cope with their transient interests. By contrast, user-initiated personalization was more effective at meeting user needs, although it required users' time and effort, which was an issue in the stadium environment.

The lab experiment was relatively easier to set up and conduct. It tried to recreate the LSE environment, and as a result, it produced a large amount of data, including some context-related information (for example, users' concerns about spending too much time personalizing during the event).

Finally, initial concerns that the participants would 'see through' the mock-up used in the lab study proved unfounded. When debriefed, without exception, all participants expressed considerable surprise that the mock-up used in the lab study was not a fully functioning technical solution.

9 DISCUSSION

	Research questions addressed in this chapter:
1	**What is the potential for mobile personalization to contribute to the positive aspects of user experience at LSEs?**
2	**What are the key contextual factors to be used for mobile personalization at LSEs?**
3	**How can personalized mobile applications be designed to optimize user experience at LSEs?**
4	**How does mobile personalization impact on user experience at LSEs?**
5	**What are the key gaps in user-centred research that arise from this thesis?**

9.1 Introduction

The overall aim of thesis was to investigate how personalized mobile applications can render the user experience more active and engaging at LSEs. The thesis mainly deals with three key concepts: large sporting events, mobile personalization and user experience. These themes were considered in turn within this discussion: 1) design implications at LSEs, 2) general recommendations for designing a personalized mobile application, 3) implications for designing an enhanced user experience. In addition, the thesis considered methods for evaluating mobile applications and cultural implications for working with and designing for Chinese users.

9.2 User requirements for spectators at large sporting events

Spectating at sporting events is a popular leisure activity worldwide, and has also become a topic of interest to HCI. Little research has been conducted on supporting spectators in the context of sporting events (Nilsson et al. 2004; Esbjornsson et al. 2006). Some research has tried to support visitors with an enhanced spectator experience by providing a better understanding of the competition and supporting interactivity at LSEs (Hallberg et al. 2004; Nilsson et al. 2004; Sun et al. 2005; Jacucci et al. 2005; Esbjörnsson et al 2006). However, none of these studies have investigated the role that mobile personalization can play in enhancing the user experience. In addition, there is no empirical study of user experience (studies to measure user experience aided with technology) during sporting events. This research takes a new look at how personalized mobile applications can contribute to an enhanced user experience at LSEs in a contextually and socially relevant way.

This research was conducted across different types of events, including swimming, athletics, and football. It derived some common requirements for personalized mobile applications at LSEs, and also pointed out different requirements at LSEs due to the different types of sporting events. These requirements are discussed below.

9.2.1 General requirements at LSEs

There are several requirements which seem common across the events studied (swimming, football and athletics). These are described below.

Maintain a good balance between the event and event information. Spectators at LSEs reported that their primary interest was the competition taking place, and that they were not interested in accessing mass event information, especially during sporting highlights. However, during the time periods between highlights there was time for a general overview of the event and social interactions between spectators, as also highlighted by Nilsson et al. (2004). Therefore, a key requirement is to enable mobile applications to deliver personalized information/services which enable spectators to keep up-to-date without occupying too much of their attention.

Allowing spectators to control information. According to the field studies, spectators were heavily loaded with mass media information, as well as watching the competition itself, as also shown by Sun et al. (2005). There was an overload of competition information which was published/distributed in several ways, including audio, visual and paper ‘channels’ in the stadiums. It was not easy for the spectator to search or assimilate the large amount of information at the same time as experiencing the events, as described in Chapter 4.

The published information at LSEs was not under the users’ control and they were only partly relevant, consistent with Olsson and Nilsson (2002). Spectators had no control over what, and when, information should be delivered.

Spectating at a LSE means missing much detailed live information, such as that usually provided on television. The events were watched by spectators, but the significance of the events within the wider competition was often not known until later, as also indicated by Nilsson et al. (2004).

Consequently, it is important that mobile applications provide the user with the freedom to set what information they want, and when they want to receive it, supported in a personalized way, in contrast to the traditional information resources.

Consideration of spectators' social and cultural requirements. One of the characteristics of being a LSE spectator was that their experience of the event was socially constructed by seeing people go there to enjoy the company of others, which is consistent with Jacucci et al. (2005) and Esbjornsson et al. (2006). However, the social interaction between spectators only played a small role during the observed events, which led to periods of considerable boredom amongst the spectators. Social interaction happened by taking pictures, talking to group members, or chanting group slogans during the climaxes of the events. This research also found that Chinese spectators demonstrated their distinctive group image during the events. Examples of this include wearing specific uniforms or using particular accessories when cheering.

Figure 9.1 Spectators at large sporting events

A social and cultural requirement is that mobile applications should help spectators to create and maintain relationships in a personalized social network at LSEs. This can be achieved, for example, by means of generating a virtual community for a group of people sharing similar interests. This supports the group's co-experiencing of the event and caters to the Chinese culture of underpinning group relationships (Peng and Nisbett, 1999; Marcus, 2003; Marcus and Gould, 2000).

Supporting the ease of use of mobile applications. The environment is a major influence on the user experience, especially in terms of the usability of the mobile application (Robson, 1993). In the context of LSEs, users had neither the time nor the attention to navigate through complicated menus or to interpret confusing results. A clear finding from the field studies was that interaction with the mobile application needs to be simple. Interaction should be personalized for the stadium environment to allow impromptu interaction with the application with a low level of commitment from the user. For example, users should be able to personalize information within less than three interaction steps.

Moreover, a mobile application has a small screen, which means that limited information could be presented to a user, in contrast to the mass information broadcast at LSEs. The total number of navigated pages must be minimized.

9.2.2 Different requirements due to the type of sporting event

This research was conducted across different types of events. It classified the sporting events according to their temporal and spatial characteristics, and the number of disconnected events involved. For example, football was classified as a single, long-running, group event with a moving focus of action. By contrast, athletics events consisted of multiple, shorter, individual events, many of which occurred at discrete geographical locations. Different types of sporting events have different requirements on personalized mobile applications, and these are discussed below.

Personalize information for different type of sporting event. The research found that there were specific types of information needs during the athletics events, which were not present during the football competition. Users required simpler, more general information for multi-sport events (e.g. results) and they required deeper, more detailed information for single sport events (e.g. competition strategy). Unlike other location-aware applications (Abowd et al. 1997; Oertel et al. 2002), the spatial relationship of interest is the location of the sporting action in relation to the spectators' (usually) fixed viewing point within the stadium. Since multi-sport events have several simultaneous events occurring at different locations in the stadium, spectators can often only actively participate in those events close to where they are sitting. Therefore they required simpler, general information on events in other areas of the stadium. In contrast, during single events, such as football, although the focus of the action moves, the movement of all players on the field mirrors the movement of the ball, and action is rarely contained within one location for long. Spectators at the football event could follow the event irrespective of their physical location and thus required deeper, more detailed information in order to be better engaged with the event. In addition, users required group information for team events (e.g. competition history of a football team) and individual information for individual sport events (e.g. an athlete's competition history).

Personalize information delivery. Information can be delivered *within* longer, more continuous events, such as football matches. The temporal factor was less influential: spectators were willing to interact with a mobile application during most stages of the event, with the exception of goal scoring opportunities. In contrast, the temporal factor was more influential during the multiple shorter events (e.g. athletics event) due to the intermittent scheduling of these events. Information should be provided *after* the shorter events, with prompt, simple and timely information needed to satisfy user needs. The study revealed that participants expressed frustration at not being able to follow the action from multiple events which were occurring simultaneously. The information during multiple events, such as athletics, produced the 'temporal tensions' described by (Tamminen et al. 2004) which were not so apparent with continuous events such as football. The information at the multiple shorter events has a short-term and a relatively steep decay curve. For example, some information (e.g. distances between competitors) is only valued immediately after the finish of an athletics race. Its value is much less (or even close to zero) if it is presented after subsequent events.

Use different ways to present information. Information presentation needs to take into account the type of event, the extent to which it is geographically distributed, and the physical characteristics of the application. Where events have multiple, distributed sources of action, such as athletics, screen elements (such as 'boxes' and/or 'lines') are needed to group information and minimize cognitive load. Videos and stills, including other views of the action will enhance the user experience where screens are large enough to accommodate them. Picture-in-picture images will enable a degree of parallel processing of events or incidents that are spatially distributed.

Consider social interaction at different events. The social interaction between spectators happened differently at different events. During the single event, a greater social interaction occurred naturally, and this may have been because of the single focus of attention of the spectators, irrespective of where they were physically located. In contrast, the spatially distributed multi-event resulted in less focus by spectators on common area of action. The mobile applications need to encourage people to communicate and share experiences with other people within a stadium (Esbjornsson et al. 2006) by providing conversation topics of common interest.

9.3 Design of personalized mobile applications

The research focused on designing a personalized mobile application which can enhance the user experience at LSEs. It produced results that can be used as general considerations for the development of personalization applications. It raised several issues in relation to the design of an effective personalized mobile application, and these are discussed in the following section.

9.3.1 Considering context in designing personalized mobile applications

A personalized mobile application should try to recognize the whole context within which it is being used. The importance of context is highlighted by Dey et al. (2001) who describe how a goal of context acquisition is to determine what a user is trying to accomplish. Because the user's objective is difficult to determine directly, context cues can be used to help infer this information and to inform an application on how best to support the user. Therefore understanding the context is an essential element of user-centred design.

The contextual factors can be considered as the inputs or triggers for the mobile personalization application which will influence the output presented to the user (Norros et al. 2003). Personalized mobile applications aim to adapt to the different contextual factors in order to optimize the provision of information/services to the user.

The context needs to be looked at from a user, rather than a technological point of view. This research undertook three field studies at LSEs in the UK and China, with the aim of identifying influential contextual factors that can be used to prescribe the behaviour of a personalizable/adaptive mobile application for spectators at LSEs. Eleven aspects of context were found to be highly significant within the large sports arena: a spectator's preferences and interests in sports, progress of events, location in the stadium, event types, language, 'with whom', mobile screen, nationality, public media channels present in the stadium, knowledge/experience of the user in relation to the particular sporting event, and the social atmosphere present in the stadium. The significance of context was much more than 'where I am sitting' which was the typical term used by participants to describe their environment. The range of identified influential contextual factors can be used by a personalized mobile application to enhance the user experience at LSEs.

A key design opportunity for personalized mobile applications at LSEs was to study the context to maximise the relevance of information/services. Relevance was described by Sperber and Wilson (1995) as: personal; contextual; depending on what has been communicated before; varying with the cognitive and affective state of the addressee; and a function of effort and effect. The research found that the contexts can be used to maximise the relevance of information content, information delivery time, interaction mode and social communication services delivered to users over a personalized mobile application.

Personalized mobile applications can study context to consider relevant information content/services (Dey et al. 1999). The key influencing context factors can be used as attributes to filter and supplement the mass of information available. A mobile application should personalize the information content/services, based on the key contextual factors. For example, it can prepare detailed information relating to items of interest, present other information in general form (interest and preference in sports factor). It can adapt the content to a user's location, as has been indicated by McCarthy and Anagost, (2000), Dey and Abowd, (2001), Dey et al. (2001). For example, it can display different viewing angles according to a user's current seat in a stadium (location factor). The information content can also be adjusted to the users' attention, with only important information being presented when the users' attention is limited (attention factor). It can deliver the content depending on how much knowledge the user has. For example, it can present professional information to a more experienced user, but display basic information to a new one (knowledge/experience factor).

Personalized mobile applications can apply context to encourage people to communicate and share experiences with others, consistent with Joly et al. (2009). It can create opportunities for interaction with fellow spectators who sit together, by providing conversation topics of common interest, and supporting real, geographically-bounded temporary communities. However, the collection and sharing of personal information introduces potential privacy issues, as has been widely discussed (Sheehan, 2002). This concern can reduce the potential for context to be used to form temporary, spatially defined social networks.

Personalized mobile applications can use context to deliver information according to relevant time windows. As highlighted by May (2001), windows of opportunity open and then close again, and information delivery must take these windows into account. These windows influence benefit, and the expenditure of effort. In line with Sperber and Wilson (1995), an individual may chose to process something whose effects may be lost if not processed immediately, and ignore something which can be processed later. Windows for information delivery can be also highly dependent on the context (*event progress factor*) as indicated by Tamminen et al. (2004). Windows for information delivery occur *during periods identified as* ‘pre-event’, ‘quiet periods in the sporting action’, ‘climaxes’, ‘breaks’ and ‘post-event’. In contrast, information windows occur immediately after ‘climaxes’ in the sporting action.

Personalized mobile applications can apply context to provide relevant changes in the interaction mode. This reflects the contextual adaptation described by Dey et al. (1999), based on Pascoe (1998). Depending on the users’ attention, interaction can be overt or unobtrusive, so that if a user is actively engaged in something, information can be made available (e.g. by SMS), rather than being pushed to the user.

The analysis of the context of use helps to provide an understanding of the situations in which the personalized mobile applications will be used; to identify user requirements (and how they vary) during a LSE; to address issues associated with usability of mobile applications; and to provide contextual validity during product evaluation.

