Developing an Engaging Local Community Application as a Tool for Promoting Social Integration

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Abstract

This thesis firstly presents the exploration of an engaging user interface and navigation design for local community mobile applications. Furthermore, it seeks for the best suitable tool for both rapid prototyping and production development. The research and content is structured based on design and creation research methodology which is a user-centric and iterative process. To evaluate the suggested interface design and the selected tool, an interactive prototype was developed in this thesis. The results argues that card-based user interface and navigation design has the potential to enhance user engagement. In addition, AngularJS as the selected tool is a suitable framework for rapid prototyping as well as production development.

**Keywords**: Local community mobile applications, User interface design, Prototyping, Production development, JavaScript
Popular science summary

An individual or a group is considered socially excluded if they are denied the opportunity of participation in the common social activities experienced by the majority of citizens in their community, whether they actually desire to take part in or not. Information and Communication Technologies (ICT) can have a beneficial impact on tackling social exclusion through different dimensions. ICT applications can develop social networks by formation of virtual communities. People can make connections with their peers and build relationships with people who have similar interests. However, one of the elements missing in ICT aiming at tackling social isolation is lack of user engagement. Hence, this thesis explores an engaging user experience for local community mobile applications.

User interface design is one of the main elements to provide an engaging user experience. In addition, the key factor to achieve a positive user interface is prototyping through an iterative approach. Therefore, this thesis investigates the best suitable user interface design for local community mobile applications. It also seeks for a framework that while is efficient, easy and fast for prototyping in early phases of the process, it also supports programming capabilities for developing production applications.

Based on the findings in this thesis card-based design facilitates the user experience to a great extent. Cards design is based on deck-of-cards metaphor. In this design each card represents a unit of content that can be manipulated as well as cards in the physical world; they can be stacked, shuffled, discarded and flipped. Furthermore, AngularJS which is a JavaScript framework is the proposed tool for prototyping design solutions as well as production development. AngularJS provides necessary foundation for rapid prototyping and also embraces the fundamental criteria needed for building rich applications.
Acknowledgment

This project is a continuation of the work carried out within Medea’s Living Lab the Neighborhood at Malmö University. It has been a real pleasure to work with the researchers involved in this project; Bo Peterson, Per Linde, Per-Anders Hillgren and Bachelor’s student Joakim Lithell.
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<th>Definition</th>
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<tbody>
<tr>
<td>AMD</td>
<td>Asynchronous Module Definition</td>
</tr>
<tr>
<td>AJAX</td>
<td>Asynchronous JavaScript and XML</td>
</tr>
<tr>
<td>CSS</td>
<td>Cascading Style Sheets</td>
</tr>
<tr>
<td>CRUD</td>
<td>Create, Read, Update and Delete</td>
</tr>
<tr>
<td>DOM</td>
<td>Document Object Model</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>HTML</td>
<td>Hypertext Markup Language</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communication Technologies</td>
</tr>
<tr>
<td>IPTS</td>
<td>Institute for Prospective Technological Studies</td>
</tr>
<tr>
<td>JRC</td>
<td>Joint Research Centre</td>
</tr>
<tr>
<td>MIL</td>
<td>Methods, Information and Learning</td>
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<tr>
<td>MVC</td>
<td>Model View Controller</td>
</tr>
<tr>
<td>MVP</td>
<td>Model View Presenter</td>
</tr>
<tr>
<td>MVVM</td>
<td>Model View View Model</td>
</tr>
<tr>
<td>SPA</td>
<td>Single Page Application</td>
</tr>
<tr>
<td>UI</td>
<td>User Interface</td>
</tr>
<tr>
<td>URL</td>
<td>Uniform Resource Locator</td>
</tr>
<tr>
<td>USE</td>
<td>Usefulness, Satisfaction and Ease of use</td>
</tr>
<tr>
<td>XML</td>
<td>Extensible Markup Language</td>
</tr>
</tbody>
</table>
1. Introduction

1.1. Research goals

This Master’s thesis focuses on parts of a project undertaking at Malmö University titled Methods, Information and Learning (MIL) as tools for integration. This project is a continuation of the work carried out within Medea’s Living Lab the Neighborhood at Malmö University. The main focus in this project is to develop a digital platform to support social and economic integration and place-making for disadvantaged housing estates. This digital platform enables both individuals and organizations to exchange information, promulgate their needs and stay informed about the services available in their neighborhood.

Place-making is an integrated approach to create liveable public places and spaces for people. It seeks to create a sense of place through the design of spaces intended to contribute to community inclusion and engagement. A sense of place is recognised as “an important component of wellbeing as it forms part of an individual's identity, contributes to the creation of a group, neighbourhood or cultural identity.”[1][2].

Social networking sites can be used to foster social inclusion, meet local needs and build positive links between the economic, social and civic aspects of local development. There has been a remarkable rise in the number of people using the Internet in the past decade [3]. Unsurprisingly, there has been a huge rise in accessing the internet via mobile phones. According to StatCounter, the use of mobile devices to access the internet has increased by 67% worldwide from 2013 to 2014 [4]. Furthermore, one of the primarily purposes for users going online is for communication and the popularity of social media has rapidly increased over the past few years [5]. Social networking sites provide digital platforms for people to communicate, interact and exchange information.

As mentioned above, MIL project aims to connect people and services in the community by providing them a digital platform to promote their offers and declare their needs. One of the most important areas to consider in the provided platform is user engagement. User engagement is a quality of the user experience that emphasizes the positive aspects of interaction - in particular the fact of being captivated by the
technology. “Engagement is heavily influenced, for example, by the user interface and its associated process flow, the user’s context, value system and incentives” [6]. The challenge here lies in the aspect of User Interface (UI) and user experience design. Hence, this thesis addresses challenges involved in designing and developing an engaging software.

**Objectives and research questions**

The suggested digital platform to foster social inclusion in MIL project is a mobile application. This mobile application called “Lindängen App” and aims to connect people and services at the neighborhood level by providing them a platform to promote their offers and declare their needs. This application enables both individuals and organizations to promulgate their needs and at the same time stay informed about the services available in their community. The objective in this thesis is to develop an engaging user experience for local community mobile applications and in particular for Lindängen App as the case study in this study. Therefore, the main study’s aim is broken down into the following research questions:

RQ1 what user interface and navigation design is best suitable to develop an engaging user experience for local community mobile applications targeting youth people?

RQ2 what JavaScript framework/library is best suitable for both rapid prototyping and production development?

**Target User**

The target user in this thesis is youth between the age of 14 and 19. However, the target group is broader in the MIL project. The main study has a wider target group that includes everyone living in a deprived community. The target group in this thesis, however, is narrowed down to be able to provide accurate results in the given timeframe. In addition, when it comes to approaching the potential users, a group of young people is more approachable through schools and public sectors. On the other hand, it is widely recognised that social exclusion produces deep and long-term damage to the living conditions, social and economic participation, emotional life, and health status of young people. According to Eurostat children and active-age people are more at risk of social exclusion than elderly people [7].
Case study
This research is carried out on a certain district in Malmö, Sweden called Lindängen. The city of Malmö as the third biggest city in Sweden has established itself as a city that can deliver solutions to many of the challenges that other cities in the world are facing. One of the biggest successes of Malmö was the transformation of an industrial city, with a decreasing population, to a “city of knowledge” with new industries and growing population, while at the same time establishing processes for an environmentally sustainable development. However, Malmö has not been able to deliver sustainable solutions in the social area. Several districts such as Rosengård, Seved, Holma-Kroksbäck, Segevång and Lindängen have been known as problematic areas and Malmö as a problematic city. These districts are characterized by low results in schools, child poverty, high unemployment rate and crime, and a high reliance on social welfare. Generally, the challenge lies in the fact that the majority of people living in these areas have an ethnical background other than Swedish [8].

The method used to conduct this thesis is design and creation which is a user-centric approach and involves potential users in several steps in the process [9]. The potential users participated in this project have been chosen from Lindängen School that is located in Lindängen area.

