Efficacy of Short Simulation Videos on Feedback for Smart Hospital Environments

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Abstract. This project is focused on developing smart health infrastructure with simulations of a smart hospital physical environment. The focus of the project is exclusively on "the physical architecture of a smart hospital". The project is driven by the motivation to develop preliminary amateur simulations of smart environments for a hospital setting that could potentially help planners develop an understanding of how to develop the current infrastructure. Today's world is rapidly evolving and with expanding research on smart city digital environments, but smartification of physical hospital infrastructure is significant and part of the entire development of a smart environment in hospitals or in any smart environment. Further, such implementation is extremely important in small towns and in less developed economies. As the population grows or the need for more specialized treatment rises, the demand for medical services is increasing rapidly. The goal of this study is to develop quick simulated environment landscapes towards making a few productive suggestions that could potentially lead to developing a smart environment in a specific Aizu-area hospital (as a case study). In this context, the physical architecture of the selected zones in Takeda hospital will be further investigated. The focus of the project is not architecture or smart interior designing, but the efficacy of quick video simulations in generating basic ideas and collecting quick feedback, and thus, ability to use the software called Google Sketch-up productively and use it to run basic usability studies to explore how citizens react to such video simulations, and what they think to be lacking in such quick simulation videos. In other words, the idea is to learn the impact of video simulations as stimuli in helping citizens to generate more ideas about their needs in a hospital environment, and then communicate the same with architects and/or city planners as the next step.

1. Introduction

Most smart environment projects in the literature include the vision of ambient intelligence and includes extensive discussion on the ubiquity of information technology, the presence of computation, communication, and sensorial capabilities in an unlimited abundance of everyday appliances and environments [1]. Not many of these studies deal with the smart interior design of buildings and its relationship to land use. In this context, this paper deals with the idea that architectural design is often associated with aesthetics and style, but it is also very important to building performance and sustainability [2]. Unlike many or most other smart environment projects, the idea here is not to focus on the newer technologies that are used in smart hospitals (e.g., IoT, AI etc.). This project is focused on studying the efficacy of quick video simulations of a smart hospital physical environment in developing ideas and generating feedback for smart health physical infrastructure as in interior design of buildings and spaces (not cyber-physical systems).

Research in various fields have identified the positive impact of video-facilitated feedback to improve performance, communication skills etc. With that research in mind, the idea is to explore if such first prototype video simulations, developed by fellow visitors or users of the facilities can help generate and communicate ideas for improvement as to what visitors or potential visitors would like to see in their hospital environment. That further enables us to study how easy or difficult it could be to develop such user-generated videos and generate a continuous feedback loop.

The focus of the project is exclusively on the physical architecture of a smart hospital with four specific hospital areas as example spaces.

The video simulations in this study focused on:

A. Lobby (Waiting Room)
B. Nursing Station
C. Payment Area
D. Patient Room

These specific areas in any typical hospital are the most important and most visited by patients, other than operation theaters, and other examination rooms. The user feedbacks are designed to include general daily-life user convenience, with comments not being made as specialists (interior designers, smart environment experts). Thus, the video simulations were made to test if reasonable and limited developments in the above-mentioned hospitals zones could be identified by general visitors, and if the simulations looked to make reasonable sense, and if such videos could be successfully communicated with experts to generate more wider levels of feedback leading to development of more professional simulations made by experts.

More specialized areas as operation rooms, diagnostics areas etc., are not part of this study, as general visitors technically

do not have the expertise to comment on how such areas should be developed, and the logistics of such development.