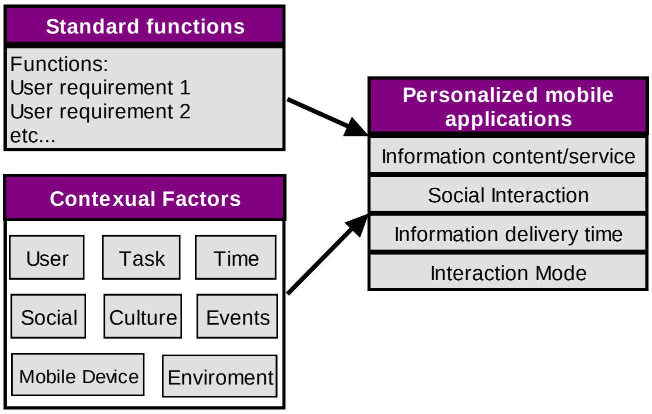

Figure 9.2 Use of contextual factors in a personalized mobile application

9.3.2 Different approaches to personalization of a mobile application

User-initiated personalization and system-initiated personalization are the major approaches to the design of personalization (Martinez et al. 2009). System-initiated personalization in this research refers to the adjustment initiated by a mobile application, based on a user profile as a guide to provide content appropriate to what the user is believed to be interested in (Hjesvold et al. 2001). In contrast, user-initiated personalization is a user-driven process, where users adjust the mobile application to provide content tailored to their specific need (Stephanidis et al. 1999). A few empirical studies have pointed out that the effectiveness of personalization varies depending on the approach of the personalization used (Nunes and Kambil, 2001; Coner, 2003; Treiblmaier et al. 2004; Martinez et al. 2009).

Nunes and Kambil (2001) and Coner (2003) have assessed whether users prefer user-initiated personalization or system-initiated personalization for websites. The authors found that user-initiated personalization was more effective than the system-initiated personalization, in terms of satisfaction. In contrast, Martinez et al. (2009) compared how digital library users react to these two approaches of personalization. The results show that users were more positive to the system-initiated personalization, due to the fact that the system-initiated personalization automatically presented suitable functionality, whereas the user-initiated personalization required users to choose functionality by themselves.

This research indicates that in terms of the impact on user experience, neither user nor system-initiated personalization emerged as a single best approach across the range of spectator activities analysed. The research emphasized the role of the user and what possibilities they have to act within the scope of LSEs. Generally speaking, the research found that user-initiated personalization is more effective in (1) less distributed environments, and (2) where the interaction costs are low in relation to variance in the possible outcomes. In effect, this refers to situations where it doesn't matter to the end user whether they interact with an application now or later.

System-initiated personalization is preferred (1) for multiple and diverse events that are difficult to follow, 2) when the attention 'costs' of user interaction are relatively high (e.g. during sporting climaxes), 3) when the environment is large and unfamiliar, and 4) when robust adaptation can occur (e.g. due to strong and stable preferences).

There are four key factors to consider which can help prescribe whether a mobile application uses system-initiated or user-initiated personalization. These factors were discussed in Chapter 8 (section 8.5.3).

In reality, a hybrid approach will provide the benefits of the reduced user interaction of system-initiated personalization and the greater specificity of a user-initiated approach as indicated by Alpert et al. (2003) and Papanikolaou et al. (2003). System-initiated personalization can present location sensitive functions, and can also react to stable/strong preferences, if these exist. On top of this layer, interfaces can present a series of options that allow personal choice. These options can include and promote those that have been determined as preference candidates (e.g., based on previous selection, or cross-platform transferable viewing habits) – see Figure 9.3. In this way, the user's locus of control is visible, and dynamic user selection is supported.

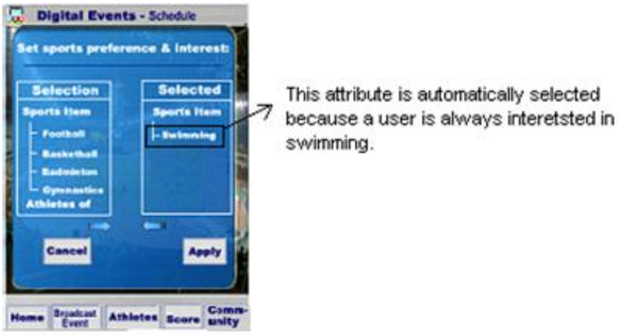

Figure 9.3 An example of interface indicating a mixed approach of mobile personalization

There are some obvious concerns with a hybrid approach, and these are discussed below.

Support of high visibility. The interface should indicate to a user if automatic personalization is turned on, as highlighted by Kuutti and Häkkilä (2006). In particular, a spectator may be unclear whether personalization is happening automatically, or whether they need to perform some of this function. Status indicators, or coding of individual content, can indicate whether that content has been generated by system- or user-initiated personalization, or a combination of both. It is important to have an intuitive interface which can ensure easy understanding. By way of an example, the interface can first indicate to the users which approach for personalization is operating. Icon  indicates system-initiated personalization,  means user-initiated personalization, and  refers to a combination of both approaches of personalization. See Figures 9.4, 9.5 and 9.6.

Figure 9.4 An example of interface indicating system-initiated personalization

Figure 9.5 An example of interface indicating user-initiated personalization

Figure 9.6 An example of interface indicating both approaches of personalization

Editing personalization parameters. The personalization parameters should not only be transparent to a user, but they should also offer the options of creating and editing one's own personalization parameters, as indicated by Barkhuus and Dey (2003). The user interface should allow the adding of personalization parameters in a flexible way. For example, if a user clicks the status indicator, the personalization parameters can be displayed (see Figure 9.7). Meanwhile, it allows a user to edit the attributes or to simply turn off the personalization.

Figure 9.7 An example of interface editing the combination of personalization

Highly personal personalization parameters need to be defined by the users themselves. For example, the location could also be personal such as ‘stadium’, or ‘home’, which the user defines what or where ‘stadium’ is for her/him.

Managing conflicting personalization parameters. On some occasions, personalization parameters can conflict each other, which should be solved in a simple and straightforward manner. When personalization parameters conflict, there should be a clear indication of which personalization attribute is the primary one. For example, some personalization parameters such as definitions of ‘quiet periods in the sporting action’ (during which users prefer to use user-initiated personalization) and a ‘new, unfamiliar environment’ (during which users require system-initiated personalization), can appear at the same time, if the user has not identified priority. The user interface should allow users to identify and edit their priorities.

Easy personalization. Interfaces should require minimal attention of the user when accessing or changing personalized content (Häkkilä and Isomursu, 2005). A user can either pre-set personalization parameters before the delivery of a service via the personalization page, or can do this in real-time as services are delivered to them.

Personalization parameters suitable for small screen display. Personalized parameters can be segmented, according to a users’ mental model, in order to overcome the conflict of limited screen space and a large amount of information. The extended tree menus work well to organize the segmented information. It can also reduce the interaction steps for users, since it does not require users to access multiple screens in order to perform their personalization choices. Moreover, it can reduce users’ cognitive loads by presenting all personalization choices on one page, consistent with design guidelines that promote recognition over recall (Shneiderman and Plaisant, 2005).

A semi-transparent menu can be used to lay the personalization page over the main body of content. This promotes parallel processing of visual information, helping to integrate function and content within a small single view. This also provides the user with information without detracting unnecessarily from content provision.

Privacy. Privacy refers to ‘the claim of individuals or groups to determine for themselves when, how, and to what extent information about them is communicated to others' (Minch, 2004). Information about the preferences, activities, and context of people using the applications can be collected to personalize the services for individuals and groups of users. However, this information is often regarded as personal data, and the use of personal data raises privacy issues. The use of personalization appears to decrease user's trusting, which supports the view that individuals feel that personalization violates their privacy, as indicated by Thomas and Krogsoeter, (1993).

Privacy concern is a major issue for all users of personalized mobile applications. Many pieces of research on personalized services has either ignored the challenges of privacy and focused efforts solely on maximizing utility, or has completely bypassed the use of personal data (Krause and Horvitz, 2007).

Some systems balance personalization and privacy concerns by only tracking preferences information; most users are comfortable giving this information, as long as it remains disconnected from their physical selves (Riedl, 2001). Some personalized systems use an anonymous infrastructure, which allows users of personalized systems to enjoy anonymity and at the same time receive full personalization. Users would be unidentifiable, unlinkable, and unobservable to third parties, but linkable for the personalized system through a pseudonym (Schreck, 2003; Alfred, 2007).

This research has tried to mitigate the privacy issue by the allowing the sharing of group information instead of individual information. Personal data (spectators' preferences and locations) were shared only within users' own group. This concern is based on the consideration of a key component of Chinese culture, which is collectivism (Kim, 2004) – this describes how, within Chinese society, individuals are integrated into strong cohesive groups. These groups provide protection throughout an individual's lifetime, in exchange for unquestioning loyalty. Chinese users are reluctant to stand out from their groups, and for this reason, the sharing of group information with other groups is acceptable, while sharing of individual information outside of the group is less acceptable.

In addition, the personalized application can allow users to easily manage the information they are willing to share with others, as indicated by Hawkey and Inkpen, (2006). For example, the application should allow users to select whether their personalization attribute is accessible to other users. The use of personalization attribute information should distinguish between that shared with the user's friends and that shared with others. For example, a user can choose to recommend a method of contacting them when s/he is at LSEs, showing the text 'at LSEs for friends' and perhaps 'not available' for his or her colleagues.

9.4 Designing to optimise user experience

9.4.1 Theoretical background to user experience

Despite the emerging importance of user experience, there are several barriers to using this concept as a key design objective. There is not yet a common definition of user experience because it is associated with a broad range of both fuzzy and dynamic concepts, e.g., emotion, affect, experience, hedonic, and aesthetics (Law et al. 2008). There is a lack of guidance to enable designers to explicitly incorporate user experience within a user-centred design process.

However, there is much interest in this subject from design, business, philosophy, anthropology, cognitive science, social science, and other disciplines. Among these, there are some initial efforts to create theories of user experience (Alben, 1996; Macdonald, 1998; Buchenau and Fulton, 2000; Mäkelä and Fulton 2001; UPA, 2006; Hassenzahl and Tractinsky, 2006; Nielsen-Norman Group, 2007; Desmet and Hekkert, 2007; Sward and MacArthur, 2007; UXnet, 2007). These existing theories of user experience are useful at a general level, however, they are *too* general to be used as a practical tool in product design or the concept design context. Rasmussen (2000) argues that as society becomes more dynamic and integrated with technology, there is a need for greater multidisciplinarity in tackling human factor problems. Therefore a range of literature is useful in terms of identifying the user experience components that can be employed within a user-centred design process.

This research follows the approach taken by Arhippainen and Tähti (2003) and Hassenzahl and Tractinsky (2006) in considering user experience comprising multiple components – user, product, usage context, social and cultural. The *user* component of user experience refers to the mental and physical state of the individual who interacts with the system. The *product* component of user experience includes all applications, systems, services, and infrastructures that are involved in the interaction with the product. The *usage context* component defines the physical and social environmental factors for the experience. The *social* component of user experience describes that aspect which is created by social interaction, while the *culture* component means the key relevant values and traditions of the user group.

This research considers user experience to be a formative construct that is measured in terms of its components, rather than being a construct that is measured directly (Lin et al. 2005). Each component of user experience can be assessed separately, although some components may be interlinked. By way of an example, some participants tended to link their social experience (e.g. social communication) to cultural experience (e.g. the sense of group belonging and group communication). The *user* component seems to be most influential when assessing user experience in this study. Participants considered this component as the basic criteria to determine their experiences.

Listing the sub-component of each user experience factor requires a specific product and context in mind, but there is a danger that not all attributes actually affect user experience (Arhippainen and Tähti, 2003). Therefore, this research considered the sub-components of each user experience components, based on the literature review as well as the understandings of users and the LSE context during previous research activities. Some attributes which are mentioned in the literature were not considered. For example, the attribute of ‘past experience’ for the user component does not influence user experience as such when watching a sporting event. Those components and sub-components formed the basis for a tool for gathering user experience of mobile personalization at LSEs in this research.

9.4.2 Designing user experience with user-centred research

The approaches of studying user experience are various, given its complexity and depth. How can a mobile application be designed to optimize user experience? Some answers to this question can be found in the following:

Focus on shaping the actual experience of the user. This refers to undertaking studies with users examining how they act, what they want, and what context they are in, rather than focusing on the internal content of a product. For example, this research first conducted user studies to observe what the current spectator experience was at stadiums, and what was missing during the events. Then the research derived the usage implications of mobile personalization at LSEs. Following this, field studies were carried out to study influential contextual factors at LSEs, which can be used to tailor the behaviour of the application as appropriate. By considering users' needs according to key contextual factors, content design can maximise the user experience of the product for a specific individual within a particular usage environment.

Think of meaning, not information. Humans care less about raw data than they do about what information means to them (Cooper and Reimann, 2003). To design information content means to conceptualize users' needs into meaningful things. Data should be interpreted by the users according to their meaning to the user. Focusing on meaning, instead of information in the design of a product, means that design adapts to the user experience rather than to its internal presentation.