1.2. Outline

Design and creation research method is used throughout this work. This is a highly established process that involves five steps: awareness of the problem, suggestion, development, evaluation and conclusion [9]. This thesis is subsequently structured based on the five activities in this research strategy. In the beginning the review of literature and related works is presented, followed by the problem identification and motivation behind the research questions. Chapter 3 describes the methods used in this thesis. Investigating and suggesting possible solutions for the research questions are described in chapters 4 (interface and navigation design) and 5 (prototyping tools) and the requirements for the software artifact and implementation process is explained in chapter 6. This is then followed by evaluation of the artefact discussed in chapter 7. Chapter 8 gives a reflection on the overall outcome in this thesis and presents the conclusion.
1.3. Limitations

This section describes the aspects of the main project that this thesis will not cover. Fostering social inclusion in deprived neighborhoods is the main focus in MIL project. This thesis, however, will not address this issue since it is more concerned with social science. Furthermore, the given timeframe for this Master’s thesis is not long enough to investigate the impacts of the suggested solution on social regeneration. Hence, this paper narrows down the argument by focusing on suggesting an engaging user experience, and a suitable set of prototyping and development tools for Lindängen App.
2. Problem identification and motivation

This chapter is divided into 2 sections. It begins with discussing the motivation behind the MIL mission as the main project and looking into the current ICT technologies and their impacts on social inclusion. The second section explains the motivation behind the research questions in this thesis. It identifies engagement elements and discusses the impact of positive user experience on improving user engagement. This is then followed by discussing the importance of prototyping in creating an engaging user experience.

2.1. ICT and its impact on social inclusion

An individual or a group is considered socially excluded if they are denied the opportunity of participation in the common social activities experienced by the majority of citizens in their community, whether they actually desire to take part in or not [10][11]. Looking behind different surveys in different European countries, the importance of the socio-economic integration of migrants and making coherent societies, while respecting ethnic, religious and cultural plurality in contemporary Europe, becomes relatively clear. The number of people living outside their country of origin doubled to approximately 200 million, between 1985 and 2005. Statistics for Europe show a more dramatic rise of migrants. The number of resident immigrants grew from an estimated 23 million in 1985 in a period of 15 years to more than 56 million [12][13].

According to the recent research in Institute for Prospective Technological Studies (IPTS), which is one of the seven scientific institutes of the European Commission's Joint Research Centre (JRC), ICT can efficiently support integration strategies and contribute to facilitating the social and cultural integration of immigrants. Roots & Routes TV¹, for instance, is an international video community targeted for young people with migrant origin. It started in six German cities, and is currently extended to Finland, France, Greece, Hungary, Italy, the Netherlands, Spain, Sweden and the UK. Young people with different cultural roots get together in workshops and produce creative products. They present their products on a web-TV and also present their work

¹ http://www.rootsnroutes.tv/
in annual events in all cities involved. This ICT-based tool enables them to demonstrate their wishes and demands to the public [14] [15].

ICT can have a beneficial impact on tackling social exclusion through different dimensions. ICT applications can develop social networks by formation of virtual communities. These virtual communities provide a more diverse interaction between people and reduce loneliness and social isolation. People can make connections with their peers and build relationships with people who have similar interests [16] [17]. Moreover, it enables citizen even living in deprived neighborhoods and isolated groups broadcast and publish their ideas which may enhance their self confidence and self-esteem [18]. It can also reduce social isolation of less mobile groups of people for instance some Muslim immigrant females or single mothers [19].

As an example, the City of The Hague's virtual portal digitalehofstad\(^2\) provides an online space for citizens to make connections with their neighbors and enables them to discuss with each other in forums. This website enhances networking and social integration so that people in a neighborhood know each other better and are able to share their local information and discuss about their issues.

Burtonline\(^3\) is another example of a virtual neighborhood website in Netherlands that claims to cover the entire country. Users can receive messages and posts from other users living nearby, only by typing in their postal code. Visitors share and receive different sort of information form supply and demands for second hand products to posts about personal services. However, the number of posts and responses is very low especially in poor neighborhoods.

Another website that aims at giving voice and openly accessible meeting space especially to ethnic communities is Maghreb.nl\(^4\). This is a highly interactive website that provides an online space for young people of Moroccan – the children and grandchildren of first generation immigrants - origin living in the Netherlands to meet virtually, discuss and share information and it might lead to more contacts between immigrants and autochthonous population groups and thus contributes to integration. The site is very popular and receives on average 2,500 visitors per day [20].

However, in spite of all these efforts towards tackling social isolation, researches show that there is a very low amount of people in deprived neighborhoods and among

\(^2\) http://digitalehofstad.nl/
\(^3\) http://buurt-online.nl/
\(^4\) http://www.maghreb.nl/
excluded groups that actually use these platforms. The ICT enabled technologies are
currently benefiting people who are already advantaged and are willing to enhance their
skills and networks [19] [20]. While lack of access to suitable equipment was initially
identified as the key reason for non-use of ICT [21], to involve more end users,
experiences using ICT need to be relevant to the person’s daily life, need to give the
person a sense of empowerment in that area, and need to be positive in nature [22].

2.2. User engagement

As discussed above, one of the factors missing in ICTs aiming at fostering social
inclusion is lack of user engagement. Engagement is considered “a desirable -even
essential- human response to computer-mediated activities” [23]. Usability is one of the
elements that influence user engagement. However, usability factors, namely
efficiency, effectiveness and satisfaction are no longer the only factors in attracting
users in interactive systems, but how well a system is able to engage users and provide
them with an experience [24] [25]. A range of engagement elements were identified by
O’Brien & Toms in an exploratory study that includes aesthetics, affect, focused
attention, challenge, control, feedback, interest, motivation, novelty, and perceived
time [23]. The table below illustrates a definition for each element gathered by O’Brien
& Toms [26].
<table>
<thead>
<tr>
<th>Engagement element</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aesthetics</td>
<td>Visual beauty or the study of natural and pleasing aesthetics of computer-based environments [27].</td>
</tr>
<tr>
<td>Affect</td>
<td>“The emotional investment a user makes in order to be immersed in an environment and sustain their involvement in the environment.” [27]; “The user's emotional response to the system” [28].</td>
</tr>
<tr>
<td>Focused Attention</td>
<td>The concentration of mental activity; concentrating on one stimulus only and ignoring all others [29].</td>
</tr>
<tr>
<td>Challenge</td>
<td>The amount of effort experienced by the participant in performing an online task.</td>
</tr>
<tr>
<td>Control</td>
<td>How “in charge” users feel over their experience with the technology.</td>
</tr>
<tr>
<td>Feedback</td>
<td>Response or reaction from the task environment or system that communicates the appropriateness of the users past actions or demonstrates progress toward a specific goal [30]; “Information that is sent back to the user about what action has been done or what result has been accomplished” [28].</td>
</tr>
<tr>
<td>Interest</td>
<td>The “feeling that accompanies or causes special attention to an object or class of objects” [31].</td>
</tr>
<tr>
<td>Motivation</td>
<td>Elements that bring about focus or a desire to proceed with an activity [27].</td>
</tr>
<tr>
<td>Novelty</td>
<td>Variety of sudden and unexpected changes (visual or auditory) that cause excitement and joy or alarm [32]; Features of the interface that “users find unexpected, surprising, new, and unfamiliar” [33].</td>
</tr>
<tr>
<td>Perceived Time</td>
<td>Users’ perception of estimated time spent on task.</td>
</tr>
</tbody>
</table>

Table 1: Engagement elements definitions [26]

Exploring an engaging user experience for local community mobile applications is done by investigating a suitable user interface and navigation design. Hence, from the list suggested by O'Brien & Toms, the engaging elements in respect with user interface and navigation design are considered in this work, namely aesthetics, affect, feedback, interest, novelty and perceived time. Three of these elements namely affect, feedback and perceived time fall into usability which is a part of the overall user experience, whereas novelty, aesthetics and interest are translated into attributes representing the other dimension of user experience. In this thesis the term usability refers to the first
group of elements and the term user experience implies the second group. These two dimensions of user experience add structure to the design and evaluation process of this thesis. In the evaluation process the degree to which the potential users feel the elements above is presented.

Visual aesthetics is one important dimension of non-instrumental qualities. First impression about the system has a significant influence to the overall judgments and user satisfaction [34] [35]. Lavie and Tractinsky [36] suggest the existence of two distinct dimensions of web site aesthetics namely, classical aesthetics and expressive aesthetics. Classical aesthetics emphasizes orderly and clear design and is related to design rules advocated by usability experts, while expressive aesthetics is manifested by the designer’s creativity and originality and by the ability to break design conventions. Factors that represent traditional notions of aesthetics are for instance, well organized, clear, clean and symmetrical whereas elements representing expressive aesthetics are originality, fascinating design, and using special effects. Throughout this thesis the term visual aesthetics can appear interchanged with beauty, visual appeal, and attractiveness.

Novelty is the curiosity evoked by the task and the participant’s interest in the task [26]. A novel, surprising, unfamiliar or unexpected user interface is one dimension that can contribute to the overall quality of experience. Novelty is one of the key design factors that significantly enhance the system’s ability to attract users [37].

Exploring an engaging user experience for local community mobile applications is done by reviewing the most popular content presentation and navigation designs in chapter 4 following by discussing and evaluating the chosen approach. The metrics explained above along with usability factors are the basis for evaluating the suggested UI design.

