Designing a Public Experimental Terminal for Citizen Engagement

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DESIGNING A PUBLIC EXPERIMENTAL TERMINAL FOR CITIZEN ENGAGEMENT

Research-in-Progress Paper

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Abstract
Experimental research involving human participants has received an increasing interest in the Information Systems (IS) discipline. Much of today’s experimental research is done with student participants, which comes with the advantage of easy availability and homogeneity of the sample. However, non-representative student samples are also often criticized due to limited generalizability. Thus, an important challenge is to engage citizens in experimental research following an open science paradigm. In this ongoing design science research project, we propose design requirements and design principles for public experimental terminals to increase engagement of citizens in experimental research. On this basis, we create an instantiation of an operational experimental terminal that can be deployed in the public space. With our research project, we present a novel approach to raise awareness and actively engage citizens in experimental research.

Keywords: Experimental Research, Citizen Engagement, Design Science Research, Kiosk Systems

1 Introduction
Experimental research involving human participants is getting increasingly important in the Information Systems (IS) discipline as a method to study decision making processes and user behavior (Jung et al., 2017; Gupta, Kannan and Sanyal, 2018). Today most experiments are conducted in laboratories where participants are physically present or online where participants log in remotely to the study using their own devices. Participants are typically students recruited either from panels maintained by a university institution (e.g., a lab or a research department) or via social media or flyers where no panel is available. Conducting experiments with a predominantly student sample comes with advantages (e.g., availability and homogeneity of participants) but also disadvantages (e.g., limited generalizability due to the non-representativeness). One approach to overcome these disadvantages and to reach a higher external validity of the results is to conduct field experiments taking place in natural settings with a more diverse participant sample. In 2019 the Nobel Price in Economic Sciences was awarded to three US scientists for their experimental work in the field and the method is becoming increasingly important in many disciplines.

Now that experimental research has become a widely used method in IS research, it is time to think one step further, expanding the scope along two dimensions: involving more diverse, especially non-student subjects and going into the field more often. This may push experimental research in IS to a new level, but also requires overcoming established structures in scientific work as well as breaking down existing barriers to participation for non-student experimental subjects. One prominent paradigm to involve society in research projects is Citizen Science which can be described as “the (large-scale) involvement
of citizens in scientific endeavours not only as participants but as co-researchers” (Weinhardt et al., 2020, p. 273). Involving society is a challenge for any research discipline, including IS. Citizen Science is a promising innovation in open science following the intention to increase scientific literacy, democratize science and close the gap between what science does and what is relevant for the public in every-day life (Weinhardt et al., 2020). Moreover, involving diverse stakeholders, including the broader society, is one of the Principles of Responsible Science established in the position paper Vision 2030 by the Responsible Research in Business and Management (RRBM) network. As outlined by McCarthy et al. (2020) and Davison et al. (2019) although stakeholder involvement is critical to establishing responsible research in IS it is not yet adequately practiced. Besides the great potential this also comes with many exciting research challenges including citizen engagement, motivation, and rewards as well as data quality (Rotman et al., 2012; Crowston and Prestopnik, 2013; Lukyanenko et al., 2019).

Sustainable voluntary engagement is a critical success factor in Citizen Science projects (Sprinks et al., 2017). We define citizen engagement based on user engagement as “the emotional, cognitive, and behavioral experience of a citizen with a technological resource that exists, at any point in time and overtime” (Lalmas, O’Brien and Yom-Tov, 2014). In this paper we specifically focus on the challenge of initially triggering citizen engagement in experimental research. A key question is how to attract attention and interest of potential experiment participants who may have no idea about experimental research. As a promising way we propose to create easy-accessible touch points in public spaces in form of kiosk systems that we call “public experimental terminals” (PETs). From the hardware side these consist of a touchscreen and a small PC integrated in a robust housing. While for the hardware setup we can use systems available from the shelf, designing the interface is a completely new challenge for researchers aiming at increasing citizen engagement in experimental research.

