A Usability Study of Smart Home Apps Alexa and Nest

Zhengchen Zhou
George Mason University

During the pandemic, more and more people work from home, which increases the need to make homes smart and especially safer and more efficient. Amazon Alexa and Apple Nest are the two major players in today's smart home system market. They are capable of using voice interaction to control music playing, set alarms, playing audiobooks, and providing other real-time information. They can also be used as a home automation system to control multiple smart devices. Both apps will undoubtedly remain enticing options for people after the office reopens and many people return to the office. It is therefore in the interest of technology companies to ensure that apps have good usability, which will drive the industry forward. The current study, therefore, aims to determine how the various sub-dimensions of usability affect the overall user experience of the two smart home apps. The usability of the apps will be evaluated by performing a task analysis of several common use cases for each app and then administering validated usability measurements. Once the study is complete, design recommendations for each smart home app will be based on the results obtained.

INTRODUCTION

The smart home is the integration of technologies and services through home networks to improve the quality of life. It uses different technologies to equip home components for smarter monitoring and remote control. It enables home components to interact with each other in influential harmonics between them so that daily home tasks and activities can be automated without user intervention or controlled remotely by the user in a simpler, more convenient, more efficient, safer, and cheaper way. Smart homes have interconnected devices that can be accessed through a central point - a smartphone, tablet, laptop, or gaming console. Appliances such as door locks, TVs, thermostats, home monitors, cameras, lights, and even refrigerators can be controlled through a single home automation system. The system is installed on a mobile or other connected device, and users can create a schedule for certain changes to take effect.

History of Smart Home Systems

In 1975, X10 was released as the modern root of smart home tech. It's a home automation system that transport digital information to the home's existing wiring. Early application of this technology used command consoles plus modules to remotely control devices in their homes. (Stanley, J., 2021)

The Z-Wave platform was introduced in 2005. It also uses RF, and operates in the sub-1GHz band. A big advantage is that it is immune to interference from Wi-Fi and Bluetooth. Products with built-in Z-Wave form a mesh network. The network allows remote communication between devices. Homeowners can also easily add non-Z-Wave products by plugging them into a Z-Wave accessory module.

In 2010, the Nest Learning Thermostat was developed by a former Apple engineer. It totally changed the game for smart home technology, specifically by making the home wireless Internet the channel of choice control. It also introduced data collection capabilities that could track activity in the home. Plus, it can automatically program smart thermostat settings based on that data. In 2014, Google acquired Nest Labs and put the search engine giant at the forefront of the smart home technology race. (O'Toole, J., 2014) In 2014, the first Amazon Echo smart speaker hit the market. Alexa, the virtual assistant for Amazon's smart home products, is now a widely-popular household name. Homeowners can control thousands of Alexa-enabled devices using simple voice commands. Since then, the competition between the tech giants has been in full pace.

Usability in App Design

When asked how to make interfaces easy to use, Steve Krug once said "Don't make me think. ". He explained that the user should understand what he wants to do. If a person is confused staring at an interface, that person is more inclined to close the application. MacKenzie, McAlister, Desai, & McCarthy (2005) agree with Krug that if an application is to be successful, it should not make you think. In addition, they add that a crucial element of usability heuristic is consistency.

Keeping consistency helps users navigate the application easily and without difficulty. In addition, they add that simplicity is another important heuristic to consider. An interface with a high word count can scare users away. Less text also means smaller pages, so users don't have to scroll up and down. In addition, it reduces the amount of material on the interface, so users can easily find the needed information (MacKenzie et al., 2005). There are a few other guidelines for application usability that will benefit the layout. These guidelines are important when developing application interfaces. Once achieved, they can provide the application with an advantage over its competitors (Borges, 1998; Ivory, Sinha, & Hearst, 2001).

