FINDING THE APPROPRIATE TEST CONTEXT FOR MOBILE APPLICATION PROTOTYPES - A DECISION MODEL BASED ON A CASE STUDY

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1. Introduction

During the last few years, mobile devices have had an increasingly significant impact on our globally connected world. In only three decades the number of active mobile devices went from zero to 7.2 billion devices [Cisco 2014]. Research predicts the usage of mobile devices will replace desktop systems in many areas [Cisco 2014], i.e. mobile devices are becoming the primary way for people to access the internet. Thus, especially for mobile consumer applications the market has become extremely competitive. In this market delivering high quality software which addresses the user's needs and has an appealing interface becomes a competitive advantage.

Consequently, companies are adopting user-centred approaches to achieve a good user experience for their products. The main focus of user-centred approaches is to shift from traditional design that is driven by technology, to an approach which has an ongoing focus on customer and stakeholder needs. This is achieved by emphasizing the validation of prototypes with varying levels of fidelity with end users early on in the process. However, there is still little experience on mobile testing and standardized approaches and tools are not yet established [Hornbaek 2006], [Coursaris and Kim 2011].

This paper investigates the current state of testing mobile application prototypes in the software industry. Based on 25 qualitative interviews, a case study with SAP SE, Microsoft Corporation and Nokia HERE evaluates the current approaches to mobile testing and existing challenges. Key aspects of the case study are discussed and based on the findings a decision model to find the adequate test context for a mobile application prototype test is presented. The paper is structured as follows: Section 2 provides an overview of related literature and defines terms relevant in this paper. Section 3 describes the research setup. The case study is presented in section 4 and discussed in section 5. Section 6 describes the decision model while section 7 closes the paper with a summary.

2. Background and definitions

Usability studies for mobile applications have different characteristics compared to usability studies for desktop software [Nielsen and Budiu 2013], which makes testing for the rising amount of mobile applications challenging. Traditionally testing for desktop software is conducted in a controlled lab environment, while current research emphasizes the importance of an original test context when it comes to testing for mobile applications. Moreover, the intention behind the usage of a mobile application is different and often based on interaction with the environment. In contrast, the setting for a desktop system is relatively fixed. In fact, mobile devices also have additional technical limitations to testing; for instance, smaller screen sizes. On the one hand, this makes it more difficult for researchers to observe

interactions on the device when in an original mobile context. On the other hand, there are technical difficulties to record the screen. Additionally, natural influences on mobile devices such as limited network coverage or limited memory capacity apply, when testing in a real context. Taking all this into consideration, the test setting for mobile application prototypes needs to be different than the setting for desktop software. Thus, two fundamental aspects, need to be considered for mobile application prototype testing. First, the applied research methodologies need to incorporate various influences and factors caused by the different environments. Secondly, existing tools and test settings have to be adapted according to emerging requirements.

Coursaris and Kim, created a comprehensive meta-analytical review of more than one hundred empirical mobile usability studies, both in a lab environment and in the field [Coursaris and Kim 2011]. They emphasize to be aware of limitations for lab-based research and to conduct research for mobile products in a real context, which is not simulated [Coursaris and Kim 2011, p.131]. Additionally, Krannich proposes a tool-based model for rapid prototype testing in a real context [Krannich 2010]. Along with this proposal he provides a comprehensive discussion about mobile contexts [Krannich 2010, pp.109] and mentions two dimensions: the cognitive dimension, and the situational dimension relevant to the mobile context [Krannich 2010, pp.116]. Coursaris and Kim suggest a framework for mobile usability testing, which bases context on four variables: user (knowledge, experience, perception), environment (physical influences), technology (device type, interface, input mode), and task (open vs. closed) [Coursaris and Kim 2011, p.121]. Their model can be tied to the two dimensions defined by Krannich. The influence of the context on mobile applications is investigated by Tamminen [Tamminen et al. 2004]. A high physical influence is present for a use case when at least one influence factor such as light, noise, etc. interferes strongly or multiple influence factors interfere simultaneously with it.