Thus, there is a lack of knowledge on how to design PETs that not only inform and raise interest of citizens in experimental research, but also trigger psychological and behavioral engagement of citizens. Hence, we address the following research question: Which design principles should guide the design of public experimental terminals (PETs) to increase user engagement of citizens?

To address this question, we conduct a Design Science Research (DSR) project (Kuechler and Vaishnavi, 2008). This research-in-progress paper presents results of the first design cycle. Overall, with our DSR project we contribute design knowledge for public terminals in the specific context of performing experimental research with citizens. We contribute with three design principles for a PET and its instantiation in an operational distributed terminal system.

2 Conceptual Foundations

2.1 Experimental Research in IS

Experimental methods entered the field of economics in the 1980s and have been gaining in importance ever since. Kahnemann’s Nobel Prize-winning experimental work has fueled a rapid spread of experimental methods in many scientific disciplines. In Economics and in early experimental work in IS experiments were mainly conducted in order to test theories (e.g., to validate the technology acceptance model by Bagozzi et al. (1992)), but in the meanwhile their purpose has been largely expanded. For example, experimental methods in IS are used to evaluate IS artifacts or to explain user behavior and decision making.

The primary strength of experiments lies in the isolation of causal relationships by exposing some participants to a specific treatment and others not, while maximizing internal validity by controlling for as many potentially confounding factors as possible (Recker, 2013). The easiest way to maintain a

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maximum of control is to conduct experiments in dedicated laboratories. Such lab experiments are by far the most prominent in IS but are also often criticized for the lack of ecological validity. This mainly refers to the artificial setup that is much less complex than the real-world decision context that is to be investigated such that generalizability of the results is quite questionable due to missing realism. Moving outside the lab and going into the field to study human behavior in real environments is one approach to increase ecological validity.

A second concern that is often raised in the IS community is the choice of the subject pool. Most experiments recruit participants from student panels which raises the question whether the behavior of this special group is comparable to the public. Although there is evidence from the economic literature that non-students behave much like students in standard economic games (e.g., Lichtenstein and Slovic, 1973; Fehr et al., 1998), it is questionable whether this is can be transferred to the IS context where practical relevance is strongly empathized.

Expanding subject pools to non-standard subjects and going into the field could further strengthen experimental methods in IS but comes with several challenges. It requires engaging citizens in research projects which is a difficult endeavor as subjects need to be recruited out of campus and motivations differ from those of students (Rotman et al., 2012). Thus, new recruitment strategies and incentive structures need to be proposed.

2.2 Kiosk Systems & Terminals

Kiosk systems are public-access terminals that can serve different purposes ranging from providing information (e.g., info terminals in museums or airports) and services (e.g., ticket systems, ATM) to entertainment or advertisement (Borchers, Deussen and Knörzer, 1995). Multiple kiosk systems providing the same information at different places constitute a distributed kiosk environment (Luse et al., 2018). Implementing and maintaining such a distributed kiosk architecture is more complex than installing a single system as remote control is necessary in order to establish cost- and time-efficient maintenance processes and the interface design should be carefully adapted to the different locations.

User interface guidelines for public information kiosk systems have been proposed in the human-computer interaction field. They focus on a range of factors including user requirements, location and accessibility, modes of interaction, and content (Maguire, 1999). Existing research on e-commerce kiosk systems shows that ease of operation, data security, convenience and reliability of data are the key determinants of ease of use and usefulness (Tung, 2001). Adoption of kiosks has also been researched in the context of E-Government. For example, the UTAUT study by Wang & Shih (2009) has shown that performance expectancy, effort expectancy, and social influence have a significant positive influence on behavioural intention to use kiosks by citizens. Specifically, performance expectancy had the strongest effect on intention. Furthermore, facilitating conditions (e.g., location, support, etc.) were found to have a significant positive influence on use behaviour.