Consider the complexity of human behaviour. Human behaviour is rich, complex, muddled and hard to organize into rules and formal models (Robson, 1993). This concern can be tackled by designing computational behaviour directly from human behaviour. Interaction design of a product should match the information architecture of the product with the users' mental model that controls the immediate user experience (Kuniavsky, 2003). For example, the interaction design in this research was preceded by user studies undertaken to analyse the users' underlying mental models relating to what they were trying to do, and how they were trying to do it (in Chapter 6).

Maximise usability. A user-centred approach to building a product is composed of several iterations of studying with users (Shneiderman and Plaisant, 2005). By studying users, the design is able to discover and address problems that are related to user experience. For example, the design in this thesis considered multiple elements, including content, conceptual, interaction and presentation design. Each element is a project composed of activities, such as user studies, and design (in Chapter 6).

Use a multiplicity of user-centred approaches. The philosophy of user-centred research aims to improve design by linking an understanding of user experience to the design goals (Kuniavsky, 2003). It follows how an experience unfolds, and how it is articulated, however there is not a single all-purpose user-centred method (Kuniavsky, 2003). There is a range of methods, each having different strengths and weaknesses. Use of multiple user-centred approaches is suggested to produce a more complete picture and to contribute to the verification of findings (McGrath et al. 1982). A multiplicity of user-centred methods has been applied across each stage of this research (see Figure 9.8).

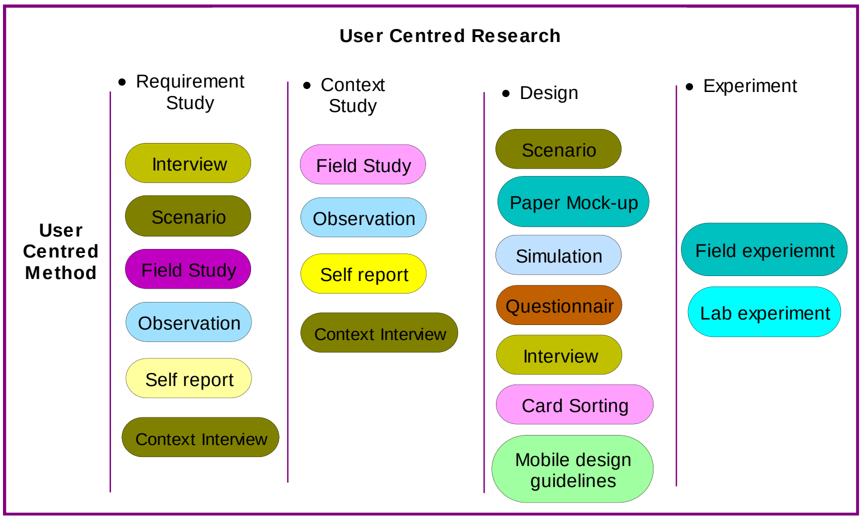

Figure 9.8 Use of a multiplicity of user-centred research methods

Chapter 4 used scenario-based interviews and field studies to provide a high-level understanding of users and to determine the design space. Chapter 5 employed field studies, which included observation, self report and context interviews, to develop an understanding of relevant contextual factors. The design in Chapter 6 used scenarios, paper mock-ups, and simulation to demonstrate the design concepts. It used interviews and questionnaires to reveal users' preferences and also card sorting to uncover people's mental models for interaction design and followed mobile design guidelines to address presentation design. Finally, both field and controlled lab experiments (described in Chapters 7 and 8) were conducted to examine the effects of mobile personalization at LSEs. Different methods supported multiple viewpoints on the research questions, which could not have been gained with a single method.

User-centred research and its multiple methods can be used effectively in explorative product design (Carroll et al. 2002). The variety of methods used in this thesis presented a case study for this approach in order to design an enhanced user experience within a specific application scenario.

9.5 Considerations of methods for evaluating mobile applications

In recent years, there has been much debate on whether mobile applications should be evaluated in the field or in the traditional lab environment (Esbjörnsson et al. 2003; Kjeldskov and Stage, 2004). This research enabled a comparison of the use of field and lab experiments, based on similar users, mobile applications and application domains. The field experiment in this research brought potential Chinese users to real sporting events to carry out task-oriented testing. It focused on examining the role of mobile personalization at LSEs. The lab experiment recreated the context of a sporting event within a lab setting and examined different approaches to mobile personalization in the context of LSEs. The comparisons between a field and a lab study are discussed below relating to the aspects of users' behaviour (Duh et al. 2006), usability problems indentified (Kjeldskov et al. 2004), user requirements discovered, the experiment settings (Kjeldskov and Stage, 2004; Baillie, 2003; Salvucci, 2001) and the communication experienced during the experiments (Kaikkonen et al. 2005).

An analysis of positive versus negative behaviours (Duh et al. 2006) was undertaken. This data included obvious interactions with the application, comments and rating scale data according to the user experience definitions. Although precise comparisons were not possible due to the variations in the two experiments, participants reacted more negatively in the laboratory setting when completing similar tasks and using similar prototypes. When in the field, they were influenced by the atmosphere surrounding the sporting event, and this resulted in an enhanced user experience. In addition, they focused more attention on the actual usage of personalization on the mobile application, rather than on issues to do with the interface. The lab setting was less engaging than the field setting; participants were more likely to be critical, and they took longer to perform certain tasks by focusing (and commenting) on interface issues, such as the fonts and colours used.

The number of usability problems identified during both the field and lab experiments were similar (there were forty usability problems with the user-initiated prototype identified over all participants in the field setting, and there were forty-two usability problems with the user-initiated prototype found in the lab setting). These findings are consistent with those of Kjeldskov et al. (2004) who state that the difference in effectiveness between field and lab experiments was non-significant in identifying most usability problems. Also, some context related problems, such as the font being too small to read in an open stadium, were identified in both experiment settings. However, differences were discovered: the lab experiment reported problems in detail related to the interface design, for example, the colours and icons on the interface. On the other hand, the field experiment identified issues of validity and precision of the data presented by the application when using the application in a stadium. It also stressed the problems of mobile 'use' rather than simply application usability, and typically these problems were expressed in the language of the situation (Duh et al. 2006).

In relation to user requirements identified, the research found that the field experiment discovered ten more requirements than the number of requirements obtained from the lab study. There were more requirements mentioned relating to the LSEs context during the field experiment, such as the presentation of event results according to the event progress.

With regard to the experiment setting, the field experiment was more difficult to conduct than in the controlled lab room, as suggested by Brewster (2002) and Baillie (2003). The field experiment was influenced by external factors, such as weather, outside disturbances, and noise, while users were impacted by things happening in the field. For example, some users were distracted from the field experiment by turning attention to the competition happening in stadium. The lab experiment, on the other hand, offered more control over the conditions for the experiment, as shown by a number of authors such as Kjeldskov and Stage (2004), Baillie (2003) and Salvucci (2001).

The field experiment provided a more open and relaxed atmosphere for communication between the researcher and users. Users talked more freely about the use of the personalized mobile applications and their feelings, as indicated by Kaikkonen et al. 2005. The field experiment assisted Chinese users (typically reluctant to communicate their thoughts) to reduce the tension of communication as they felt they were not being directly examined. Users generally held broader views and gave more information during the experiment, such as expressing contextually related requirements.

The suggestions for selecting a suitable method for evaluating mobile applications were derived, based on these comparisons. A lab experiment is recommended when the testing focus is on the user interface and application-oriented usability related issues. In such cases, a well designed lab study should provide the validity required, while being easier, quicker and cheaper to conduct. However, the results suggest a field experiment is more suitable for investigating a wider range of factors affecting the overall acceptability of the designed mobile service. Such factors include the system function and effects of actual usage contexts aspects. Where open and relaxed communication is important (e.g. where participant groups are naturally reticent to communicate), this is more readily promoted by the use of a field study.

9.6 Cultural implications of studying and designing for Chinese users

China is a vast country with an ever-increasing number of mobile users. According to statistics published by China's Ministry of Information Industry, there were 574.63 million mobile subscribers as of the end of March 2008 (China's Ministry of Information Industry, 2008), with the subscriber base more than doubling in the last five years. Designing mobile applications specifically for Chinese users is increasingly important. This thesis has demonstrated 1) how personalized mobile application design can take Chinese cultural requirements into consideration and 2) how traditional user-centred methods should be adapted for studying Chinese users.

9.6.1 Design implications for Chinese users

Information structure. To design the information architecture, it is necessary to reflect the relational-contextual style of Chinese users (Kim, 2004; Choong and Salvendy, 1998) with users understanding and classifying information according to this type of relationship. For example, users classified information according to the progress of the events they were watching. During the sporting events, users' needs were to: access event broadcasts, check event results, view athletes' information and interact with a local community. These needs were classified into one group in the design.

Highly structured content. The design content should be grouped logically, a condition which is compatible with the Chinese culture of 'high power distance' enabling users to handle highly structured information (Fu, 2007; Kim, 2004). For example, the design in this thesis partitioned the content into mutually exclusive groups with distinctive identifiers based on the prior content analysis and interaction design stages.

Consistent navigation. Consistent and predictable interface design is particularly important for Chinese users (Fu et al. 2007; Han, et al. 2007; Kim, 2004) because of the cultural influences relating to the avoidance of uncertainty - the extent to which members of a culture feel threatened by uncertain or unknown situations. For example, navigation design in this research emphasised the consistency of navigation through content and menu options.

Sharing of group information. The sharing of group information with other groups is acceptable, while sharing of individual information outside of the group is less acceptable, based on the Chinese culture of collectivism (Kim, 2004). The design should consider information of group sharing instead of individual sharing. This design consideration is described together with the privacy concern in Section 9.3.2.

9.6.2 Adaptation of user-centred methods for Chinese users

The field of HCI promotes user-centred research, which aims to improve design by linking an understanding of the user experience to the design goals (Kuniavsky, 2003). However, most existing user-centred research methods have been generated and developed in Western countries, and are based on Western cultures. A key question arises - are these user-centred methods applicable to research involving Chinese users? Most existing user-centred research methods are generated based on the premise that the methods which predominantly originated from the West are used and will work in the East (Edward, 1990). The literature neglects to detail the effectiveness of these user-centred methods when used for Chinese participants because of the cultural differences in language, cognitive style and personal and social values, which was a theme introduced in Chapter 2 (Kim, 2002; ~~Lin, 1997~~Lin, 1977; Peng, 1997; Liu, 1988; Choong and Salvendy, 1998; Cha et al. 2005; Evers and Day, 1997). Some examples of the limitations of Western user-centred methods (Kim, 2002; Fernandes, 1995; Herman, 1996; Yeo, 2001; Vatrapu and Pérez-Quiñones, 2004; Liu, 1988) were found, and have beendescribed in Chapter 3.

This thesis adapted several culture-specific, user-centred design methods which had specific relevance for the Chinese user, based on their cultural influences. These are outlined below.

In light of the Chinese culture of discouraging speech (Kim, 2002; Lin, 1977; Peng, 1997; Liu, 1988), this study employed Emotion Cards (Desmet, 2000) to facilitate the communication with Chinese users. Emotion Cards are a non-verbal self-report method to measure the emotional responses of users. They are a group of cards depicting cartoon faces with eight distinct emotional expressions, which helped the Chinese users to verbalize their attitudes and opinions and to engage in a dialogue with the researcher. Typically, a participant would select a card that best expresses his or her experience in relation to mobile personalization, which would initiate a deeper conversation with the researcher. An example is that, when interviewing Chinese users about how they felt using the mobile personalization prototypes in the LSE context, generally they would simply state that "it was okay". However, when presented with the Emotion Cards, they would pick up one emotion face and would talk more freely. The cards are quick and intuitive to use, and furthermore, they were found to be a convenient way to create an informal atmosphere in which the users felt free to discuss experiential aspects of the mobile application. Nevertheless, some limitations of the method were noted. First, the Emotion Cards were sometimes difficult to interpret by users. For example, some users interpreted the emotions of male and female faces on the Emotion Cards differently, even though they are supposed to represent the same emotional response. Second, the Emotion Cards are static facial expressions which might influence how recognisable the faces are. Research shows that dynamic facial expressions are recognised better than static facial expressions (Collier, 1985). Third, it has to be remembered that 'user experience' is a much more complicated construct than the expressions conveyed on the Emotion Cards; therefore the cards can be further developed for more accurate portrayal of feelings. The fourth problem is related to cultural variation. Since experience is a very subjective feeling, the same facial expression may mean different things to individuals with different cultural backgrounds. Instead of cartoon faces, Emotion Cards can be adapted to something more familiar to the Chinese culture, a good example of which is the emotion ticket (Chavan and Munshi, 2004). The emotion ticket is a technique that allows users to express their feelings towards technologies in India. It was designed to resemble cinema tickets, where each ticket stands for a specific emotion, in the traditional Indian culture. The Rasa appears explicitly in Hindu theatre, and the design of emotion tickets reminds Indian users of theatres, a place where they feel more comfortable about expressing emotions.

