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Masterarbeit

Design and Development of a Public Display Survey Platform

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Betreuer:	Prof. Dr. Florian Alt
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Zusammenfassung

Kurzzusammenfassung der Arbeit, maximal 250 Wörter.

Abstract

In recent years public displays (PD) have proliferated in public space and are becoming part of our daily lives. New interactive applications for PDs are flourishing in shopping malls, train stations, and airports. Their development requires extensive evaluation, being a complex and time intensive endeavor itself. Getting feedback on metrics such as usability involves high effort. So far, many interactive PDs are still lacking a feedback channel from the display to the display provider. To solve this problem we developed an interactive survey platform and carried out an extensive literature review. *PDSurvey* aims to facilitate the conduction of surveys on public displays and is a toolset for further PD evaluation. In this thesis we present the design and development process of our platform and propose a list of standardized questionnaires, resulting from an extensive literature review. Furthermore we present the findings of our field study, in which we assessed the general acceptance of questionnaires being conducted in public space and which feedback channels are best suited for users to respond to questionnaires in a digital form. Our findings imply that the majority of users preferred to complete a survey directly on-site, nonetheless around a quarter refrained from using PDs for responding to the questionnaire. Offering the tablet as a feedback channel represented a good alternative, even though users have to switch devices. Surveys conducted on public displays are a reasonable alternative to online surveys, with the limitation of social desirability and a decrease of privacy.

Acknowledgments

I would like to thank Jiamin Shi, Axel Hösl, Dr. Julie Wagner, and the entire Mediainformatics chair, for their great spirit and support. It was great to be able to complete my Master studies and thesis at the chair. Additionally, I would like to thank my parents for their continuous support throughout my entire education. Much would not have been possible without their love and support. But above all, the thanks goes to Prof. Dr. Florian Alt, for his guidance, feedback, support and the time devoted to my Master's thesis.

Aufgabenstellung

Development of a Public Display Survey Platform

Problem Statement Public displays are quickly proliferating in public space. At the same time, interactive applications are still scarce, since their development is costly and the effect on the user - and thus their benefit - is often not clear. Hence, interactive displays applications are usually developed, deployed, and carefully evaluated in research contexts. In most cases, evaluation focusses on particular aspects only, such as user performance, user experience, or social implications, due to the significant effort associated with planning, preparing and conducting public display evaluations.

Scope of the Thesis To tackle the aforementioned challenge, the objective of this thesis is to develop a survey tool that allows interactive public display installations to be comprehensively assessed. In a first step, an extensive literature review will be conducted with the aim to identify important aspects of public display deployments - both from a researcher as well as from a practitioners' perspective - as well as to develop an understanding of how these aspects could be addressed through surveys. Based on the literature review, a web-based survey platform will be implemented that can easily be used to evaluate and compare public displays through different channels. Such channels include both evaluation directly at the display or through a (mobile) website that allows participation also via a smartphone or tablet. The platform should allow public display owners to configure their own surveys based on their needs. Optionally, the survey tool itself will be evaluated with an interactive public display application.

Tasks (1) conduct a literature review to identify (research) questions that are of interest to researchers and practitioners
(2) produce a comprehensive set of questions that can be used to assess these questions by means of a survey
(3) develop a web-based public display survey platform consisting of (a) an administration interface that allows (groups of) questions to be selected for use within the tool and (b) a responsive UI that can be rendered on different devices (public display, smartphone, tablet, laptop)

Requirements Strong skills in web programming, independent scientific work and creative problem solving, experience in creating questionnaires is a plus.

Keywords Public displays, interaction, applications, survey, questionnaires, web

Ich erkläre hiermit, dass ich die vorliegende Arbeit selbstständig angefertigt, alle Zitate als solche kenntlich gemacht sowie alle benutzten Quellen und Hilfsmittel angegeben habe.

München, April 15, 2015

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Contents

1 Introduction

1.1 Outline

In recent years there is a clear trend towards more interactive displays in public areas. At airports they are used for finding your gate, in shopping malls as a store locator and in other brand stores for assessing user satisfaction or to give users a more immersive shopping experience. The applications for public displays are ever growing, however still no common design guidelines exist [3]. This reinforces the need for evaluating all new lab studies via lab or field studies. The evaluation of public displays requires prior knowledge and is rather time intensive. To facilitate this step and to allow for better comparison and analysis of public display setups, we suggest the development of PDSurvey, a public display survey platform.

there is an increasing number of public displays, used for more public displays.

Public displays have been an object of research since XXXXX. They differ from other interactive displays by being owned by a display provider, and not by the user using it. In recent years public displays have evolved from originally replacing billboards with digital signage (advertisement on digital screens), to becoming ever more interactive in their area of application. Examples in research for new interactive applications are CityWall [23], MirrorTouch [20], Digifieds [], Looking Glass [], ...

This interactive capability of displays in recent years also provides the basis for conducting surveys on-screen. Surveys can be conducted via different research methods, such as questionnaires, interviews, observations, focus groups or logging. The interactive capability of public displays is of similar importance for conducting questionnaires as the emergence of the web in the early 21st century for online survey platforms. It is now possible to conduct questionnaires and log data directly from public displays and use it as a feedback channel to the display provider.

Already in 1983 a study was conducted by Sproull and Kiesler, comparing email with traditional mail surveys. Their findings were a faster and cheaper conduction of surveys via email, with less social desirability. Possible restrictions were the limited spread of computers and thus a distorted population [26]. In 1998 commercial companies like SurveyMonkey were founded, providing online survey platforms.

The same counts for surveys being conducted on public displays, which opens up a whole new feedback channel. With the introduction of the iPhone in 2007 and the iPad in 2010 users became much more accustomed to using screens with touch support. The increasing acceptance of touch screens combined with more sophisticated touch screen technology opens the path for interactive questionnaires in public settings.

Our research contributions are the categorization of questionnaires being used for the evaluation of public displays, based on an extensive literature review. Furthermore we introduce the PDSurvey platform, and present first practical experiences from our field study. Which feedback channel is preferred, and what the motivation was for approaching the public display and questionnaire. Our main research question is how to automatically evaluate public display setups via surveys carried out on the displays themselves.

In the following we will ...

The rest of this thesis is structured as follows. Chapter 2 gives an overview of related work, introduces the reader to the area of public display evaluation, and presents our clustering of standardized questionnaires. Chapter 3 deals with the implementation of the PDSurvey platform. First the requirements and design decision are discussed, followed by a short overview of the architecture, and concluded with an in-depth overview of the finished platform. In chapter 4 the descriptive field study presented and our survey platform evaluated. Future work is discussed in Chapter 5. A conclusion complements the thesis.

My Outline

1. Introduction: clear trend

2. Goal of thesis: why the study was undertaken. » Do not repeat the abstract !!
3. **background information**: present sufficient information, allow the reader to understand the context and significance of the question you are trying to address.
4. **Motivate** your reader to read the rest of the thesis. You should draw the reader in and make them want to read the rest of the paper. An important/interesting scientific problem that your paper either solves or addresses.
5. Present the **research question**
6. **Give an Overview**: guide the reader to what lies ahead.

Scope for the practical part of the thesis. What is the system supposed to look like. What is the current state of the practical work in research and in the industry. Which partners do we have, where do we want to deploy this system. What are the goals for this evaluation platform?

Benefits of PDSurvey platform:

- being able to work with big data. collecting a large number of responses from a variety of displays in various settings, and assigning a specific context to every display connected to PDSurvey. Once enough data is collected, having the ability to evaluate and compare the displays between each other. Interesting questions for analysis would be, which role the context plays on how the users behave, when running identical software settings on the displays, but only varying the context (position, size of display, surrounding environment of the display, positioning it outdoors or indoors, influence of the weather, type of building it is positioned in) – see Chapter 4: Modeling

1.2 Other introductions for inspiration

1. paper 60 mueller2010mm - Requirements and Design Space for Interactive Public Displays: Good introduction from Mueller et al. [19]: “Digital immersion is moving into public space. [...] analogies to HCI (utility, usability, likeability) often hold true, but not always! These need to be evaluated individually.”
2. Another good introduction as an inspiration: “MyPosition: Sparking Civic Discourse by a Public Interactive Poll Visualization” » check out the introduction there! [28]
3. paper 18 cites Mark Weiser, on his predictions regarding Ubiquitous Computing and how it will be the third revolution after main frame (1st) and personal computer (2nd). for the quote see GDrive ‘Quotes and Notes from Literature’
4. copy further notes from https://docs.google.com/document/d/1f2MJHMh5Yvvh9d4hhIT0WmgdlBbZ9rX5b

Important things to keep in mind! Make sure that it is obvious where the introductory material (the old stuff) ends and where your contribution (new stuff) starts?

2 Background and Related Work

Our research is based on an extensive literature review, with over 100 papers viewed. This led to the development of the public display survey platform (see chapter 3) and the categorization of standardized questionnaires (see section 2.2). A short summary of the most relevant paper is described in section 2.1. The goal of the literature review was to find out how other researchers evaluated public displays and to develop an understanding of how these aspects can be addressed through surveys. The aim was to identify important aspects of public display deployments, both from a researcher's as well form a practitioner's perspective.

2.1 Related Work

Public display evaluation has already been addressed in literature. Alt et al. [3] give an overview of study types, research paradigms, and evaluation methods used for evaluating public displays. Müller et al. present with MirrorTouch [20] an updated evaluation and additionally extract metrics used for quantitative field studies. According to their findings almost exclusively descriptive field studies are used in the area of public display evaluation. For a more in-depth introduction to public display evaluation the doctoral thesis of Alt [2] gives a good overview. For a general recap of how to best design, evaluate, and report experiments, the book by Field and Hole [11] was used. Kirakowski [17] provides a good introduction for practitioners of what to watch out for while conducting surveys, with his list of FAQs

Papers which inspired us and which themselves have a good approach towards the evaluation of public displays, are amongst others: Overcoming Assumptions by Huang et al. [13], Worlds of Information by Jacucci et al. [16], and Looking Glass by Müller et al. [21]. **TODO: describe each of the papers in one short sentence**

Based on the previous evaluation of related work and the time-consuming nature of field studies (even for small quantitative questionnaires) the demand for a simplification or automation of the evaluation process becomes clear. Due to the essential importance for the validation of public display installations and research in general, a toolset such as the PDSurvey platform can be a great relief.

One constraint of public display research represents the opportunistic nature of the setups and the discrepancy between lab studies and field studies [22]. Thus there is an additional demand for evaluating each public display setup individually and if possible directly in the field.

Before we started developing the research platform, we did some research on which similar tools there are available on market.

A set of related survey platforms aiming for a similar goal ...

The first one we looked at was SosciSurvey [1], a popular tool developed by the Institute for Communication Science at our university. One major drawback of their approach was the difficulty of extending and embedding the SociSurvey platform. For our purpose it was easier to build a new platform already supporting a responsive layout and RESTful interaction. Other tools similar to the SociSurvey platform are LimeSurvey [2], an open-source PHP project.

Commercial solutions which support far more than the free platforms, are

eSurvey Creator [3]

SurveyMonkey [4], might be the toughest opponent based on the functionality of the tool. But it is not visible that they offer running dedicated public displays in a dedicated mode for the evaluation platform. One They also offer a set of sample surveys, available for use in their platform

[1] `https://www.soscisurvey.de/` (last accessed on November 26, 2014)
[2] `http://de.wikipedia.org/wiki/LimeSurvey` (last accessed on April 6, 2015)
[3] `https://www.esurveycreator.com/` (last accessed on April 6, 2015)
[4] `https://www.surveymonkey.com` (last accessed on April 6, 2015)

[5], however they

SoGoSurvey [6]. One of the best solutions!

UX Suite by UsabilityTools [7], has a handy backend for configuring the surveys, although it is lacking the pre-configured standardized questionnaires.