Table 1. Areas of Focus and Existing Features

Picture Area	Existing Features
Lobby (Waiting room)	● Chairs together on a panel ● 3-meter distance to reception counter from the sitting area ● The reception area divided into 5 specialties ● Payment Machines at the back ● Coffee shop at the farthest corner
Nursing Station	● Sitting arrangement for 7-8 nurses at a time ● Computers in front of the main desks ● Accessory machines (blood pressure monitors on the wheel) ● Nurses facing the reception desk ● The Middle area in the nursing station has a roundtable for meetings
Payment Area	● The receptionist is facing the customer/patient with a 2-meter gap dividing the two individuals - COVID screen on the front ● Immediate access to the credit card machine (handheld) ● No automatic credit card machine ● The cash payment machines are at least 7-8 meters away ● For credit card payment, only one person at a time has access.
Patient Room	● In a 4-person room, inadequate space dividing the four patients - not enough sitting area for the patient visitors ● Personal TV access with a card - not automatic (no big screen for the entire room) ● No sitting for visitors to the patient in a common room (4 patients in one room) ● Common bathroom at a distance depending on the position of the bed ● Some rooms may not have enough light and windows may not be suitable (no floor to ceiling windows)

Table 1 highlighted the existing features we see in the actual hospital areas, and that would help readers understand the simulations in a better way.

New Ideas in Simulation Videos

Limited changes were designed and suggested in the simulation videos with reference to existing videos.

A. Some design changes
B. Some direction changes
C. Some distance between position changes

These points were used to design the existing simulation videos as the first prototype suggesting some reasonable spatial changes.

2. Review of the Literature

The role of the physical environment in any 21st century hospital is immense [3], and the quality and characteristics of the hospital environment result in positive outcomes [4].

The review of the literature focused on the following two most important areas of study:
[1] Visual simulation in smart hospitals towards developing user and nature-friendly environments. Some examples of the important points mentioned towards making the hospital environment nature-friendly includes (a) direct access to the outdoors through a balcony, (b) an outdoor view through a window, (c) a nature artwork, and (d) an indoor plant [3].
[2] Smart Hospital Physical Design - Google SketchUp for Site Design: A Guide to Modeling Site Plans, Terrain, and Architecture (2009) [5] illustrates a holistic approach to using SketchUp for prototyping an architectural landscape: how it works and more importantly, what to do with it.

The following video was also used for researcher training purposes to learn about hospital design animation using Google SketchUp - https://www.youtube.com/watch?v=oUMCILMbvNc

3. Method

The following methodology has been used for this basic usability study to test the efficacy of the simulation videos as beta version amateur videos to collect basic feedback about the architecture and the interior design of the most frequently visited areas in a hospital:

1st, the identified four areas in Takeda hospital were researched - the public spaces including the lobby, nursing station, payment area, and patient room, with simulations developed after personally visiting those areas, taking photos, and observing ethnographically, how visitors use the space, and how they move around the space during crowded times, and when not many visitors are around. Some observations included where visitors prefer to seat when seats are generally available, if older patients feel frustrated with the zones and how much space is available, general sitting arrangements, directions, spaces, and positions between beds, etc.
2nd, video simulations were designed in a way that explained a futuristic, upgraded, and limited revised view of the divided areas in the chosen hospital, and the researcher introduced his/her suggestions for each area with the simulation, that included brainstorming on how to design the simulation videos on all the identified zones in the hospital. The process included a better learning of the Google Sketch-Up software towards iteratively designing productive yet amateur simulation videos. The process included identifying if and how the simulation videos addressed the areas of concern in the physical environment. The idea was to make the video simulations easy to understand and productive as first prototypes. To confirm its usefulness, the process included the researcher receiving feedback as an ongoing process from viewers who watched the videos for possible impact and as a resource for further discussion on possible changes in the hospital infrastructure.
The simulation videos are not professional quality, but an attempt to explore if citizens could come up with simple revisions on their own and suggest improvements to the city planners and architects and interior designers.
This is part of the experience design research, where the user is part of the design process [5].

Video 1: Physical architecture of the lobby - https://youtu.be/lfpUhwZwFfI
Video 2: Physical architecture of the nursing station - https://youtu.be/eerXLzrOw_k
Video 3: Physical architecture of the payment area - https://youtu.be/5-5ZtUSqS5Y
Video 4: Physical architecture of the patient room - https://youtu.be/w9dWM9zkUpo

3.1. Example Screenshots

The following screenshots are simple illustrations of the zones, as reasonable improvements on the existing infrastructure. The basic idea is to explore if such depiction is considered reasonable enough to generate feedback towards what needs to be implemented as part of any revised design plan.