**Prototyping and further development**

Iterative design that is creating a design prototype, evaluating the prototype, and then repeating the process several times is the key factor to provide a positive user experience [38]. A prototype can be used to test and evaluate design ideas. A prototype can span from a paper drawing (low-fidelity) to a fully functional artefact (high-fidelity) [39]. Fully interactive prototypes enable designers to work through every detail of the participant’s experience through tasks due to the fact that participants can operate the
prototype as if it were the final product. Most importantly, fully functional prototypes clearly defines navigational scheme to the users [40]. Low-fidelity prototypes, on the other hand, while are particularly helpful in order to provide a shared understanding, do not exemplify all interactions application components [41]. A very rapid, but low quality development may have “dirty” effects, meaning that it might negatively affect further developments, hindering understanding, collaboration and commitment [42].

Since the first research question in this thesis explores the best suitable UI and navigation design for local community mobile applications, a fully functional prototype is essential to assess the selected design. On the other hand, the prototype for the case study in this project will be the initial result of an ongoing project where further developments will be performed on the provided solution in this thesis. Hence, to investigate the best tool to prototype Lindängen App, core criteria for building and maintaining a rich application have been considered. Therefore, the second research question in this thesis aims to investigate a prototyping tool that also has required programming capabilities for further development. A review of prototyping tools for functional prototypes is done in chapter 5 followed by describing the chosen set of tools.
3. Methods
This chapter describes the research methods used to structure this Master’s thesis as well as the process and data generation techniques used to approach the provided solution.

3.1. Research methods
As the objective of this thesis is to explore and evaluate a computer-based solution, design and creation research method is used throughout the work. Design and creation is an iterative and artifact-centric research strategy that involves five steps: awareness of the problem, suggestion, development, evaluation and conclusion [9].

This thesis is subsequently structured based on the five steps in this research strategy. The problem is discussed in the motivation section following by reviewing literature and related works in chapter 2. The following chapter describes the process used to design and develop the solutions. Subsequently, possible solutions are suggested in chapter 4 and chapter 5 and the implementation and evaluation process is explained in chapter 6 and chapter 7. This is then followed by a reflection on the overall outcome in this thesis and presenting the conclusion in chapter 8.

3.2. Development process
Design lifecycle model shown in figure 1 forms the development procedure in this thesis. This is an iterative and user-centered model that starts with identifying needs and establishing user requirements. As the second step, some designs are generated as alternatives in an attempt to meet the requirements identified in the previous step. Subsequently, functional prototypes of the selected designs are developed, evaluated and redesigned. After the last evaluation final product is produced [39]. The activities carried out during each lifecycle phase in this project will be discussed in depth in implementation and evaluation chapters.
Identifying needs and establishing requirements

It is a step towards firstly understanding as much as possible about the end users, the task and the context and secondly, setting a set of stable requirements based on the needs identified [39]. In this thesis, several focus group sessions are conducted to identify user needs and determine fundamental features as well as non-functional requirements of the solution. In addition, a focus group is carried out with potential users to carry out the user need research more in depth and finalize the conceptual design process. Moreover, semi-structured interviews are conducted with participants in this step.

Design

In this step some designs are generated as alternatives in an attempt to meet the needs and requirements that have been identified in the previous step. Prototyping enables designers to test out ideas immediately in this stage. A prototype can be anything from paper drawing (low-fidelity prototyping) to an interactive system (high-fidelity prototyping). Low-fidelity prototyping can answer questions in this step [39]. In the initial steps of design in this thesis, mock ups are produced to quickly demonstrate and evaluate design concepts.
Build an interactive version
In this step interactive versions of the design solutions (high-fidelity prototypes) are
developed. High-fidelity prototypes enable designers to resemble the final product and
gather accurate feedback form potential users [39]. In this thesis, a functional prototype
is developed in this stage to evaluate and test the design solution as well as the selected
tools. The set of tools used to produce the fully functional prototype in this thesis is
discussed in chapter 5.

Evaluate
It is a step towards evaluating generated functional designs against requirements. In
this thesis, the degree to which the potential users feel the engaging elements is
measured. Usability and user experience goals that were identified early in the design
process are used to evaluate the design in this step. Evaluation techniques used in this
step are unobtrusive observation and survey. Furthermore, this stage can reflect on the
selected prototyping tools that have been used to prototype the design.

3.3. Data generation techniques

Focus group
Focus group is an activity to gather in-depth information and perceptions from key
stockholders through moderated group discussions. This is a useful technique to
explore different views and collect subjective perspectives. The strength of focus
groups lies in the effects of synergy in group discussions which can reveal valuable
information and consensus view of an issue and/or highlighting areas of
conflict/disagreement cheaply and quickly [39].

Interviews
In design and creation method, interviews are often used to generate data for
requirement specification and also elicit users’ feedback on prototypes and final
artefacts. Interviews can be divided into three types, namely, structured, semi-
structured and unstructured interviews. The following type is used in this thesis:
**Semi-structured interviews**
In this type of interview there are themes and questions to be covered, however, the order of the questions can be changed and questions can be omitted depending on the flow of the conversation. Moreover, the interviewees are able to speak with more details and the interviewer might ask additional questions if new issues are raised during the conversation. Semi-structured interviews are mostly used in exploratory studies [43][44].

**Unobtrusive observation**
Observation is a way of finding out what users actually do during a specific activity, rather than what they report they do when questioned. This is a useful data gathering technique at any stage during the design and creation technique. Unobtrusive observation is a direct observation of people to gather user experience from non-verbal expressions without the researcher taking part in the action [39][45].

**Survey**
Survey is an efficient method to systemically collect the same kind of data from a large audience. This research strategy can be based on questionnaire, interviews, documents and observations [9]. Survey questionnaires is one of the methods used to collect data in the evaluation stage in this thesis. The survey questionnaire in this thesis is designed to measure engaging metrics suggested by O’Brien & Toms [23], and is constructed of a set of questions to assess user experience as well as usability metrics. Usability questions are based on Usefulness, Satisfaction and Ease of use (USE) method. USE is a usability evaluation questionnaire established on four dimensions: usefulness, ease of use, ease of learning and satisfaction [46].

**Prototyping**
Prototypes communicate the message “this is what it could be like” [47]. Prototypes answer questions and support designers in choosing between alternatives. A prototype can span from a paper drawing (low-fidelity) to a fully functional artefact (high-fidelity) [39].
**Low-fidelity prototyping**

Low-fidelity prototyping ranges from a series of hand-drawn mock-ups to printouts. In principle, low-fidelity sketches are simple, cheap and quicker to create. These characteristics are helpful in enabling early visualization of alternative design solutions and ideas, which helps to provoke innovation and improvement. An additional advantage to this approach is that when using rough sketches, users may feel more comfortable suggesting changes [39].

**High fidelity prototyping**

Conversely, in user interface design high-fidelity prototypes are often computer-based and interactive. High-fidelity prototypes are assumed to be effective in collecting true human performance data, for example measuring time to complete a task, and in demonstrating actual products to clients, management, and others [39].

3.4. Ethics

Since the development procedure in this study is based on an iterative and user-centered model that involves users in many part of the process, ethnical aspects have been taken into consideration. The surveys in this study did not require any name or personal data that can be linked to the person and the name of the participants involved in interviews were not collected. Pictures from participants is taken by permission from the participants directly and they were informed how the pictures will be used.
4. Interface and navigation designs

To explore an engaging user experience for local community mobile applications, content presentation and navigation designs are explored in this chapter. This is done by reviewing primary multimedia user interface and navigation designs for mobile applications between the years of 2010 and 2014. This chapter discusses the main pros and cons of the user interface designs and it is then followed by explaining the chosen approach.

4.1. Interface and navigation designs for mobile applications

Launchpad

Launchpad also known as Springboard was the most popular UI and navigation design for mobile applications in 2011. This design shows a grid of visual elements representing the most important functionalities of the application. These elements act as launch points into the application and are displayed using suitable icon images and often with a title to clarify their functions for users. This UI design is still popular and Android, iOS and windows Phones use this navigation at the operating system level. The main advantage of using Launchpad is that it provides an overview of the application content as well as a quick access to every category. Moreover, it works equally well across the platform [48]. On the other hand, some user experience experts claims that the main drawback of Launchpad is that it locates all options to the same level of importance; however making more important option’s icons bigger than others can solve this problem to some extent [48].