2.1 Definitions

The understanding of the terminology prototype is very broad in related literature. It ranges from a sketch on paper to a pre-version of a product. In software engineering, three artefacts are related to the term prototype: wireframes, mock-ups, and proof-of-concepts. For this paper, the term prototype refers to artefacts from very low- to high-fidelities simulating the software's user interface on a mobile device. In this Paper a mobile device is considered to be transportable to different contexts and have a built-in touch screen, e.g. smartphones or tablet devices. Due to interaction patterns similar to desktop systems, devices with fully equipped keyboards, such as laptops and 2-in-1 devices used in laptop mode, are excluded from this definition.

Dey et al. provided the following general definition of context: "any information that can be used to characterize the situation of entities (i.e., person, place, or object) that are considered relevant to the interaction between a user and an application, including the user and the application themselves" [Dey and Abowd 2001]. In this paper, mobile context adheres to this definition and thus, includes all environmental influences as well as any cognitive influences of the user.

3. Research setup

The case study presented in this paper is based on a total of 25 interviews with employees of three companies and several on-site visits that allowed for observations and discussions with further employees. The aim of this research is to investigate how software companies use mobile application prototypes in their development processes and to identify existing challenges with regard to mobile testing.

Case company selection was based on two criteria: companies should be large, with at least 500 employees and have several hundred employees involved in software development. The following three companies were selected for this research:

1. SAP SE is the 3rd largest software company in the world. SAP's core business is standard business software, which is entering the mobile market fast.
2. Microsoft Corp. is the world's biggest software company, offering a variety of software products for consumers and enterprises, as well as its own operating system for mobile devices.
3. Nokia HERE is highly experienced with products for mobile devices since its core business focuses on maps and location based services.

Employees performing end user engaging activities, such as user researchers or user experience designers, were identified as meaningful interview partners. Table 1 provides an overview of interview partners including their roles and experience in the respective companies.

Table 1. Overview of interview partners

Company	Count	Role	Experience
SAP SE	3	User Researcher	> 10 years
	4	UX Designer (incl. experience, interaction and Visual design)	> 10 years
	5	Tech Person (i.e. prototype developer, architect, team lead)	> 5 years
	4	Design Thinking experts	> 5 years
Microsoft	3	UX Researcher	> 10 years
	1	Design Researcher	> 5 years
	1	Tech Person	> 10 years
Nokia HERE	2	User Researcher	> 5 years
	1	UX Designer	> 5 years
	1	Visual Designer	> 5 years

The interviews were conducted according to a semi-structured interview guide to allow for a comparison between the case companies and to ensure similar topics are covered in each session. The interview guide is composed of 4 sections:

1. A general section asking the participants to describe their position and work in the company
2. A section asking about prototyping and testing in general
   a. When during the process are prototypes testes and validated?
   b. What type of prototypes are used?
   c. With whom are these prototypes testes and validated?
   d. What does the process of testing look like?
3. A section about the test environment for mobile devices
   a. Which products are optimized for mobile usage?
   b. In what context are tests conducted?
   c. In which settings are tests conducted?
   d. Which data sources are recorded?
   e. What are the characteristics when it comes to testing of mobile prototypes?
4. A section about mobile application prototypes
   a. How are prototypes for mobile devices tested?
   b. How does the testing process change, when testing mobile application prototypes?
   c. What are the challenges?

If possible, interviews were conducted in person at the workplace to understand the context and make observations as well. However, due to huge distances, some interviews were conducted via phone or conference tools. When evaluating recordings and handwritten notes, an anonymous reference was added to each statement to ensure traceability. Then statements were clustered according to topics from the interview guide. Resulting in Clusters on the development process and roles included, the understanding of prototypes, (mobile) research methodologies, (mobile) data collection, (mobile) test setting, and challenges.

If not stated otherwise, statements made in the following case study are based on one or more interviews or observations made during the on-site visits and interviews.

4. Case study

Mobile application prototype testing is done to different degrees at the case companies, with Nokia having the most experience and actually experimenting with testing in the field. All interviewees agree on the importance of context for testing mobile application prototypes, but mentioned a conflict with

time and budget constraints when it comes to implementing mobile application tests and usability studies.