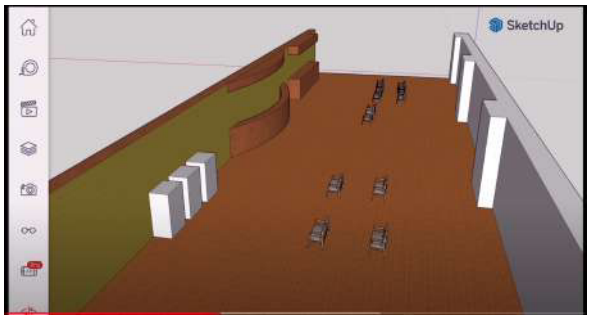


Figure 1. Lobby Area

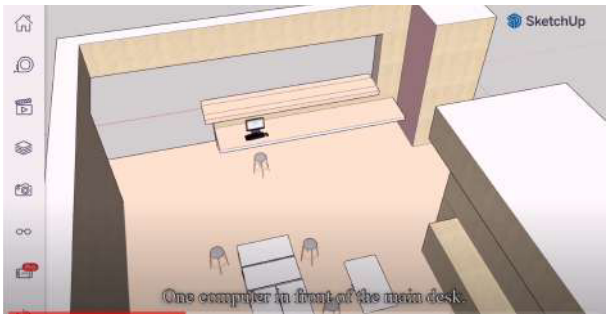


Figure 2. Nursing Station

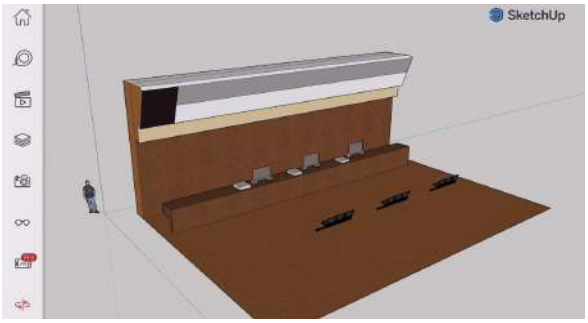


Figure 3. Payment Area

Figure 4. Patient Room

As mentioned earlier, these simulations could be repeatedly updated with repeated feedback from hospital visitors, with simple software-level updates.

3.2. The Sample

A sample questionnaire was handed out to 20 participants. This batch included mainly undergraduate students who visit Aizu Takeda hospital from time to time, and even if they have not visited the hospital, they could develop a fairly good idea of a more efficient layout design based on the simulation. The participants were mostly male, 21-22 years old computer science students, and live in the Aizu area as students at the university. They are not experts in landscape design but have a computer science background with basic-moderate experience in CAD. So, this feedback was at an amateur level with designers making more realistic and practical changes at a later stage, based on this initial feedback.

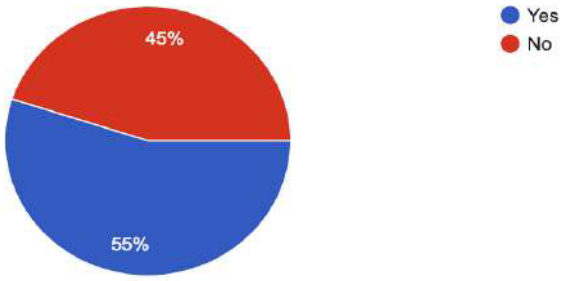
3.3. The Questionnaire

The questionnaire was created in Google forms with the YouTube link to the four videos that participants are encouraged to watch carefully and take notes, before starting to answer the questions. The actual questionnaire is divided into three sections, with the first section being general impressions about the hospital scene in Aizu, and the possible impact, according to the participants, that these simulation videos could have. The section 1 questions had basically Yes/No/Maybe responses. Section 2, focused on the video quality and primarily had a 5-point Likert scale type of response with 1 - completely agree and 5 = completely disagree. Section 3, focused on the presentation content in the videos and primarily had a 5-point Likert scale type of response with 1 - completely agree and 5 = completely disagree.

