

**How companies promoting smart homes in response to the challenges introduced by
Smart Home Technology**

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On my honor as a University Student, I have neither given nor received unauthorized aid on
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The widespread of smartphones and high-speed internet gives rise to the enormous market of smart home technology products. Global smart home technology is expected to grow from USD 78.3 billion in 2020 to USD 135.3 billion in 2025, at a CAGR of 11.6% (MARKETSANDMARKETS, 2020). Governments have established various policies and special funds in response to stimulating these booming, newly emerged markets. Take Europe as an example. A wide range of public-funded projects across the EU aims to facilitate smart home devices' growth, making the future more prosperous (Wilson, Hargreaves, & Hauxwell-Baldwin, 2017). Companies like Amazon, Google, Apple, etc., have released their smart home ecosystems in response to the market growth.

A smart home is *"a residential environment with information and communication technologies, which provide suitable functions for the residents' convenience, security, entertainment, and comfort needs"* (Marikyan et al., 2019). A well-designed smart home provides residents with the ability to control their houses' maintenance in an optimized way (Choi, Kim, Lee, & Park, 2021). Residents in a place equipped with smart homes can access and control all the individual devices through a central control system: either through a central hub like Alexa, Google Home, or Apple Homepod or through their smartphone app. These control centers often equip AI with voice control, increasing the convenience of human-machine interaction and a programmable routine system that enables personalized optimization. The current smart home technologies in the market provide us with

convenience and comfort, yet there are still potential challenges hidden beneath the prosperity.

The research question I hope to answer in this paper consists of several parts: first, how do companies deal with trust issues? Since all smart homes require internet connection, consumers would naturally worry about privacy and security issues. What if some malicious persons hacked the entire system and left the whole house undefended. The second question is how companies persuade consumers to buy smart home products as they normally are more expensive than traditional ones. It costs approximately USD 15,000 in total to upgrade a three-bed, two-bath property into a fully functional smart home (Charlton, 2021), a considerable amount of money for an average-income family.

Literature Review

Most of the articles used in this paper are rather recent, published from 2019 to 2021. There have been many kinds of research on potential risks smart home technology brings up. Thus, it is not difficult to gather credible research papers and categorize the major challenges consumers face while choosing smart home devices (Wilson, Hargreaves, & Hauxwell-Baldwin, 2017). However, there is little research on how companies solve these risks and challenges and analyze their solutions. It is necessary to identify the current solutions and elaborate on the answer with potential issues.

Methodology

The methods employed in this paper mainly consist of collecting and analyzing data and concluding. The smart home technologies' challenges will first be managed, analyzed, and then categorized into three categories. The challenges brought by smart home technology have already been thoroughly researched, so there are an adequate amount of data. Then the current ways companies trying to solve these challenges will be collected and examined. Thus, it is possible to analyze the solutions brought up by the companies against this vast amount of challenges and make further suggestions or alternative solutions if current solutions do not work out.

Part 1: Trust issue in Smart Home Technology

Any device, from a smart TV to a WiFi-connected AC, voice control hub, or a set of smart lightbulbs, can collect our personal information in a smart home installed property. Even though one individual piece of information from these smart homes can be considered uninterpretable, the combined data from several devices could create a useful pattern that could reveal unwanted information about the user. As more smart home devices are connected, the cost of giving away this personal information to malicious persons is increasing (Arngren & Salmela, 2021). One estimation is that by 2030, the average person will own and use at least 15 connected devices (Heslop, 2019). This considerable number of smart home devices do cause serious trust issues for users.

Unwanted information collection

One primary concern is the spread of smart speakers. Recent research suggests that 59% of smart speaker users have privacy concerns, in which 91% reported unwanted voice data collection being the primary concern (Clementi). Yet, the voice control hub is still dominant in a smart home ecosystem. Most smart home products support voice control through a central hub like Alexa, Google Home, or Apple Homepod. Controlling all devices through voice command dramatically reduces the time and effort users usually need compared to a voice control not supported system.