All companies work with prototypes of different fidelities including wireframes, clickable dummy prototypes and beta versions of applications. Nokia interviewees even reported about the usage of interactive paper prototypes for mobile applications. These prototypes have a cardboard frame with a cut out screen which represents the mobile device. The different screens in the form of sheets of paper are placed behind the frame to allow scrolling and to make the prototype feel more realistic. However, testing the interaction on paper is only possible to some degree. Therefore, interactions are tested with digital prototypes. These prototypes can be constructed with various tools and are usually based on web technologies that can be presented easily on a mobile device. Interviewees mentioned technical problems while viewing and testing such interactive prototypes on an actual device. One problem is the different rendering on different devices, resulting in free space or blur.

4.1 Mobile context

As mentioned before interviewees agreed on the importance of context for mobile application testing. Accordingly, researchers at all case companies aim to test mobile application prototypes at least on the actual device. However, the influence of the mobile context, depends on the purpose of the application and the test to be done. Thus, researchers from SAP SE, Nokia HERE and Microsoft mentioned cases, where the context is unimportant to the test e.g. the positioning of elements.

4.1.1 Application type and context requirements

Mobile applications provided by SAP are in general business related enterprise applications. Which makes their context universal in contrast to specific apps e.g. navigation apps as developed by Nokia HERE where the context of usage is more obvious. In order to provide the right context for enterprise applications real data accessibility is an issue to consider, as it can have a great effect on the usability and test experience.

Microsoft Interviewees stated the importance of testing mobile application prototypes in a mobile environment, because people might notice and understand things differently in a lab environment than they would in the real context. For productivity apps, the context relevance actually increases with the number of other apps used in conjunction, because it becomes important to understand the interaction between apps in a real context. In contrast, the context is not crucial for the experience of games and other entertainment apps, since people are usually sitting down somewhere focused on playing.

Nokia HERE mainly provides maps and location-based services through a variety of products for both mobile and desktop devices. The map service is a very good example of an application where the context is crucial to the user experience. Consequently, interviewees stated that the real context is very important which makes the test setup much more complicated. In order to establish a real context even in a lab environment, researchers try to accommodate the content to fit the current location of the lab. For location-based functionality and scenarios, the location should be in the vicinity of the address of the lab to provide valid content. This is of high importance as test participants might be familiar with the area and interviewees reported that inconsistencies can interrupt testing and confuse the participants.

4.1.2 Physical and cognitive environment

Researchers from Microsoft reported the physical and cognitive environment as critical to truly evaluate the usage and user experience of a mobile product. For the interviewees this constitutes the biggest difference and difficulty of mobile application prototypes testing as opposed to testing desktop applications. Physical influences such as noise, movements and interaction with other people, are hard to control, regardless of the application type. However, the impact on the usage of the application depends on the use case. Additionally, the cognitive environment in which people are using mobile products is important because, as opposed to desktop software, people are doing other things besides, are distracted and only have a limited attention to the application.

Researchers at SAP also mentioned the physical context as significant for tests on the usability and accessibility of a prototype, because of influences such as light, noise, and so on. A specific example mentioned is the evaluation of applications with respect to network coverage. In cases were data

connectivity is relevant to the application in terms of behaviour and experience, proof of concept implementations are tested with different simulated network throughput, i.e. WLAN, 3G and EDGE.

4.1.3 Device variety

Researchers from all companies mentioned the device variety and especially screen sizes as a big challenge in mobile application porotype testing, that cannot be addressed manually. There is a huge device fragmentation due to screen size, platform, operating system, etc.

Especially at SAP standard software is often based on universal technologies such as HTML5 and not on one specific platform. Therefore, testing a variety of devices in different combinations of operating system, version, screen size, and device class leads to an enormous set of possibilities. It is absolutely not economical to test such a variety manually. Interviewees mentioned a matrix based approach to cover a broad range of devices when testing. For this approach devices are clustered and organized in a matrix to test at least one device out of every device category based on the expertise of the testers and a checklist which serves as a script. On the other hand, it can also be challenging to test prototypes that were created for a specific variation, as reported by Nokia researchers.

4.2 Mobile testing environment

According to our interviews, none of the companies already have standardized tooling, test setups or protocols for mobile application prototypes. Therefore, researchers at all three companies decide about test setup and tooling based on their experiences, the research question, and others factors such as time and budget. For experience studies, testing on the actual device is seen as the minimal test context for mobile application prototypes, due to interaction patterns specific to the device.