The study also created a User Advisory Board which was involved throughout the whole design process, in order to encourage users to think aloud (i.e. to verbalize their thoughts). The User Advisory Board consisted of a group of four users who had experience of mobile personalization and had watched a large sporting event in an open stadium within the preceding six months. They were aged between 26 and 31 and split equally between males and females. This method was based on the premise of Chinese users working better with those familiar to them (Yeo, 2001). The User Advisory Board is a way of achieving the continuity of users throughout the design process. The advantage of applying this method is that the participants become familiar with each other, are aware of the ongoing issues with the product, and are able to focus on new input, rather than going back over old ground. However, a disadvantage is that, after a while, the users who participate as members of the User Advisory Board will come to think like the members of the development team: they become less able to focus on meeting user needs and thinking beyond the design constraints. This limitation can be overcome by introducing new users into the design process, who then work with the User Advisory Board during design activities. These new users can be influenced by the presence of the advisory group and this encourages them to verbalize their thoughts and discuss aspects of the design, thus overcoming the traditional Chinese value of discouraging speech.

Another potential issue with a user-centred research method is that the Chinese cultural emphasis on harmony may contribute to a reluctance to express negative attitudes, because of the desire of the participant to project a desirable and pleasant image to others (Peng, 1997). The effect of emphasising harmony can be minimized by asking indirect questions and by increasing the confidentiality of users' responses during the interview. The indirect questions are structured, projective questions, whereas direct questions are structured and personal (Robert, 1993). For instance, instead of asking 'do you enjoy interacting with this mobile prototype?' a researcher can ask 'would you like to use this mobile prototype for a longer period of time? And why?'. Users who have had a positive experience with the mobile application are more likely to consider using it for a longer time than those who had a negative experience. There is strong evidence of the link between positive attitudes, the intention to use and actual usage (e.g. Venkatesh et al. 2003). Interestingly, this approach is using intentions as an *indicator* of attitudes, whereas technology acceptance models typically use attitudes as *predictors* of intentions and usage. The use of indirect questions encouraged participants to verbalise their concerns over the time and effort required to manually personalize the application, without feeling that they were being overly critical.

Another technique is to increase and ensure the confidentiality of users' responses. One way is to inform users that the data collected is kept for internal analysis, and by emphasising confidentiality, users are more likely to give honest responses, especially towards personal questions.

The 'middle way' (Peng, 1997; Liu, 1988) approach to overcoming conflicts is common for Chinese people: the emphasis is on finding 'the middle way' in which truth can be found in each of two competing propositions. To counteract this cultural tendency, the questionnaires employed after the first study incorporated an even number of points – an even-point scale - in order to force participants to make a decision to one side of the scale or the other. A by-product of this approach was that forcing participants to make more categorical statements during the design process often revealed that they could contribute more fully than they initially thought. For example, users realized that they could actually explain more reasons for their ratings on the questionnaire than they had initially thought.

The research also found that several user-centred methods were particularly useful within the specific context of Chinese culture. In particular, field studies and scenarios were shown to have benefits over and above their normal application within user-centred design.

Field studies provided a more open and relaxed atmosphere for communication between the researcher and participants in this research. It seemed to be more casual, and the users described the use of the application and their feelings more freely, as demonstrated by Kaikkonen et al. (2005). For Chinese users (typically reticent to communicate their thoughts), a field study helps them to reduce their communication tension, as they do not feel as if they are being directly examined. Users generally held broader views and could talk about things more widely.

The scenarios that were used during the experiments in this research served as a way for Chinese participants to take on the persona being described in the scenario. This helped to reduce tension as they felt that they were not being directly examined: rather it was the *persona* within the scenario that was being examined. Since Chinese users come from a high power distance culture, they may not respond as freely and openly to the interviewer (Yeo, 2001; Liu, 1988) – they feel uncomfortable being observed or being placed ‘under the spotlight’. Being provided with a scenario, users are more easily able to express their opinions and needs within a specific context.

9.7 Conclusion

This chapter has discussed user requirements for spectators at LSEs, and found overall consistency with other literature. Moreover, it also highlighted different requirements according to the different types of sports events, and these requirements can be used by the design of a personalized mobile application.

This chapter has also considered the design of personalized mobile applications which can enhance the user experience at LSEs. It discussed how contextual factors can be used to prescribe the behaviour of a personalized mobile application as also indicated by some related works. Different approaches to mobile personalization were considered here. Unlike other literature (Weld et al. 2003; Thomas and Krogsoeter, 1993), this research has found that neither user- nor system-initiated personalization emerged as a single best approach across the range of spectator activities analysed. There are four key factors to consider which can help prescribe whether a mobile application uses system-initiated or user-initiated personalization. A hybrid approach is also suggested by this research to the benefits of the reduced user interaction of system-initiated personalization and the greater specificity of a user-initiated approach.

There is lack of guidance for practitioners to incorporate user experience into user-centred design. This research considers user experience comprising multiple components – user, product, usage context, social and cultural. Those components and sub-components formed the basis of a tool for gathering user experience of mobile personalization at LSEs in this research.

By comparing experiments conducted in the field as well as in the lab, the differences are discussed from the aspects of users' behaviour, usability problems identified, user requirements discovered, the experiment settings and communication during the experiments. As a result, a lab experiment is recommended when the testing focus is on user interface and application-oriented usability related issues; a field experiment is suggested for investigating a wider range of factors affecting the overall acceptability of the designed mobile service.

Finally, this chapter has also highlighted the need for culturally sensitive user-centred design methods. Several approaches were used to maximise the effectiveness of requirements capture, design and experimentation for Chinese users, such as the use of a User Advisory Board, Emotion Cards, even-point rating scales, indirect questions, the use of scenarios and field studies. These adaptations were relatively successful in overcoming the limitations of using Western-derived methods with Eastern end-users, and it is recommended that they are considered when undertaking similar studies.

10 CONCLUSIONS

10.1 Introduction

Spectators at LSEs are often overloaded with large amount of information (Sun et al. 2005). In addition, they can lack effective social interaction with fellow spectators at LSEs (Esbjornsson et al. 2006). This research was initiated to address a potential solution to these issues - personalization of information/services delivered over mobile devices in order to enhance user experience at LSEs. It employed a user-centred approach which emphasises real users and their experience. This chapter draws together answers to the research questions tackled in this thesis, outlining the main contributions that have been developed, and identifying further research issues that have arisen as a result.

10.2 Contribution to knowledge

10.2.1 The benefits of mobile personalization at LSEs

RQ1: What is the potential for mobile personalization to contribute to the positive aspects of user experience at LSEs?

Chapter four describes two user studies which set out to understand users, their requirements and their current user experience at LSEs. These studies derived the requirements for mobile personalization at LSEs.

Several basic issues were identified which a personalized mobile application could tackle in the LSE context, in order to enhance user experience. These were (1) information flow, (2) environmental constraints, and (3) social interaction in the stadium.

Support information flow. Mobile services should provide spectators with information in a personalized way. It is important to allow users to decide what information they have access to, and when the information should be made available. Personalization should not simply push information at spectators, but should support an active engagement with the event. Personalized mobile applications should support users' control over information, and a personalized mobile application should allow users to specify their preferences over what information they want to receive.

Reduce environmental constraints. Personalized mobile services should not simply draw spectators' attention away from a sporting event, but should supplement the existing LSE context, for example, by presenting location-sensitive information/services to spectators. Also, interaction should be personalized for the stadium environment to allow impromptu interaction with the application with a low level of commitment from the user, As an example, the system can enable system-initiated personalization in an exciting environment; it can switch to user-initiated personalization during quitter moments.

Enhance social interaction. Personalized mobile services can help to create and maintain relationships in a virtual social network - this supports group co-experiencing of an event and caters to the Chinese culture of underpinning group relationships. By doing so, interaction opportunities can be proposed based on users' interests, and greater social interaction between spectators can be promoted.

A subset of the results from the second spectator experience study was published at:

Sun, X., & May, A. (2007) *Mobile personalization at large sporting events - user experience and mobile device personalization.* Human-Computer Interaction 2007, Vol.11: 293-302.

10.2.2 Influential contextual factors at LSEs

RQ2: What are the key contextual factors to be used for mobile personalization at LSEs?

Chapter five examined the main contextual factors which would influence how mobile personalization should be incorporated into the design of mobile products. It presented the results of three field studies undertaken at LSEs in the UK and China, with the aim of improving the user experience through the design of personally-relevant mobile services. These field studies investigated which aspects of context were relevant within the confines of a LSE, and how they could be used to prescribe the behaviour of a personalized mobile application.

There were 11 common contextual factors identified by participants as influencing their user experience across the three field studies. These were: spectators' preferences and interests in sports, progress of events, location in the stadium, event types, language, 'with whom', mobile screen size, nationality, public media channels present in the stadium, knowledge/experience of the user in relation to the particular sporting event, and the social atmosphere present in the stadium.

These contextual factors can be used by a personalized mobile application to enhance the user experience at LSEs. They can help to prescribe the behaviour of a personalized mobile application in terms of information content design, temporal design, information interaction design and social interaction. The design implications were based on the role that user-initiated or system-initiated personalization can play in enhancing the user experience. At a basic level, personalization can maximise the relevance of information/services to the end user by taking into account the situational needs of the spectator, and by adding value over and above other information and communication channels within a stadium. For example, personalized mobile applications can deliver information that is based firmly on spectators' sporting preferences, and the progress event of the event taking place.

Detailed results from this study were published at:

Sun, X. & May, A. (2009) *The role of spatial contextual factors in mobile personalization at large sporting events.* Personal and Ubiquitous Computing, Vol.13 (4): 293-312.

10.2.3 Design of mobile personalization at LSEs

RQ3: How can personalized mobile applications be designed to optimize user experience at LSEs?

Chapter six described the process used to design the user experience of the personalized mobile application for use by spectators at LSEs. The design process included four roughly sequential stages of design: content, conceptual, interaction and presentation design. Each stage considered multiple components of user experience, relating to the users, their culture, social environment, usage context, and the mobile product. *Content design* investigated the functionality and information of the personalized application that should be presented or made available to the user at a LSE. A content matrix was created by listing the system functions based on previous user requirement studies and the contexts which personalization needs to adapt to, derived from previous mobile context studies. Content design considered user experience components by supplementing relevant functions (user component) and enhancing the social environment (social component) in the context of large sporting events (usage context component).

Conceptual design envisioned the physical form factor of the mobile application taking into account where and how it is going to be used. To design a system which will be understandable by the intended users, a number of different conceptual ideas were generated and selected with users. Conceptual design considered user experience components by envisioning an understandable system (product component) which is compatible with the context surrounding a sporting event (usage context component).

Interaction design tried to optimise the user experience by matching the information architecture of the 'system' with the users' mental model of how information and functions are organised in the LSE context. A series of scenario-based workshops were conducted to create an early 'top down' vision of the users' mental model within a LSE context. Understanding the users' mental model of a 'system' can help lead to a user interface design based on simple interaction requiring minimal user attention in the LSE context - therefore helping to maximise the product and event components of user experience.

Presentation design prescribed the visual design of the content categories and menus that the user would see and interact with, including the means of navigating the interface. It considered the design constraints relating to (1) the limited interface (small screen and input application) and (2) the usage environment (users do not have the time or attention to navigate a complex interface or interpret ambiguous results). These design constraints were dealt with using extended tree menus, visibility of system status, and support for user control. Presentation design impacted directly on the product component of user experience, and it also took into account the cultural considerations of the end users to enhance the cultural aspect of user experience.

Each component of the UE was tackled separately during its each design stages. However, each design stage also builds on the outcomes of previous stages to maximise the other components of user experience.

The design process is described in a paper, detailed below, which is to be submitted to Design Studies

Sun, X. & May, A. (2009) *Designing the user experience for personalised mobile services at large sporting events.* Design Studies.

10.2.4 The role of mobile personalization at LSEs

RQ4: How does mobile personalization impact on user experience at LSEs?

Chapters seven and eight reported on field and lab experiments with personalized mobile prototypes. The studies found that mobile personalization could play a positive role in enriching the user experience from five aspects of user experience:

- From the *user* aspect, mobile personalization effects are: fulfilled expectations, perceived ease of use, a feeling of familiarity with the application, the sense of being in control, a feeling of personal attention, and increased fun.
- To consider the *social* aspect, the personalization causes the effects of improved social communication, acting as an ice breaker, and improves the reflection of personal identity and feelings of acceptance within a social group.
- Regarding the *usage context* aspect, mobile personalization helps users to cope with the physical event environment by delivering location-sensitive updated information/services in a stadium. This influences how much a user understands the event as well as how much a user becomes involved with the event. It also helps develop the social environment in a stadium by finding and generating groups of users who are willing to communicate and share common interests.
- In relation to the *culture* aspects of user experience, the impacts of personalization are the reflection of group identity and an increased sense of belonging.

- From the *product* (i.e. mobile application) aspect, personalization enhances perceived useful functionality as well as ease of use.

There are two basic approaches to personalization: user-initiated personalization and system-initiated personalization, and either approach is a potential solution to enhancing user experience. System-initiated personalization is more effective for tasks where: (1) the information environment is more diverse, (2) a quick real-time response is needed, and (3) the benefits of relevant services would be outweighed, to some extent, by the costs of user interaction with the application. User-initiated personalization is more effective in less distributed environments, and where the interaction costs are low in relation to variance in the possible outcomes.