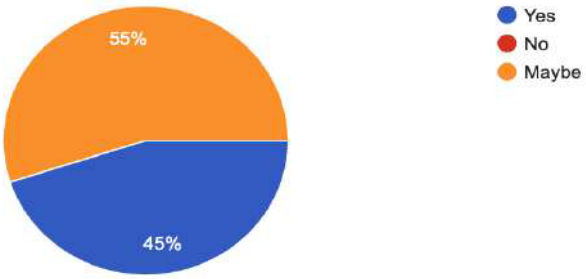
4. Findings

The following four pie charts represent the general impression about hospitals locally, including the smart architecture that is existing, and the possible impact of the simulation videos. These questions were asked as part of the pre-test study.

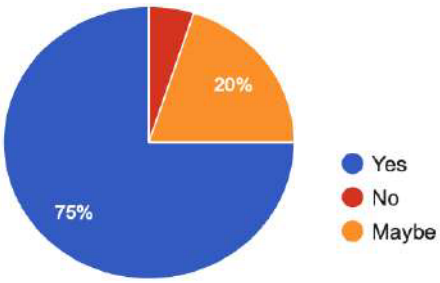
Do you have any experience visiting one of the major hospitals in the Aizu area?



Are you largely happy with the way things are planned in the hospitals?



Do you think smart hospital landscape and physical architecture planning could be further improved?



Do you think these smart hospital simulation videos could provide landscape and design planners with ideas about what citizens want in a smart hospital environment?

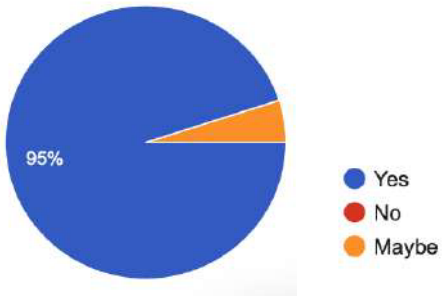


Figure 5. Impression about Local Hospitals & Possible Impact of Simulation Videos

The above and below questions (Figure 5 & 6) were asked to explore the general perception of these participants about the ability of simulation videos to help generate ideas. They were not told (and nowhere does it mention) if these videos are professional or amateur quality.

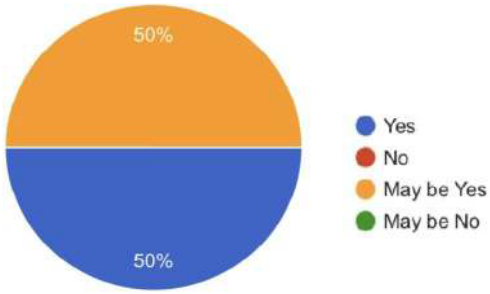


Figure 6. Possible Impact of the Simulation Videos

In Figure 6, the participants were asked if they think as an initial video draft, these four simulation videos will likely serve the purpose of providing designers and planners with an initial idea of what citizens and visiting patients might prefer?

The table 2 below shows video type responses in a Likert scale. Also, it shows the extent to which the content is presented in a clear and easy-to-understand way.

Although people do not strongly agree in many cases, generally, considering these as amateur and preliminary videos, mostly positive responses were received in terms of the video quality and what it aims to achieve. However, responses also show there is much room for improvement. The video design, text, graphics, animation and segmentation, audio/video mostly received positive feedback.