SurveyPlanet () seems to be the best solution found so far! However the embed code is only based on iframes.

Qualtrics [8]

For additional information on currently available web-based survey tools, refer to [6] and ... » **FOOTNOTE or CITATION?**

[9].

Free Online Surveys is missing some question types (e.g. the Likert scale) and freeonlinesurveys.com

+++ clarify what the difference is between the already existing approaches to our approach. +++ REST API is missing, not designed for use on public displays. Thus no overlay and seamless integration into public display applications is possible. The only exception so far migth be Qualtrics, based assessing their Site Intercept demo.

Unique about our approach is the fact that we will have the opportunity to conduct surveys across a broad number of devices and platforms, due to its modular and RESTful architecture. The benefit is that the whole platform retrieves all data via a RESTful API, allowing the greatest possible coverage of public displays and end consumer devices. Additionally we offer a range of standardized questionnaires, which specifically aim at usage on public displays, introduced in section 2.2.2.

2.2 Background

As a result of the literature review, besides getting a better understanding of how public displays were evaluated, a side effect was getting an overview of the questions asked to evaluate public displays and their applications. This turned out to be a quite valuable approach, since we haven't seen any compilation of questionnaires used for public display evaluation so far. Our goal was to find patterns and to build clusters of questionnaires being useful for the evaluation through automated public survey display platforms.

In the following we will first describe our methodology for gathering the information (section 2.2.1), followed by a categorization of standardized questionnaires (section 2.2.2), and wrapped up by a summary of our findings (section 2.2.3). The categorization of the standardized questionnaires can be found in Table 2.2.2.

2.2.1 Methodology

The procedure for the selection of papers to review, was as follows. As a starting point all papers form the appendix of Florian Alt's doctoral thesis [2] were read. Afterwards interesting related work and citations were followed based on the papers from the previous step. This was supplemented with targeted research on Google Scholar and the APM Digital Library. To round off the literature review the publications of two authors, who are very active in this field, were reviewed. A full list of all papers reviewed can be found in Appendix D.

[5] `https://www.surveymonkey.com/blog/en/sample-survey-questionnaire-templates/` (last accessed on April 6, 2015)

[6] `http://www.sogosurvey.com/Features/List-of-All-Features.aspx` (last accessed on April 6, 2015)

[7] `http://usabilitytools.com/ux-suite/` (last accessed on April 6, 2015)

[8] `http://www.qualtrics.com/site-intercept/` (last accessed on April 6, 2015)

[9] `http://www.capterra.com/survey-software/` and `http://www.idealware.org/articles/fgt_online_surveys.php` (last accessed on April 6, 2015)

The first step, the analysis of the appendix was fairly straight forward. All papers were read from start to finish (pages 335 to 343), in order to get a first overview of the current state of research. The second step, pursuing related work and citations of interest, was carried out in a more subjective manner. Whenever interesting papers or projects were mentioned, the cited paper was also skimmed through. For the third step, a more strategic approach was used. Based on the insights gained from the previous steps, Google Scholar and APM was checked for literature relevant to our research question. The Keywords, that were used amongst others for the research in these online libraries, were:

- Standardized Surveys for Usability
- Standardized Surveys for User Experience
- user satisfaction questionnaire
- public display evaluation
- standardized public display evaluation

The last step for collecting relevant papers consisted of profiling publications of two relevant authors in the area of public display research, namely Jörg Müller and Marcus Foth. The process started out by first finding a list of their publications. Since the literature review made by Florian Alt (see first step) already covered papers up to 2011, only ones published between 2012 and 2014 were viewed. On each opened papers from this time frame a keyword search was carried out, to see whether it contained an evaluation which might be relevant for us. These keywords were: *questionnaire*, *survey*, *question*, *interview*, *(field) study*, and *evaluation*. If none of these words could be found, the headlines and the abstract was skimmed through. All papers containing a reference to evaluating public displays were saved locally and analyzed in more detail. For Jörg Müller the best list of his publications were found on his personal website[10], and for Marcus Foth two websites were evaluated [11].

2.2.2 Standardized Questionnaires

All questionnaires found during the literature review phase were categorized into a schema, inspired by the research questions introduced by Alt [2] (chapter 2.8.2), serving as a guideline for our classification of standardized questionnaires. Since the categories *audience behavior* and *user performance* from Alt can not be evaluated through questionnaires, the research questions are not represented in the following. We extended the prior categorization with findings from the literature review phase, described in the previous section 2.2.1,

During the literature review phase a comprehensive list of widely used questionnaires was assessed. Other people's collections incorporated into our categorization can be found in the bibliography [8, 10, 12, 18, 29].

A full overview of all standardized questionnaires found in literature can be found in Table 2.2.2, grouped by the following categories: user experience, usability, user acceptance, user performance, display effectiveness, privacy, social impact, context, and demographics.

A list of other people's collections can be found here: Lewis and Sauro [18] list discuss 19 questionnaires at the HCI conference, Garcia [12] describes the SUMI, PSSUQ, and SUS questionnaire.

User Experience User experience describes the overall satisfaction and experience the user has with a display. The evaluation can be carried out through questionnaires.

[10] `http://joergmueller.info/publications.html` (last accessed on November 17, 2014)

[11] `http://www.vrolik.de/publications/` (last accessed on November 18, 2014) and `http://eprints.qut.edu.au/view/person/Foth,_Marcus.html` (last accessed on November 18, 2014)

Usability The category was added

User Acceptance User acceptance analyzes user's motives and incentives for approaching the display. The evaluation can be carried out qualitatively (subjective feedback, focus groups) or quantitatively (questionnaires).

Display Effectiveness Display effectiveness evaluates the economic perspective of display efficiency.

Privacy Privacy takes a look at the users privacy concerns.

Social Impact Social impact considers everything related to social behavior, the influence on social interaction and communities, as well as social effects.

Context One category new category, is the collection of context data, relative to the public display. On most normal studies the context doesn't change during evaluation and thus is not as important. For the evaluation of public displays, especially when multiple displays are deployed in different locations running the same application, it will become if importance to also assess the static and dynamic context of each deployed display. External influences such as the weather, time of day, special events or semester break can have an influence on the number and type of people passing by a display. Additionally static context parameters, such as the display type, display size, position on wall and inside of the room might also influence how the display setup is perceived in public. Once recorded, these static and dynamic parameters can be evaluated with knowledge discovery algorithms for big data, a whole research field for itself. So far no previous works are known on this area so far, evaluating a large public display deployment based on their difference in context.

Demographics In most surveys background information about the participants is also of interest. This varies from general questions (gender, age, religion, education), more personal questions (relationship status, family, children, country of origin), skills (personal, professional, technical), personal beliefs, political affiliation or voluntary commitment.

Three background questionnaires, which we haven't used ourselves yet, but which go more in depth, are the Adult Literacy and Lifeskills Survey (ALL) [12], the PIAAC Conceptual Framework of the Background Questionnaire Main Survey [13] and a Police Background Questionnaire [14].

Miscellaneous All questions and questionnaires, which can not be assigned to any of the previous categories, belong to this category.

Cheverst et al. [7] evaluated whether there were any previous experience with Bluetooth, or recommendations for possible new features. For the evaluation of the Digifieds platform Alt et al. also evaluated: "We asked them about their mobile phone usage (e.g., how often they used it, if it had a touch screen, if they used it to surf the web, and if they had installed third party apps) and whether they had used the UbiDisplays before" [4].

1. POST OR REFERENCE THE TABLE WITH THE CATEGORIZATION HERE

[12] `http://nces.ed.gov/surveys/all/` (last accessed on April 1, 2015)

[13] `http://www.oecd.org/site/piaac/PIAAC(2011_11)MS_BQ_ConceptualFramework_1Dec2011.pdf` (last accessed on April 1, 2015)

[14] `http://www.slmpd.org/images/hr_forms/commissioned/BackgroundQuestionnaire.pdf` (last accessed on April 1, 2015)

2. My Categorization: https://docs.google.com/document/d/1D925jJ7bmRc1EZdCTz32lmW2hniMiq7GzBWxX8rmhpE/edit (Google Docs)

2.2.3 Findings

Findings:

1. use both quantitative and qualitative methods for data collection (explain why this is important, teaser this as a requirement for the platform, how it could be implemented)
2. support mutliple sections, all displayed at once or (optionally) spread across multiple users
3. support various question types (e.g. 5-point and 7-point Likert scale, multiple choice, numeric responses, comments)

These findings bring us to the next chapter, the research platform to develop, capable of conducting all of these questionnaires.

3 Implementation

In this chapter we will deal with the infrastructure and technical realization of the public display survey platform. First, the requirements for the survey platform are discussed (section 3.1). Subsequently the architecture resulting from the design decisions will be the main focus (section 3.2). To facilitate the training period for successors we will also take a brief look at the software model (section 3.3). For more specific information and for information regarding maintenance of the project, please refer to the documentation found on the CD enclosed or on the GitHub repository (see Appendix B).

In figure 3.2 a brief overview of the PDSurvey platform and its components is given. The platform consists of three major parts: a backend for display providers (PDAdmin), a RESTful server (PDServer) and the user interface itself, being embedded on the end user devices (public displays, tablets, smartphones or other devices).

3.1 Requirements

The starting point for the PDSurvey platform, and the Master's thesis itself, was the official announcement[15], describing the scope of the thesis. This problem statement already included first requirements for the survey platform to develop, and was also a trigger for further literature review and talks with people from the industry.

1. *development of a survey tool* that allows interactive public display installations to be comprehensively assessed
2. a web-based survey platform will be implemented that can easily be used to evaluate and compare public displays through *different channels*
3. *different channels* to support: 1) evaluation directly at the display or 2) through a (mobile) website that allows participation via smartphone or tablet.
4. *configuration options* for public display owners

Additional requirements, that have emerged during research and in discussions, are listed below:

- easy *embedding of questionnaires* on websites of public display owners (provide API / embed code)
- support *various devices*: public displays of all sizes, tablets, phablets, smartphones, desktop devices (responsive web design)
- allow for both *quantitative and qualitative* metods of data collection
- easy *scalability* of platform, host on a cloud platform
- use a *modular approach*, allowing successors to extend and further refine the platform
- focus on *public display evaluation*, take the context into account for evaluation
- furthermore design guidelines for the construction of public display applications introduced by Huang et al. [13] and Jacucci et al. [16] were followed.

These requirements combined with knowledge from literature review, are what makes this platform unique. The long term goal is to create a research platform, optimized for public display evaluation, delivering new insights into how users react to public display setups. All of the mentioned requirements had an impact on the chosen architecture, will be discussed in the next section.

[15] `http://www.medien.ifi.lmu.de/lehre/arbeiten/detail.xhtml-php?pub=alt_pdsurvey` (last accessed on March 24, 2015)

3.2 Design Decisions

After having assessed all requirements for the platform (see section 3.1), the next step was making design decisions for the software, programming language and frameworks to use, before starting with the practical implementation of the platform.

Two weeks were taken for assessing all of the possibilities, on the one hand to get informed what is currently buzzing, on the other hand because every decision made has an impact on the architecture. Changing a technology half way through the project is not an option for the duration of this Master thesis.

Programming language Due to the requirements and objective to support a large number of devices, operating systems, and form factors, a device-independent programming language was preferred. The choice fell on Javascript, not just due to the growing popularity[16], but also because it can be used on the largest number of platforms and devices. Another huge benefit is being able to only use JavaScript for all tiers of development, from client to server to persistence layer. Using the same language on all tiers allows us to share some parts of code between server and client. This approach has become very popular in recent years, now often being being encapsulated in a technology stack referred to as the MEAN stack, consisting of MongoDB, Express.js, Angular.js, and Node.js. Some fundamental differences to the LAMP stack (Linux, Apache, MySQL, PHP) are its shift form server-side to client-side single-page applications (SPA), faster prototyping, shift from synchronous to asynchronous, fast page loading times, less time spent writing SQL (schemaless), and the shift to using RESTful services for the backend[17]. This already led for the first time to the thought of choosing the MEAN stack[18] for the entire development. Nonetheless each part of the architecture was compared and evaluated separately, in order to find the optimal solution for this project.