A hybrid approach is likely to provide most benefits by both reducing user interaction through system-initiated personalization, and incorporating the greater specificity of a user-initiated personalization approach. The success of either approach should consider the key factors, such as factors of environment, temporal influence and personal preferences that influence the application of either approach. For some combinations of factors (e.g. large unfamiliar stadiums, and/or periods of intense activity), system-initiated personalization is preferable. In other cases, a combination of system- and user-initiated personalization can optimize the user experience

Preliminary findings from the field experiment were reported in:

Sun, X., & May, A. (2007) *Mobile personalization at large sports events–User Experience and Mobile Device Personalization.* Proceedings of ECSCW2007.

A paper has also been submitted to HCI describing more detailed findings from both field and lab experiments. It is currently under review:

Sun, X., & May, A. (2009) *The Role of Mobile Personalization in Enhancing the User Experience at Large Sports Events.* Human Computer Interaction Journal. (Submitted)

10.2.5 Implications of culture and user experience for user-centred research

RQ5: What are the key gaps in user-centred research that arise from this thesis?

One of the key gaps in user-centred research is to consider the role of Chinese culture in designing and evaluating mobile applications for Chinese users. There are important differences between Chinese and Western cultures in terms of language, cognitive style and personal and social values. Knowledge of these differences can be applied in designing the information structure, information content and navigation of a mobile application. For example, this thesis has considered several cultural design impacts on Chinese users, such as designing the information architecture by classifying information according to their relationship, designing a highly structure information, designing consistent presentation, and addressing privacy issues.

These cultural differences can also be incorporated into user-centred methods in order to design an enhanced user experience for Chinese users. Several methods were particularly useful within the specific context of Chinese culture, having benefits over and above their normal application within user-centred design. These included: the use of a User Advisory Board, Emotion Cards, even-point rating scales, indirect questions, the use of scenarios and field studies.

Another key gap is that there is not yet a common definition of user experience and there is a lack of guidance to enable designers to explicitly incorporate user experience within a user-centred design process. This has been highlighted by the recent call for papers on measurement and structural models of user experience. This thesis has summarized multiple aspects of user experience, based on the literature, which included: 1) user aspect (expectations, past experience, needs, motivation, mood), 2) the characteristics of the designed mobile application (e.g. usability, aesthetics, functionality), 3) the context of LSEs (e.g. physical context and social context), 4) social interactions occurring within the LSE context (e.g. social users, creativity in use), 5) the aspects of culture (e.g. values, beliefs). In this research, these aspects of user experience formed the basis for a tool for gathering user experience of mobile personalization at LSEs. It contributes to user experience research by exploring different ways for structuring the user experience, with an emphasis upon identifying components that enable a user-centred focus for design during the earliest stages of mobile product development.

10.3 Limitations of the research undertaken

There are number of limitations to the research undertaken in this thesis. These are outlined below:

This research only enabled personalization according to three factors (personal preferences, spectator location and sporting event) during the experiments (in Chapters 7 and 8). Although previous studies (discussed in Chapter 5) had indicated that these were the most important, other factors will undoubtedly influence the functionality and content that is appropriate for a spectator within a situated context. This limit of three factors may not be sufficient to identify the optimal way for the device to operate, and enable measurement of the complete range of impacts on the user.

Regarding the limitations of the adapted user-centred methods, this research provides only a preliminary analysis of the role of Chinese culture in adapting user-centred methods for research into mobile applications. First, there were only a small number of Chinese users involved in this research. Second, Chinese users in this study mainly came from industrial cities in the central part of China, and although some characteristics will apply across China and the Far East (e.g. desire for harmony and group relationships), others (e.g. purchasing power and conversational styles) will be more localized. Third, this study did not apply the adapted methods with non-Chinese users in order to keep focused on studying the target Chinese users. These may limit the generalisability of some of the results.

In addition, there is a potential limitation related to the way in which ‘user experience’ was incorporated into the study. User experience was assumed to comprise a number of components, relating to the individual, the ‘application’ they are interacting with, their social environment, the physical environment and their underlying culture, following the approach taken by Arhippainen and Tähti (2003) and Hassenzahl and Tractinsky (2006) in considering user experience to comprise multiple components. The attributes under each component were listed, based on an intensive literature study, and selected, based on the understanding of users and the LSE context, as explained in Chapter 4 and Chapter 5. However, the exact nature of the 'user experience' construct is unclear and there is no standard user experience measure. The construct validity and predictive power of the user experience measures are currently of particular concern, as demonstrated by the recent 'Interacting with Computers' call for papers on measurement and structural models of user experience. The lack of standard user experience measures may affect the validity of some of the results.

10.4 Reliability and validity

This research considered the issue of *reliability* through the use of triangulation (Jick, 1979). It collected similar data at a variety of times or from a number of different locations or sources. If findings replicate, this supports their reliability (Miles and Huberman, 1994). For example, the studies collected similar data on spectator experience of different events (i.e. swimming events and football events), at various times of the year. The researcher found that the same patterns occurred (i.e. a neutral spectator experience) when collecting data on different occasions, indicating that the phenomena were probably real and not the effect of chance (Jick, 1979).

This research also applied standardized data collection and design methods to yield more validated data (Robson, 1993). It employed user-centred research which entails a variety of standard methods, including questionnaires, interviews, scenario development, card sorting, and so on. Although some of the methods were adapted to the Chinese culture, most of the methods employed were the standard user-centred methods (e.g. interview, questionnaire, observation, card sorting, lab experiment, field experiment).

In addition, the research tried to hide the true nature of the studies from the participants where appropriate, and to use a data collection protocol to maximise consistency of measurement.

The *validity* of the findings can also be improved by triangulation. By using different data types (i.e. qualitative or quantitative) generated from different types of methods (i.e. interview or questionnaire), this study improved the validity of the findings (if the results from both approaches converge). For example, users' preferences were revealed in the questionnaires and could be further validated when subsequently interviewing users.

When presenting qualitative results, researchers can also draw from published literature to validate their findings (Strauss and Corbin, 1990), and this study has cited previous literature to substantiate its results. For example, the need for improving current spectator experience was in line with previous literature research (Nilsson, 2004; Nilsson et al. 2004; Esbjornsson et al. 2006; Olofsson et al. 2006; Marx and Schmandt, 1996). Some of the impacts of mobile personalization (e.g. user satisfaction, the sense of identity, feeling more capable when using mobile services) found in this research were consistent with other literature (Bonnet, 2001; Venkatesh et al. 2003; Blom et al. 2003).

Another method for validating results is to allow users to inspect findings (Miles and Huberman, 1994; Creswell, 1994). If the users agree with the interpretation, this supports the validity of the research findings, and during this research, users acted as informants as well as co-designers, while the researcher closely communicated the findings with its users.

In addition, the research tried to improve its validity by undertaking pilot studies. A universally accepted recommendation for undertaking good qulity research is that a pilot study is employed (Robson, 1993). Pilot studies help to ensure there are no unanticipated difficulties. For example, interview and questionnaire questions in experiments were pre-tested with users to check for any ambiguity in wording. In performing pilot studies, researchers can minimize the effect of unexpected problems and increase the validity of the study.

10.5 Future research

10.5.1 Method development

User-centred methods needs to be further adapted and developed, which have specific relevance for the Chinese user, based on their cultural influences. The literature neglects to detail the efficacy of these user-centred methods when used in Chinese culture because of the cultural difference in language, cognitive style and personal and social values (issues which were introduced in Chapter 2) (Kim, 2002; ~~Lin, 1997~~Lin, 1977; Peng, 1997; Liu, 1988; Choong and Salvendy, 1998; Cha et al. 2005; Evers and Day, 1997). This thesis has tried to accommodate these cultural differences by adapting several user-centred methods for the Chinese user group of interest, based on their cultural influences. These adaptations included the use of Emotion Cards, a User Advisory Board, and an even number of points on questionnaire scales. In addition, in this research scenarios and field studies were found to be particularly effective to provide a more open and relaxed atmosphere for communication between the researcher and participants.

Future studies could investigate the extent to which the influences observed in this study are replicated for different geographical areas within China and the Far East. Also it will be interesting to test the adapted user-centred methods with non-Chinese users, investigating whether the effects attributed to Eastern culture also occur with Western culture. It may be that some of the experimenter-participant effects that are relatively visible within a Chinese cultural context, are also important for Western countries but are more difficult to spot.

10.5.2 Design of personalized mobile applications

Future research needs to determine the extent to which the key influencing contextual variables can be reliably detected and used to determine personalized system behaviour. Although much context is described as indeterminable (Bellotti and Edwards, 2001), some key influences can be incorporated into interfaces that are self-adapting. In terms of internal context (particularly difficult to determine), some user preferences will be relatively stable, and transferable between different usage scenarios. For example, preferences obtained from watching webcasts on a PC may be transferable to mobile contexts. Similarly, external factors such as event type and running schedules are relatively easily determinable and useful modifiers of mobile content or functionality.

Another issue, which needs to be investigated, is privacy. This research has tried to tackle the privacy issue by allowing the sharing of group information based on the Chinese collectivism culture. However, people may have different preferences about sharing individual attributes (Olson et al. 2005), even within a group. Future research should conduct user studies to explore users’ concerns about privacy and ownership of personal data, as indicated by Heikkinen et al. (2004) and Lahlou et al. (2005). User studies can also investigate what personal information the users are willing to store on their personalized device, and in what services and use context the users are willing to use their personal information. Results from the user studies will inform on managing user privacy and the personalization of services within an intelligent environment.

This research has investigated both user-initiated and system-initiated personalization. They shared the same functionality, based on user needs at a LSE, and the same look and feel to the interface. The user-initiated interface incorporated menus that allowed the prior setting of preferences in relation to a LSE. This could occur at any stage prior to the sporting action, or even part-way through it. In contrast, the system-initiated personalized interface did not require explicit actions from the user, and was designed based on automatically detecting relevant context attributes. The design did not consider the system detection accuracy; instead it assumed that on these three attributes, the system would have a level of accuracy equivalent to that achievable through manual setting (with the exception of users' transient interests). In some situations, the desired user preferences will be highly dynamic (but still determinable), for example, as user needs change based on movement within a stadium. Future research can determine whether 'imperfect' system-initiated personalization will actually benefit the end user, or will be worse than a purely user-initiated approach in all instances.

Both of the experiments only enabled personalization according to three factors (personal preferences, spectator location and sporting event). Future research can extend the notion of context to include the other influential contextual factors discussed. This can determine how the interaction process can be simplified and user experience can be enhanced at LSEs based on the system knowing more about the user and their context.

A hybrid solution to personalization is suggested as offering the best approach to maximizing the user experience within specific usage contexts. Future work could also determine how these hybrid approaches actually achieve the balance between usability and relevance of services.

10.5.3 User experience design

There is a lot of interest in the subject of user experience from design, business, philosophy, anthropology, cognitive science, social science, and other disciplines. However, there is not yet a common definition of user experience because it is associated with a broad range of dynamic concepts, including emotion, affect, experience, hedonics, and aesthetics (Law et al. 2008).

A new challenge has emerged to define a shared definition of user experience through convergent meaning and scope. Law et al. (2008) tackle this challenge by assembling a set of existing definitions and viewpoints of user experience and collecting opinions on them from known user experience researchers and practitioners. As a result, they came up with a shared definition, however, their definition is still too general to be used as a practical tool in product design.

Future research can investigate what user experience means to a user, to help standardize and validate the measure. Flyte and Nielsen (2002) demonstrated a similar approach by conducting user studies to develop methods for understanding what was meant by ‘pleasure’ in the use of products. They looked at how users described the attributes that contribute to the experience of pleasure in using a product. By undertaking further study with users, it is possible to validate and standardize the user experience attributes that make it easier to focus effort on these aspects of mobile product design and development.

10.5.4 Design of personalized mobile applications at LSEs

Spectators at LSEs provide a unique opportunity for developers of mobile applications. For example, it was reported that around 500,000 foreign and one million domestic tourists visited the city of Beijing during the Olympics in 2008 (eTN, 2008). At such multinational events, there may be diverse sporting action taking place, as well as spectators with a range of interests, cultural backgrounds and languages. The current research has only considered user needs within the boundary of a sports stadium, and the aspect of mobility was not taken into account in this thesis. In contrast to typical personalized mobile applications, such as tourist guides (Abowd et al. 1997; Oertel et al. 2002), the users’ location within this study was relatively static, where users usually sit at the stadium while using the mobile application at real life sporting events. Future research can extend the usage scenario of personalized mobile application outside the stadium, for example, on the way to the stadium before the events, social activities after the events, and other leisure activities related to the events. Future research can also study the impact of mobility on user experience in these extended usage environments.

10.6 Conclusions

The main conclusion of this thesis is that mobile personalization plays a positive role in enhancing the user experience at LSEs. However, as the primary interest of spectators in this context is the competition taking place, the use of mobile applications should not monopolize spectator's attention from the sporting event. Mobile personalization can render the user experience more active and engaging at LSEs by supporting human-information interaction and social interaction in a stadium.

To design a personalized mobile application, neither user- nor system-initiated personalization emerged as a single best approach across the range of spectator activities analysed. There are four key factors - environment, temporal influence, personal preference and type of events - to consider which can help prescribe whether a mobile application uses system-initiated or user-initiated personalization. However, a hybrid approach can provide the benefits of the reduced user interaction of system-initiated personalization and the greater specificity of a user-initiated approach.

