Digital Co-design Applied to Healthcare Environments: A Comparative Study

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Abstract. Co-design approaches have been used by different sectors, to understand end-user perspectives. They have been diversified from traditional use in product development to sectors such as healthcare environments. They put emphasis on innovation with end-users where this is seen as a source of competitive advantage, and fits with the logic of end-user-led innovation. It does however ask the question of *how to enable such approaches* and if digital approaches are more useful than traditional paper-based methods. We propose a digital co-design tool for environment improvement that can potentially promote user involvement. This paper reports on a comparative study on co-designing a healthcare environment using the digital tool versus a traditional paper-based tool. Discussion centers on the benefits and drawbacks of proposed approach.

1 Introduction

Co-design approaches have been adopted by an array of different sectors to understand the end-user perspective. This diversified from traditional product development to sectors such as healthcare. Improving user experiences of healthcare services and environments via their involvement has become a central theme in health research [1] and strategic agendas [5]. This has involved different stakeholder groups including patients and hospital staffs in discussions about personal experiences of healthcare as well as how services and environments might be improved, often utilizing methods of co-design. It does however ask the question of *how to enable such approaches*.

As part of an ongoing research program "Participation in Healthcare Environment Engineering", in order to explore the use of technologies in the co-design process, we developed a digital tool having an interactive surface and can be positioned in hospital areas such as staff rooms on departments and wards. The rationale of the tool was to engage hospital users in participating in design and appraisal of hospital areas when having a spare moment to collect small amounts of relevant data [4]. This recognized that healthcare staffs do not have time during the working day to take large amounts of time out to participate in co-design activities for workplace improvement.

The digital tool has been used in situ within hospital spaces. The aim of this work is to discover deeper nuances of use and reports on a comparative study aimed to understand end-users' perceived engagement when using the developed digital tool verses a more traditional paper-based tool (questionnaire worksheets).

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2 Experiment Setup

The experiment was conducted in the 3D Sound Room, as shown in Fig. 1 (left), in the International Digital Laboratory, at the University of Warwick. It consists of a 16-speaker system and 3 projector displays. It enables a 3D visual and aural simulation to a hospital environment. A cardiothoracic (CT) hospital ward environment was simulated using previously obtained sound recordings and images.

Fig. 1. The 3D Sound Room and the digital tool in simulated cardiothoracic ward environment

The digital tool, as shown in Fig. 1 (right), consists of a tablet computer attached to a stand. The tablet was fixed at a height suitable for use while sitting. A screen was positioned above the tablet and displayed questions, text and images. Participants responded to questions using the tablet. The questions, revealed bespoke tasks created to investigate a single healthcare environment. Other respondents' comments were displayed on the larger top screen once they had been completed. Presenting the views of other respondents was hoped to encourage mediated discourse amongst participants. A detailed discussion of the design and development is provided in [2].

3 A Comparative Study

15 computer science PhD students at the University of Warwick took part in the experiment (mean age 29 years; s.d. 4.2). The experiment was divided into 2 phases. In Phase I, the participants were asked to use the paper-based tool, to improve 4 areas in the CT hospital ward, including the patient bay area, the ward corridor, the view outside the ward and the entrance to the ward, as shown in Fig. 2. For each participant, it took approximately 15 min to complete the tasks. Following this each completed a questionnaire containing nine statements, as shown in Table 1, and a free comment space. The questionnaire was designed based on a pervious study [3]. It contained 3 dimensions including Satisfaction of Use (**SU**), Confidence of Use (**CU**), and Behavioral Intention (**BI**), aiming to investigate participants' perceived engagement of using the tool. Participants rated their agreement to each statement as −2 (strongly disagree), −1 (disagree), 0 (neither agree nor disagree), 1 (agree), and 2 (strongly

agree). One week after Phase I, in Phase II, the participants were asked to use the digital tool to perform the same tasks and completing the same questionnaire.

