The implementation of Voice Command in Smart Homes

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Abstract

With a constant development in technology, voice command systems such as Amazon Alexa and Apple’s Siri if becoming a more natural part of standard living. This report investigates voice command of technical functions in smart homes. The report first presents generic knowledge about the theory and concepts of voice control, automation, current voice assistants and smart homes identified through a literature analysis. Using a qualitative approach, the paper further investigates the effects of voice command when implemented in smart homes. Results from the study show the wide implementation of voice command systems and how further positive effect could be generated through a combination with smart homes and nudging.
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1 Introduction

In the introductory section, a project background is conferred. Further, the purpose of the study, problem statements and needed delimitations will be presented. Furthermore, an analysis of potential inadequacies and self-critique are presented, followed by the results and a discussion of the results. Ultimately, a conclusion and recommendations for further studies has been made.

1.1 Background

Voice controlled home automation systems could offer people a more comfortable lifestyle and simplify ordinary tasks. Voice control within sustainable homes are especially beneficial for people with disabilities, enabling a lifestyle, which were previously impossible. An implementation of voice command systems could have great benefits, also offering help with assistance at the workplace.

Although the concept has been brought forward multiple times in the past, it was not until recent years the development targeting the general public took place. Due to the development being relatively new and without much testing, knowing possible effects of implementing this type of system is of great interest. This study focuses on investigating current and possible installations of voice-controlled systems in smart homes to further assess some of the possible effects of implementation.

1.2 Purpose and Problem Statement

The aim of this study is to investigate existing or possible voice control of technical functions in smart homes for the purpose of determining what possible effects those installations will generate on both home and living. Two problem statements are to be answered:

Are there any existing- or possible smart home services implemented by voice control? Which possible effects could implement voice command in smart homes have on the user?

1.3 Delimitations

The report will be limited to voice-command within the residential field due to the wide range of current development areas. Determining both short- and long-term effects on people as well as energy affected by voice-command in smart homes would require a field study, using a smart home available for tests. The time and resource limitations of this thesis makes a field study difficult and non-feasible hence this study will be based on a literature review only.
2 Method

The study stems from an overlooking literature review in order to present generic knowledge (theory and concepts) about voice control, virtual assistants, fields of use and more (Stufflebeam and Shinkfield, 2007). Computerized database key word searching was used in this review, as the technique is fast and efficient. The three main databases used for the research was Google, Google Scholar and The KTH Publication Database DiVA. Google was used to find general information as Google Scholar and DiVA were used to find most research information. Voice Command, Smart Homes, Artificial Intelligence and Automation were the main key words used in the research, in all three databases. Using the words Voice Command, Google Scholar presented around 1 700 000 results and DiVA 5 results (2018-04-21). The function ‘sort by relevance’ was used in Google Scholar, subsequently the search was narrowed down to the first 200 results. As Google showed 180 000 000 results, adding new key words as history or emotion to the search was required. Combining the words Voice Command and Smart Homes, Google Scholar presented around 184 000 results and DiVA 0 results (2018-04-25). The function ‘sort by relevance’ was used in Google Scholar, subsequently the search was narrowed down to the first 200 results. As Google showed around 44 600 000 results, adding new key words and narrowing down to the first 300 results was essential. Using the words Artificial Intelligence, Google Scholar presented around 2 410 000 results and DiVA 448 results (2018-04-28). The function ‘sort by relevance’ was used in Google Scholar, subsequently the search was narrowed down to the first 200 results. As Google showed 352 000 000 results, adding new key words as Voice Command to the search was required.

Information was brought from scientific reports, news articles and other various internet resources. A documentary analysis by qualitative research design based on a non-quantitative data collection (Creswell 2008) was conducted for the purpose of determining the effects of voice control system installations in smart homes.

The search tool Primo (KTHB Primo) was used in the search of finding complementary articles and information. Primo covers the KTH Library’s printed materials as well as E-books that the library has access to. Voice Command, Smart Homes, Artificial Intelligence and Automation were the main key words used in the research. Using the words Voice Command, Primo presented around 200 000 (2018-04-29). The function ‘ProQuest Research Library” was used to refine the finds, resulting in 50 000 finds. Adding new key words as history or emotion to
the search was required. Combining the words *Voice Command* and *Smart Homes*, Primo presented around 5 000, subsequently the search was narrowed down to the first 200 results. Using the words *Artificial Intelligence*, Primo presented around 17 000 results (2018-04-30). Adding new key words as *Voice Command* to the search was required.

The search was due to the computerized approach limited to electronically available studies, henceforth an interview research was planned to complement and verify already found information. A few alternative questions and other open-ended questions were conducted and presented via phone calls and e-mails to relevant people working within the different businesses where voice control is current. In order to address the formulated research questions, a qualitative research method was planned. However, due to the lack of respondents the entire interview research was omitted.

The different smart home services were chosen and produced with the help of an overlooking research of what a smart home is and the different areas a home can work within.

3 Theory and Concepts

3.1 Speech – and voice recognition

Speech recognition defines the process of converting speech into digital data by translating acoustic signals to a set of words whilst voice recognition aims towards identifying the person speaking (Patel, Maind, Bramhecha, Mahale, Sanghavi, 2013).