2.3 User Engagement

Engagement with information technology is researched across diverse disciplines. A recently published systematic literature study (Suh and Cheung, 2019) in the IS field has presented a comprehensive framework for user engagement. The framework focuses on antecedents, user engagement from a psychological and behavioural perspective as well as consequences. Specifically, it distinguishes technological, social, content, and individual antecedents as well as technology use, communal interaction, task performance, and overall IT appraisal as consequences.

Many different definitions of user engagement exist. The definitions range from a mental state, intrinsic motivation, affective states to actual user behaviour. We define user engagement as “the emotional, cognitive, and behavioural experience of a user with a technological resource that exists, at any point in time and over time” (Lalmas, O’Brien and Yom-Tov, 2014, p. 3). Specifically, we focus on citizens as users and the terminal system as the technological resource.
For designing PETs, technological and content antecedents of user engagement are of specific interest. The above-mentioned literature review identified design features such as interactivity, controllability, privacy, ease-of-use, portability, and compatibility as important technological antecedents of user engagement. Many of these antecedents are covered by well-established user interface guidelines for public information kiosk systems. Beyond that, interactivity is of particularly high relevance for the design of PETs. The interactivity effects model proposed by Sundar (2012) argues that interactivity affordances in the form of modality, message, and source interactivity trigger psychological outcomes that positively influence user engagement (Sundar et al., 2015). Furthermore, from a content point of view sentiment, interest, novelty, or information vividness, customization, as well as prior comment length are identified as important antecedents of user engagement.

3 Methodology

We follow the DSR process described by Kuechler and Vaishnavi (2008) aiming to deliver a solution for the real-world problem of providing DSR process modeling support for researchers. The work presented in this paper is embedded into a larger DSR project as illustrated in Figure 1. In this paper we report the results of the first cycle of conducting our research project.

We started the project by exploring the problem space (Maedche et al., 2019). We first identified relevant stakeholders. Key stakeholders are researchers, experimental lab managers, owners of public spaces, and citizens. Specifically, we performed a workshop with citizens to understand specific challenges of citizen engagement in experimental research. Additionally, we engaged with representatives of public spaces in our city, e.g., the head of tourism office, three contacts of two museums, and a contact of the public citizen office. Next, we reviewed existing descriptive and prescriptive knowledge that should guide the design of the PET to increase the user engagement of citizens. As a starting point for our design, we analyzed the results of the recently published systematic literature study on user engagement (Suh and Cheung, 2019), identified theories such as the interactivity effects model and reviewed existing guidelines as those introduced above. Based on the problem awareness and existing knowledge, we derived design requirements (DRs) and subsequently proposed design principles (DPs). Finally, we instantiated the DPs in several prototypes (Seidel et al., 2018). We went through three iterations and collected feedback to the different prototypes from the stakeholders introduced above.
4 Results

4.1 Problem Awareness

Recruiting participants to conduct experimental studies is a well-known challenge in experimental research. Experimental labs at universities maintain participant panels that are mainly composed of student participants. The recruiting of students is typically done as part of lectures or on the campus. In our own university we also maintain a panel that currently consists of approx. 3,000 registered participants. Although our panel is publicly available, mostly students are registered. To increase the number of non-student subjects in the form of citizens, we first followed a traditional marketing approach, e.g., in the form of posters, postcards, etc. at selected points of the city. However, we recognized that this is rather an inefficient approach that resulted in very low registration rates. As part of the opening event for the publicly funded project digilog@bw², we performed a series of workshops with selected citizens and learned from these interviews that we need more innovative ways of engaging citizens in experimental research. In an open group discussion, we asked participants about their expectations and about the conditions under which they would participate in experimental research. We received answers indicating that intrinsic motivation plays an important role (e.g., “I would like to learn about the results and their significance for research and practice.”). In terms of incentives and rewards for participation, rewards in form of a free catering or in form of donations for a topic-related cause were proposed. From several questions workshop participants formulated (e.g., “What will happen to me as a participant in the experiment?”) we concluded that many citizens might feel uncomfortable because they do not have a good enough idea about experimental research.