Table 2-1: Quality of the Videos

Video Type	1 ←agree	2	3	4	5 →disagree
Video 1	4 (20%)	14 (70%)	1 (5%)	1 (5%)	0 (0%)
Video 2	6 (30%)	9 (45%)	5 (25%)	0 (0%)	0 (0%)
Video 3	9 (45%)	6 (30%)	3 (15%)	1 (5%)	1 (5%)
Video 4	9 (45%)	9 (45%)	1 (5%)	1 (5%)	0 (0%)

The video content is divided into small segments and/or ideas for all four target zones. The information is presented in small and functional units.

Table 2-2: Video Segmentation

1 ←agree	2	3	4	5 →disagree
8 (40%)	9 (45%)	1 (5%)	2 (10%)	0 (0%)

The video screens were developed in a clear and comprehensible way.

Table 2-3: Video Screens

6 (30%)	12 (60%)	1 (5%)	1 (5%)	0 (0%)

The information presentation will likely capture the potential or regular patients' and designers' attention

Table 2-4: Impact of Information Presentation

7 (35%)	10 (50%)	1 (5%)	1 (5%)	1 (5%)

The video design will likely not overload the users' memory.

Table 2-5: Impact on User Memory

5 (25%)	11 (55%)	2 (10%)	1 (5%)	1 (5%)

The video text was easy to read, understand, and the video-text coordination was appropriate.

Table 2-6: Video Text

5 (25%)	10 (50%)	2 (10%)	3 (15%)	0 (0%)

Text, image, graphic and video quality are good quality.

Table 2-7: Text, Graphic and Video Quality

6 (30%)	10 (50%)	3 (15%)	1 (5%)	0 (0%)

The on-screen pictures presented are relevant for the information in the text.

Table 2-8: Relevance of On-Screen Pictures

12 (60%)	4 (20%)	2 (10%)	2 (10%)	0 (0%)

The video improved information presentation.

Table 2-9: Information Presentation with the Videos

11 (55%)	6 (30%)	1 (5%)	2 (10%)	0 (0%)

The video sound has good quality and improved information presentation.

Table 2-10: Audio Impact

7 (35%)	6 (30%)	6 (30%)	1 (5%)	0 (0%)

The following pie charts discussed the presentation content in the videos. Generally, we received positive feedback.