Alternative languages considered were: PHP, Python, Ruby, Java and ASP.NET. The biggest drawback was the additional workload on having to maintain the object model on multiple platforms. With Javascript it is possible to only having to maintain the object model once, easily keeping it consistent across all platforms (backend, frontend, server).

Based on our requirements for the platform, the feedback received from discussions with industry experts, and the desire to be able to embed questionnaires on 3rd party website, the choice to use JavaScript for the whole development process already became evident. The still open question was whether to fully go along with the MEAN stack, or if it makes sense to replace Angular.js, Express.js or MongoDB with another solution..

Frontend The next question to be answered was which technologies to use in the frontend, leading to the question whether to follow the single-page application approach or not. As of 2014 JavaScript model-view frameworks most frequently used for creating single-page apps, are Angular.js, Ember.js and Backbone.js. When looking at the numbers and the trend from recent years, Angular.js is the clear favorite. It has by far the largest user base on GitHub, Stackoverflow, and Youtube. When comparing the number of third-party modules, Angular.js also takes the lead with 800 ngmodules vs. 236 Backbone.js backplugs vs. 21 emberaddons[19]. All these factors together indicate a short training time and give hope for making fast progress as beginners. One of the biggest benefits of using a framework like Angular.js, is the ability to use two-way data-binding. Changes made to the model are automatically represented in the UI, and vice versa. Furthermore,

[16] `http://www.sitepoint.com/javascript-internet-things/` (last accessed on November 27, 2014)

[17] `http://www.ibm.com/developerworks/library/wa-mean1/index.html` (last accessed on March 26, 2015)

[18] `http://mean.io/` (last accessed on March 26, 2015)

[19] `https://www.airpair.com/js/javascript-framework-comparison` (last accessed on January 11, 2015)

the possibility to use the templating functionality, combined with the custom directives in Angular.js, was a big plus for this choice. This functionality was used for creating custom HTML tags for the question types in our surveys. These were amongst other the reasons why we chose Angular.js for this project, hoping that it will also simplify the ramp-up time for other students.

To speed up frontend development we chose Bootstrap[20] as our CSS framework of choice. Reasons for choosing Bootstrap were the large community, extensive documentation with helpful examples, large number of free tutorials and templates, its excellent integration with Angular.js (AngulatStrap[21] and AngularUI), the short training time, and because it is so well established. Alternatives considered were Foundation Framework by Zurb, however at the time of writing there was no prefabricated integration for Foundation and Angular.js. A good overview[22] and a comparison[23] of currently popular frontend frameworks was also considered.

Backend For the backend it was most important to have a solid and scalable solution with good performance, since our system might need to scale in the future, having a multiplicity of clients attached to the survey platform, all submitting responses and querying for different questionnaires. Additionally, it was of importance to offer an interface for administrators and to easily be able to exchange data with a large number of clients. For this reason a backend built solely on the principles of a RESTful API was preferred, being able to query the data from no matter which platform. Based on the decision to use JavaScript for all tiers, it was also clear to use Node.js as the underlying platform for building web applications. Reasons speaking for Node.js are its event-based and modular approach, only requiring the parts needed for your project. Another benefit is the easy implementation of authentication or internationalization, due to the concept of middlewares [24] and the native serialization of JSON. Furthermore it is great for reusing code, due to its modular and lightweight architecture and the npm package manager [25]. To simplify and speed up development with Node.js, Express.js[26] was chosen as the web application framework. Alternatives considered were Connect (simpler, less functionality, predecessor of Express), Koa[27] (generator concept) and Resitfy[28] (Express reduced for pure REST services).

Due to the decision to build a single-page application, it became vital to separate the data from presentation layer. Using a RESTful service is the current de facto standard. An alternative would be to use SOAP for message exchange. This would not only lead to an increase of data overhead, but also to a higher complexity on the server-side, and to the loss of statelessness in the requests. Should a client not support HTML or JavaScript execution, then the required surveys can still be requested directly with the REST API through rudimentary HTTP function calls, being another benefit for implementing a RESTful API.

Such an exception was Quest3D[29], a software package used by Jiamin Shi for the development of the Balloon Shooter game. When being in a situation where HTTP calls are not supported

[20] `http://getbootstrap.com/` (last accessed on December 1, 2014)

[21] `http://mgcrea.github.io/angular-strap/`

[22] `http://www.sitepoint.com/5-most-popular-frontend-frameworks-compared/` (last accessed on December 2, 2014)

[23] `http://www.sitepoint.com/grid-system-comparison-bootstrap-vs-foundation/` (last accessed on March 24, 2015)

[24] `http://www.heise.de/developer/artikel/REST-Webservices-mit-Node-js-Teil-1-Connect-als-Fundament-1802258.html?view=print` (last accessed on November 24, 2014)

[25] `http://www.heise.de/developer/artikel/2x-Nein-4x-Ja-Szenarien-fuer-Node-js-2111050.html` and `http://stackoverflow.com/questions/5062614/how-to-decide-when-to-use-node-js` (both last accessed on April 9, 2015)

[26] `http://expressjs.com/` (last accessed on April 10, 2015)

[27] `http://koajs.com/` (last accessed on April 10, 2015)

[28] `http://mcavage.me/node-restify/` (last accessed on April 10, 2015)

[29] `http://documentation.quest3d.com/index.php?title=FAQ#What_is_Quest3D.3F` (last accessed on April 10, 2015)

natively, then one can still use logging combined with a scheduled task or create a proxy on the operating system layer and tunnel all data to the PDServer.

Database Another fundamental aspect presented the question where to store the data persistently. Criteria for choosing the right database management system (DBMS) for this project were again the size of community, suitability for prototyping, and ease of integration with Node.js/Angular.js. The first question presented, was whether to choose a SQL or a NoSQL DBMS. We chose NoSQL for this project, because better scalability, a schemaless data representation, faster response time and a decreased development time [27]. Otherwise, NoSQL is better suited for rapid prototyping, because multiple schema can be mixed inside of one collection and easier evolve over time. These are all arguments speaking for using a NoSQL DBMS for our scenario.

Out of the NoSQL databases MondoDB[30] represents the most popular DBMS, especially since it integrates seamlessly into the MEAN stack. Benefits of MongoDB are being non-relational (and schemaless), plus its ability to directly store JavaScript object inside the database, being the biggest advantage. Other characteristics of MongoDB are the non-blocking write operations, being ideal for logging data. MongoDB provides a good compromise between scalability/performance and the depth of functionality. One disadvantage is that MongoDB does not support joins or transactions. For our use case, however, this is no major drawback. The benefits outweigh the disadvantages.

Alternatives looked at were CouchDB and Redis. Redis being useful for fast changing data, which is not the case for our platform. CouchDB would be an alternative worth looking at, having a better replication and conflict resolution. This additional security is however not needed. The speed benefits of MongoDB are preferred.[31]

To facilitate the object modeling process in Node.js, Mongoose[32] was chosen, providing object relational mapping. Mongoose is an object modeling package for Node.js, allowing to application data to be modeled based on schemata. Mongoose takes care of performing CRUD applications and simplifies keeping the object model synchronized across all layers.

Hosting For the hosting of the platform a free and easy scalable solution was of importance. Services offering a platform as a service (PaaS) were preferred over ones offering a infrastructure as a service (IaaS), because our focus currently is on developing and evaluating the platform. We considered the following platforms: Heroku (PaaS), IBM BlueMix (PaaS), Amazon AWS (IaaS), or hosting the entire platform on a local machine.

Our first choice was Heroku[33], due to its simplicity of setup, its native support of Node.js and the seamless integration with Mongolab[34], a platform for hosting MongoDB collections. Alternatives considered were Google App Engine, IBM BlueMix, Amazon Web Services (Amazon EC2) or hosting everything on local machines at our university. However for our scenario all of the above options had their drawbacks in comparison to Heroku. Google App Engine (as of December 2014) still had no native support for Node.js and custom runtimes had to be used to get Node.js support up and running. IBM BlueMix just got overhauled, offered full out-of-the-box Node.js support, however they only the first 30 days were free and the pricing model wasn't as attractive. Amazon Web Services offering a Infrastructure as a Service (IaaS), would have required too much administration of the server, which would have slowed down the main objective of the project, the development of the survey platform[35]. The same goes for the last option, hosting a MEAN-stack environment on our own servers at LMU Munich. All of the above are well-known solutions in

[30] `http://www.mongodb.org/` (last accessed on March 26, 2015)
[31] `http://kkovacs.eu/cassandra-vs-mongodb-vs-couchdb-vs-redis` (last accessed on March 26, 2015)
[32] `http://mongoosejs.com/` (last accessed on November 14, 2014)
[33] `https://www.heroku.com/` (last accessed on March 26, 2015)
[34] `https://mongolab.com/` (last accessed on March 26, 2015)
[35] `http://smashingboxes.com/ideas/heroku-vs-amazon-web-services` (last accessed on April 10, 2015)

the industry, however due to simplicity and ease of use we chose Heroku. For our requirements during the prototype phase Heroku was sufficient, offering one free Heroku *dyno*[36].

MEAN Stack As already predicted in the beginning, we ended up using the full MEAN stack for developing PDSurvey. The clear benefit is the ability to use JavaScript from client to server to persistence level. Scott Davis has published a good article on ibm.com with an introduction to the MEAN stack and a short recap of the last ten years of web development [9].

[36] `https://devcenter.heroku.com/articles/how-heroku-works#running-applications-on-dynos` (last accessed on April 10, 2015)

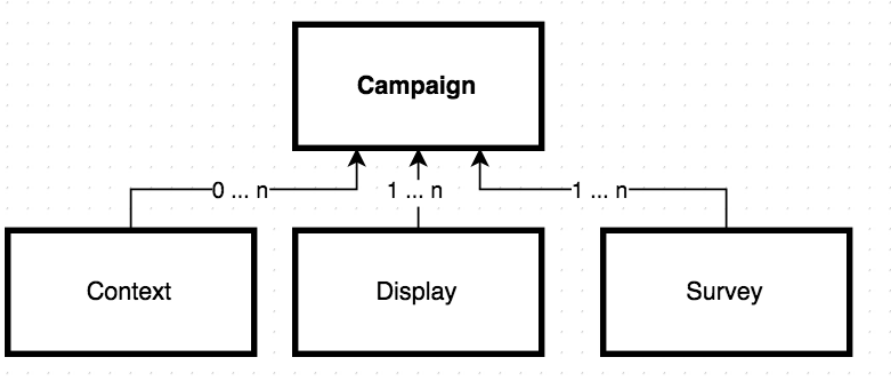


Figure 3.1: Campaign model dependencies

3.3 Modeling

The development process of the PDSurvey platform was inspired and influenced by the concept of extreme programing[37], making iterative improvements, and working agile and user centered. First user stories were written and assessed in a small group[38]. The next step was to transfer these stories to user models, describing in detail which functionality the stakeholders of PDSurvey are supposed to have. Later a first software architecture and software model was built. Dependencies between models were defined and the model was continuously refined and improved throughout the development phase. The last phase included screen designs, getting a clear view of what the interface might later look like.

The model for the *PDSurvey* platform is maintained with Mongoose. Angular.js builds its model from the REST API, and maps all changes via dynamic two-way-binding to it's scope. The REST API is provided by the Node.js server, which maps all incoming requests through an Express router to the corresponding Mongoose models. Thus all changes to the model originate from Mongoose.