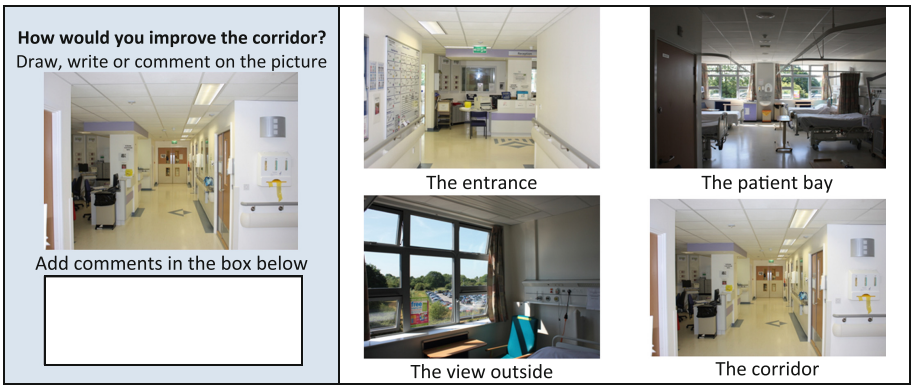

Fig. 2. The paper-based tool (on the left), and the four hospital areas to improve (on the right)

Table 1. The statements in the questionnaire and the results

Statement (variable)	Phase I (n = 15)		Phase II (n = 15)	
	Mean	SD	Mean	SD
Satisfaction of Use (SU)				
SU1. The tool was attractive to use	0.67	1.29	1.13	0.83
SU2. The tool was fun to use	0.33	1.40	1.27	0.88
SU3. The tool was pleasant to use	0.27	1.16	0.93	0.88
Confidence of Use (CU)				
CU1. I felt confident to interact with the tool	0.93	0.88	1.00	0.85
CU2. I felt confident to contribute to the design	0.47	1.25	0.93	0.70
CU3. I felt confident my contribution was recorded	0.67	1.11	1.20	0.68
Behavioral Intention (BI)				
BI1. I would use the tool again for the design	0.40	1.06	0.80	0.94
BI2. I would use the tool frequently for the design	1.13	0.83	0.93	0.70
BI3. I would tell other people about the tool	0.80	1.08	0.87	0.74

4 Results and Discussion

Table 1 shows the results of the comparative study. Overall, all the results, from both Phase I and Phase II, indicated a positive response to using both tools, i.e., mean ≥ 0 (the neutral value) suggesting that both were effective in eliciting response and comment on the healthcare CT environment. The Wilcoxon signed-rank test was performed to examine if and where differences in engagement may lie. The test results revealed no

significant differences $p > .05$ between the paper-based tool and the digital tool in terms of the perceived engagement across all 9 statements. Yet, the digital tool did elicit a more positive response, as Table 1 shows that for the digital tool 4 out of 9 statements received scores greater than 1 i.e. the statements were 'agreed', whilst for the paper-based tool only 1 statement received a score greater than 1. Besides, only 1 statement for the digital tool received a lower score than that for the paper-based tool. This might be caused by usability issues, which is out of this paper's scope.

There were three main limitations in this pilot study. One was the low number of participants, although *Cronbach's Alpha* 0.883 suggested a high level of reliability. Another was that all the participants were generally familiar with technology, as they were computer science students. Thus, engagement with individuals not as familiar with technology might be different. The third limitation was that all the participants firstly performed the tasks using the paper-based tool then using the digital tool. This could potentially have led to order effects, as in Phase II the participants had already been familiar with the tasks that they had learnt from Phase I. However, the one-week break between the two phases might go some way to control for their familiarity.

5 Conclusion and Future Studies

In this paper, we have investigated the use of an innovative digital co-design tool for improving healthcare environments. In particular, the user engagement of adopting such an approach has been tested in a comparative study on using digital tool versus paper-based tool. Although the results indicated no significant difference, the digital tool did elicit a more positive response, thus warranting further investigation.

In the future, we aim to reduce the limitations discussed in Sect. 4: We will repeat the study and invite a larger and more diverse range of participants. We will reverse the condition order to avoid and account for order effects. In the future, we also aim to investigate how participants perform co-design tasks using such a digital tool, e.g., by analyzing the frequency and sequence of using functionalities provided by the digital tool. By understanding these nuances of interaction with co-design approaches we hope to be able to develop innovate ways for user participation in healthcare to help shape the future by their effective involvement.

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