Nielsen's Usability Heuristics

Nielson (2005) proposed several usability heuristics that is widely applied in interface design. Smart home app developers should apply these heuristics to their designs because it helps to achieve user satisfaction and success over other competitors. Nielson says the system should always let users know current situation through appropriate feedback within a reasonable span. This adds momentum throughout the navigation process. Furthermore, there should be a match between the smart home system and the home device. Nielson says the smart home system should use the user's language, and use user-familiar words, phrases, and concepts, rather than system-oriented terms. By matching the real world, smart home systems can attract more users. In addition, if consistency is kept, users will feel like they have everything under control. This feeling will create fewer errors and better recognition of different tabs or layouts. In another word, the system should be consistent because the user does not have to wonder if different words, situations, or actions mean the same thing (MacKenzie et al., 2005; Nielsen, 2005). Finally, Nielsen says that users should be helped to identify, diagnose and recover from errors. Receiving feedback from the system about user actions and resulting errors helps users understand the solution to problems, which would reduce stress and frustration. This is critical for smart home applications because most functions are collapsed rather than displayed in a flat menu. These design principles are the key to succeed and retain customers.

METHODOLOGY

Participants

Our study will include 60 participants, 30 of whom will be randomly assigned to Alexa and the other 30 to Nest. Participants will be recruited from George Mason University's large, diverse student body using SONA Systems, an online research participation platform. Undergraduate students will receive credit for coursework in exchange for becoming research participants.

Materials

Performance Tasks. After assigning participants to their assigned smart home applications, we will ask them to perform five tasks with commonalities. The first task is to create a profile, log in, and add accessories to the home suite. Second, participants must select a favorite in the device. Third, participants will create groups associated with different rooms. Fourth, they will need to create a routine consisting of several groups that follow a schedule. Finally, they will need to automate my day, which means having a group of devices work automatically on a schedule. Although these are not taken from standardized or validated measures, the tasks were chosen to fairly represent the typical use cases of both applications. All tasks can be completed in roughly equal amounts of time, with roughly the same number of operations required by the user.

Usability questionnaire. The post-test is the USE Usability Questionnaire developed by Lund (2001). The questionnaire will consist of 30 items, 8 asking about usefulness, 11 asking about ease of use, 4 asking about ease of learning, and 7 asking about satisfaction. These are the four constructs that make up the metrics and contain what are considered to be the four main constructs that should be measured when considering the overall usability of a product. In the questionnaire, the questions were formatted as statements rated by the respondents on a Likert scale. Example statements are provided in Table 1. The questionnaire was followed by a space for participants to provide their thoughts on the smart home apps they use. This was a free-response section with suggestions for features that participants would like to improve and new features they would like to add to the platform. Responses were used for qualitative analysis only.

Procedure

We present this study not only to compare the user experience of smart home systems but to understand how the structures embedded in usability affect the overall positive user experience. Our model consists of four factors that affect the usability of smart home

Table 1

Example statements from the USE Usability Questionnaire

Dimension		Example Statements
Usefulness	1)	It makes the things I want to accomplish easier to get done.
	2)	It does everything I would expect it to do.
Ease of Use	1)	It requires the fewest steps possible to accomplish what I want to do with it.
	2)	I can recover from mistakes quickly and easily.
Ease of Learning	1)	I learned to use it quickly.
	2)	I easily remember how to use it.
Satisfaction	1)	I would recommend it to a friend.
	2)	It works the way I want it to.

application interfaces: usefulness, simplicity, ease of learning, and satisfaction. The usability measures will be the same for both groups, but they will use the smart home apps assigned to them to complete them. To accurately measure these metrics, we will ask participants to complete tasks against which we will measure their performance and conduct a post-test survey. The task analysis will include 5 tasks of comparable difficulty that will be completed by users. As mentioned earlier, the post-test survey is borrowed from the USE questionnaire. This questionnaire will help us to measure the strengths and weaknesses of the different domains from the core structure described in the Materials section. However, there is also a small free response section at the end of the survey for participants to expand on specific areas of strengths and weaknesses.

Once these processes are complete, we will observe the results and draw conclusions based on our sample as to which smart home systems scored higher, as well as look at the strengths and weaknesses of each service. With this information, we will be able to make recommendations to improve the overall user experience. While this is a proposed study and has not yet been formally conducted, we present below an idea of the types of results we could see.

RESULTS

Task Analysis

Upon completion of these five tasks, we will have quantitative data on the efficiency and usability of the two smart home systems. While the study has not yet been conducted, so we cannot show the results, we can show what these results will tell us. Once the task is completed, two things will be tracked, the percentage of tasks completed correctly and the amount of time it took participants to complete the task. The first of these provides insight into which platform has a higher percentage of completion, which will help explain which platform is easier to learn and navigate based on the task. The second gives us an idea of the extent to which this is the case. By knowing the average time spent on each task for each smart home app and the number of unrelated actions participants may take, we can objectively quantify the ease of use of each app

USE Questionnaire

These responses, as well as the overall survey responses and the tasks completed, will provide us with the results. As described in the methodology section above, the use questionnaire will contain 30 questions, 8 on usefulness, 11 on ease of use, 4 on ease of learning, and 7 on satisfaction. Each of these questions will be measured on a 7-point Likert scale. Scores will range

from 30 to 210, as the scores for each question will be summed.