Currently three user roles are implemented for the platform: an *admin* role (for administrators), an *expert* mode (with a mapping of n surveys to m displays), and a *novice* mode (with a simplified interface).

The development of the REST API was influenced by current best practices [5,15,25]. The API is separated into logical resources, while each resource gets manipulated through an HTTP request. For public access GET and POST is defined, for authenticated users also PUT and DELETE. For a more information about PDSurvey's REST API refer to the documentation (see Appendix B).

The software model is modeled in Mongoose and stored as MongoDB collections. There are the following collections: *Question, QuestionType, Response, Category, Surveys, User, DisplayModel, Display, Campaign, Context, User*. Of special interest are the following four collections: Surveys, Display, Campaign and Responses (see figure 3.1).

Surveys: Questionnaires are the foundation of PDSurvey, consisting of multiple sections, which in turn are made up of multiple questions. Each question is of a corresponding question type and every questionnaire belongs to a category. This allows questionnaires to be filtered based on certain research questions. Additionally we added the ability to set surveys *private* (by default), *shared* (for sharing with other users), *standardized* (scientifically recognized), or *pending* (waiting

[37] `http://www.extremeprogramming.org/rules.html` (last accessed on April 10, 2015)

[38] `http://www.tigertech.de/wie-schreibe-ich-eine-gute-user-story-und-was-ist-das-uberhaupt/` (last accessed April 10, 2015)

for review, to be shared). Every survey is assigned to an individual user of the platform, with the aim of reuse and standardization of questionnaires.

TODO ueberlegen ob ich den letzten Absatz Surveys oder Questionnaires nennen mag

Display: In the display collection all displays connected to the PDSurvey platform are contained. To allow for an evaluation across multiple display models and based on the context of the displays, the display model and a static and/or dynamic context is assigned to it.

Campaign: Campaigns resemble the most integral part of the platform, since they glue all of the pieces together and allow the distribution of surveys to public display networks. A campaign consists of displays and surveys, and creates the mapping of the questionnaires to public displays. Additionally to each of those mapping an individual context can be assigned, enabling the later comparison of results in between the public displays.

Response: All responses made to each survey are logged in the Response collection. The queries are logged individually per user, per display and per campaign. This model will be the base for further extensions, such as the automatic evaluation of the survey responses and the comparison in between different displays inside one display network. This enables to find out which properties of a display might cause certain effects.

Context: One of the benefits of creating this survey platform is the ability to collect and evaluate large amounts of data, without increasing the workload on the human component for conducting and evaluating the responses. The idea is to collect a large number of responses from a variety of displays in various settings, and assigning a specific context to every display connected to PDSurvey. Once enough data is collected, the results can be evaluated and compared in between the displays. Interesting questions for analysis would be, which role the context plays on how the users respond to the display, when running identical software settings on the displays, but only varying the context (position, size of display, surrounding environment of the display, positioning it outdoors or indoors, influence of the weather, type of building it is positioned in).

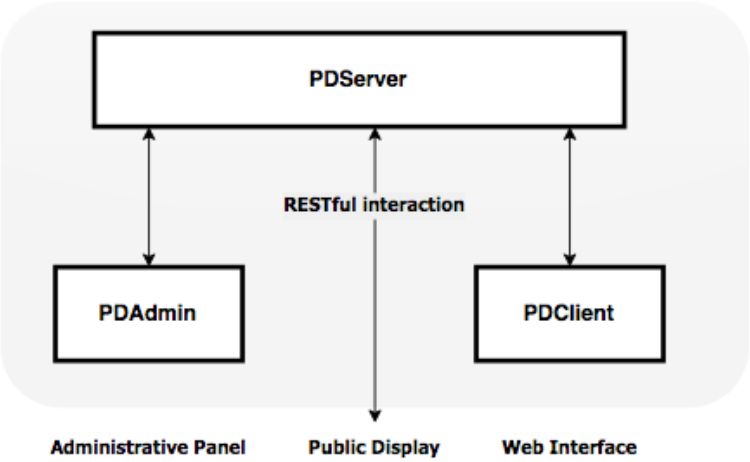


Figure 3.2: Overview of the PDSurvey platform: (a) PDServer containing the Node.js server, (b) PDBackend is the entry point for administrators and (c) PDClient the interface included on public displays and optimized for mobile devices.

3.4 PDSurvey Platform

The public display survey (*PDSurvey*) platform aims to facilitate the conduction and evaluation of surveys on and for public displays. The interactive survey platform, which can be embedded directly onto public displays and be used as a direct feedback channel from inside another application, can be split into three main parts: PDAdmin, PDServer, and PDClient (see Figure 3.2). *PDAdmin* contains the administrative interface, allowing display providers to configure questionnaires for their public displays. *PDServer* accommodates the REST service, the persistence layer, and the majority of the application logic. *PDClient* is a web based interface, containing one possibility for responding to the deployed surveys.

The code base of all three parts is deliberately separated from each other, allowing the independent refinement and less dependencies between the frontend, the backend, and the server.

3.4.1 PDAdmin

For administrative purposes we created an admin interface, enabling display providers to create, manage and distribute surveys to public displays. Display providers have the ability to create their own questionnaires or to select from a list of standardized questionnaires (introduced in section 2.2).

The entry point for PDAdmin is the dashboard. There a user gets an overview of information such as how their campaigns are running, and how many responses have been submitted already. For new users who haven't created any campaigns, questionnaires or displays yet, get prompted to use the Getting Started wizard (see figure **??**).

3.4.2 PDServer

PDServer makes a relatively simple impression. It consists of a Node.js server, which to the outside only acts as a REST server. Processing REST calls, performing CRUD operations and responding with JSON objects. Besides this REST functionality a rudimentary authentication mechanism is already implemented on the server and the capability for further logic, determining which client should ask which question next. This functionality might become of interest when trying to spread standardized questionnaires of longer length across multiple users or multiple displays. It would

be intended for the server to keep track which questions have already been answered and to tell each instance of PDClient which question to ask next, in order to achieve a balanced question profile.

The specification of PDServer's REST API can be found in the documentation (see Appendix B).

3.4.3 PDClient

Our client tool was kept as simple and minimalistic as possible. It is running on a separated code base than PDBackend, the only communication between the two is via REST, exchanging JSON objects. Reasons for this were on the one hand reduction of the application size, on the other hand different requirements for constructing a PDAdmin interface for a limited number of users, compared with PDClient, being embedded at large scale.

The goal is to reduce logic and complexity on client-side. Currently PDClient is implemented as follows: The client either receives all questions for the questionnaire (caching the questions), or it loads just the next question on-demand. For this purpose the REST interface provides the /nextQuestion API is provided. For production use one sub-page per campaign gets created, individualized via the campaign ID.

PDClient has three main components (see figure 3.2). The principal part being the *Survey page*. All questions are loaded at once on initial startup, then one question gets displayed at a time. Settings for the survey can be modified in the PDBackend (e.g. number of questions to display and duration of the survey). Once the user makes a choice, it is directly logged on the server. In case that a participant aborts answering the survey, the questions answered so far are still recorded. The *About page* was added, since employees from university gave feedback to us regarding the public display installation, prior to the beginning of development for the PDSurvey platform. They said they were skeptical and had doubts regarding the research project, when having no information whatsoever regarding which information is logged. To motivate people to participate, a *Welcome page* was added. It turned out that a significant larger number of people were willing to participate in a survey, after knowing that it doesn't take long, the research is university-related and that it will be used for a Master's thesis. These arguments were amongst others stated in semi-structured interviews, carried out as part of the field study (see chapter 4).

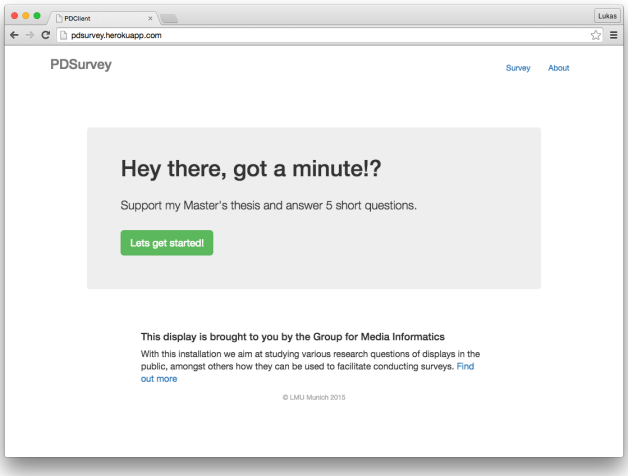
3.4.4 EmbedCode

The embed code, JavaScript Code Injection, turned out to be a pure proof-of-concept, since it was not needed for the field study at the university. The problem was that the application on which PDSurvey should be integrated did not support any HTTP calls, thus we had to fall back on another solution. This embed code was intended to be used by display operators, wanting to include optional questionnaires hovering over their normal application.

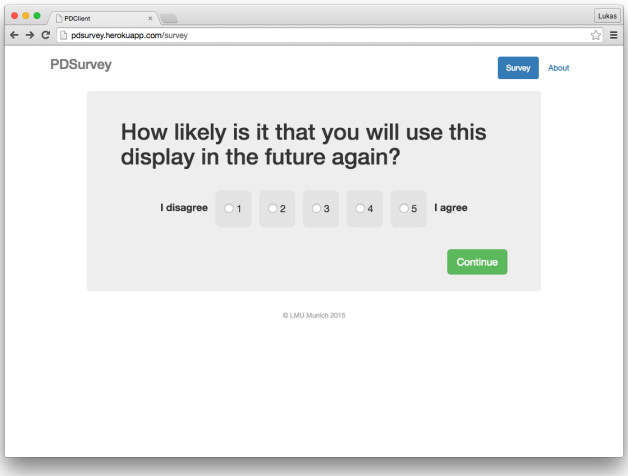
An example use case is exemplified here ... **TODO TODO TODO**

The implementation is quite simple. A JavaScript code snippet will be given to the display provider, which has to be added before the closing body-tag. This minified line of JavaScript code adds a HTML <script>-tag to the DOM of the HTML page, injecting a remote JavaScript file from the PDSurvey platform. This personalized scripts first loads jQuery and/or Angular.js asynchronously, and thereafter creates another instance of the PDClient on client side, inside of the primary website DOM. All questions for the questionnaire get loaded via REST API from the server and the responses get sent back to the server for logging.

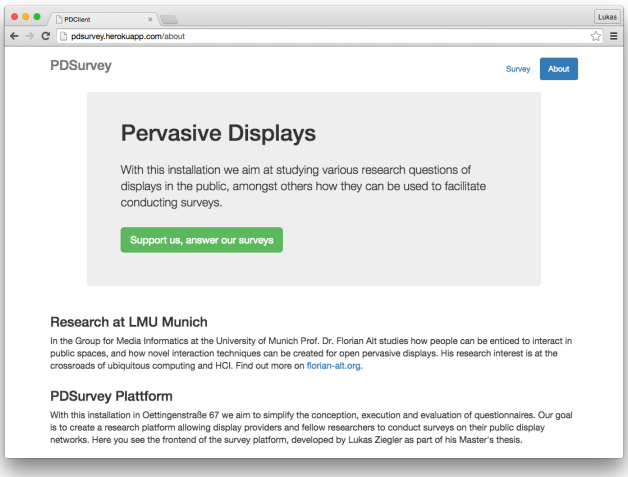
One important aspect is to prefix all classes and files with a unique namespace, to prevent any sort of collisions with the main program, where the code gets injected into. For this prototype all CSS Bootstrap classes were prefixed with $pd-$.



(a) Welcome Page



(b) Survey page



(c) About page

Figure 3.3: Overview of PDClient

Useful links for the development of this prototype were Google Analytics concept of tracking[39], Wikipedia describing the Web Bug [40], and a Stackoverflow discussion regarding embed codes [41].