4.2 Suggestion

Building on the understanding of the problem, we articulated several design requirements for PETs to increase engagement of citizens in experimental research. As introduced above, we leverage existing literature in the field of user engagement and focus on the two user engagement antecedents of content and technology to first derive a set of design requirements for PETs.

From a content perspective, existing literature emphasizes among others interest, novelty, and information vividness as important factors positively influencing user engagement (Suh and Cheung, 2019). Building on this insight, we articulate the first design requirement as follows:

**DR1:** When citizens initially recognize the PET in a public space, the system should raise interest in experimental research.

Beyond raising interest, the content delivered on the PET should be exciting for citizens in the sense that it the information is novel and vivid:

**DR2:** When users start interacting with the PET, the system should deliver novel and vivid information about experimental research.

To trigger user engagement, we specifically emphasize the importance of interactivity in the design of the PET. Following the interactivity effects model as kernel theory (Sundar et al. 2015), the terminal should include affordances emphasizing modality and message interactivity. Specifically, it should incorporate design features that afford users greater activity on the terminal. Furthermore, users should

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² Digilog@bw is a publicly funded project researching the influence of digitization on individuals and on society, thereby largely relying on a continuous dialog with society (German website: https://digilog-bw.de/).
receive responses from the system that are dependent upon their previous actions. This leads to the third design requirement:

**DR3**: When citizens use the PET, the system should incorporate interactive online experiments that trigger activity of citizens and deliver responses upon previous actions.

Finally, the terminal should not only inform about experimental research, but also enable tangible follow-up actions. Thus, we articulate the fourth design requirement:

**DR4**: When citizens use the public experimental terminal, the system should empower to perform follow-up actions, specifically enable direct registration at the citizen panel or providing feedback.

Based on the above derived requirements, we suggest that PETs should deliver interesting, novel, and vivid information. Correspondingly, the first initial design principle (DP) is:

**DP1**: Provide the system with interesting, novel, and vivid information about experimental research.

Citizens typically do not have collected experiences in experimental research. Thus, it is critical to enable citizens to understand what experimental research means. We emphasize modality and message interactivity and argue that the system should actively involve citizens in experimental activities and deliver direct responses, such as comparison of experimental outcomes with other participants, based upon previous actions. We articulate the second initial design principle grounded in the interactivity effects model as following

**DP2**: Provide the system with interactive online experiments enabling citizens to experience engagement in experimental research.

Finally, the PET should “close the loop” with citizens and enable direct follow-up actions. Specifically, we argue that it should offer a light-weight panel registration procedure and the ability to provide feedback. Thus, the third design principle is the following:

**DP3**: Provide the system with the ability to perform follow-up actions of registering at the citizen experimental panel and providing feedback.

Table 1 describes the relation between identified design requirements and derived design principles from the first cycle.

<table>
<thead>
<tr>
<th>Design Principles</th>
<th>Description</th>
<th>Design Requirements</th>
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<tbody>
<tr>
<td>DP1</td>
<td>Provide the system with interesting, novel, and vivid information about experimental research.</td>
<td>DR1, DR2</td>
</tr>
<tr>
<td>DP2</td>
<td>Provide the system with interactive online experiments enabling citizens to experience engagement in experimental research.</td>
<td>DR3</td>
</tr>
<tr>
<td>DP3</td>
<td>Provide the system with the ability to perform follow-up actions of registering at the citizen experimental panel and providing feedback</td>
<td>DR4</td>
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</table>

Table 1. Design principles and their relation to the identified design requirements

### 4.3 Development

Based on the design principles introduced above, we first created low-fidelity prototypes. After the second iteration, we implemented a Web-based user interface and deployed it on a PHEX Console (32” capacitive touch screen mounted on a heavy (>60kg) and solid stand). The software SiteKiosk and SiteRemote was installed for usage logging and remote content management and maintenance. Figure 2 shows the result of three iterations. The design (e.g., the background graphics) is inspired by the local
city marketing and the interface provides access to three basic functionalities derived from DP1-DP3. We further followed the user interface design guidelines proposed by Maguire (1999) e.g., by using clear and simple language and large buttons such that no further input device is necessary.