![Launchpad Design Example](image)

Figure 2: Trulia for iOS and Gowalla for Android using Launchpad design [48]
Hierarchal menu
Hierarchal design that is also called List menu displays the content of the application as a list and it is often used as a substitute for Launchpad when the number of items is abundant. Similarly to the Launchpad design, each item in the Hierarchal is a launch point into the application. The menu can be arranged according to alphabetical order, priority or group. This is a user-friendly UI design that provides a detailed content to the user. However, the depth of the list menu content should be within three levels. Users can lose their patience if there are too many levels [48] [49].

![Hierarchal menu example](image)

Figure 3: Kayak for iOS using Hierarchal menu Design [48]

Gallery
This design pattern displays live feed such as photo and stories arranged in a grid, a carousel or a slideshow. In a grid the user is required to scroll down/up to browse the content whereas in carousel and slideshow content can be browsed one by one by swiping left/right. Carousel and slideshow allow users to concentrate on one unit of content at a time which is one of their strong pros [48].
Cards
Cards UI design is based on deck-of-cards metaphor. In this UI design each card represents a unit of content that can be manipulated as well as cards in the physical world; they can be stacked, shuffled, discarded and flipped. Cards can be browsed and handled by gestures such as swiping. For example, Jelly\(^5\) is a mobile application that is built on cards metaphor; it uses “swipe down” gesture to scroll the content [48].

Furthermore, in card-based design swipe gestures can be used for actions more than browsing the content. Google Now\(^6\), Tinder\(^7\) and Facebook Paper \(^8\) are some examples using gesture-based controls. These gesture-based controls are different from the simple swipe views in carousel and slideshow that is discussed in Gallery UI design. For example, in Google Now the cards can be swiped away if the user does not need them. Similarly, in Tinder swiping left or right indicates positive or negative responses meaning that swiping right is to like a profile or left to pass it.

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\(^5\) https://jelly.co/
\(^6\) http://google.com/landing/now/
\(^7\) http://www.gotinder.com/
\(^8\) http://facebook.com/
4.2. Selected design

To simultaneously provide simplicity and innovative-looking user interface, card-based UI design is chosen for Lindängen App. Cards are fast becoming the most popular UI design especially for mobile devices [50]. Many of the popular applications such as Facebook, Twitter⁹, Google Now and Tinder have moved to the direction of cards user interface design. Cards design tries to deliver information in a readable and scan-able format that is easy to navigate with a single finger, and it is often the thumb. Browsing the content in cards is often done by a set of interaction gesture methods such as swiping. The beauty of such gestures is that navigating through the content is with the minimum amount of motion. According to Wroblewski, a Product director at Google, “We use our phones most often with one hand, and more specifically, we navigate with one finger — the thumb. It’s all in the thumb” [51]. In addition, cards are pieces of content that are easy to scan and ready to share.

To assess the claims above and determine if cards is a suitable UI design to improve user engagement in Lindängen App, a functional prototype is developed during an iterative process in this thesis and users’ feedback are collected through user-centered methods such as interview and observation. Cards UI design evaluation will be discussed in detail in chapter 7.

⁹ http://twitter.com
4.2.1. Cards design versus cards architecture

There are two types of cards design; one is a user interface design while the other is an architecture model. There is an important distinction between the card-based UI design and the card architecture model that is behind the implementation of cards by some platforms such as Google Now, Twitter. The card UI design provides a gesture-based navigation unit content while the architecture model delivers individual pieces of content aggregated together into one experience.

Cards UI design refers to a container that logically encapsulates bits of concrete information. The card UI updates the classic way of interacting with physical cards. In most cases, a card is a rectangular block that contains a small amount of easily digestible information. This rectangle generally has a border to convey encapsulation of the content, in other words, a separation of the content within the card from content elsewhere on the screen. In desktop views, there are often many cards placed next to each other, and the borders or coloring of the cards is used to separate information between each of the cards. However, in most card-based mobile views there is one card at a time showing on the mobile screen with a card-swiping system to navigate to other cards. This UI design provides an easy navigation to other cards with one finger, and it is often the thumb. Cards combine a content design with a set of gesture interaction methods such as, swiping, flicking and flipping that changes user experiences and consequently engagement metrics [52].

On the other hand, cards architecture model does more than presenting content blocks, but utilizes the structured interface of a card to display data from a variety of third-parties and pushes relevant information into the card and delivers personalized information to the users. The traditional way of presenting data by many pages of content linked together are changing towards an aggregated approach to content. In cards architecture model individual pieces of content aggregated together into one experience [50]. This aggregation depends on the following metrics:

- The user preferences, interests, interactions and consuming data.
- The user location
- User’s friends interests and preferences
- The targeting advertising eco-system
For example, Google is changing from a search engine to personalized information pushed to mobile devices. This product aims at simplifying daily life activities and it uses cards UI design for displaying information. Through the Google Now application, Google sends notifications to users that are context-aware and also use the information that user has searched for [50].
5. Rapid prototyping tools

This chapter begins with comparing the most popular JavaScript frameworks and libraries to investigate a suitable tool for both rapid prototyping and production development. These frameworks and libraries are the most recent and popular client-side tools for rapid application development that also support modern web application architecture for production development. The review is then followed by describing the reason behind choosing the selected tools.

Mobile application users use a variety of smartphones with various operating systems. Web-based development approach provides a cross-platform solution that works on all devices with different operation systems. Achieving cross-platform portability is the main reason for using technologies like Hypertext Markup Language (HTML), Cascading Style Sheets (CSS), and JavaScript [53]. In addition, this approach enhances building and maintaining the application as developers write and maintain a single source code for any mobile operating system [53]. Framework/library selection in this thesis are based on firstly core criteria for rapid prototyping and also required capabilities for further development.

JavaScript is a relatively lightweight programming language that has become one of the most dominant technologies of the web due to its simplicity while being able to deliver rich and dynamic web content [54]. Additionally, in recent years there has been a rise in emerging new libraries and frameworks that are written on top of the JavaScript language aiming at adding programming capabilities missing from the standard web browser. These libraries generally try to speed up the pace of JavaScript-based application development. Such JavaScript libraries include AngularJS\textsuperscript{10}, Backbone.js\textsuperscript{11}, DurandalJS\textsuperscript{12}, EmberJS\textsuperscript{13}, jQuery\textsuperscript{14}, KnockoutJS\textsuperscript{15}.

\textsuperscript{10} https://angularjs.org/
\textsuperscript{11} http://backbonejs.org/
\textsuperscript{12} http://durandaljs.com/
\textsuperscript{13} http://emberjs.com/
\textsuperscript{14} http://jquery.com/
\textsuperscript{15} http://knockoutjs.com/
5.1. JavaScript frameworks/libraries

All of the libraries and frameworks in this review are client-side and open source. Moreover, except jQuery they are all based on Single Page Application (SPA) approach which benefits in terms of speed, no page reloads, mobile optimization, real-time pushes and notifications. SPA applications download a single payload containing all the scripts, stylesheets, and mark-ups users need for common tasks and then perform a lot of additional behaviour in the background. In SPA applications everything happens on one page although the Uniform Resource Locator (URL) might change. These applications call the servers only for data, but not for HTML, CSS, or JavaScript [55]. The version (v) of the reviewed frameworks/libraries at the time of this study is mentioned, due to the fast pace of software development tools enhancement.

AngularJS (v1.2.8)
AngularJS is developed and maintained by Google and delivers a solution that assists with creating single-page applications. AngularJS offers two-way data binding meaning that it establishes a two-way connection between the application UI elements and underlying data in the business logic. Additionally, this toolset is based on extending the HTML vocabulary for applications, this provides a template-based declarative solution for building web applications. AngularJS’s goal is to enhance browser-based applications in an effort to make both development and testing easier. For several years AngularJS was closer to Model-View-Controller (MVC) but over time it's now closer to Model-View-View Model (MVVM) pattern [56]. In addition, there is a large community behind AngularJS that helps developers to overcome issues [57].

Backbone.js (v1.1.0)
This is a flexible and minimalistic framework that separates concerns into three parts based on MVC architecture pattern. Backbone.js abstracts data into models and Document Object Model (DOM) manipulation into views and binds these two together using events. Backbone.js is a flexible library that allows developers to decide about the structure of the software. In addition, there is a strong extension community around this framework that provides solutions for problems [58] [59].
**DurandalJS (v2.0.0)**
This is a framework that is built on KnockoutJS and RequireJS\(^{16}\). It supports MVC, Model-View-Presenter (MVP) and MVVM architecture. DurandalJS uses KnockoutJS for data binding and uses RequireJS to modularize the code on the Asynchronous Module Definition (AMD) standard. AMD specifies a mechanism for defining modules so that the module and its dependencies can be asynchronously loaded \([60]\).