For inspiration, of what the finished embed code functionality could have looked like, have a look at the Qualtrics blog article "Website Feedback Surveys"[42] and at the demo of Qualtrics Site Intercept.

3.4.5 Feedback Channels

As of now PDSurvey offers a ready built survey tool for all devices being capable of running a browser and displaying the PDClient website. Thus a large number of feedback channels is conceivable. For our scenario these were a tablet, smartphone, and laptop/desktop. Integrating PDClient on a public display itself is also no problem, as long as the public display application is a web application itself (embed code), or it supports embedding a browser window on top of the application.

In case that the application does not integrate well with a web page being displayed on top of the actual application, then a custom integration needs to be built making use of the REST calls. All REST calls needed to receive the questionnaire and send responses to the PDSurvey platform (in JSON format) can be found in the documentation (see Appendix B).

3.4.6 (Future Work)

PROBABLY PUT THIS IN THE VERY END OF THE PLATFORM; BEFORE CONCLUSION

Authentication: using passport, HTTPS was not offered in the beginning. As of now it is not needed, since we only had one client. All REST Update and Delete functionality was restricted to the URI of the PDServer, which is also the desired approach in the production setting.

Evaluation of results: dynamic queries, information visualization

Context: refine the Context model and build the evaluation of the responses based on the Context model, assigned to each and every display and/or campaign.

Unit testing: not done yet

[39] `https://developers.google.com/analytics/resources/concepts/gaConceptsTrackingOverview` (last accessed on November 26, 2014)

[40] `http://en.wikipedia.org/wiki/Web_bug` (last accessed on November 26, 2014)

[41] `http://stackoverflow.com/questions/3534524/how-does-the-embedded-google-analytics-javascript-work` (last accessed on November 26, 2014)

[42] `http://www.qualtrics.com/site-intercept/website-feedback/` (last accessed on April 6, 2015)

4 Field Study

The field study took place during the first two weeks of March, from 3/3/2015 to 3/15/2015 in Oettingenstrasse 67, a faculty building of Ludwig-Maximilians-Universität München. Data was collected from the displays on 14 consecutive days and 28 semi-structured interviews were carried out on five working days during the same two weeks. A total of 117 interactions were registered with the public display installation and 57 survey responses were recorded.

The goal of this study was to validate our research questions, and to see how users respond to questionnaires being conducted on displays in the public. We chose to conduct a descriptive study, with a focus on ecological validity, since our research prototype is still in an early development stage.

4.1 Research Questions

One of the main reasons why we performed this field study, was to get a better understanding of our assumptions and to see how users react to questionnaires on displays in public. Besides, it was of importance to conduct a study "in the wild", because there often is a discrepancy between lab studies and field studies. This phenomena has been discussed by Ojala and Kostakos in 2011: "The first important conclusion we have arrived at is that there exists a huge difference between results obtained in a lab and in the wild using the exact same configuration" [22].

An assumption we made for the development of our first research prototype of the PDSurvey platform was that we can simplify the conduction and deployment of surveys to large public display networks. Since this is a rather large claim, we broke down this hypothesis to more fine-grained statements.

We already had an application running on a public display in a faculty building which attracted lots of regular and new users. On this display setup we evaluated the following research questions:

1. Which channels are best suited for completing surveys in public?
2. Why did the users approach the display? What motivates them to fill in surveys in public?
3. How did the user notice and perceive the survey on the display?
4. Which question types are best suited for questionnaires carried out in public?

In addition to these questions we were also interested in user stories, in the feedback real-world users gave us in regards to answering surveys on screens in the public. For this reason we also conducted semi-structured interviews in parallel to the quantitative evaluation of the PDSurvey platform. In order to get as authentic and personal feedback as possible, we stuck only roughly to the designated questions of the semi-structured interview (see Appendix E).

These research questions were represented in the PDSurvey questionnaires and semi-structured interviews. Questions which would go beyond the scope of this thesis, and might serve as follow-up questions for further research, are gathered in Chapter 5, Future Work.

4.2 Study Setup

A descriptive research type was as the study type, aiming to describe and observe how users react to the new display setup. One single prototype is deployed, without varying any variables. The goal was to get first feedback on how people perceive filling in questionnaires in public, before getting into more fine-grained research (see Future Work, chapter 5). Both quantitative and qualitative data was gathered as part of the field study. Quantitative data was obtained through the PDSurvey system and qualitative data was collected through semi-structured interviews.

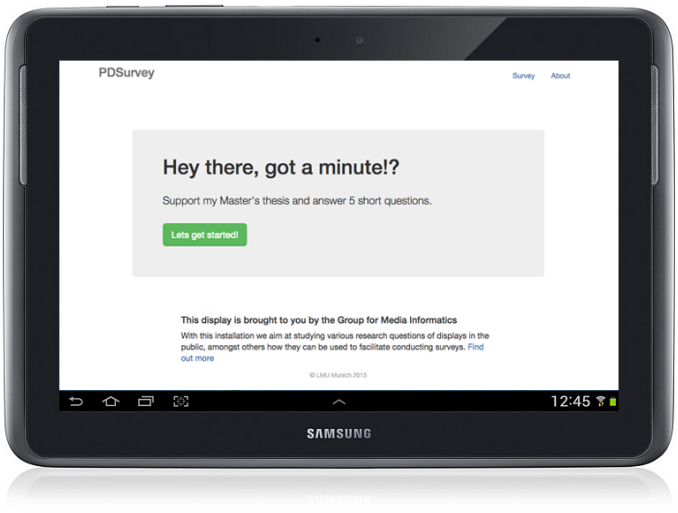


Figure 4.1: PDClient: Motivating users to participate in a short questionnaire

4.2.1 Design

Our primary goal was to find out which channel users preferred to respond to surveys in public. Each user had the choice to respond to the questionnaire on a TV display, on a tablet to the right of the TV screen, via their own smartphone or via email. We displayed the same five questions on all four feedback channels (see Table **??**). We chose to limit the number of questions asked via all four channels to 5, to avoid a low participation and response rate.

Wording	Question Type
1. How often have you used this display before?	Numeric
2. How likely is it that you will use this display in the future again?	5-point Likert scale
3. Which devices do you possess or use regularly?	Multiple choice, 5 options
4. In which area do you study / work?	Text field
5. What was your motivation for approaching and using this display?	Text field

Table 4.1: Questions asked on all four feedback channels

In order to also get first insights into how well certain question types are suited for surveys in public, where a short completion time is crucial, we varied between the following question types and kept them in the same order: numeric questions, Likert scale, multiple choice (based on check boxes) and two text fields for responses of undefined length.

To increase the motivation for participation, additional intrinsic motivation was given to increase the response and acceptance rate of the public surveys, as proven by Richard Ryan in his self-determination theory[43] [24]. We stated that the questionnaire consists of five questions, that it will only take one minute to complete and the results are for a Master's thesis at the university. This information was displayed as a splash screen on the tablet (see Figure 4.1).

Since we conducted a descriptive study, we only observed how users used our study setup. The parameter of interest was the feedback channel chosen to respond to the survey. Due to the fact that we didn't have any conditions, no independent variables are present.

To find out more about the users' motive for approaching the display setup, we also carried out semi-structured interviews in parallel to the field study of the PDSurvey platform. The goal of the

[43] http://www.selfdeterminationtheory.org/

interviews was to get qualitative feedback from all age groups and backgrounds. Getting a better understanding of how people respond to questionnaires in public, helps us develop the PDSurvey platform more target-orientated.

4.2.2 Participants

In total 54 questionnaires were submitted and 28 semi-structured interviews were conducted during the two week study period. As for the study size, we took the findings from Alt et al. [3] as a rough guide, according to which most field studys have an average of 26.9 interviews and 38.4 questionnaire responses.

Questionnaires were completed mainly by students, but with various backgrounds. Since our research focus was to find which feedback channel is best suited for conducting automated questionnaires in public, we only included one question in the quantitative PDSurvey questionnaire to collect demographic data.

Based on the fourth question ("In which area do you study / work?") we can draw a conclusion about the study field of the survey participants. Out of the 54 questionnaire responses 42 submissions could be assigned to a study field. The remaining 12 submissions consisted of responses such as *bavaria, bib, home, munich, muc* or were left empty. The study fields most frequently represented were Computer Science (23,8%), followed by Political Science (14.3%), Japanese Studies (11.9%), and Anthropology (11.9%). Other study fields mentioned were Cultural Science, Business, Physics, Sociology, Ethnology, Communication Science, Sports, and Science & Technology.

For the semi-structured interview we collected more detailed information about demographics of the participants. Out of the 28 participants, 20 were male and 18 were female. The age of all people interviewed ranged between 20 and 69, with an average age of 31 years. Due to the wide variety of faculties and a library being located in the same building, various technical backgrounds were present. What they all had in common was their affiliation to LMU Munich, either because of being a student themselves, working at the university or being otherwise related to the university. In total 23 students, three employees, and two retirees were interviewed. The study fields which were most frequently represented are Computer Science (16.7%), Japanese Studies (16.7%), Ethnology (12.5%), and Political Science (12.5%). Other areas mentioned were Sociology, Communication Science, Law, Physics and Engineering. The full list of demographics, including exact ratios, can be seen in Table 4.2.

	people participated in survey		**people interviewed**
10	Informatics	4	Informatics
6	Political Science	4	Japanology
5	Anthropology	3	Ethnology
4	Cultural Science	3	Political Science
4	Business	1	Communication Science
2	Physics	1	Sociology
2	Sociology	1	Law
1	Ethnology	1	Physics
1	Communication Science	1	Engineering
1	Sports	3	workers (PhD, public officer, SysAdmin)
1	Science and Technology	2	in pension

Table 4.2: Demography for the survey data (left) and the semi-structured interview (right).

The selection of the participants for the completion of the surveys was not influenced by us. All survey responses were made in their own interest, no reward was given for participating in this "in the wild"-study. The selection of the participants for the semi-structured interview was

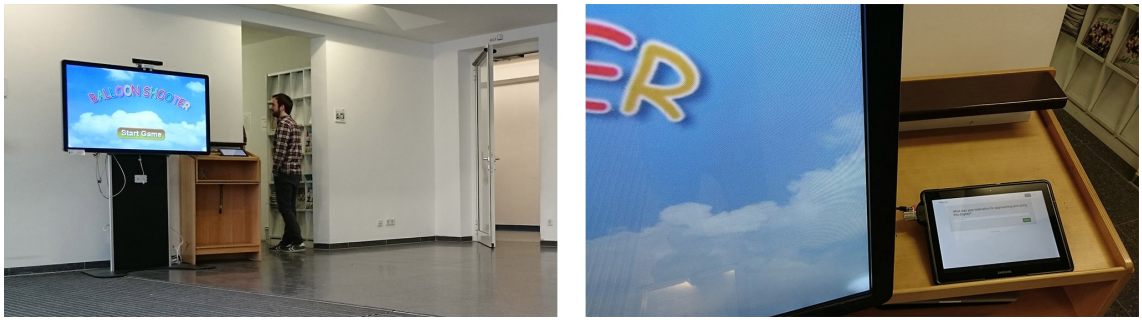


Figure 4.2: Overview of the study setup in the entrance hall of the faculty building.

influenced by how users reacted to the display setup. Our primary goal was to observe and interview active users of the public display setup, in order to get a better understanding of how they perceived the setup and to get insights into which feedback channel they chose why. In order to also understand why people did not approach, or if they have any concerns, people passing by were also interviewed.

Before starting the semi-structured interviews, all people participating were asked whether they have previously noticed the display setup and/or the option to fill in a survey.

This allowed us to differentiate three groups: participants who approached the display by themselves (and were observed doing so), people passing by the display (noticing the display, however not approaching it) and the last group of people simply passing by (not having noticed the display). The distribution between the groups was as follows: 11 active participants, 17 passerby (14 noticed the displays before, 3 haven't).