Amazon has developed several ways to reduce this smart speaker panic. According to the userguide, users can choose to disable the microphone by pushing a build-in microphone off button that electronically disconnects the microphone. A bright red ring will show up, indicating that the microphone is offline. There is also a way to view, hear, or delete the stored recordings at any time through the App (Amazon). Google and Apple have provided similar functions that allow users to control the recording. The major companies have developed similar ways to stop the microphone distrust, yet further improvements could promote security. The red circle light indicates the microphone-off mode is always on. This red light could cause disturbance in light-sensitive scenarios, like sleeping or movie watching. A better way is to turn off the light after a short time, along with a voice indication and a push in the smartphone App.

Malicious Hackers

Another concern is hacking through the internet. These techniques generally exploit vulnerabilities of the system used by the victim. Password attack is the major way malicious users hack smart home devices. According to a survey conducted by Google, 52% of people reuse the same password for multiple accounts (Poll & Google, 2019). Hackers could use dictionary or brute force attacks to find the correct password by traversing through countless combinations. Since most users use a simple password, these attacks are likely to succeed (Soewito & Yonathan Marcellinus, 2020). Thus, the hacker can use one password to access the user's cloud database and control all the online smart home devices. Another potential problem is intersecting data during transmission. Since major smart home providers like Apple, Google, and Amazon all require cloud control, all data generated by smart home devices need transmission, giving hackers chances of interception.

To prevent such a crisis, Apple's Homepod, Google Home, and Amazon Echo all encrypt the data during transmission. Advanced Encryption System (AES) is used during the encryption process. This encryption algorithm consists of various advantages: high security, low cost, and unique algorithm and implementation characteristics. The algorithm itself is resistant to attack, mathematical complex, randomness in output, and much safer than other algorithms, making it unable to crack using current computers (Soewito & Marcellinus, 2020). Thus, intersecting data during transmission is no longer feasible to hackers.

On the other hand, most major smart home companies have a two-step verification system that pops up when a new computer tries to log into the account. This dramatically reduces the risk of leaks caused by simple and repeated passwords. Amazon's two-step

authenticator involves sending a security code to the recovery email during the login process. Google uses Google prompts, which generates a push on Smartphone Apps like Gmail or Google App. On the other hand, Apple has an entire hardware and software ecosystem and uses notifications on iPhone or Mac to verify the login. Yet, two-step authentication requires extra time during the login process and reduces the user experience in a certain way. According to Brigham Young University's research, it requires 28 seconds on average to complete the security codes and 16.1 seconds to complete the push (Reese et al., 2019). From the data, it is easy to conclude that pushing is more user-friendly than security code. Apple has an advantage due to its robust product ecosystem, while Google is less competitive since it requires downloading an extra App. Amazon, although offers pushes from Amazon App, by default, uses email during the authentication process, are less user friendly than Apple and Google. A possible solution for Amazon is to auto-transfer the authentication system from Email code to pushes once the user installed Amazon App on his or her phone.

Part 2: Huge Cost in Smart Home Technology

It is generally agreed that smart home products are more expensive than traditional ones. A website that offers smart home plans gives an estimated cost between USD 970 to USD 3310 (HomeTechHacker, 2019). Customers will not easily accept such a price to upgrade their property to smart homes. Besides, it takes time for users to get used to the new system and might cause users confusion during the adapting period, which is another obstacle while promoting smart home technology.

Money cost

One way companies deal with the high price is to offer a product with fewer functions but cheaper in price and an advanced product with a higher price, which is called targeting in marketing. *"In marketing, if you're trying to talk to everybody, you're not reaching anybody"* (Yesbeck, 2019). Amazon, for example, has offered several versions of its smart speaker: Echo dot, which costs USD 40 to 50, and Echo Studio, with a cost of USD 200 (Amazon). Customers who do not require high sound quality can go for the Echo dot, while those who value sound quality more than price could choose Echo Studio. The profit from Alexa is considerable: users spend at least USD 2 billion per year on Alexa skills (Levy, 2019). Such a strategy is considerably helpful in persuading consumers to buy smart home devices.