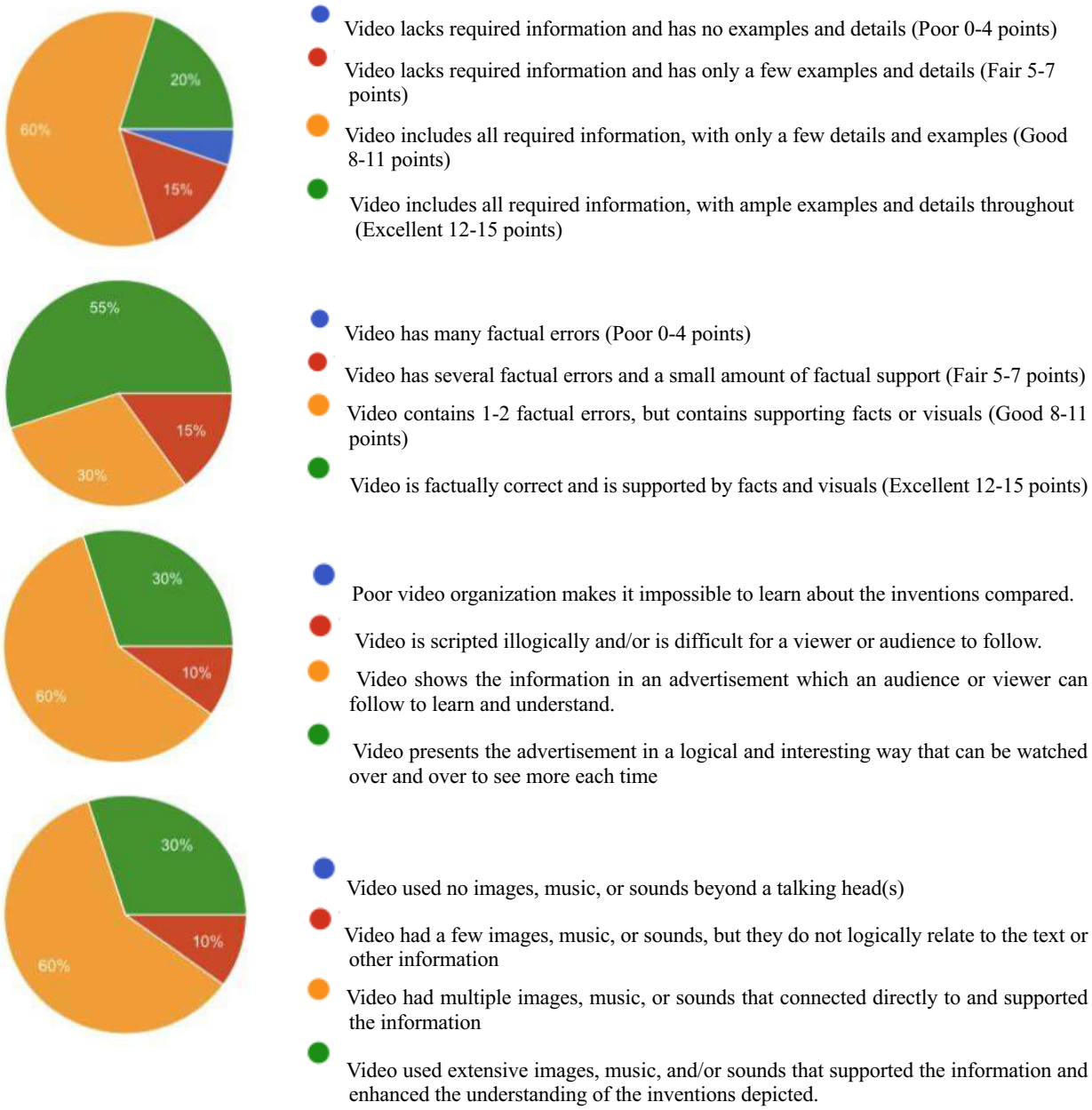


Figure 7. The Video Presentation Content

For all the above four pie charts, the responses suggested that the respondents do think that the videos have the necessary ingredients to generate modest amateur feedback, but still there are only few required details and examples in place, is mostly factually correct, it's reasonably understandable in terms of the content, and it mostly has the necessary images, music and sound to make it attractive and comprehensible. However, that does not mean that the simulations could be professionally usable but could be a modest starting ground for potential revisions.

Where do you think these amateur promotional videos lack when compared to professional videos launched by companies? (Click all that you think applies)

1. Lacking in video quality
2. Lacking in video presentation
3. Lacking in video content
4. Lacking in information
5. Lacking in audio quality
6. Lacking in camera positions
7. Lacking in subtitles