Out of all people passing by no one has noticed the option to fill in a survey. Out of the active participants, 5 out of 11 have noticed the option to respond to a survey on different channels.

To increase the amount of feedback, we approached people from all three groups. The number of survey responses was not artificially increased by asking passersby was.

> TODO: think about which information is RELEVANT and which is not! for me the devices they possess might be of relevance. people not possessing a smartphone or tablet, might be less willing to use these devices.

4.2.3 Apparatus

The permanent setup consisted of a XXX-inch TV screen, connected to a laptop running Windows 7, and a Samsung Galaxy Tab 10.1 tablet positioned to the right of the TV screen on a console. Our object of investigation was the TV screen with touch support, running an interactive game called *Balloon Shooter*, developed by Jiamin Shi. After users completed the game, they were asked via a notice to fill in a questionnaire on one of the four provided feedback channels (see Figure 4.4). The courtesy for the Balloon Shooter game and the survey implementation on the TV screen goes to Jiamin Shi.

Each user had the opportunity to respond to the questionnaire either directly on TV screen (1), on a tablet to the right of the big TV (2), via their own smartphone (3) or via email (4). The first option was embedded natively into the Balloon Shooter game, offering a consistent UI and the most direct feedback channel. Choosing the tablet as an option, the users were prompted to move to the right and to answer five questions on the tablet. The Samsung Galaxy Tab 10.1 was displaying the responsive frontend of PDClient, being enclosed in an Android Kiosk App, namely KioWare Lite[44]. Choosing the third option prompted the user to either scan a QR code with their smartphone or to open a URL in their mobile browser. The last option consisted of an input field

[44] http://www.kioware.com/android.aspx

embedded into the Balloon Shooter game on the TV screen, asking the user to enter their email address. The address was logged to a txt-file, which was scanned every 5 minutes by a Windows task scheduler. An email reminder was sent to the user with the request to complete the survey. For sending the email from the TV screen a Python script was written to send the email via the universities SMTP server[45]. Screenshots of all four options can be found in the Appendix on page 37.

For the permanent setup the following data was logged on all four feedback channels: The timestamp of the users choice, which feedback channel the user chose to respond to the survey, and whether they skipped the call to participate in the survey or if they stopped playing the game (determined via timeout).

For conducting the semi-structured interviews two questionnaires (one for participants, one for passerby), a voice-recorder (smartphone) were used in addition to the permanent setup.

For the evaluation in the field study itself a self-made questionnaire was used, since the focus was on finding which channels and question types are best suited in general for being used on public display. This was the reason why we did not use any of the standardized questionnaires mentioned in section 2.2. Screenshots of the questionnaire run on the PDClient can be found on the enclosed CD.

The main application installed on the public display was a game called *Balloon Shooter* developed and run by Jiamin Shi, a PhD student at the Group for Media Informatics at LMU Munich. It was first installed on January 7th 2015 and has been running in different versions since then. Public audience was already used to it for roughly two months and adapted to it well.

4.2.4 Location

All parts of the field study were carried out in Oettingenstrasse 67, the faculty building for Computer Science. In the same building there are also research institutes for Ethnology, Political Science, Japanese Studies, and Physics. The study was carried out in the entrance hall of the university building. Figure 4.3 gives an overview of the entrance hall and of the paths most people take while crossing the room. The excerpt is based on the universities floor plan[46] and was inspired by Sandra Zollner [1]. There she also published that at the time of her study "approximately 59% of all passers-by used path 1", to get something from the lockers or to leave through the door to the library. 28% of the people were taking path 2 and 13% were taking path 3.

In our field study it was also evident that the majority of the visitors took path 1 were usually fairly target-orientated or in a hurry. Otherwise, on days with bad weather people had their break in the entrance hall or waited for someone. On days with good weather people usually took their breaks outside and only passed through the entrance hall, coming from the library, picking up something from the locker room and going outside.

4.2.5 Procedure

All participants of the semi-structured interview were asked a similar set of questions (see Appendix E). Based on the group they belonged to, either questionnaire 1 (for participants of the display setup) or questionnaire 2 (for passersby) was chosen. In order to speed up the interviewing process and to get away from a plain question-response schema, the questions on the printed out questionnaire only survey as a rough guideline.

For people having trouble understanding the concept of the public display installation, the situation was described as follows. "Imagine you are in a shopping mall or at an airport using one of those large displays to find some information. After having found what you were looking for,

[45] https://github.com/lukasziegler/python-send-mail

[46] `http://www.uni-muenchen.de/funktionen/gebaeudeplaene/7070_d_00.pdf` (last accessed on March 22, 2015)

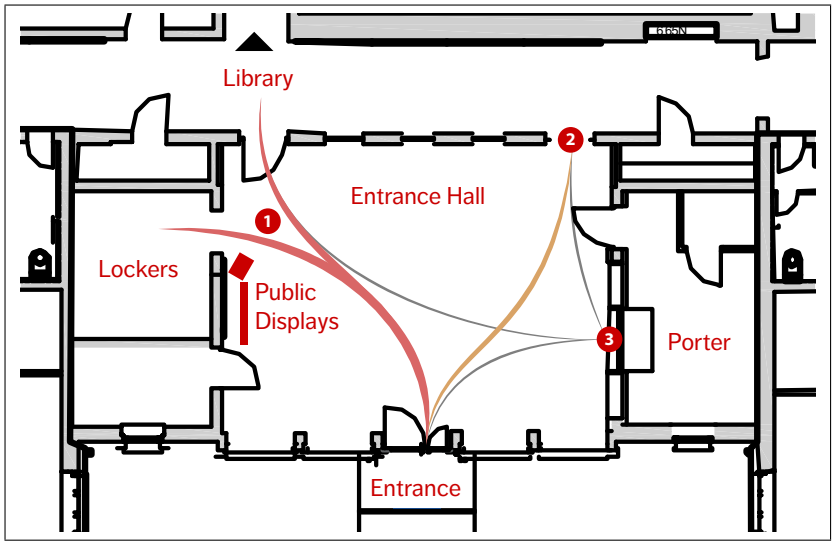


Figure 4.3: Floor map of the entrance hall, where the field study was carried out. User paths, and the surrounding environment including facilities such as the library can be seen.

you get asked to answer a short questionnaire. How would you react to it?" A full transcription of all questions and responses can also be found on the enclosed CD.

The participants for the PDSurvey questionnaire were not additionally motivated. All they saw was the options panel after completing the Balloon Shooter game (see Figure 4.4) or the welcome screen of the tablet (see Figure 4.1) while passing through the entrance hall. A complete copy of what the users were able to interact with, can be seen on the attached CD (see Appendix A).

4.3 Results

We received a total of 57 filled in surveys, submitted via all four of the provided feedback channels, and carried out 28 semi-structured interviews. No treatments were applied to the dataset, descriptive statistics will follow bellow. The presentation of the evaluation is divided into three parts. First we will have a look at which feedback channel is most popular, followed by the quantitative results of the PDSurvey questionnaire, and rounded off with the results from the semi-structured interview.

4.3.1 Feedback Channels

NOT SURE HOW TO BEST POSITION THIS PART

The majority of the surveys were submitted on the tablet (87.72%). Four responses were recorded directly on the TV (7.02%), two via smartphone (3.51%), and one via email (1.75%). Since this listing only contains the number of responses, it should not be taken as a base for the comparison of the feedback channels' popularity. Due to the tablets sole purpose to be used to fill in surveys in our setup, and the additional intrinsic motivation given on this channel (see section 4.2.1), this ratio has to be treated with caution. For a comparison of the **feedback channels** the log data from the option panel and the responses from the semi-structured interviews are better suited (see Table 4.3).

After having completed one session of the game, users had the option to choose a feedback channel. Based on this log data of the TV screen a better comparison of the feedback channels can be made, since all direct responses made on the tablet are excluded from this summary. The most popular feedback channel was the tablet (46.15%), followed by the TV screen (30.77%),

Figure 4.4: Options panel to choose a feedback channel

smartphone (15.38%), and email (7.69%). In order to have another source of input, the same question was asked at the end of every semi-structured interview. Based on this quantitative data from the interviews the response via tablet (42.86%) was most popular again, followed by the TV screen (32.14%). Interestingly, for the interview data the option to respond via email (17.86%) is more popular than smartphone (7.14%).

From Survey Data		**From Interviews**
30.8%	on public display	32.1%
46.1%	on tablet	42.9%
15.4%	on smartphone	7.1%
7.7%	at home / via email	17.9%

Table 4.3: Preferred feedback channel for answering surveys.

4.3.2 Survey Responses

How often have you used this display before? In our questionnaire executed on the public displays we asked five questions. Out of the 57 responses people have on average used the display 6.9 times before. For 25 people (43.9%) of the users it was the first time using the display setup, 11 people (19.3%) have used it once before, 18 people (31.6%) between two and ten times, and the remaining 3 people (5.2%) more than ten times.

How likely is it that you will use this display in the future again? For the second question, based on a 5-point Likert scale, the response was fairly uniformly distributed (average=3.04, SD=1.46). The whole scale from 1 (not likely at all) to 5 (very likely) was represented. No clear trend could be seen. When only considering the responses collected from the large TV screen, a better perception can be noticed. There the responses to this question had an average of 4.5 (SD=0.866), showing a trend towards a positive perception of the large display setup. However, due to the low number of responses for the TV display, this conclusion can not be regraded as significant.

Which devices do you possess or use regularly? Taking a look at the devices users possess might give us first insights into why users chose which feedback channel. Overall, the majority of the people participating in the survey already owned a smartphone (79.3%). The second most popular response was laptop (73.6%), followed by tablet (41.5%), and desktop computer (26.4%). Still, 18.9% of the users indicated that they possess a feature phone and use it regularly. On average each participant possessed 2.4 devices. When looking at which combinations of devices were most frequent, twelve people responded that they own a smartphone + tablet + laptop. Twelve other people indicated that they possess a smartphone + laptop, and six people own a smartphone + laptop + desktop.

In which area do you study / work? The fourth question was used to get a little insight into the background of the survey users. Only the occupation of each participant can be derived from the questionnaire. As far as was indicated all people responding to the questionnaire installed on the public display setup were students. The majority of people interacting with the TV screen study Coputer Science (23.8%), followed by Political Science (14.3%), Japanese Studies (11.9%), Anthropology (11.9%), Cultural Science (9.5%), and Business (9.5%). Table 4.2 shows a full list of which study field or work field the participants specified.

What was your motivation for approaching and using this display? The main reasons why people have approached the display were “curiosity” (12x), “fun” (10x), “boredom” (8x), “interest” (2x), and “during breaks” (2x). Other reasons mentioned were “it is there, so why not?”, “it is there and colourful”, or “I’ve never seen it before in this spot, wanted to know what it is about”.

4.3.3 Interview Responses

As mentioned earlier, we also conducted semi-structured interviews. The evaluation of the semi-structured interviews was based on Grounded Theory, for a systematic evaluation of the interview transcripts. A total of 28 semi-structured interviews were conducted, of which 72.4% of the participants were male and 28.6% were female. The average age was 31 years, with an age distribution ranging from 20 years up to 69 years (median=25, SD=13.2). Eleven of the 28 interviews were conducted with actual participants of the public display study setup (39.3%), the remaining 17 interviews (60.7%) consisted of people passing by the display.

To avoid any interferences between the two groups, each passerby was asked before starting the interview whether he has noticed the public display installation, and whether he has already interacted with the installation. Out of all passerby no one has previously been interacting with the game or survey platform. 82.4% (14 of 17) of the passerby have already noticed the public display installation before, however, none of the passerby has previously participated in the game. The remaining 17.6% have neither approached the display nor noticed it previous to the interview.