Another way to reduce costs is by saving household costs in the long run. According to Energy Efficiency Market Report published in 2013, smart homes' deployment can reduce between 10% and 25% in electricity demand (International Energy Agency, 2013). A national survey on how prospective users perceived benefits and risks of smart home technologies showed that 86% of the respondents treat energy saving as smart home technology's main purpose (Wilson, Hargreaves, & Hauxwell-Baldwin, 2017). Some smart home products have built-in functions that analyze power usage. Sengled has developed such an app that it collects and shows total power consumption, electricity saved, and money saved from any given period in the history of smart light bulbs. This offers users direct feedback on long-run return by choosing smart home devices and promotes further consumption.

Time cost

Besides the money barrier, time consumption is another factor that drives potential users away from smart homes. The installation process takes time to finish. Other aspects of their daily lives take up time and prevent them from engaging in the boring and obscure installation process. Also, the effort needed to get used to the entire system is tremendous. "It's just taken months to just use it and realize where it's useful...It wasn't intuitive what parts of it you can do straight away." (Hargreaves, Wilson, & Baldwin, 2017). The time needed to install and get used to the system prevents users from purchasing smart homes.

Companies do develop a solution to reduce a large amount of time consumption. Thanks to the high ownership rate of smartphones, software initialization becomes less and less complex. A well-organized application with visual guides is much easier to interpret than an installation manual—our brain processes visual information up to 60,000 times better than plain text information. The brain's hardware is designed to understand visuals better than text, with 90% of the information received is non-verbal (Gole, 2021). Besides the visual provided by the application, the highly automated setting system can also reduce the software installation time. Most apps minimize the steps users need during installation. As a result, a user would normally choose a few options, fill in some personal information initially, and then staring at the progress bar during the rest of the installation time. The software does all the things for the user, and there is nothing to worry.

Also, the ecosystem created by Amazon, Google, and Apple makes adapting to smart homes easier. Without the standardization these companies made, the smart home technology market would be filled with products with unique designs and unable to link different devices

through a network. The existence of these standards gives users the ability to adapt to any new device that supports them. The new product can be controlled through the central hub via APIs and reduces the need to install specific apps. Small companies also prefer these standards as they can enjoy the existing market Amazon, Apple, and Google created by being part of the ecosystem. At the same time, smart home giants can also expand their customers along with the small companies without the need to invest extra money in new products. Following standardizations satisfies both customers and companies.

However, these standardizations can still confuse new customers. The three existing standardizations can make costumers not certain to stick to one: what's the difference between these systems? Which one works best in my house? Which one saves the most money? These questions naturally come to mind when trying to purchase smart home devices. Chances are, potential customers will lose interest and leave the market due to this confusion. To fix this issue, the Zigbee Alliance recently announced a project that involves some tech giants, including Apple, Amazon, and Google to develop and promote a new, royalty-free, and secure connectivity standard for smart home products (Wiltz, 2020). With this new standard, there will no longer be barriers for newcomers in the smart home market. Customers can purchase any new products that follow the new standard and combining them into the existing network of Amazon's, Google's, or Apple's.

Conclusion

Smart home products have become a piece of widely possessed furniture in nowadays houses. We enjoy both the convenience and the challenges these products brought to us by choosing to live in a smart home. Despite these challenges, people worry about, smart home technology providers are trying their best to promote their products in response to these concerns. The current solutions companies offer still require further advancement, with some basic attempts to fixing the problem. The alternative solutions I provided in the passage could use guidance to promote the current solutions companies offer and solve these challenges more nicely and satisfyingly. Smart home technology will certainly keep growing rapidly as technology progress, and the challenges that confuse us today will be perfectly solved in the future.

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