At Microsoft a conflict between the importance of a real context and the limitations of reduced context due to test setting or fidelity of the prototype, especially in a low-fidelity prototype, was mentioned repeatedly. Prototypes are usually presented on the actual device, regardless of the fidelity, even for internal design reviews. However, low-fidelity prototypes are lacking context relevant properties and look and feel.

At Nokia the platform and the experience of the user were mentioned as important consideration in mobile tests. Both have a huge influence on the interaction, because each mobile platform uses different patterns. Therefore, the platform, and experience of a user are selection criteria for test participants testing mobile products.

In all three companies, cases were mentioned, that do not require the actual context and can easily be tested in a lab environment or even with a desktop setup. SAP interviewees mentioned testing the information architecture as having a small contextual influence, which makes it unnecessary to test on the device itself. Microsoft interviewees mentioned classical settings for usability studies as sufficient for studies on mobile devices regarding the positioning of elements. Another example mentioned are gaming and other entertainment apps where the context is not crucial for the experience, since people are usually sitting down somewhere and are focused on playing.

Researchers at SAP and Microsoft stated that using emulators for mobile testing might sound useful for prototypes which are not in a state to run on the actual device. However, in both companies, the interviewees agreed that emulators are not suited for the purpose of mobile testing. At Microsoft emulators are not used at all anymore, while at SAP emulators find an application in remote prototype presentations.

4.2.1 Field tests

Experiences with Field test were rarely mentioned during our interviewees. From all case companies we heard that it takes a lot of effort and resources to conduct studies in a real environment.

At Microsoft it is common to primarily take notes and in addition photographs to capture the scene in field tests. Additionally, a setup was mentioned, where a camera is installed for filming the interaction, the hands and how people hold the device. This was not experienced as practical for field studies, because it interferes too much with participants.

Nokia researchers seemed to have the most experience with field studies. According to our interviewees, some prototypes require testing in a real context. Therefore, researchers experimented with two technical settings for field test in a real context:

1. Participants were equipped with a GoPro camera mounted on their heads to record from the point of view of the participant.
2. In the other setup, a moderator follows the test participant closely with a video camera connected to a notebook, which streams the video signal to another screen. Thus, the observers following the participant at a distance can see the interactions on their screen. This setup is experienced as complex and unreliable and the public setting influences the participants significantly.

In contrast to the Microsoft interviewees, Nokia interviewees stated that for tests in a real context recording becomes more important for the later analysis, because note taking and close observations are often limited.

4.2.2 Lab test

From our interviews it seems that lab-tests on the actual device are the most common form of mobile application tests. In such situations it becomes important to record the screen of the mobile device. In our interviews four setups to record the screen of mobile devices during lab-test were mentioned by interviewees:

1. Mirroring the screen of the device on a second bigger screen or another device that can be observed by the researchers is conducted at all case companies. Researchers agreed that in this setup, visualization of the interactions are often missing on the mirrored screen. Additionally, Nokia researchers mentioned that it is challenging to merge audio and screen capture afterwards.
2. At all three companies the screen is sometimes recorded with a camera mounted onto the device. All interviewees agreed that this setting interferes and influences the user behaviour, which makes it problematic to use in cases where the context is critical to the experience.
3. Recording the screen with a video camera, by asking the user to keep the device within a certain box-shaped area marked by tape was reported from researchers at Microsoft and SAP SE. A camera is focused on this area to record the interactions between the device and the screen. With this setup the user sometimes covers the screen with his hand and it feels unnatural to keep the device within the box.
4. At Nokia, the existing camera setup of the usability lab is used for mobile tests as well. In this setting, the cameras have to follow the screen of the device; which is prone to failure.

Nokia Researchers try to keep the behaviour as close as possible to the natural user behaviour, even in a lab environment. In addition to the technical changes described above, the prototype needs to be presented on the actual device as naturally as possible. This means a presentation in full screen mode without gesture recognition by the host application used for presentation of the prototype.