The concept of user experience in the use of products is complex. This study has investigated user experience from a multidisciplinary approach. User experience components in this study, which were derived from an extensive literature review, are the individual, the 'application' they are interacting with, their social environment, the usage environment and their underlying culture. User-centred research approaches were applied to improve the design of user experience by studying how an experience unfolds, and how it is articulated. It is important to recognize that user-centred methods need to be adapted to ensure that they are effective for Chinese user groups and their cultural influences.

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APPENDICES

List of appendices, by chapter:

Appendix 1A: Research schedule

Research Schedule		
When	**What**	**Progress**
Year 1	Literature studies (in mobile personalization, related work, user experience, context, culture, large sporting events, mobile HCI, user experience centred research approaches).	Done
	Research conceptual framework.	Done
	Analysis of research methods for Chinese users.	Done
	User Studies: study user characteristics, observe current spectator experience, define user requirements and imply usage pattern for personalization mobile application at LSEs.	Done
Year 2	User Studies: study context at three sporting events in China and the UK, define influential contextual factors, study the impacts of those influential contextual factors.	Done
	Design for both user-initiated and system-initiated mobile personalization: content analysis, conceptualization and user study, interaction design and user study, presentation design and user study.	Done
	Prototyping: implement the prototypes of both user-initiated and system-initiated user interface for the experiments.	Done
Year 3	Field experiment: examine the role of mobile personalization by investigating user experience under three conditions: 1) using a traditional paper-based source of information; 2) using a mobile device that provides event-based features, but no ability to personalize it; and 3) using a mobile prototype that provides features that can be personalized by the end user.	Done
	Lab experiment: compare two personalization approaches by investigating user experience under three conditions: (1) using paper-based (not mobile) content; (2) using a mobile prototype where personalization parameters were set by the user; and (3) using a similar prototype where parameters were set automatically.	Done
	Scientific document writing and publishing.	Done
Year 4	Scientific document writing and publishing.	Done
	Thesis writing.	Done

Appendix 4A: User study scenario

Scenario 1: Preparation before the event

Background: Mike just arrives at the athletics stadium.

Episode 1: Mike sets his preferences list on the mobile application for watching the athletics in the stadium.

*** Is the function needed?**

Set the preferences on the device:

not needed **definitely needed**

1 2 3 4 5

*** What kind of preference would Mike like to set for watching the athletics in sports stadiums?**

*** How could Mike set the preference list on the mobile application?**

Episode 2: Mike arrives at the sports stadium. It is a very large stadium and there are lots of people there. Mike feels uneasy about finding his seat. He asks the personalized mobile device to guide him to his seat.

*** Is the function needed?**

Guidance to location (finding seat):

not needed **definitely needed**

1 2 3 4 5

*** How does Mike want to the personalized mobile device to guide him?**

Episode 3: Mike's personalized mobile device is now connected to the stadium's network (wire/wireless). Mike's personal settings for enjoying the event are suggested for him. He sets his personal settings on the device.

*** Is the function needed?**

Get information of interest:

not needed **definitely needed**

1 2 3 4 5

*** What information does Mike want to personalize during the event?**

*** How to set the personal setting?**

*** What functions are missing in this scenario?**

Scenario 2: Watching the event

Background: Mike is watching the athletics event while getting information/services from the personalized mobile device, according to his requests in the stadium.

Episode 1: Mike cannot see everything clearly from his seat position. Mike uses the personalized mobile application to get different viewing angles, based on his location.

Is the function needed?

*** get different viewings of events:**

not needed **definitely needed**

1 2 3 4 5

Episode 2: He records some interesting moments of the athletics using the personalized mobile application

Is the function needed?

*** record interesting moments during events:**

not needed **definitely needed**

1 2 3 4 5

*** What functions are missing in this scenario?**

Scenario 3: Interactivity and social interactions during the events

Episode 1. Mike gets an alert that an athlete of interest is running the 3000 metres. He uses the personalized mobile application to view the detailed progress. After this event, he chooses to view the last 5 minutes replay, to record the replay and to send it to his community.

Are these functions needed?

*** get notifications of information of interest**

not needed **definitely needed**

1 2 3 4 5

*** watch the replay on the personalized mobile application**

not needed **definitely needed**

1 2 3 4 5

*** record replay on the personalized mobile application**

not needed **definitely needed**

1 2 3 4 5

*** build up Mike's own community in the stadium**

not needed **definitely needed**

1 2 3 4 5

*** share information with the community in the stadium**

not needed **definitely needed**

1 2 3 4 5

Episode 2. Now there is a break. The personalized mobile application notifies Mike that it is time to vote for who is the best athlete. He begins voting. 5 minutes later, the spectators' voting information is displayed on a large public screen, as well as on Mike's personalized mobile device.

Is the function needed?

*** judge and vote during the event**

not needed **definitely needed**

1 2 3 4 5

*** What functions are missing in this scenario?**

Scenario 4: Activities after the event

Background: The match is over, and the athlete which Mike supports has won!

Episode 1: Mike takes a picture of the event. When the picture is taken, the highlights of the event are added to the picture, according to his interests. Mike emails these "special pictures" to his friends via his personalized mobile application.

Are these functions needed?

*** make "special pictures" on the device**

not needed **definitely needed**

1 2 3 4 5

*** share information with friends via the device**

not needed **definitely needed**

1 2 3 4 5

*** What functions are missing in this scenario?**

Will you use the personalized mobile device for the Olympic Games (or other large sporting events) in the future?

And why?

Appendix 4B: Adapted TAM questionnaire

Please circle the answer that most clearly expresses your feeling about that particular statement. Write any comment you have below each statement.

Perceived ease of use	Strongly agree	agree	neutral	disagree	Strongly disagree
1. The mobile personalization application would be easy for me to understand.	5	4	3	2	1
2. The mobile personalization application mobile personalization application would be flexible for me to use at the sporting event.	5	4	3	2	1
3. The mobile personalization application would be easy for me to use at the sporting events.	5	4	3	2	1
Comments:					
Perceived Usefulness					
	Strongly agree	agree	neutral	disagree	Strongly disagree
6. The functions provided by the mobile personalization application would meet my needs at the sporting events.	5	4	3	2	1
7. The mobile personalization application would help me to enjoy the sporting events.	5	4	3	2	1
8. The mobile personalization application would be useful to me at the sporting events.	5	4	3	2	1
Comments:					

Attitude toward using All things considered, my acceptance of using the mobile personalization application at the sporting events is a ______ idea. Good Bad 5 4 3 2 1 Wise Foolish 5 4 3 2 1 Beneficial Harmful 5 4 3 2 1					
Comments:					
Behaviour Intentions					
	Strongly agree	agree	neutral	disagree	Strongly disagree
11. I intend to use the mobile personalization application to help me watching the sporting events.	5	4	3	2	1
12. I intend to use the mobile personalization application to help me enjoy the sporting events.	5	4	3	2	1
13. I intend to use the mobile personalization application at the sporting events.	5	4	3	2	1
Comments:					

Appendix 5A: A sample of contextual study sheet

A sample context sheet shows how the results of each context study were recorded and coded. The following sample presents only partial results of the first context study at the Accenture Loughborough International Athletics 2007 in the UK.

Contextual Factors	User 1	User2	User 3	User4	User 5	User6	User7	User 8	Total number
Preference & Interest (User Factor)	1	1	1	1	1	1	1	1	8
Event Progress (Time Factor)	1	1	1	1	1	1	1	1	8
Language (Culture Factor)	1	1	1	1	1	1	1	1	8
Location (Event Factor)	1	1	1	1	1	1	1	1	8
With Whom (Social Factor)	1	1	1	1	1	1	1		7
Mobile Screen (Infrastructure Factor)	1	1	1	1	1	1	1		7
EventType (Event Factor)	1	1	1	1	1	1	1		7
Task Status (Task Factor)	1	1	1	1	1	1			6
Knowledge (User Factor)	1	1	1	1	1	1			6
Weather (Event Factor)	1	1	1	1	1	1			6
Media in Stadium (Environment Factor)	1	1	1	1					4
Social Atmosphere (Social Factor)	1	1	1						4
Crowds (Environment Factor)	1	1	1						4
Mood (User Factor)	1	1	1						4

Appendix 6A: User-initiated personalization user interface

Pre-setting of personalization and its effects

Pre-setting can be accessed by clicking the personalization icon from the home page. The dual list box selection - left to right - organizes the personalization parameters in an extended tree menu for users to select. There are three groups of personalization parameters which a user can set: 1) location in a stadium (Figure1), 2) users' preferences and interests in sports (Figure2), and 3) event progress (Figure3). The effects of personalization are described below, relating to the five chosen functions in the design.

Function 1- Event broadcast. The personalized mobile device broadcasts the event, based on the setting of a *user's location* in a stadium.

Figure 1 Screenshots of location personalization and its effect in broadcasting an event (pre-setting)

Function 2 - Athletes' information. The information of athletes of interest is set and presented according to *users' preferences in sports*.

Figure 2 Screenshots of preference personalization and its effect in presenting athlete information (pre-setting)

Function 3 - Event results. The event results are classified into different detail levels according to the setting of *event progress*. For example, during the progress of 'peak' moments, the personalized mobile device only displays the relevant information based on *users' preferences in sports*.

Figure 3 Screenshots of event progress personalization and its effect in presenting event results (pre-setting)

Function 4 - Event schedule. The personalized event schedule is displayed by highlighting *a user's preferences and interests in sports*.

Figure 4 Screenshots of preference and interest personalization and its effect in displaying event schedules (pre-setting)

Function 5 - Community generation and activities. The personalized mobile device generates a virtual community with a group of people based on *users' preferences in sports* as well as their *location in the stadium*. The community activities include group discussion as well as group sharing, based on user requirements.

Figure 5 Screenshots of location and preference personalization in personalizing a community (pre-setting)

Figure 6 Screenshots of effects in creating a community

Instant setting of personalization and its effects

Instant setting is another approach for users to personalize at an event. Users can click the personalization icon when a service/information is presented. A transparent menu is presented and overlaps with the main body of content in order to make the most of a small screen. Its setting and effects on the five chosen functions are illustrated below.

Function 1- Event broadcast. The personalized mobile device broadcasts the event based on the setting of a *user's location* in a stadium.

Figure 7 Screenshots of location personalization and its effect in broadcasting the event (instant setting)

Function 2 - Athletes' information. The information on athletes of interest is set and presented, based upon *users' preferences in sports*.

Figure 8 Screenshots of preference personalization and its effect in presenting athletes' information (instant setting)

Function 3 - Event results. The event results are classified and displayed into different detail levels, according to the setting of *event progress*.

Figure 9 Screenshots of event progress personalization and its effect in displaying event results (instant setting)

Function 4 - Event schedule. The personalized event schedule is displayed by highlighting a *user's preferences and interests in sports.*

Figure 10 Screenshots of preference personalization and its effect in displaying event schedules (instant setting)

Function 5 - Community generation and activities. The personalized mobile device generates a virtual community with a group of people, based on *users' preferences in sports* as well as their *location in the stadium.*

Figure 11 Screenshots of location and preference personalization in personalizing a community (instant setting)

Figure 12 Screenshots of effects in creating a community (instant setting)

Appendix 6B: System-initiated personalization user interface

System-initiated personalization and effects

The system-initiated personalization detects a user's context without requiring the users' input. It presents information/services based on the relevant contextual factors: (1) location in the stadium, 2) users' preference in sports, 3) event progress). A user can choose to turn off the personalization by clicking on the personalization icon, or s/he can choose to edit the personalization parameters. The setting and its effects of system-initiated personalization relating to the five chosen functions in the design are described below.

Function 1- Event broadcast. The personalized mobile device broadcasts the event based on the detection of a *user's location* in a stadium.

Figure 13 Screenshots of system-initiated location personalization and its effect in broadcasting the event

Figure 14 Screenshots of turning off the system-initiated personalization

Figure 15 Screenshots of editing the personalization in broadcasting the event

Function 2 - Athletes' information. The personalized mobile device collects *users' preferences in sports* and displays the event information of athletes of interest during the event. Similarly, a user can choose to turn off or edit the personalization parameters.

Figure 16 Screenshots of system-initiated preference personalization and its effect in presenting athletes' information

Figure 17 Screenshots of editing the personalization in athletes'' information

Function 3 - Event results. The event results are classified and presented in different levels of detail according to the detecting of *event progress*. The brief, important information matching *users' preferences in sports* are displayed during peak moments of the event.

Figure 18 Screenshots of system-initiated preference personalization and its effect in presenting event results

Figure 19 Screenshots of editing the system-initiated personalization in event results

Function 4 - Event schedule. The personalized mobile device displays the event schedule by gathering a *user's preferences and interests in sports.*

Figure 20 Screenshots of system-initiated preference personalization and its effect in presenting event schedules

Figure 21 Screenshots of editing the system-initiated personalization in event schedules

Function 5 - Community generation and activities. The personalized mobile device generates a virtual community by detecting *users' preferences in sports* as well as their *location in the stadium*.