**Ember.js (v1.2.0)**
Ember is a framework that is based on MVC architecture pattern. It provides template (written in the Handlebars\(^{17}\)), views, controllers, models and a router. Ember and AngularJS are similar in a few superficial ways such as data binding, however there have significant differences in the approach they provide for building web applications \([61]\).

**JQuery (v1.9.9)**
JQuery is a lightweight library designed to simplify complicated tasks that require many lines of JavaScript code to accomplish. It wraps those complicated tasks into methods that can be called with a single line of code, for instance, Asynchronous JavaScript and XML (AJAX) calls and DOM manipulation. Jquery makes event handling, animation, and AJAX simpler with an easy-to-use API \([62]\).

However, although jQuery is the most popular library in terms of DOM manipulation, it does not provide framework features and does not bring structure to the code \([59]\).

**KnockoutJS (v3.0.0)**
This is a library that aims to simplify JavaScript user interfaces by applying the MVVM pattern. Knockout’s mission is to simplify automatic user interface refresh. It stresses on dynamic user interfaces with underlying data model and declarative user interface binding. The user interface gets updated on model changes by using two-way binding and dependency tracking of model data. In addition, it has a comprehensive documentation and tutorial system \([63]\).

\(^{16}\) http://requirejs.org/

\(^{17}\) http://handlebarsjs.com/
5.1.1. Core features comparison

Table 1 illustrates a comparison of core features in the considered JavaScript frameworks/libraries. These core features are described below:

**Observables**
Observables are JavaScript objects that can notify subscribers about changes.

**Routing**
Routing handles browser URL requests.

**Two-way bindings**
Two-way bindings refers to a two-way connection between the application UI elements and underlying data in the business logic.

**Compose/partial Views**
Partial views define views that can be rendered inside a parent view.

**Filtered list views**
Filtered list views is having views that display objects filtered by a certain criteria.

**Custom HTML elements**
This is a feature that enables developers to extend the HTML functionality and expand its elements.

Among the features described above routing and two-way data bindings are the most important features in terms of rapid prototyping as well as single page application development. Routing is an essential feature in single page applications to handle user’s state and loading required resources as needed without page reload. Moreover, two way data binding allows developers to avoid boilerplate codes when working with DOM, it also isolates the logic from the template. Boilerplate code is a repetitive section of code which needs to be included in many places with little or no alteration [64]. Two way data binding bounds the application UI elements and underlying data in the business logic in which any changes occurs in one of the parties updates the related property in the other party accordingly.

In addition, custom HTML elements are very useful when developing a complex application. These elements fully encapsulate all of their HTML and CSS, meaning that styles render as intended.
As it is shown in table 2, Backbone.js lacks many of the core features. For example, it does not include two-way bindings which is one the most important features described above. The lack of this feature leads to a lot of boilerplate code in attempt to synchronize views and models. While it is possible to compensate these features by adding third-party plugins, it requires dedicating time to research and learn, which in turn increases implementation time.

On the other hand, although jQuery is the most popular library in terms of DOM manipulation, it does not provide any of the core features. Moreover, in jQuery synchronizing data between HTML user interface, logic and server comes with too many inefficient jQuery selectors and callbacks.

In addition, while KnockoutJS provides a solid two-way data binding [65], it does not cover routing and this makes KnockoutJS a library rather than a framework. These features can be done with writing a considerable amount of boilerplate code or with the help of plug-ins, which means more decisions to make and more implementation time.

Table 2: JavaScript frameworks/libraries core features comparison

<table>
<thead>
<tr>
<th>Feature</th>
<th>AngularJS (v1.2.8)</th>
<th>Backbone (v1.1.0)</th>
<th>DurandalJS (v2.0.0)</th>
<th>EmberJS (v1.2.0)</th>
<th>jQuery (v1.9.9)</th>
<th>KnockoutJS (v3.0.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observables</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>–</td>
<td>✓</td>
</tr>
<tr>
<td>Routing</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>–</td>
<td>✓</td>
</tr>
<tr>
<td>Two way bindings</td>
<td>✓</td>
<td>–</td>
<td>✓</td>
<td>✓</td>
<td>–</td>
<td>✓</td>
</tr>
<tr>
<td>Composed/partial views</td>
<td>✓</td>
<td>–</td>
<td>✓</td>
<td>✓</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Filtered list views</td>
<td>✓</td>
<td>–</td>
<td>–</td>
<td>✓</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Custom HTML elements</td>
<td>✓</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>
EmberJS, DurandalJS and AngularJS embrace more of the core features, however, only AngularJS empowers developers to extend the HTML language by using custom directives. These directives come in the forms of custom HTML elements, custom attributes and custom class names and can be used as regular HTML elements. Custom HTML elements feature enables developers to define their own elements, attributes, classes, or comment types [66].

5.1.2. Major benefits comparison
The following table shows a comparison of the reviewed JavaScript frameworks/libraries in terms of major benefits. These major benefits are as follow:

**Flexibility**
Flexible frameworks/libraries play well with third-party plugins.

**Opinionated**
Opinionated frameworks/libraries provide a specific structure for the software.

**Comprehensive documentation**
Comprehensive documentation refers to a complete and detailed official set of documentation which assists developers with guidelines to use the framework/library.

**Strong community**
Strong community refers to an active community of project contributors and users to get help when facing issues.

**Testability**
This property refers to the ease of testing a piece of code.

**Modularity**
This characteristic refers to the capability of dividing applications into smaller components that are independently operable.

Among the benefits outlined above flexibility, comprehensive documentation and opinionated are the most important criteria in terms of rapid prototyping. As the name implies, rapid prototyping is a rapid process and using ready-to-use solutions is an essential approach in this process. Hence, the client-side tool needs to be flexible and plays well with other tools and plugins that provides ready-to-use solutions such as UI widgets and back-end services. Furthermore, documentation is an important criteria to start using a new tool in a time-limited process. Furthermore, an opinionated framework
imposes patterns on how to achieve common tasks in the best possible way using the framework. This benefits developers to build a trustful foundation in the prototyping process that can be used for further development in future.

On the other hand, testability and modularity are important requirements for production applications. Build time is shortened in modular applications and modules are loaded on demand. Modular applications are easy to understand and maintain, separating applications into smaller units that can be developed and deployed independently makes the application more maintainable and testable.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>AngularJS (v1.2.8)</th>
<th>Backbone (v1.1.0)</th>
<th>DurandalJS (v2.0.0)</th>
<th>EmberJS (v1.2.0)</th>
<th>jQuery (v1.9.9)</th>
<th>KnockoutJS (v3.0.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexibility</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Opinionated</td>
<td>✓</td>
<td>–</td>
<td>✓</td>
<td>✓</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Comprehensive documentation and community support</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Testability</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Modularity</td>
<td>✓</td>
<td>–</td>
<td>✓</td>
<td>✓</td>
<td>–</td>
<td>✓</td>
</tr>
</tbody>
</table>

Table 3: JavaScript frameworks/libraries major benefits comparison

As table 3 shows all frameworks/libraries play nicely with other libraries and third-party plugins and are flexible in terms of integration. However, AngularJS and Ember are less flexible than others due to their opinionated approach. Backbone.js and jQuery are non-opinionated and does not bring structure to code and leave a lot of decisions to make to the users. They allow developers to structure their code and diverge form the golden path; golden path is recognized as the best-practice solution. While these
frameworks let developers to make their own decisions in solving problems, it might create major issues. Opinionated frameworks are beneficial particularly when multiple developers are working on a complex application [65]. In non-opinionated frameworks problems can be solved in different ways that might not be the best practice solution. Subsequently, a lot of time is spent on finding out and learning the best solutions. Furthermore, it might cause difficulties when it comes to taking over projects since the new developer needs to spend time on figuring out the structure of the written code.

All the frameworks and libraries provide comprehensive documentation and have strong communities to guide users.

While all frameworks/libraries support unit testing by supporting popular JavaScript testing frameworks, AngularJS, DurandalJS and EmberJS simplifies the writing of unit tests with the built-in dependency injection system. However, Angular supports it further by including many features to help writing tests. For instance, Angular Scenario Runner helps writing user scenarios in the testing environment. Unit testing is breaking down the logic of the application into small units and testing each unit without worrying about its dependencies. Unit testing is about isolation and separation of concerns. It makes AngularJS a better framework when it comes to testing [66].

In addition, modularity helps code organization and it is the key factor to improve unit testability and maintainability. jQuery and Backbone are the only frameworks/libraries that are not modular.

5.2. Selected framework

The suggested client-side framework is AngularJS, the reason for choosing Angular is discussed in the following section. Additionally, Firebase\textsuperscript{18} as a back-end service and Ionic\textsuperscript{19} as an interface framework are used in implementing Lindängen App in this thesis.