4.2.3 Remote and unmoderated Testing

Remote testing was described by interviewees from SAP and Nokia HERE. SAP carries out remote presentation and feedback session, because they provide easy access to customers and stakeholders. For such sessions the mobile device is connected to a stationary computer through a VGA adapter and the screen of the device is mirrored to the computer and shared via a conference tool. In this setup user interactions are not visualized, thus, the presenter needs to explain exactly what interactions are performed. This setup is actually not a user test since the adapter connection limits the mobility of the device significantly, but it helps in getting quick feedback. Additionally, Prototyping departments perform unmoderated testing by sending a prototype version to a stakeholder and asking for feedback. It is seen as beneficial to record the audio for such tests. When it comes to testing mobile application prototypes remotely additional challenges arise, such as tracking interactions or giving control of local prototypes to the participant via conference tools. According to the interviewees, remote testing is the least preferred way to conduct tests with mobile application prototypes, but it is often unavoidable.

Nokia does remote testing for web applications in a beta stadium and also aims to adopt this for mobile application prototypes. The professional provider used for remote testing also offers mobile testing, but interviewees mentioned confidentiality concerns with regard to mobile applications. In fact, test

participants need to install a beta application on their device to test it, instead of opening a link to test a web application. In contrast to a lab situation, it is impossible to check whether the user takes screenshots or videos secretively. If Nokia works on sensitive unpublished products, even uploading prototypes to an external server is seen as critical and an endangerment of confidentiality. Therefore, Nokia is working on an extra level of security to be built into those beta applications. This will restrict access after an expiration time. Remote testing for mobile application prototypes was mentioned to be beneficial, although it requires more effort in terms of confidentiality.

4.2.4 Data Collection on mobile devices

Researchers from Microsoft and SAP reported difficulties with data collection on mobile devices. SAP researchers pointed out that touch points of the user's interactions with a mobile prototype are not visible to the researcher. This especially applies if the prototype is mirrored to another screen. For desktop testing, the mouse movement of a user was an important indicator of the user's focus. This information is missing especially in recordings. Moreover, there is much more movement on mobile prototypes to observe, in contrast to single clicks and simple scrolling on desktop prototypes.

Additionally, Microsoft interviewees expressed difficulties to collect data on mobile devices, especially constant video or screen captures. Constant video streaming is often dependent on hardware, other tools that collect this kind of data, or developers to integrate the respective code into the prototypes. Furthermore, there are no possibilities to integrate such code into low-fidelity prototypes. To capture what is on the screen of a mobile device with video data, specific video equipment and more control are required. Another challenge mentioned by Microsoft interviewees is that some behaviour occurs so infrequently, that it is not possible to observe it in a worthwhile manner in field or lab-based studies.

4.3 Summary

Researchers at all three companies try to at least test mobile application prototypes on the actual device. For lab-based testing, it could be observed that existing tools and setups, developed for desktop testing, are adapted to the requirements of mobile application prototype testing. The most common approach seen was to mount an additional camera directly onto the device in order to capture user interactions with a prototype. Another variant, seen at SAP and Microsoft, asks the users to keep their mobile device in a defined area with camera focus. So far, mobile application prototype testing in the field with the real context has rarely been done. A reason mentioned was that settings are too complex and tools not yet suitable.

Overall, the findings from the case study with SAP SE, Microsoft Corporation and Nokia HERE comply with the related research presented in section 2. Showing that issues and challenges still exist and the importance of context and its different dimension are still valid.

5. Discussion

The case study presented in the previous section 4 identified gaps regarding both the tooling and the methodology for mobile application prototype testing's. Current tools are merely adapted to the specifics of mobile application testing, however the "ideal" scenario of testing such applications in the field while being able to observe all necessary behaviour cannot be achieved as it is too technically complicated and too costly in terms of time and resources. A proposal for a tool that addresses some of these challenges and aims to support testing of web based mobile prototypes including low fidelity wireframes is discussed in [Meyer et al. 2016].

However, some of the challenges mentioned by the interviewees cannot be solved by tooling alone. As pointed out, even for experienced experts in the field of research and prototype testing there is no standardized processing for such projects. Decisions regarding prototypes and their execution context are mainly based on the experience of these expert. Thus, this research synthesizes best practises of industry experts to provide a practical decision model to novice researchers and people newly involved in prototype testing.