To provide interesting, novel, and vivid information about experimental research (DP1) the landing page links to the website of the [blinded for review] lab via the button on the very left entitled “Learn More”. The website provides news about current research activities and publications and upcoming events as well as information about the infrastructure and participation in experiments.

The middle button (“Try It”) starts one randomly selected interactive online experiment out of a library of short demo experiments we exclusively developed or adapted for the presentation on the kiosk systems (DP2). This library regularly is updated and expanded. Demo experiments follow a standardized three step procedure: First, a short introduction to the experiment and instructions are displayed in textual form or as a video (max. 1 min). Second, the experiment is started, and citizens can participate in the experiment. Demo experiments include for example interactive prototype testing (e.g., chatbots) or basic economic games (e.g., risk assessment). Third, after finishing the main part of the experiment, a comprehensive summary of the results is displayed in a way intended to emotionally involve the user (e.g., by comparing individual performance to previous participants). Some experiments are incentive aligned as participants can take part in a lottery with a real prize (money or voucher) that is raffled once a month. The last screen also includes the invitation to register for the participant panel immediately via a saliently presented link to the registration page (DP3).

Panel registration is also accessible directly from the landing page via the button on the right (“Sign Up”) (DP3). We offer two possibilities for registration: full registration via the PET (includes inserting personal data into a registration form) and a short registration (requires only inserting an email address to receive a link to the full registration that can later be performed via a personal device) as due to privacy concerns citizens might not want to enter to much personal data when possibly being observed by others. The feedback icon in the bottom right corner of the landing page links to a short form where users can evaluate the system (DP3).
5 Conclusion and Next Steps

In this research-in-progress paper, we report first results from our DSR project aiming to design a public experimental terminal to increase citizen engagement in experimental research. We define initial design requirements and design principles, iteratively develop a Web-based user interface, and deployed it on a kiosk system.

As a part of our strategic initiative on Digital Citizen Science at the Karlsruhe Institute of Technology (KIT) our project presents an innovative approach to actively engage citizens in experimental research. The design principles we developed and plan to further refine after the evaluation will help to establish distributed terminal networks for citizen engagement in experimental research projects that can largely benefit from an open science approach. Carefully designed and deployed PETs bear the potential to break down barriers to participation in scientific research projects for citizens such that Citizen Science projects can be largely enrolled.

While raising initial attention, awareness and citizen engagement for experimental research is a necessary and promising first step towards more deeply involving citizens in experimental research, there are several open challenges to be considered. Among others this includes the question of how to establish sustaining engagement over a longer period and how to motivate and reward citizens for participation. The movement towards opening the scientific process will also require researchers to follow completely new directions by building mutual recognition of prestige and competencies.

As a next step on this road towards establishing Citizen Science as an open science paradigm for experimental research we plan to conduct empirical evaluations of the PET design presented in this paper. Therefore, we will implement the website unser-campus.digital as an online/mobile version of the kiosk interface that can be accessed via the Internet. As part of a public online event with citizens, we plan to present it to participants and conduct interviews that will serve as a basis for the further refinement of the requirements and principles in cycle 2 of the DSR project. Subsequently, we will deploy the terminal at different public places (e.g., a museum, a tourist office, and an open space) at the inner city. Here, we will conduct on-site interviews with citizens. In addition to the qualitative data, we will collect and analyze log data with a special focus on the click paths to the panel registration and the quantity of new panel sign ups.
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