**AngularJS (v1.2.8)**

AngularJS is a suitable tool both for quick prototyping projects and large-scale production applications. As tables 2 and 3 show AngularJS is the only framework that embraces all core features and requirements.

\textsuperscript{18} https://www.firebase.com/

\textsuperscript{19} http://ionicframework.com/
As mentioned earlier, routing and two way data binding are the most important features to consider while selecting the tool. AngularJS provides observable objects and supports two-way bindings between the application UI elements and underlying data in the business logic. This feature handles the synchronization between the DOM and the model, and vice versa and it saves considerable amount of time writing boilerplate code to synchronize views and models. In addition, AngularJS is a powerful framework in terms of extensibility as it is the only framework that provides custom HTML elements. This is a useful feature in terms of complex application development. This feature empowers developers to create custom elements and attributes that can be used as HTML elements.

Furthermore, AngularJS covers all of the most important features mentioned earlier both for rapid prototyping and production development. As an opinionated framework AngularJS brings structure to the code from the very beginning stage of the development process and proper structure can improve maintainability. In particular, it benefits projects such as Lindängen App that has an iterative development process and the final product is a continuation of the interactive prototype. AngularJS is relatively a flexible framework that plays well with third-party plugins. For instance, it is currently the only framework that Ionic framework supports. Ionic is a mobile web-application framework for building user interface interactions such as animations and gestures. In addition, Firebase as a real time backend service provides a binding framework with AngularJS, named AngularFire\(^{20}\). These two technologies are used in developing Lindängen App in this thesis. AngularJS is a mature framework with comprehensive documentation and a large community behind it. This means a large amount of information available for solving problems.

On the other hand, testability and modularity are important requirements for production applications. AngularJS enables building up a modular system. A modular system is easier to understand, maintain, reuse and to extend. Furthermore, according to AngularJS documentation "Angular is written with testability in mind" \([57]\). AngularJS is written from the ground up to be testable and it includes many features to help writing tests. For instance, it support testing by an end-to-end and unit test runner setup. In addition, Angular has as a fairly elaborate and easy to use dependency injection solution which leads to high testability \([68]\).

\(^{20}\) https://www.firebase.com/docs/web/libraries/angular/index.html
**Firebase – A Real-time Backend**

Firebase is used as the backend service in Lindängen App. This is a real time data storage which stores and synchronizes data instantly across every device. It saves, stores and updates data in real time directly from the browser and it can be used as an entire back-end service. Moreover, it is a cross-platform service and also allows users work offline. It allows developers to build a client-only application and synchronize data without managing the server. Additionally, it supports popular JavaScript libraries and provides framework binding for most popular ones, namely, AngularFire, EmberFire\(^{21}\), ReactFire\(^{22}\) and BackFire\(^{23}\).

** Ionic**

This is an open source framework that focuses on user interface interactions. It empowers full user interface interactions such as animations and gestures. This framework helps building native-feeling mobile applications with web technologies, namely, JavaScript, HTML and CSS and it currently requires AngularJS. This framework is used to build the swipe gesture interface navigation for cards in Lindängen App.

\(^{21}\) https://www.firebase.com/docs/web/libraries/ember/
\(^{22}\) https://www.firebase.com/docs/web/libraries/react/
\(^{23}\) https://www.firebase.com/docs/web/libraries/backbone/quickstart.html
6. Implementation

The process used to design and develop the proposed solution in this project, is based on the design lifecycle model shown in figure 1 in chapter 3. This user-centered model includes four iterative steps. The goals and activities conducted during the first three phases, namely identifying needs and establishing user requirements, design, and functional prototyping are summarized in this chapter and the last phase which is evaluation is described in chapter 7.

6.1. Identify needs and establish requirements

Several focus group sessions conducted with the MIL team during the time frame of this thesis. The goal in these sessions was to identify user needs and determine fundamental features of the solution. Moreover, non-functional requirements such as user engagement metrics were important subjects discussed with the focus group as well as question development and prioritization exercises.

Additionally, a focus group was conducted with 6 students from Lindängen School to carry out the user need research more in depth and finalize the conceptual design process. To convey the concept to the participants better and consequently collect more accurate feedback, a simple prototype was demonstrated in the focus group activity. Furthermore, semi-structured interviews were conducted with each participant afterwards. The theme of the questions was about the means of communication the participants use to stay informed about the events happening nearby. In other words, by what means they receive information about the new available services in their neighbourhood. Moreover, some of the questions explored the participant’s views towards the cards UI design.

Interviewees reported that the main way to broadcast coming events in Lindängen area is paper announcements and local newspapers. People living in Lindängen mostly use letters and paper-based notices to spread their offers and services. Moreover, during the conversations with participants it became clear that they were skeptical to a new design to some extent. They were more comfortable with the traditional way of presenting data by many pages of content linked together rather than card-based design.
System requirements
The suggested solution in MIL project is a mobile application that provides a digital platform for its target group to exchange information, promulgate their needs and stay informed about the services available in their neighborhood. To develop an engaging user experience, the Lindängen App user interface is based on the card-based UI design and allows users to browse the content through a deck of cards.

The primary system requirements are as follow:

- The application provides Create/Read/Update/Delete (CRUD) functionalities.
- Unlogged users can only view and read the cards whereas logged-in users can also create and edit their own cards.
- There are two different categories of cards; actors and events. Actor cards are created by the users who wish to broadcast their activities, resources and services. On the other hand, event and announcement cards intend to advertise short term activities, for instance, a spontaneous soccer game, a flea market or a farm party. The differences between the cards are shown by visual means to the users.
- Ability to supplement data with pictures and Global Positioning System (GPS) information and link to webpages, social media on the cards.

6.2. Design and development

As RQ1 suggests, this master thesis aims to develop an engaging user interface and navigation for local community mobile applications targeting youth people?.. The emphasis is on creating a positive user experience with a simple user interface but yet delightful to its target group. Therefore, the focus in prototype development is on user interface and navigation design. To robust user engagement card-based UI and navigation design is suggested for Lindängen App, the reasons behind choosing this UI design over other common designs is discussed in depth in chapter 4.

Figure 7 illustrates the first user interface mockups and sketches made in the initial low fidelity prototyping. This is then followed by developing an interactive prototype and testing and evaluating the solution which is discussed in the next section.
6.2.1. Functional prototype

The functional prototype developed in this thesis is a single page and web-based mobile application written on AngularFire; this is a framework built on JavaScript and in particular on AngularJS and Firebase. The reasons behind the selected tools to develop the functional prototype are discussed in details in chapter 5.

The final functional prototype in this thesis provides basic functionalities, namely CRUD functions. In addition, browsing content through a deck of cards is implemented so that generated cards by end-users can be browsed in real time by others. Users can navigate to the next card by swiping down the cards and navigate backwards by swiping up. Figure 8 demonstrates screenshots of cards produced using the functional prototype.

The user experience evaluation is conducted as a workshop with 35 students in a school located in Lindängen area which is the case study of this project. Engagement metrics were measured using the final prototype in the workshop. Next chapter explains the details of the evaluation phase.
Figure 8: Screenshots of cards produced using the functional prototype
7. Evaluation

This chapter evaluates the card-based design implemented in Lindängen App and measure the engaging elements on the final result. In the evaluation process the degree to which the potential users feel the engaging factors is measured. This step gives also a reflection on the chosen JavaScript framework that is used to develop the Lindängen App interactive prototype. This chapter is subsequently divided into two main sections. In the beginning the evaluation process on the card UI design is discussed. This is then followed by a reflection on the selected JavaScript framework.

7.1. Cards design evaluation

This section explains the results gathered from a user experience evaluation and usability testing session carried out in a local school located in Lindängen district. Since the main goal of this thesis is to develop an engaging user experience for Lindängen App, engaging factors were measured in the evaluation step. Evaluation techniques used in this project are unobtrusive observation and survey. Firstly, participants were observed during the use of the prototype, they then completed a survey developed based on the engaging elements discussed in chapter 2. The survey is constructed of: (1) a set of questions to assess user experience (2) questions based on a usability evaluation method established on four dimensions: usefulness, ease of use, ease of learning and satisfaction.

As discussed in chapter 2, the engaging factors applied in this work are based on the list suggested by O'Brien & Toms [23]. Chosen metrics are with respect to user interface design, namely aesthetics, affect, feedback, interest, novelty and perceived time. Three of these attributes: affect, feedback and perceived time fall into usability which is part of the overall user experience, whereas novelty, aesthetics and interest are translated into attributes representing the other dimension of user experience. In this thesis the term usability refers to the first group of elements and the term user experience implies the second group. These two dimensions of user experience add structure to the design and evaluation process of this thesis. Hence, this section is divided into two parts. The user experience evaluation of the artefact is discussed in the beginning and it is followed by functionality evaluation and demonstrating usability testing results.
The prototype developed in this thesis is based on the cards UI and navigation design and provides the CRUD functions. In addition, browsing content through a deck of cards is implemented in the functional prototype so that generated cards by end-users are available in real time to others.