Proposed Analysis

Independent sample t-tests will be conducted using quantitative time data collected from the task analysis of each of the five tasks. These tests will determine the average time spent on each task for the two smart home applications in any area where the two smart home applications provide roughly equivalent performance. For example, if the t-test results are not statistically significant, then it is reasonable to assume that the services are not fundamentally different in terms of usability - at least in the context of these separate tasks. In addition, another independent sample t-test will be used to directly compare the average score each smart home application received on the USE Usability Questionnaire. The results of this t-test, if it shows a statistically significant difference in mean scores, will inform the discussion around the overall perceived usability and positive user experience of these two smart home apps.

DISCUSSION

The two smart home systems we chose, Amazon Alexa and Google Nest, are two world leaders in the field of smart home systems. Both have done a great job of not only providing systems that can accommodate so many different devices, but they have also created a system that seems easy to navigate and for users to learn to use. This is another reason to explore their usability because we want them to score high, but we can narrow down which aspects of each platform are strengths and which aspects still need improvement. This study will not only tell us which smart home systems currently have the best overall user experience, but it will also show us where they excel and give us an idea of what other smart home systems can do to improve their experience.

Smart devices are what drive brands and their ability to succeed, but once they've attracted users, it can overshadow use if they become frustrated with trying to enjoy using them. The point here is that while this study can give us unexpected results, it will still provide valid concerns for smart home systems and point to ways to improve.

Another important consideration is the limitations of this study. We outline a proposed study that we intend to use to measure overall usability and positive user experience. However, it is also important to understand what limits our study from really measuring what we want to measure. One possible limitation is the weighting of each construct in the USE questionnaire. Although the USE questionnaire is a popular choice for measuring usability and has been successful, not all constructs are measured equally. For example, Usefulness has 8 questions associated with it, while Ease of Learning has only 4 questions associated with it. It may affect how we interpret the results we will receive.

Another potential limitation is the relationship between the tasks we chose and the USE questionnaire. We planned to measure the interrelationship between the performance of common tasks and our questionnaire, but since there is an unknown relationship between our tasks and the questionnaire, it is important to understand this when interpreting the data. However, even in this case, having participants complete these tasks will help them to have a comprehensive understanding of smart home apps before rating their usability. Without these tasks, we would only be measuring their perceived usability against their prior expectations.

Even keeping these legitimate concerns in mind, we believe this will be a strong indicator of the usability of these products and will help us explain the strengths and weaknesses of each product. Without a full understanding of how usability affects the overall positive user experience, smart home apps run the risk of frustrating users. This study aims to deepen the current understanding of how usability affects the overall positive user experience by analyzing two of the most influential smart home systems: Alexa and Nest.

REFERENCES

Lund, A. M. (2001). Measuring usability with the use questionnaire12. Usability interface, 8(2), 3-6.

Neilsen, J. (2012). Usability 101: Introduction to usability. Nielsen Norman Group. Retrieved November 1, 2021, from https://www.nngroup.com/articles/usability-101-introduction-to-usability/.

O'Toole, J. (Ed.). (2014, January 14). Google buys Labs for $3.2 billion. CNNMoney. Retrieved December 14, 2022, from https://money.cnn.com/2014/01/13/technology/google-nest/index.html

Rivera, J., Davis, F., Mouloua, M., & Alberti, P. (2010). Usability Evaluation of Two Social Networking Sites. Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 54, 1421 - 1424.

Schrepp, M., Thomaschewski, J., & Hinderks, A. (2017). Construction of a Benchmark for the User Experience Questionnaire (UEQ). International Journal of Interactive Multimedia and Artificial Intelligence, 4(4).

Stanley, J. (Ed.). (2021, December 21). The history of smart home technology. Family Handyman. Retrieved December 14, 2022, from https://www.familyhandyman.com/article/the-history-of-smart-home-technology/