Projects in an enterprise environment most often work against budget and resource constraints. Such a tool will help to determine the right test context and help to make grounded decisions about effort and

resource distribution. Moreover, this might be used as basis for argumentation to decision makes and management.

6. Decision model

As mentioned in all three case companies and related research, the context a mobile application prototype or application has to be tested in becomes an important consideration, in order to ensure reliable results. As defined in section 2.1 the mobile device can be moved around and thus can be executed in an infinite variety of contexts. Dependent on the circumstances in which it is used, i.e. a task a user needs to perform, and the scope of application attributes, the context is more or less substantial for the user experience.

Table 2. Definition of context classes for testing mobile application prototypes

Class	Context	Description
A	no mobile context	the context is independent from a mobile device and can be conducted in a laboratory, conference room, etc.
B	on the actual device	the prototype is executed on the mobile device
C	original environment	the real situation and environment as it is typical for the use case are applied for the test

Based on the interview results and knowledge gained out of related research, a decision model has been developed, which will help novice researchers to determine how a mobile application or prototype should be tested. Additionally, the tool can help researchers to argument their decisions or a larger amount of required resources with management. In this model, the right choice of test setup, which is acceptable and keeps the effort as low as possible depends on three criteria: the research goal, the degree of influence on the application by the surroundings and the type of application. For the decision model three possible context classes for a user study or test were identified. The classes are depicted and described in Table 2.
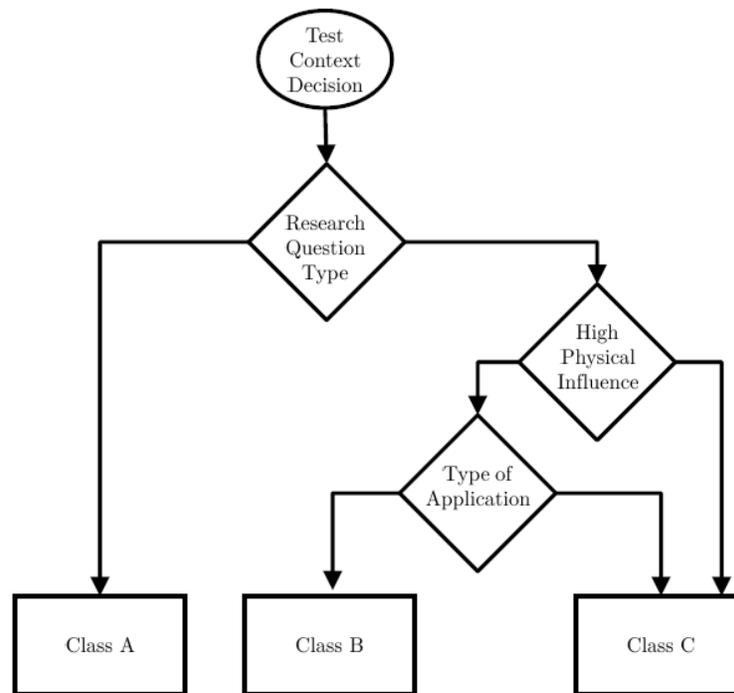

Figure 1. Decision model for an appropriate context class

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Figure 1 depicts a decision tree with three nodes representing the decision criteria for choosing the appropriate test context: research question, degree of physical influence, and application class.

A first decision can be made based on the type of research question. As research experts explained questions regarding the information architecture, functionality completeness or technical feasibility do not require a mobile context and often not even testing with end users. Thus, these kind of research questions fall into class A. For other research questions, i.e. regarding interaction or usability, the test context depends on the influence of the environment on the use case and on the application type.

The level of influence from surroundings, such as noise, movement, etc. on the application can vary from low to significantly high influence. If the physical influence on the use case is high, end user tests should be conducted in class C, the real context. If, however the physical influence is low, it depends on the application class whether a prototype should be tested in class B or C.