To evaluate the prototype, a four-hour workshop carried out with students from Lindängen School. 35 students participated from two classes within the field of Swedish and Civic education. Participants were given an introduction to the concept of the Lindängen application and then were asked to create cards for their favorite services.

![The workshop at Lindängen School](image)

**Figure 9:** The workshop at Lindängen School

Generated cards by participants were about spontaneous activities such as organized soccer games, a rapidly arranged flea market and school projects. They also created cards about services and organizations located in Lindängen area and some of the cards were peace messages or a few words about the community. Figure 10 shows some of the cards generated by participants during the workshop.

![Cards created by participants](image)

**Figure 10:** Cards created by participants
7.1.1. User experience

As one of the goals of this work is to explore the best suitable interface and navigation design to develop an engaging user experience for Lindängen App, the user experience of the prototype with primary focus on the card-based UI design has been investigated.

Observation

The observation in this step was carried out with a focus on the user’s facial expressions, gestures and interacting with the application as they perform activities. User’s emotional and non-verbal cues such as frustration and delight were written down. For this purpose, 4 random participants (2 girls and 2 boys – one of them was left-handed) were observed in the following phases in the workshop:

1. Creating new cards.
2. Browsing the deck of cards
3. Reading content of the generated cards

Based on the observations in the first phase, participants did not encounter any difficulty to discover the approach for creating new cards. All 4 users, found the button for adding new cards, relatively fast. Filling out the form and taking a new photo or choosing an existing photo went well for the chosen participants. However, some problems occurred during uploading the cards which are more concerned with usability elements, hence they will be discussed in the usability section.

In the second phase, participants were observed while browsing the deck of cards to see the cards generated by their fellows. It was observed that browsing cards required minimal actions with minimal amount of motion. Although, 2 of the observed participants needed gesture indications and clues to find out the navigation approach in the beginning, all of them performed the gestures and browsed the content easily after receiving the hints. Furthermore, all of the users could browse the deck of cards using the thumb of the same hand holding the mobile phone. One of the chosen participants was left-handed and it was observed that he was also able to browse the cards by using only left hand with no problem.

As the last phase, the meaningfulness and valuableness perceived by the users were studied by observing user’s reaction to the content of cards created in the workshop. Facial expressions showed that the 4 participants were comfortable reading the cards
It was also observed that 3 of the participants was delighted while reading the positive messages about the Lindängen community.

As mentioned before, usability metrics were also taken into consideration while observing users, for example, the ease of accomplishing the given tasks. Usability metrics will be discussed in depth in the usability section.

**Survey**

This section describes the outcome of the survey questionnaire conducted in the workshop. The survey is a 15-item questionnaire designed to measure engaging metrics. The survey questions were developed on the basis of engaging user experience attributes suggested by O'Brien & Toms [23], along with sensory appeal and simplicity metrics. As mentioned before, three of the engaging factors namely affect, feedback and perceived time fall into usability which is one part of the overall user experience, whereas novelty, aesthetics and interest are translated into attributes representing the other dimension of user experience.

User experience metrics are translated into 12 attributes as follows:

- **Aesthetics:** appealing, pleasant, symmetrical, consistent, clean, and clear
- **Novelty:** original
- **Interest:** worth taking action, and worth recommending
- **Sensory appeal:** minimal action
- **Simplicity:** easy-to-scan

On the other hand, to measure the usability related elements, the survey included USE questions. USE is a set of questions aiming at evaluating four dimensions of usability: usefulness, ease of use, ease of learning and satisfaction [45]. The outcome of USE questions will be discussed in the usability session.

Each question in the survey questionnaire has a five-point rating scale from strongly agree to strongly disagree: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. The survey questionnaire can be find in Appendix I. The outcome of the survey for user experience related questions is demonstrated in the chart below.
The chart above reflects that overall the users responded positively or neutrally in respect of the user experience of the prototype. The majority agreed or strongly agreed on aesthetic related attributes of the application. They mostly found the application attractive, clean, consistent, pleasant and symmetrical. The only aesthetic attribute that participants did not respond as positive was clearness of the application, 46% of them was neutral and 32% either disagreed or strongly disagreed. Furthermore, most of the participants found the application unique, 63% either agreed or strongly agreed over the prototype novelty. They mostly responded positively to the questions with respect to the interest’s attributes. 74% of the participants were more likely to take action and use the software in future and 74% would like to recommend the application to their
friends and family members. In addition, 82% of the study participants agreed or strongly agreed that browsing cards requires minimal actions and only 17% were neutral. 63% of the participants grasped the content of the cards easily whereas 23% were neutral and 15% responded disagree or strongly disagree.

7.1.2. Usability

Usability is a subset of the overall user experience and is not a merely, single dimensional property of a user interface, but it associates with the effectiveness, efficiency and satisfaction with which specific users can achieve a specific set of tasks in a particular environment [37]. Usable interfaces are characterised by their ability to offer an effective, easy, learnable, and satisfying user experience [39].

Observation
As mentioned previously, 4 chosen participants were observed during 3 activities that include creating new cards, browsing the deck of cards and reading the content of generated cards. In the first phase it was observed that adding new cards with heavy images was not as fast as expected. One of the participants encountered difficulties uploading cards with images and since there was no waiting indication implemented in the prototype, the user pressed the save button multiple times. Consequently the card was created multiple times and a sense of frustration was observed. However, no usability problem was found during the two next phases. Participants were able to browse the cards smoothly and no problem occurred while performing gestures. It was observed that both right- and left-handed participants was also able to navigate and browse the deck of cards using the same hand holding the mobile phone.

Survey
The survey questionnaire included USE questionnaire to measure usability metrics. USE is a commonly noted usability measurement method and questions in this method fall into 4 categories namely, usefulness also known as efficiency, ease of use, ease of learning and satisfaction [45]. Usability results from the survey questionnaire is demonstrated in the chart below.
The outcome demonstrated above indicates that the overall reaction to the software in terms of usability was relatively positive. Participants responded with strong level of agreement over the ease of leaning and usefulness of the application, respectively 80% and 68% of the participants agreed or strongly agreed. In addition, 54% of the users were satisfied with the tool. The least positive responses was over ease-of-use metric and while 32% of the participants responded positively, 40% of them were undecided. There was a slight number of responses indicating disagreement over usefulness, satisfaction, and ease of learning (9%, 6% and 6% respectively) and 29% of the participants disagreed or strongly disagreed over the ease-of-use of the application.

**Reflection on the evaluation outcome**

The results obtained in the evaluation stage indicated a comfort level by the participants while using the application. The overall reaction to the prototype was positive. Based on the survey and observations, cards UI and navigation design implemented in Lindängen App covers the two dimensions of aesthetics - classical aesthetics and expressive aesthetics, to a great extent. It also became clear that cards are easy to scan as participants grasped the content quickly. Moreover, participants responded positively to the swiping gestures implemented in the prototype. Based on the
participant’s overall judgments the gestures required to navigate through the cards needs minimal actions and can be done using the same hand holding the mobile phone for both right- and left-handed people. In addition, most participants had positive attitudes towards the novelty of the application. They also showed interest in taking action and use the application as well as recommending it to others. The meaningfulness and valuableness of the application perceived by the users were also positive. Facial expressions and participants’ reactions to the positive messages towards some of the generated cards showed a level of delight. The outcome of the usability measurement indicates a strong level of agreement over the ease of leaning, perceived usefulness metrics and they were moderately satisfied with the prototype.

On the other hand, it became evident that the application was not clear to the participants in the first glance due to the lack of gesture indications and navigation cues and participants did not respond as positive about clearness of the application which is one the aesthetic attributes. Furthermore, uploading new cards was not as fast as expected. This usability problem can be interpreted as the main reason for receiving disagreements over the ease of ease metric. This usability problem is fixed in the next version of the prototype but not tested with potential users.

7.2. A reflection on AngularJS framework

As discussed in chapter 5, AngularJS is the only framework that covers all major features in the core framework. The most useful feature in rapid prototyping the Lindängen application was custom HTML elements which is only supported in AngularJS. Custom HTML elements come in the forms of custom HTML elements, custom attributes and custom class names. This feature in AngularJS enables developers to expand HTML and create new elements that can do almost anything inside the framework from teaching the browser new functionalities to provide DOM manipulation, creation and event detection. Custom HTML elements can be used as regular HTML elements and it subsequently brings additional functionality to HTML and makes it more flexible [33].