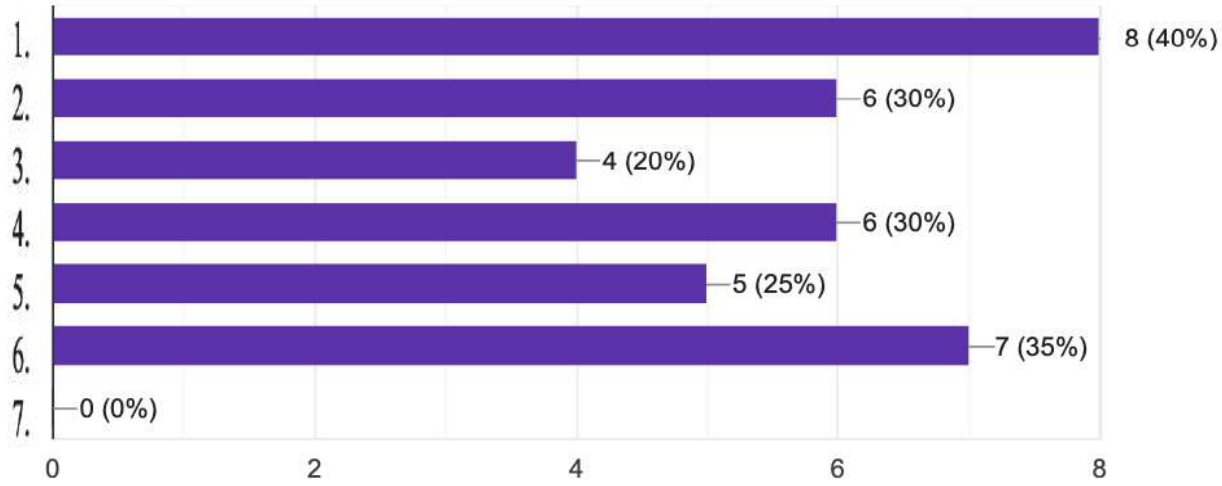


Figure 8. Comparison with Professional Videos

Figure 8 demonstrated that the participants, although sounded positive with their feedback about the video quality, and the presentation content, also identified how these amateur videos lacked in quality and content when compared to professional quality videos mostly used by architects and professional landscape designers.

The following Table 3 demonstrated the most significant self-reported comments made by participants about the four videos they encountered.

Table 3: Self-Reported Comments on Simulation Videos

I understand the structure of the hospital. The structure of the nurse station left an impression on me.
The volume of BGM is loud, it interferes with reading subtitles. Also, it may not be an easy-to-understand movie for everyone, because audiences must read the subtitles themself. For example, elderly people may find it difficult to read it. I think it's better to include narration.
It was easier to imagine because it can be seen in 3D.
First video doesn't have any new things.
The expression is a little too hard, so I thought it would be better to make it softer.
The subtitles explained the proposed parts in detail and were easy to comprehend. I think this is a great video to provide planners with a creative design. I think there is one thing that could be improved in this video. All the videos show the scale of the room and the human; however, the image of the human is at the edge of the screen, making it hard for the imagination to work (In particular, video1). I think that placing the man's picture inside the designed room would convey more about the size of the room. In addition, it would be possible to provide more detailed explanations by using arrows or circles around the areas with subtitles explaining the detail.
The video definitely serves the intended purpose. It would help a bit more if lengthier subtitles had a bit more time to read. Other than that, I guess the video is great. It would also help hospital planners and designers if some more details are included because in the videos, it consists of very little details. It's better to show other things like doors and their types (some doors slide to open and do not take much space, but some open in a way that it needs a lot of space) so that the planners can get a clearer idea on the space available to make the necessary changes.

6. Discussion

1. The data shows the following:
   A. Data shows a mostly positive perception of the simulation videos.
   B. However, there is significant room for improvement in terms of
- video content,
- details provided
- audio-visual presentation
- design of the videos
- clarity for different age groups (old age people, non-experts, etc.)

One of the major drawbacks of this study is the fact that participants are not experts in video simulations, and they may not be entirely aware of the tools available even within Google Sketch-Up that could help make the videos better or of more professional quality. Secondly, the study does not mention the fact that computer science students who are the participants in this study may have more exposure to such video games like environment as shown in the simulation videos. However, if common citizens, especially older generation people are included in the study, we may get more diversified views and feedbacks about the efficacy of such videos in terms of audio, video, content comprehensiveness etc., as these citizens may more frequently visit the hospital, and may be in a better position to provide more comprehensive feedback.

7. Conclusion

Amateur simulation videos were created towards developing a feedback loop to gain initial feedback on a few possible ideas for improving the interior design of some of the Takeda hospital areas. These videos are in no way complete simulations but have been developed to explore what end users think of the video quality including content, presentation, organization of information and layout in a multi-modal environment. Preliminary results show a positive perception of the videos, although there is much room for improvement. Future studies should map the possible areas of improvement in the interior designs, and then go in-depth into analyzing the same with longer and more robust content of such simulation videos, and with citizens who visit the hospital on almost regular basis.

8. References

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