Looking at the scientific background of all 28 participants, 79.2% are students, the remaining 20.8% either already worked full-time or were in pension. The majority of students studied Computer Science (16.7%), Japanese Studies (16.7%), Ethnology (12.5%) or Political Science (12.5%).

From what has been mentioned, the main reason for approaching the public displays was in 6 out of 8 cases “curiosity” (6x). Two other reasons were “for fun” (1x) and “waiting for someone” (1x). Reasons for not approaching the display were “no time” (2x) and “it is in the entry zone of the university, it feels strange when one plays with it” (1x).

From the open coding phase the following patterns can be seen:

ASK JULIE!

- reason for approaching: see above - number of questions found acceptable: 5 - 10 - reasons for choice of feedback channel: - requirements for a survey, to attract users:

- most interesting feedback: reason PRO / CON using a certain channel

The semi-structured interview was most useful to get a better insight into why certain users chose which feedback channel. Reasons mentioned influencing their choice were “”

see Table 4.4.

4.3.4 Additional Observations

The response time for responding to the five questions was on average 1:02 minutes, ranging from 0:36 to 3:06 minutes.

How many questionnaires were fully completed, how many were aborted? Which questions were left empty? Does this infer anything for the quantitative vs. qualitative surveys?

Questionnaires on public displays are best suited for quantitative surveys. Users want a short interaction time, not having to think much about their answers and for roughly XXXXX percent of the participants it holds true, that they do not like being observed while making responses in public. From this observation, the implication for the **question types** can be derived: question types ideally with a single-click interaction are preferred (e.g. Likert scale, multiple choice with all options given, yes/no-questions). Then followed by numeric, dropdown and multiple choice questions with one option for open-end responses. For these question types the user has to think a little bit more, he has to assess more precisely in order to make his response. One example stated by a participant, in regards to the numeric question ‘How often have you used this display before?’, was that “It would be great if you had the possibility to choose from a predefined range, because typing is not always optimal. I would prefer if areas would be given instead of oneself having to think about the exact number.” Last, being no big surprise, are text fields combined with open-ended questions. As a take away for text fields: wherever possible rephrase the question so that you can respond to it as short as possible.

4.4 Discussion

It is interesting to see that the tablet is the most popular **feedback channel** in all scenarios, although responding via the TV screen would be more a more direct approach and not require moving to another device. Nevertheless all offered feedback channels were present in the evaluation and during the semi-structured interviews for each channel a good reason was given. What can be said that the crowd usually distinguishes into three groups. The first (and slightly larger) group preferring the option of *direct response*. They are not as considerate about answering questions in public and their privacy aspect. For them it is more important to complete the survey as quick as possible and not having to think about it later, as long as nothing too private or personal gets asked. One person said “If something too private would be asked, I would simply abort and go away from the display”. The second group is more *privacy* concerned, often older of age, or actually wanting to take the time to think about all of their responses in depth in order to give high-quality responses. This group prefers to take the questionnaire away from the public setting into their home. The third group chose the feedback channel purely based on their *habit* and what they are accustomed to. Two ladies in their mid-twenties responded immediately “on my smartphone, because I am most used to it”.

These observations go along well with the five adaptation factors stated by Huang et al. [14]: task specificity and deep integration, tool flexibility and generality, visibility and exposure to others’ interaction, low barriers to use, dedicated core group of users.

Another assumption we had was confirmed by our observations and the semi-structured interviews: the smaller the display, the safer and more private the users feel. An exception to this finding could be old people. Once people become short-sighted or more insecure and unconfident with using new devices, they prefer having a large input surface. But for the majority of younger people this held true.

Additionally we made the observation that users responded ...

The people who prefer the direct option, didn' take options 3 or 4, because it is too indirect. it would require additional commitment, which is not in the moment. therefore they would prefer to do it right now, to do someone a favour or because they are curious. but their envolvment to the topic of the research is not high enough, that they would offer to contribute later.

We are aware of certain limitations of our descriptive study. Our limitations are consistent with the findings found by Ojala et al. [22]. The effects of curiosity, impact of novelty, and influence of weather had an influence on our field study. Due to the novelty effect caused by the tablet, and the intrinsic motivation we added through the splash screen on the tablet (see section 4.2.1, selt-determination theory), the participation rate on the tablet was increased. For our primary research question, which feedback channels is best suited, the impact of novelty, curiosity and of the always-visible tablet, should not have an impact. We based the evaluation of the feedback channel not on the overall number of responses, which was therefor distorted, but on the option panel and on the interview responses.

Despite these effects, it was striking to see a response rate of 42.4%, when comparing the 50 responses made on the tablet with the total number of 117 interactions made with the public display setup. When we exclude all participants who directly accessed the tablet and did not see the option panel to use one of the four feedback channels, the response rate on the tablet was still 5.1%.

Otherwise, it should be mentioned that both the TV screen and the tablet were always on and that all questions were optional. One suggestion for improvement is to only turn on the screen of the tablet when it is selected on the TV screen as the desired feedback channel.

All in all, it can be said that people prefer to respond to questionnaires in public directly, as long as the questions don't get too private. Nonetheless the more feedback channels one offers, the better it is, since the variety of user backgrounds also bring different preferences and attitudes. When designing public display setups for getting more sensible user input, the display size should also be taken into consideration. So far we have made the observation, that users feel more secure on smaller screens.

For the development of our public display survey platform the study showed that we are on a good path. - people are willing to respond in public - put a higher priority on how users are motivated to participate, currently not embedded yet for scalable solutions, currently it was manually embedded - a higher focus on fast, one-click responses

TV Screen	
Pro	**Contra**
	Display is too large (4x)
Most direct, immediate feedback (4x)	Everyone could watch me (2x)
I am already standing here (2x)	Feels too public (3x)
Seems easiest	That is mean, when the screen is so large
Requires less personal information	The keyboard on the display would have been too large and confusing
All on one device	Display is uncomfortable for reading long questions
I can use it without putting my glasses on	Don't feel comfortable standing in focus in such a large room
Seems to be the fastest option	The system is too innovative, that is why I wouldn't trust it yet
	Because of social desirability influencing my responses
Tablet	
Pro	**Con**
The display is smaller and better laid out (5x)	
Better sensitivity / user experience (2x)	
It feels more private (2x)	
Because it is its sole purpose	
You are not in the way of others	
I am more used to it	Redundancy (2x), why do I need a tablet when I can respond on the T
Most interactive option	Personal aversion (1x), he had bad experiences with tablets
Less people watching	
Because I expect a better input	
Requires less personal information	
More comfortable standing here	
Smartphone	
Pro	**Contra**
	Too much effort (4x)
	Too indirect (3x)
	Requires more personal information (3x)
	I am not sure how complex and time-consuming it would be to set it u
I use it most often	I don't know if I would know how to do it
It belongs to me	Too small display for comfortably answering surveys and long questi
	Too cumbersome
	I would assume that I would have to install some sort of software
	Privacy aspect
Email	
Pro	**Contra**
	I would forget about it (5x)
I can do it at home (4x)	I don't like to submit my email address (4x)
I have more time to complete the survey (3x)	I don't like to postpone it (3x)
Better warranty of privacy	It would take too long to complete (2)
I could deliver qualitatively better results	Too much effort (2x)
I wasn't sure which kind of questions to expect	Requires more personal information
	Too Indirect

Table 4.4: Reasons stated for or again each feedack channel

5 Future Work

Based on the development process of the *PDSurvey* platform, inspired by the literature review and survey responses, we came to the following thoughts of what else might be of interest for follow-up studies.

For the survey platform itself we had to cut back on our goals early, due to the limited resources and development time of 2,5 months. Since it is intended for fellow students to further improve on the platform, we let out certain aspects of a classic survey platform. It would be interesting to see some of the following extensions to *PDSurvey*. The first and biggest need for improvement is a proper visualization of the quantitative and qualitative results, e.g. with the use of information visualization and JavaScript libraries such as D3.js[47] or Morris.js[48]. Because this was not our main focus for this thesis, we only implemented basic logging of all results, without any automated evaluation or visualization. A second aspect for improvement would be to support more data sources. Currently 'only' data from questionnaires are logged, but it could also be of interest to support the logging of video feeds, audio feeds, touch interaction (pixel coordinates), or other meta data from the display setups. For logging large amounts of data an integration with storage solutions such as Dropbox could be of interest. Based on their Dropbox API[49] files can be stored and referenced from third-party applications. A third part for improvement could be to offer more sophisticated evaluation mechanisms. When combining more log data with better evaluation mechanisms, better insights into areas such as user performance can be established. Integrating the functionality to automatically evaluate all survey responses based on their validity, reliability and on metrics such as standard deviation, will not only simplify the overall evaluation of public displays and their interactive applications, but also the overall quality of the end product being evaluated.

While executing our field study we thought of additional research questions, which would be of interest, but would go beyond the scope of this thesis. One such aspect is the number of questions tolerated per feedback channel. While executing the field study and semi-structured interviews some people noted that they would be willing to give more detailed responses, when they could fill in the questionnaire at home. Getting better insights into the constraints of each feedback channel would be of high interest for the construction and deployment of questionnaires in public settings. To find out whether this variable differs between the chosen feedback channel, location of the display setup, and its surrounding environment, or if other factors also play a role here. Another interesting question might be in which setting a user is most willing to answer surveys on public displays.

Another research question of interest might be how to best deploy standardized questionnaires consisting of 20+ questions. The problem being that no user wants to complete too extensive questionnaires in a public setting. One approach could be to analyze, whether it is possible to break down long questionnaires across multiple users, and aggregate the results, taking into account that the derived findings will not be as extensive and may not allow any inferences. According to Jacucci et al. [16] there are often significant similarities between standardized questionnaires. Therefore it might be possible to break down each questionnaire to its principal components, to bundle all matches, in order to reduce the total amount of questions and to be able to split all questions across multiple users on the same display. Should this turn out not to be feasible approach, then questionnaires of different length can still be distributed based on metrics such as user involvement, or the chosen feedback channel. Users choosing a well-established and comfortable feedback channel, such as email, might be willing to respond to longer questionnaires, than participants in public. Another approach could be to track users across time and recognize returning users, in order to continue with the questionnaire where they last left off.

[47] `http://d3js.org/` (last visited on April 13, 2015)

[48] `http://morrisjs.github.io/morris.js/` (last visited on April 13, 2015)

[49] `https://www.dropbox.com/developers/datastore` (last visited on April 13, 2015)

Getting a better understanding of public displays in general, and their design guidelines in particular, will also improve how to best integrate questionnaires in public display deployments. Finding better design guidelines for the development of interactive applications will be of benefit. Questions can include the influence of the environment, e.g. how personal questions can get in different public settings, or how much privacy the display should offer (the smaller the display, the more private the context seems). This is one assumption derived from the interview responses in our field study. The influence of the display size on parameters such as perceived privacy and security is an area of high relevance when conducting surveys in public. Other questions of interest might be what the ideal placement of the question itself on the screen is, how to best embed the survey (as a pop up, overlay, or full screen), how (un)obtrusive the design should be, or when to best interrupt the user from his primary task (before, during, or after).

Last but not least, getting better insights from controlled experiments in lab settings on the effects of the content, context, environment and further parameters would be interesting to find out. Being able to assess how many qualitative and/or quantitative questions can be posed, would be of interest. Also getting insights into which question types are best suited for which feedback channel. One result of our field study was the importance of fast, when possible single-click, responses. All these questions would lead to getting better insights into how surveys should be constructed to take best advantage of the PDSurvey platform.

6 Conclusion

1. which feedback channel:
2. which question types:
3. quantitative vs qualitative:

Evaluating interactive applications on public display installations is as crucial as the development process itself. In this thesis we gave an overview of how other public display applications have been evaluated in literature, presented a categorization of standardized questionnaires, and introduced the *PDSurvey* platform. This survey platform allowed us to assess our research questions through a lab study. Our main research questions were which feedback channel is best suited for completing surveys in public and what motivated our users to participate.