An example for a custom HTML elements used in Lindängen App is swipe-cards and swipe-card HTML tags that is shown below in listing 1. These custom HTML tags contain the deck of cards and provides the swiping gestures for browsing the cards.
In addition, AngularJS as an opinionated framework provided an efficient and easy platform for prototyping and developing Lindängen App. AngularJS as a structured framework along with its core features such as observables and two-way bindings speeded up the prototyping process. The Lindängen App prototype is built on a trustful foundation that ensures further development without dedicating time on exploring the best solution.

Furthermore, its comprehensive documentation and the strong community behind it made the learning curve steeper and it also will benefit next developers who will take over the project in future. In addition, it’s flexibility with other frameworks made the rapid prototyping faster and easier. The Lindängen App prototype uses Firebase as a real time back-end service as well as Ionic as a user interface framework. These two frameworks worked perfectly with AngularJS and there were no issue regarding the integration of these frameworks with AngularJS and it made the prototyping stage significantly fast.

On the other hand, AngularJS provides the possibility for further development. The features and requirements discussed above benefit rich application productions as well. These features not only cover the primary system requirements established during the focus groups discussed in chapter 7, they can support future requirements. Additionally, AngularJS as a SPA framework with a built-in routing and navigation provides interactivity, speed and a fluid user experience as the page does not reload at any point in the process.
Furthermore, AngularJS’s modularity and ability of dependency injection as its two major features are the key factors for maintaining a complex application. “Angular is written with testability in mind” [63]. It is designed to simplify unit testing by providing support and guidelines.
8. Discussion

This research set out to address two subsequent research questions: (RQ1) what user interface and navigation design is best suitable to develop an engaging user experience for local community mobile applications targeting youth people? (RQ2) what JavaScript framework/library is best suitable for both rapid prototyping and production development? This chapter demonstrates the results obtained in this thesis by summarizing the answers to the research questions, explains the limitations of the work, concludes the findings and outlines the future work.

8.1. Reflection on the overall outcome

RQ1: what user interface and navigation design is best suitable to develop an engaging user experience for local community mobile applications targeting youth people?

In answering this research question, most popular content presentation and navigation designs have been reviewed and card-based design format was selected. To find out whether the chosen design empowers an engaging user experience, an artifact was developed for the case study in this project through the design and creation approach. This is an iterative and artifact-centric research strategy that involves five steps: awareness of the problem, suggestion, development, evaluation and conclusion [9]. In the evaluation step, a range of engagement attributes identified by O’Brien & Toms [23], was measured on the final prototype. These metrics targets the overall user experience perceived by end users. Some of these metrics fall into usability category which is part of the overall user experience.

Based on the findings in the evaluation step, card design facilitates an engaging user experience to a great extent. This UI and navigation design covers classical aesthetics and expressive aesthetics as the two dimensions of visual aesthetics. Furthermore, it empowers the novelty of the application. Results shows that cards design facilitates the application in delivering concrete information in a readable and scan-able format. In addition, swipe-able cards are easy to navigate with a single finger for both right- and left-handed people, and it can be the thumb. Findings also indicates a high level of interest in taking action and using the application as well as recommending it to others by the potential end-users.
On the other hand, due to the lack of gesture indications and navigation cues the clearness of the application was omitted. This issue is considered an essential future improvement for the application. Furthermore, although uploading new cards was not as fast as expected, the four overall usability measures that include usefulness, ease of use, ease of learning and satisfaction were acceptable. This usability problem is fixed in the next version of the prototype however it is not tested with potential users.

Results explained above indicate that in spite of the fact that potential users were sceptical towards the design of the application in the first focus group, they were satisfied when they used the application in real. In the first focus group conducted with 6 of students from Lindängen School, participants were more comfortable with the traditional way of presenting data by many pages of content linked together than card-based design. However, it was observed that the same students participated in the final evaluation were delighted about the application design. It can be interpreted as user’s habits that is a human behaviour to resist to change.

RQ2: what JavaScript framework/library is best suitable for both rapid prototyping and production development?

This research question seeks for a framework that while is efficient, easy and fast for rapid prototyping, it also supports programming capabilities for developing production applications. AngularJS as the chosen framework provides necessary foundation for rapid prototyping and also embraces the fundamental criteria needed for building rich applications. This is a ready solution with strong capabilities. Using AngularJS, it was possible to develop Lindängen App which is the case study in this thesis on the best possible structure over the framework without allocating time on exploring the best-practices. It reduced the code volume and makes the code clean, structured, and maintainable. This can benefit future developers to continue and maintain the project efficiently.

On the other hand, DurandalJS can also be a suitable front-end framework to prototype and develop web applications. It provides most of the core features and criteria. However, it does not support custom HTML elements which benefited us significantly in prototyping Lindängen App using AngularJS. In addition, testability as one of the important features in maintainability is more supported in AngularJS.
8.2. Limitations

This thesis did not cover the impact of MIL project on social area and fostering social inclusion in particular. It did not address the issues concerned with tackling social exclusion in deprived neighborhoods which is the main focus in MIL project. This paper, however, narrowed down the argument by focusing on investigating an engaging user experience, and suggesting a set of development tools to develop and evaluate the suggested solution.

8.3. Conclusion and future work

Firstly this thesis explored an engaging user experience for local community mobile applications. In doing so, the most popular content presentation and navigation designs were outlined (ch. 4). On the other hand, this thesis investigated JavaScript frameworks and libraries to find out the most suitable set of rapid prototyping tools that also support production development features and criteria (ch. 5).

The case study in this thesis is titled “Lindängen App” which is the proposed solution by MIL team to foster social regeneration in Lindängen district. To evaluate the answers to the objectives in this thesis, an interactive prototype of Lindängen App was developed using AngularJS as the chosen framework and card-based design was applied as the chosen UI design. To determine the quality of card design, user experience engaging metrics were used in the evaluation process.

In conclusion, card-based design format can empower local community applications to a great level in terms of user experience. As discussed in section 8.1, results obtained from the evaluation process indicated that swipe-able card-based design covers most of the user experience elements to an acceptable level. In addition, AngularJS as the chosen JavaScript framework provided an efficient, fast and easy platform for rapid prototyping the case study in this thesis. At the same time, it fullfields the core criteria for developing a large-scale and complex application and it is a suitable platform for developing mobile applications from prototyping to production scale.

The suggested user interface and navigation design in this thesis can enhance user experience for mobile applications, in particular local community applications. This can be considered for other researchers for future work, to strengthen user experience. In addition, the target group in this thesis is youth people between the age of 14 and 19.
A wider range of end users can be determined in future work and the suggested design can be evaluated with users with a wider range of age group.
References


Appendix I: Survey questionnaire

Please rate your agreement with statements below.

1. This application is attractive.
   Strongly Disagree  1 O  2 O  3 O  4 O  5 O  Strongly Agree

2. I found this application pleasant to use.
   Strongly Disagree  1 O  2 O  3 O  4 O  5 O  Strongly Agree

3. The look of this application is symmetrical.
   Strongly Disagree  1 O  2 O  3 O  4 O  5 O  Strongly Agree

4. The layout of this application is consistent.
   Strongly Disagree  1 O  2 O  3 O  4 O  5 O  Strongly Agree

5. This application has a clean layout.
   Strongly Disagree  1 O  2 O  3 O  4 O  5 O  Strongly Agree

6. Performing tasks is straightforward and clear.
   Strongly Disagree  1 O  2 O  3 O  4 O  5 O  Strongly Agree

7. This application is novel and interesting to me.
   Strongly Disagree  1 O  2 O  3 O  4 O  5 O  Strongly Agree

8. I think that I would like to use this application frequently.
   Strongly Disagree  1 O  2 O  3 O  4 O  5 O  Strongly Agree

9. I would recommend this application to a friend.
   Strongly Disagree  1 O  2 O  3 O  4 O  5 O  Strongly Agree

10. It requires the fewest steps possible to accomplish what I want to do with it.
    Strongly Disagree  1 O  2 O  3 O  4 O  5 O  Strongly Agree
11. The cards are easy to grasp.
   Strongly Disagree  1  2  3  4  5  Strongly Agree

12. This application is useful.
   Strongly Disagree  1  2  3  4  5  Strongly Agree

13. This application is easy to use.
   Strongly Disagree  1  2  3  4  5  Strongly Agree

14. I learned to use it quickly.
   Strongly Disagree  1  2  3  4  5  Strongly Agree

15. I am satisfied with this application.
   Strongly Disagree  1  2  3  4  5  Strongly Agree