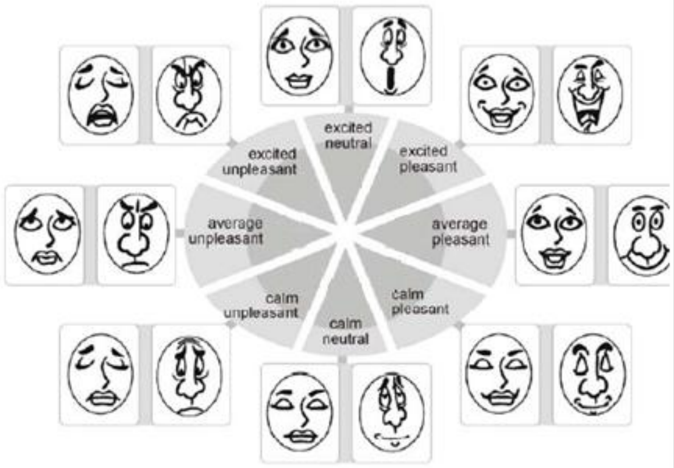
Figure 22 Screenshots of system-initiated preference personalization and its effect in creating a community

Figure 23 Screenshot of editing the system-initiated personalization in a community

Appendix 7 and 8A: A sample of a user experience questionnaire, completed after each task

The user experiences under three conditions were surveyed after each task in the experiment. A sample of one condition (i.e. user experience with the user-initiated personalized prototype) is given below.

Please circle the score that most clearly expresses your experience of using the user-initiated prototype to perform task 1.



Please explain Why:

Excited pleasant experience					Excited unpleasant experience
6	5	4	3	2	1

Appendix 7 and 8B: A sample of a user experience questionnaire, completed at the end of all tasks

The user experiences under three conditions were also surveyed at the end of the experiment. Users completed questions regarding their experiences in the multiple perspectives of product, user, culture, LSE context and social experience with the prototypes, based on literature studies. A sample of one condition (i.e. user experience with the user-initiated personalized prototype) is given below.

Please circle the answer that most clearly expresses your feeling about that particular statement. Write any comment you have below each statement.

User aspect	Strongly agree					Strongly disagree
1. I feel pleasant using the **user-initiated prototype** during the event. (literature : emotion – pleasant)	6	5	4	3	2	1
2. My expectations of the events are taken into account using the **user-initiated prototype**. (literature : expectation)	6	5	4	3	2	1
3. My motivations regarding the events are taken into account using the **user-initiated prototype**. (literature : motivation)	6	5	4	3	2	1
Reasons:						

Social aspect	Strongly agree					Strongly disagree
4. I feel the engagement of groups of people in social communication at the event using the **user-initiated prototype**. (literature: social user)	6	5	4	3	2	1
5. The **user-initiated prototype** supports me in *creating* experience with others at the event. (literature: creativity in use - sense of creating experience)	6	5	4	3	2	1
6. The **user-initiated prototype** supports me in *sharing* experience with others at the event. (literature: creativity in use - sense of sharing experience)	6	5	4	3	2	1
Reason:						

Usage context aspect	Strongly agree					Strongly disagree
7. The **user-initiated prototype** supports me while watching the sporting action in the stadium environment. (literature : physical event context)	6	5	4	3	2	1
8. The **user-initiated prototype** supports me with the knowledge, resources, and influences of others in relation to me in the stadium environment. (literature: social event context)	6	5	4	3	2	1
9. The **user-initiated prototype** supports me watching the events and participating in a social situation in the stadium environment (literature: physical and social event context)	6	5	4	3	2	1
Reasons:						

Culture aspect	Strongly agree					Strongly disagree
10. The **user-initiated prototype** supports my sense of group belonging at the event. (literature : culture emphasis on sense of group belonging)	6	5	4	3	2	1
11. The **user-initiated prototype** emphasises my group image at the event. (literature : culture emphasis on group image)	6	5	4	3	2	1
12. The **user-initiated prototype** supports group interactions at the event. (literature : culture emphasis on group interaction)	6	5	4	3	2	1
Reason:						

Product aspect	Strongly agree					Strongly disagree
13. The **user-initiated prototype** is perceived to be useful to use at the event. (literature : Perceived usefulness)	6	5	4	3	2	1
14. The **user-initiated prototype** is perceived to be easy to understand at the event. (literature : Perceived ease of use)	6	5	4	3	2	1
15. The **user-initiated prototype** is perceived to be easy to use and useful at the event. (literature : Perceived ease of use and usefulness)	6	5	4	3	2	1
Reasons:						

Appendix 7 and 8C: Field experiment data concerning user interface and user requirements

User interface of the personalized prototype

To examine how appropriate the content was personalized on the interface, the *user-initiated* personalized interface was evaluated quantitatively by calculating the percentage of tasks completed, and analyzing user comments.

The experiment recorded approximately 18 hours of video capturing the 18 subjects' interaction steps while completing each task. In summary, 95.5% of the tasks were completed successfully. The 4.5% unfinished tasks were caused by user interface problems, which are discussed below.

Based on users' comments, users showed high levels of acceptance toward the concept, and the user interface of the personalized mobile prototype was easy to use. Users' detailed comments are explained in terms of the mobile HCI literature (Shneiderman and Plaisant, 2005; Kim, 2004; Hackos and Redish, 1998; Weiss, 2002; Goto, 2006; Preece et al. 2002, Kuniavsky, 2003; Cooper and Reimann, 2003 ;):

- ***Consistency.*** Consistency is an important principle for mobile interface design (Weiss, 2002), and it was found to be particularly important for Chinese users (Fu et al. 2007; Han, et al. 2007; Kim, 2004) because of the cultural influences relating to the avoidance of uncertainty - the extent to which members of a culture feel threatened by uncertain or unknown situations. The interface design was consistent for navigation through content and menu options. In addition, design aspects such as font, size, and colour were consistent throughout.
- ***Clear information structure.*** The design content was grouped logically by grouping related functions together. It suited the Chinese users' relational-contextual style where users understood and classified information according to their relationship (Kim, 2004; Choong and Salvendy, 1998).
- ***Less interaction.*** The use of extended tree menus reduced the interaction steps, since they did have to access multiple consecutive screens in order to perform

their personalization choices. It also reduced users' cognitive loads by presenting all personalization parameters on one page.

- ***Sense of familiarity.*** The settings that were made by the users implied that the users focused attention on various features of the system. This resulted in a higher degree of familiarity with the system through discovery.
- ***Recognition.*** It was easy for users to perceive the properties of an object on the interface, matching them to what the actual properties of that object were, such as the function icons, which were found to be representative.
- There was also a ***learning process*** found during the testing. Users learned how to use the interface with a short demonstration, based on task completion, and there were few requests for help.

For those unfinished tasks, 35 usability problems with the personalized mobile prototype were reported. These are described in the following table.

Table 1 Usability problems of the personalized mobile prototype, identified during the experiment

Task	Usability problems	Frequency
Task 1: Check event schedule	Cognitive load, which concerned the amount of cognitive resources needed to use the system (Shneiderman and Plaisant, 2005). 1. The font used was Arial 8-9 to present information. It required considerable users' attention to read or distinguish, especially in the open stadium.	5 times
Task 2: Read athlete information	Ergonomics, which related to the physical characteristics of interaction (Preece et al. 2002). 2. It took too much time to set the personalization parameters when watching the football event. The ease-use-of interface affected users' willingness to personalize.	8 times
	Feedback, which concerned how the system sent information back to the user about what action had been taken and system notifications in relation to system events (Cooper and Reimann, 2003). 3. There was no clear feedback provided after a user personalized a parameter about a football player. Some users tried to set the parameters more than once.	4 times
Task 3: Check event results	Information, which was regarding what information was presented by the system at a certain time (Weiss, 2002) 4. Some users discovered that displayed information did not match the real events, such as the description of how a football player scored.	6 times
	Ergonomics, which related to the physical characteristics of interaction (Preece et al. 2002). 5. Although the user-initiated user interface was easy to use, users pointed out the negative aspect of taking time and effort to use it at a scoring moment.	5 times
	Cognitive load, which concerned the amount of cognitive resources needed to use the system (Shneiderman and Plaisant, 2005). 6. The font used was too small to read in the open stadium.	3 times
Task 4: Build up a community	Feedback, which concerned how the system sent information back to the user about what action had been taken and system notifications in relation to system events (Cooper and Reimann, 2003). 6. There was no clear feedback provided after a user personalized a parameter in setting up a community.	4 times
	Aesthetics, which referred to the look and feel of the user interface. 11. Some users preferred to use colour coding for different types of events.	7 times

User requirements of mobile personalization at LSEs

User requirements were examined to validate the requirements derived from Chapter 4. Moreover, it is interesting to see how user requirements changed in the field experiment setting (where users worked with the personalized prototype while watching the event). Data was gathered at the end of the tasks during the experiment. Users talked about the mobile personalization functions in terms of their requirements at LSEs. The results were coded according to different event progress, and as a result, user requirements gathered during this experiment covered the entire ‘required’ user requirements listed in Chapter 4 (see Tables 4.4 ~ 4.7).

Table 2 User requirements during the experiment

User requirements at LSEs	Frequency of requests
Before LSEs	
Event schedule (timetable) based on users' preferences	12 times
Athlete information based on users' preferences	8 times
Guidance to stadium location based on users' location	7 times
Map of stadium based on users' location	5 times
Ticket information based on users' preferences	4 times
Event news based on users' preferences	2 times
Locate friends based on users' location	2 times
Calm moments at LSEs	
Event broadcast based on users' location	15 times
Athlete information based on users' preferences	14 times
Replay of events based on users' preferences	12 times
Event results based on event progress and users' preferences	12 times
Generate community based on users' preferences	10 times
Community discussion	10 times
Statistics of number of people in community that support the same sport type or athletes	8 times
Explain sports technique based on event progress	7 times
Broadcast other related events based on users' preferences	5 times
Climaxes at LSEs	
Event results based on event progress and preferences	16 times
Athlete information based on preferences	10 times
Professional analysis based on event progress	8 times
Community sharing	4 times
Break at LSEs	
Event results based on users' preferences	15 times
Replay of events based on users' preferences	14 times
Event schedule (timetable)	12 times
Stadium map for food, toilets, emergency exits, police, ATMs, cheering products based on users' locations	9times
Community discussion	8 times
Community sharing	8 times
Event news based on users' preferences	6 times
After LSEs	
Event schedule based on event and users' preferences	12 times
Traffic outside stadium based users' location	10 times
Food ordering based on users' preferences	9 times
Event news based on users' preferences	8 times
Weather report based on users' location	7 times
Community sharing	6 times

Appendix 7 and 8D: Lab experiment data concerning user interface and user requirements

User interface of both personalized prototypes

Similar to the field experiment (in Chapter 7), the user interfaces of both personalized prototypes were examined to check that they were not significantly influencing the experiment outcome. Moreover, it enables a comparison of field experiment and lab experiment. Both interfaces were evaluated by calculating the percentage of tasks completed and analyzing user comments.

The experiment amounted to around 20 hours of video recording depicting the 18 subject's interaction steps while finishing each task. In summary, 93.4% of the tasks were completed successfully in the user-initiated prototype and 96.7% of the tasks were successful in the system-initiated prototype. Some interface problems were identified and discussed later.

Qualitatively, users considered that the user interfaces of both personalized mobile prototypes were easy to use. Users' detailed comments are explained in terms of the mobile HCI (Shneiderman and Plaisant, 2005; Hackos and Redish, 1998; Weiss, 2002; Goto, 2006; Preece et al. 2002, Kuniavsky, 2003; Cooper and Reimann, 2003).

Interface of *user-initiated* personalized prototype:

- Consistency. Consistent interfaces are a basic principle of good human factor design (Weiss, 2002). The interface elements such as font, size, and colour were consistent in the design, the control button was at the bottom of each menu page and the navigation status was always presented on the top of each page. This principle is particularly important for Chinese users (Kim, 2004) because of the cultural influences relating to the avoidance of uncertainty - the extent to which members of a culture feel threatened by uncertain or unknown situations.
- Clear information structure. The highly structured information grouped related requirements together. It suited the Chinese users' relational-contextual style which users understood and classified information according to their relationship (Kim, 2004; Choong and Salvendy, 1998).

- Less interaction. The use of an extended tree menu helped to organize personalization parameters together in one mobile screen which in turn reduced the interaction steps and users' cognitive load at LSEs. The semi-transparent menu, which overlaid the main body of content, also helped to minimize the interaction.
- Sense of familiarity. The settings that were made by the users implied that the users focused attention on various features of the system, which resulted in a higher degree of familiarity with the system.
- High affordance. It was easy for users to perceive the properties of an object on the interface matching to what the actual properties of that object were.

Interface of *system-initiated* personalized prototype:

- Consistency. The user interface kept the presentation consistent across different screens and consistency in the structure, which catered for Chinese users' concerns because of the cultural influences relating to the avoidance of uncertainty (Kim, 2004).
- Clear information structure. The highly structured information grouped related functions together, which took into account the relational-contextual style of Chinese users, with users understanding and classifying information according to their relationship (Kim, 2004; Choong and Salvendy, 1998).
- Navigation. The "Top-down" interaction design was appreciated to allow users get overall information at first sight; detailed information can be retrieved depending on users' selections.
- Visibility of system status. A status indicator in the design helped users to understand the behaviour of the system-initiated personalization, which reduced the uncertainty of a user during operation.
- High affordance. Users found it easy to perceive the properties of an object on the interface matching to what the actual properties of that object were.