In the field study we offered the users four feedback channels to respond to the questionnaire. The options with direct response were most popular, however the tablet dominated the primary display (TV screen). The tablet was preferred due to its smaller form factor, better usability, and because responding didn't feel as public. Despite the additional effort of, responding via smartphone of email was still an option for some. Reasons stated for the smartphone were personal possession and habit, for email because of having more time, being able to do it at home, and better warranty of privacy. It is interesting to see that around a fifth of the participants chose an indirect and more time consuming option, even though they had the opportunity to use low effort input devices such as the tablet or the TV screen.

Our field study has shown that there is an area of application for surveys being conducted on public displays and that this approach can simplify and improve the evaluation of interactive applications. When scaling this approach to large display networks, the evaluation process of new interactive applications can be simplified. In order to gain good insights into why certain effects and differences arise in public display setups, it is vital to assess detailed information about the context of each application, allowing us to determine which characteristics cause certain effects. This aspect is also the point, which makes our platform unique.

We expect the number of interactive public display applications to increase in the future, and herewith also the demand for fast and easy evaluation. Why not utilize the interactive capability of todays public displays and use it as a direct feedback channel for quantitative evaluation? When running large display networks, this can be the first step towards fast and effective problem analysis.

> intrinsic motivation is of importance > fast, single-click interaction > many prefer direct responses > a low effort input technique is important,

With our work we addressed the issue of time-consuming public display evaluation and contributed to the systematic evaluation of public display setups. With the overview of standardized questionnaires for public display evaluation we hope to bring a benefit to XXX.

resume: it is a viable approach. the response rates were good (10%). majority of the participants preferred direct responses, however there still were a few who didn't.

» conclude in such a way, that the reader feels satisfied!

NOTIZEN

es lohnt sich » quantitative Daten lassen sich automatisiert erheben

unsere MOTIVATION war ...

wichtig zu beachten ist ...

We showed that ...

and delivered a proof-of-concept for the evaluation of public displays to be executed on the displays themselves.

Manko: privacy, social desirability,

the thesis was important, because it

> (showed a proof-of-concept) > gained first insights into which feedback channels are suited for which context.

RESULTS, OUR CONTRIBUATION Our findings show ...

1. > contribution: with the categorization of research questions / standardized questionnaires
2. > interaction has to be fast, ideally a single-click interaction per question asked
3. > we assume that the size of the public display has a direct proportional influence on the level of privacy and security. This however only is an assumption, which needs to be further investigated.

Concerns that have been expressed: social desirability, less privacy These concerns should be taken into consideration when designing questionnaires, whether the benefit is larger than the drawback. Benefits being: direct response, no procrastination, immediate feedback of the users impressions, less people needed for evaluation, semi-automated evaluation of the log data.

1. context-based evaluation, across a multitude of displays, allowing us to recognize patterns
2. include other data sources
3. say why it is relevant: There is a ever increasing amount of displays, currently only a few interactive applications for these displays, assessing user satisfaction and other metrics is a time and resource intensive task,

Appendix

A Content of enclosed CD

1. /docs/
2. /pdsurvey/
3. /pdemail/
4. /pdclient-static/
5. Google Docs
6. transcribed interviews!

B Documentation of PDSurvey Platform

A user, developer and maintenance documentation for the PDSurvey platform can be found in the GitHub repository [50] and on the enclosed CD.

C Papers Evaluating Public Displays

List of relevant papers, which include an evaluation of public displays.
TABLE: 1st column (paper), 2nd column evaluation (quantitative, qualitative, no evaluation)
TODO

D Questionnaires for Field Study

E Questionnaires for Field Study

Embed the following PDFs

1. interview-participants.pdf
2. interview-passerby.pdf
3. semi-structured-interview.pdf

F Screenshots of Platform

All screenshots including the copyright of the Balloon Shooter game belong to Jiamin Shi. // with courtesy to JIAMIN SHI.
1st option: tv screen
2nd option: tablet
3rd option: smartphone
4th option: email

[50] https://github.com/lukasziegler/masterarbeit/tree/master/docs

Figure F.1: All four four options for completing a survey, the order being randomized on every instance.

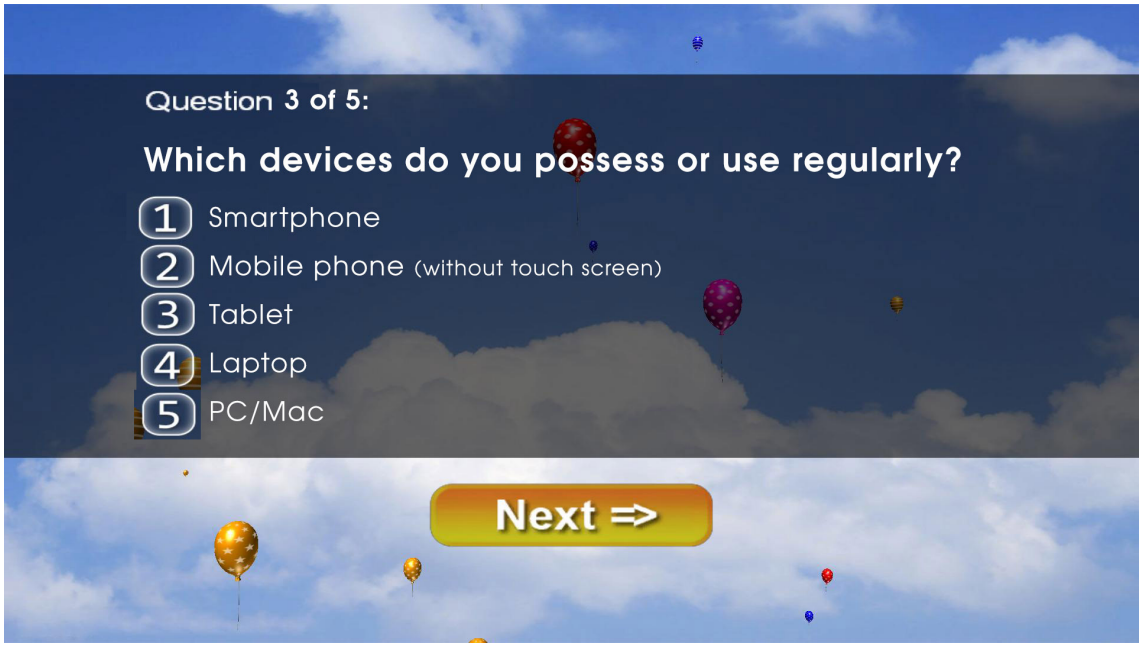


Figure F.2: Option 1, directly answering on the TV screen. Here you see a sample question getting asked on the interactive display.

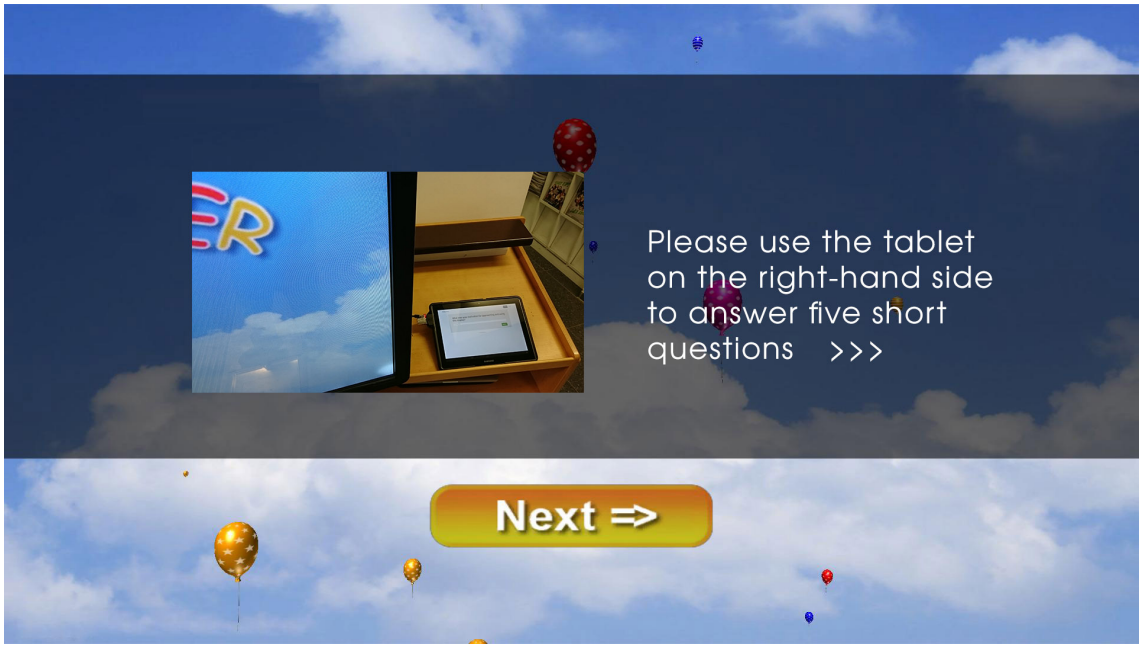


Figure F.3: Option 2, the screen the user sees when choosing to complete the survey on the tablet.

Figure F.4: Option 3, participating with your own smartphone, either by scanning the QR code or by typing the URL in the mobile browser.

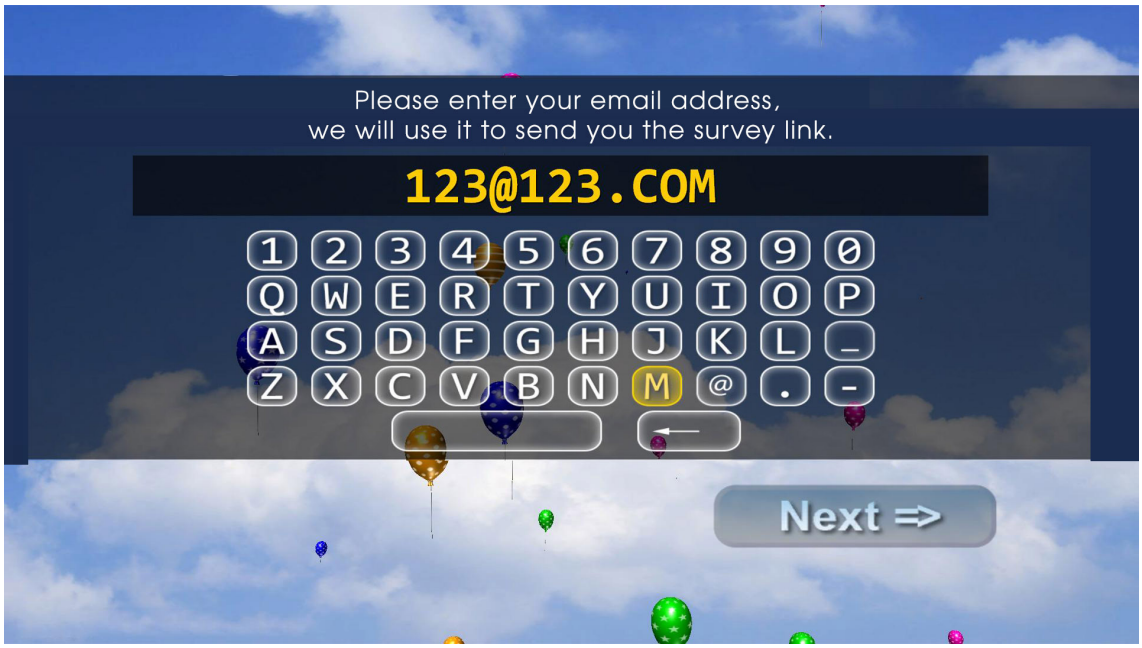


Figure F.5: Option 4, submitting ones email address and getting the survey link to participate in response.

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