Required cognitive focus

	High	Medium	Low
None	B	B	C
Partial	B	C	C
Full	C	C	C

Content dependency

Figure 2. Classification model for mobile applications according to content dependency and required cognitive focus

As depicted in Figure 2, nine mobile application classes can be defined along two dimensions:

1. Content dependency: Degree to which the content and information displayed by a mobile application are modified in dependence to the context the application is executed in. There can be no, a partly or full dependency on the content. For instance, an ordinary game application has no content dependency because the game functions exactly identical and displays the same information regardless of the execution context. Whereas, for example, a maps application is as a location based app fully dependent on the environment, also functionality might change depending on the context. Partly dependent applications lie in between these extremes and might display different data depending on the execution context.
2. Cognitive focus: Degree of cognitive attention which is required to use an application in order to achieve the intended goal. A mobile game requires frequent interaction and thus needs a high cognitive focus to succeed. A medium cognitive focus is required when the interaction with an application is infrequent, i.e. an app is used in conjunction with other apps. Applications which are intended to be used simultaneously to other activities require a low cognitive focus, e.g. using a navigation app while driving.

When the content and environment are independent testing in class B is sufficient for a high and medium cognitive focus, as the influence of the environment on the user is limited. However, if the focus is low, and other actions the user is performing at the same time become relevant, the real context is required for testing. Apps with partly dependent content and high cognitive focus can still be tested in class B

because some aspects of the test context can be simulated without influencing the experience too much. However, if the cognitive focus for such an app is only medium or low, test should be of class C and provide the real context. As soon as the content fully depends on the environment, tests should be conducted in the real context.

As evident from Figure 2, the suggested class C is widely applicable for many cases. However, this model only provides a suggestion, and the final decision has to be made by the responsible researcher, taking other aspects, i.e. time and budget constraints into account. There might be cases where it is not possible to conduct the test in the real context, even though the decision model suggests class C.

7. Summary

This paper presents a case study on mobile application prototype testing based on interviews with employees of three major software companies. The case study discusses the current state of testing mobile application prototypes and respective challenges present in the companies. Naturally, researchers apply different methodologies in different companies and even in different departments of the same company. Therefore, the findings might not apply to all departments in the case study companies or to other companies from the software industry. However, the challenges and methods described by our interviewees match the findings from related literature as described in section 2.

In general, researchers in the case companies are aware of the importance of context when testing and the benefits of testing in the real context. However, cost and time issues often require lab-based or even remote testing. Based on this situation and statements from the interviewees the paper presents a decision model aimed at finding the appropriate test context for a mobile application prototype, based on research goal, level of physical influence on the use case of the prototype and the type of application with regards to cognitive focus necessary and level of dependency between content and environment. Overall three possible test context classes for mobile studies are defined:

- Class A - Testing without any mobile context (Lab-based or remote Studies)
- Class B - Testing on an actual mobile device (can be lab-based or remote), and
- Class C - testing on the actual device in the real context (Field Studies)

References

Cisco, "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2013-2018", 2014.

Coursaris, C. K., Kim, D. J., "A meta-analytical review of empirical mobile usability studies", Journal of usability studies, Vol.6, No.3, 2011, pp. 117-171.

Dey, A. K., Abowd, G. D., "A Conceptual Framework and a Toolkit for Supporting the Rapid Prototyping of Context-Aware Applications", Human-Computer Interaction, Vol.16, No.2, 2001, pp. 97-166.

Hornbaek, K., "Current practice in measuring usability: Challenges to usability studies and research", International Journal of Human-Computer Studies, Vol.64, No.2, 2006, pp. 79-102.

Krannich, D., "Mobile Usability-Testing - Ein toolbasiertes Vorgehensmodell zum Rapid-Prototyping und Usability-Testing von Mobilen Systemen im originären Benutzungskontext", Dissertation Universität Bremen, Fachbereich 3 (Mathematik und Informatik), 2010.

Meyer, S., Häger, F., Uflacker, M., "Enhancing Early Mobile Application Prototype Testing: Requirements analysis through interviews and a System Design ", submitted to Norddesign, 2016

Nielsen, J., Budiu, R., "Mobile Usability", New Riders Berkely, USA, 2013.

Tamminen, S., Oulasvirta, A., Toiskallio, K., Kankainen, A., "Understanding mobile contexts", Personal and Ubiquitous Computing, Vol.8, No.2, 2004, pp. 135-143.

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