Problems for both interfaces were also reported and are described as follows:

The problems of the user-initiated personalized prototype are illustrated in the Table 1. The problems of the interface of the system-initiated prototype are described in Table 2.

Table 1 Usability problems of the user-initiated prototype, identified during the experiment

Task	Usability problems	Frequency
Task 1: follow sporting action	Offer informative guidance, which means guidance should be substantial and understandable by the user (Shneiderman and Plaisant, 2005) 1. Users did not recognize that the personalization icon is clickable.	3 times
	Ergonomics, which related to the physical characteristics of interaction (Preece et al. 2002). 2. It took too much time to set the personalization parameters when entering the multiple athletics events.	7 times
Task 2: obtain player information	Aesthetics, which referred to the look and feel of the user interface. 3. User preferred to have vivid icons for the clickable items on the menu page, such as an athletes' information icon.	4 times
	Offer informative guidance, which means guidance should be substantial and understandable by the user (Shneiderman and Plaisant, 2005) 4. Users did not recognize that the personalization icon is clickable.	5 times
	Feedback, which concerned how the system sent information back to the user about what action had been taken and system notifications in relation to system events (Cooper and Reimann, 2003). 5. There was no clear feedback provided after the users personalized a parameter.	3 times
Task 3: review match scores	Ergonomics, which related to the physical characteristics of interaction (Preece et al. 2002). 6. It took users' time and energy to work with the prototype at the athletics events. It became a major concern about actually using the personalization.	6 times
	Aesthetics, which referred to the look and feel of the user interface. 7. Some users preferred to use different colour to display event results. 8. Some users preferred to use colour coding for different types of sporting events.	4 times
Task 4: join a community	Aesthetics, which referred to the look and feel of the user interface. 9. Some users preferred to be able to personalize the appearance, e.g. set their own colour or background in their community page.	3 times
Task 5: check event schedule	Ergonomics, which related to the physical characteristics of interaction (Preece et al. 2002). 10. It took too much time to set personalization in order to check the event schedule.	8 times
	Aesthetics, which referred to the look and feel of the user interface. 11. Some users preferred to use colour coding for different types of events.	7 times

Table 2 Usability problems of the system-initiated prototype, identified during the experiment

Task	Usability problems	Frequency
Task 1: follow sporting action	Support use of control. A fundamental cause of potential poor usability arises from the uncertainties of context recognition (Bellotti and Edwards, 2001). 1. Users were not supported with the recognition of what personalization parameters were set on.	5 times
	Ergonomics, which related to the physical characteristics of interaction (Preece et al. 2002). 2. It did not consider how users' preferences may change over time. Users' preferences varied over both a short or long timescale. For example, few users wanted to view the events according to their friends' locations in the stadium instead of their own locations.	6 times
Task 2: obtain player information	Aesthetics, which referred to the look and feel of the user interface. 3. Users preferred to have vivid icons for the clickable items on the menu page, such as an athletes' information icon.	3 times
	Offer informative guidance, which means guidance should be substantial and understandable by the user (Shneiderman and Plaisant, 2005) 4. Users did not recognize that the personalization icon is clickable. Users were not aware of the personalization status.	3 times
	Ergonomics, which related to the physical characteristics of interaction (Preece et al. 2002). 5. It did not consider a user's actual interests at the event, such as a sudden interest in a new athlete.	3 times
Task 3: review match scores	Editable, which means the interface should offer an easy way to edit the personalization attributes. 6. Some users hoped to have an easier way to edit or update its personalization parameters, for example, by 'learning' based on interaction patterns.	5 times
	Aesthetics, which referred to the look and feel of the user interface. 7. Some users preferred to use colour coding for different types of sporting events.	3 times
	Cognitive load, which concerned the amount of cognitive resources needed to use the system (Sheneiderman and Plaisant, 2005). 8. The font used was Arial 10 which was considered too small for users to read information.	4 times
Task 4: join a community	Privacy concern, which is a main consideration in applying the system-initiated personalization (Gong and Tarasewich, 2005) 9. Users pointed out the privacy concern, stating that sharing of group information with other groups is acceptable, while sharing of individual information outside the group is less acceptable.	5 times
Task 5: check event schedule	Ergonomics, which related to the physical characteristics of interaction (Preece et al. 2002). 10. It did not consider how personalization preferences may change over time, for example, some users wanted to view events which were nearby in the athletics stadium.	6 times
	Aesthetics, which referred to the look and feel of the user interface. 11. Some users preferred to use colour coding for different types of events.	3 times

User requirements of mobile personalization at LSEs

User requirements were discussed at the end of the experiment to validate the requirements derived from Chapter 4, as well as to enable the comparison between field study and lab experiment. The requirements were recorded according to the different phases of the event progress, such as before the event, calm moments during the events, climaxes, breaks and after the events. See Table 3.

Table 3 User requirements during the experiment

User requirements at LSEs	Frequency of requests
Before LSEs	
Event schedule (timetable) based on users' preferences	10 times
Athlete information based on users' preferences	8 times
Guidance to stadium location based on users' location	5 times
Event news based on users' preferences	1 time
Calm moments at LSEs	
Event broadcast based on users' location	12 times
Athlete information based on users' preferences	8 times
Event results based on users' preferences	7 times
Replay of events based on users' preferences	5 times
Generate community based on users' preferences	4 times
Community discussion	4 times
Climaxes at LSEs	
Event results based on users' preferences	12 times
Athlete information based on users' preferences	7 times
Replay of events based on users' preferences	4 times
Break	
Replay of events based on users' preferences	11 times
Event results based on users' preferences	10 times
Event schedule (time table)	8 times
Community discussion	6 times
Community sharing	6 times
Event news based on users' preferences	3 times
After LSEs	
Event schedule based on users' preferences	11 times
Traffic outside stadium based users' location	10 times
Community sharing	6 times

The results show that there were fewer requirements observed compared to the user requirements derived from the user studies in Chapter 4, as well as in the previous experiment in Chapter 7. It may be influenced by the experiment setting in the controlled lab room.

Appendix 7 and 8E: Scenario-based tasks during the experiments

Lab experiment: <u>Non-personalized mobile prototype</u>

Mike arrives late in the stadium to watch a football match. Mike uses the mobile device to found out information relating to the results of the match.

Task 1: Please found out information of interest and relating to the real-time progress of the match.

Mike is watching the football match. He wants to view some information on players that interest him. He finds out information **on players of interest via the mobile device.**

Task 2: Please find information on a particular player of interest, using the mobile device.

During a long break, Mike has nothing to do. He sees some of his neighbors playing with their mobile devices in the stadium. He uses his device to join a community.

Task 3: Please join a community and participate in community-based activities via the mobile device.

The football match has finished. Mike uses his mobile device to check the schedules of coming events.

Task 4: Please check the schedule of matches and find one of particular interest.

Lab experiment: <u>Personalized mobile prototype</u>

Mike arrives late in the stadium to watch a football match. Mike uses the mobile device to set his preferences relating to athletes and ‘event progress’. The device provides tailored information relating to the results of the match.

Task 1: Please personalize ‘event progress’ and your ‘preference relating to athletes’ on the mobile device and found out information of interest and relating to the real-time progress of the match.

Mike is watching the football match. He wants to view some information on players that interest him. He **personalizes his preferences for players** on the mobile device and finds out information **on players of interest via the mobile device.**

Task 2: Please personalize your ‘preferences for players’ on the mobile device and find out information on a particular player of interest, using the mobile device.

During a long break, Mike has nothing to do. He sees some of his neighbors playing with their mobile devices in the stadium. He uses his device to profile his personal requests in order to build up a community based on his **sporting preferences and location in the stadium**. After personalization, the community is set up for him. Mikes joins a community.

Task 3: Please personalize your ‘preferences in sports’ and your ‘location’ on the mobile device and join a community and participate in community-based activities via the mobile device.

The football match has finished. Mike uses his mobile device to check the schedules of coming events. He personalizes **his ‘preference in sports’** in order to get a personalized event schedule. Upon his setting, the mobile device presents him the personalized schedules of coming events.

Task 4: Please personalize your ‘preference in sports’ and check the schedule of matches and find one of particular interest.

Lab experiment: <u>Control condition</u>

Mike arrives late in the stadium to watch a football match. Mike finds out information relating to the results of the match.

Task 1: Please found out information of interest and relating to the real-time progress of the match.

Mike is watching the football match. He wants to view some information on players that interest him. He finds out information **on players of interest.**

Task 2: Please find out information of interest on a particular player of interest.

During a long break, Mike has nothing to do. He finds and joins a community in a stadium.

Task 3: Please finds and joins a community in the stadium.

The football match has finished. Mike checks the schedules of coming events.

Task 4: Please check the schedule of matches and find one of particular interest.

Field experiment: User initiated personalization

Mike arrives at the sporting stadium to watch a large athletic event. Mike feels the stadium is very big and there are lots of interesting things going on in the stadium. Then he connects his mobile device to the stadium to receive live TV broadcasts.

And he personalizes the suitable viewings on his mobile device **according to his location** in the stadium. Upon his setting, the device provides the personalized close up view of events to him. He chooses one which seems to be interesting to view the detail of the event.

Task 1: Please personalize your 'location' on the mobile device and select a suitable viewing angle for a live action broadcast via the mobile device.

During the events, Mike wants to view the athletes' information relating to his interests. He **personalizes his preferences for athletes** on the mobile device. Based on his settings, he views the personalized athletes' information.

Task 2: Please personalize your 'preferences for athletes' on the mobile device and find out information on a particular player of interest via the mobile device.

Mike is watching two athletes of interest running the 3000 metres. As the athletes are approaching the finishing line, Mike wants to know the current results. Therefore, he personalizes **his preferences relating to athletes and event progress** on the mobile device. Based on his settings, Mike easily reads the personalized event results **relating to athletes of interest and event progress.**

Task 3: Please personalize 'event progress' and your 'preference in athletes' on the mobile device and read information of interest and relating to the real-time progress of the event.

During a long break, Mike has nothing to do. He uses his device to profile his personal requests to build up a community **based on his sporting preference as well as his location in the stadium.** After personalization, the community is set up for him. Mikes joins the community.

Task 4: Please personalize your 'preference in athletes' and your 'location' on the mobile device then join a community and participate in community-based activities via the mobile device.

The event is finished. Mike uses his mobile device to check the events taking place on future dates. He personalizes **his preferences for sports** on his mobile device. The device provides him with the personalized event schedule as requested.

Task 5: Please personalize your 'preference in sports' and check the schedule of events and find one of particular interest.

Field experiment: System-initiated personalization

Mike arrives at the sporting stadium to watch a large athletic event. Mike feels the stadium is very big and there are lots of interesting things going on in the stadium. Then he connects his mobile device to the stadium to receive live TV broadcasts.

Then, his mobile device **detects his location in the stadium.** Mike uses the mobile device to view the broadcasting event. He chooses one which seems to be interesting to view the detail of the event.

Task 1: Please select a suitable viewing angle for a live action broadcast via the mobile device.

During the events, Mike wants to view the athletes' information relating to his interests. So he uses his mobile devices which automatically detects his sporting preference and provides him **personalized information based on his preference in athletes**. He views the personalized athletes' information.

Task 2: Please find out information on a particular player of interest via the mobile device.

Mike is watching two athletes of interest running the 3000 metres. As the athletes are approaching the finishing line, Mike wants to know the current results. The device **detects the finishing moment and provides the personalized event results.** Mike easily reads the personalized event results **relating to athletes of interest and event progress.**

Task 3: Please read information of interest and relating to the real-time progress of the event.

During a long break, Mike has nothing to do. He uses his mobile device which automatically sets up a **personalized community for him based on his preference in sports as well as his location in the stadium.**

Task 4: Please join a community and participate in community-based activities via the mobile device.

The event is finished. Mike uses his mobile device to check the events taking place on future dates. His mobile device automatically provides him a **personalized schedule list based on his preference for sports**.

Task 5: Please check the schedule of events and find one of particular interest.

Field experiment: <u>Control condition</u>

Mike arrives at the sporting stadium to watch a large athletic event. Mike feels the stadium is very big and there are lots of interesting things going on in the stadium. He views the event.

Task 1: Please find a suitable viewing angle for a live action.

During the events, Mike wants to view the athletes' information of his interest.

So he finds out the athletes' information.

Task 2: Please find out information on a particular player of interest via the mobile device.

Mike is watching two athletes of interest running the 3000 metres. As the athletes are approaching the finishing line, Mike wants to know the current results. So he finds and reads the information relating to the real-time progress**.**

Task 3: Please read information of interest and relating to the real-time progress of the event.

During a long break, Mike has nothing to do. He finds and joins a community in the stadium.

Task 4: Please join a community in the stadium.

The event is finished. Mike checks the events taking place on future dates.

Task 5: Please check the schedule of events and find one of particular interest.