Speech recognition works using algorithms through acoustic and language modelling. Acoustic modelling represents the relationship between linguistic units of speech and audio signals; language modelling matches sounds with word sequences to help distinguish between words that sound similar” (Syntony, n.d.).

Voice recognition is a technique in computing technology by which specialized software and systems are created to identify, distinguish and authenticate the voice of an individual speaker (Techopedia, 2018).
3.2 History of Voice Control

The history of speech recognition is far greater than most people might think, stretching back since the mid 20's. The first speech recognition system, named Audrey, was created by Bell Laboratories in 1952. Audrey was rather rudimental and limited technology wise, understanding only ten digits - spoken by particular people (Pieraccini, 2012). About 10 years later, IBM developed and demonstrated their Shoebox Machine. The device recognized and responded to 16 different spoken words, including all ten digits “0” to “9” as well as calculating commands such as “plus” or “minus” (IBM, 2018). In recent years, the technology has gained mass appeal, resulting in a positive and fast progress until this day.

Shoebox Machine recognized and responded to 16 spoken words, including the ten digits from “0” through “9”, only in English by a designated speaker. These limitations later proved to be problematic, increasing the scepticism opposing voice recognition.

Mid 1970’s came the Hidden Markov Model (HMM) (Rabiner, 1989). The HMM considerably altered the development of a feasible speech recognition software. With the help of HMM speech recognition started using a statistical method measuring the probability of unknown sounds being words. Now, the potential to recognize an unlimited number of words became imminent due to the method allowing the number of understandable words go up to a few thousands.

These choices of observation distribution in each state of the model allow accurate modelling of virtually unlimited types of data. The first mass accessible voice command system was launched by Apple Inc. as they released the virtual assistant named Siri in 2011 (Bostic, 2013).

It was due to the development of both hardware and technology innovation had developed enough for companies to make voice technology available on the mass market and with the number of smartphone users growing, Apple’s first iPhone encouraged Google to release a voice search app for the smartphone during the year of 2008 (Schalkwyk, Beeferman, Beaufays, Byrne, Chelba, Cohen, Garret, Strope, 2010).

The search app made it possible for Google to crowdsourse data and thereby enhance its voice technology by using billions of received search queries. This led to better predictions of what the users where probably saying.
Smartphones was the ultimate platform to test voice recognition and control. This due to the fact that a considerably high number of people in the modern world owned a smartphone, making the computation possible via the cloud (Schalkwyk, Beeferman, Beaufays, Byrne, Chelba, Cohen, Garret, Strope, 2010).

It was not until recent years voice command systems became marketed as the primary feature of a product. Voice control becomes more of an integrated component in most technologies at the moment due to it being the most intuitive and hands-free way of interaction between person and technology. A fully integrated component in most technology is most likely to be within the nearest future. The system being able to process voice commands in English with more than 90% accuracy, allowing the field of technology to progress at a fast rate (Vrinda, Shekhar, 2013).

3.3 Voice recognition and Artificial Intelligence

Spotted in the evaluation of a study presenting HMM, artificial intelligence is presently being used in different fields of life including speech recognition, remote sensing, transportation, aviation, law, robot control, stock trading, medical diagnosis, and toys (Beigi, 2011). A first study, discussing automatic speech recognition, show the approach of artificial intelligence is operated in answering machines of customer care and call centres (Morgan, 2012). Another study made by, also discussing acoustic modelling in speech recognition, claims customer satisfaction is achieved by promoting the enhanced and improved customer handling (Hinton, 2012). The speech recognition software enables the computers to handle first level of natural language processing, text mining, and customer support. Speech recognition needs a highly integrated and considerate technique, making it a difficult issue because of the lack of ample vocabulary according to the previous mentioned study. Speech is a fundamental form of human connection but the complexity and the fact that there are thousands of languages and even more dialects adds an extra layer of difficulty to this issue (Morgan, 2012).

Although speech recognition has been used and developing rather well in different fields, the accomplishment of error free speech recognition has remained difficult. A study, discussing speech recognition and AI, declares the fact that these technologies are not capable enough to compete with the accuracy of human listeners due to the lack of reliable software, thus
developing flawless and highly efficient speech recognition techniques remain a challenging task (Choudhary, Kshirsagar, 2012).

In terms of recognizing the patterns of speech, AI can be considered a great opportunity. It is due to the fact that AI can transform the speech of well-structured algorithms by appropriately following all stages (Saon, George, Chien, 2012).

Representation of correct and appropriate inputs, demonstrating speech units and designing of recognition algorithms are different activities where the approach of AI plays a vital role, stated by a study discussing software engineering using artificial intelligence techniques (Ammar, 2012).

3.4 Available Voice Assistants

A voice assistant is a software agent that can perform tasks or services for an individual, by using the technology of voice recognition. Following voice assistants are a few of which can be found on the market today.

**Apple’s Siri**

Siri was one of the first and most well-known voice command services, introduced to the general public through the iPhone. Initially released on the iPhone in 2011, it has quickly been implemented to almost every apple product (Apple Inc, 2018). Siri’s main purpose is to make interaction within the device simpler and works well when it comes to sending text messages or execute basic commandos. Although it has received critique when it comes to understanding (Van der Velde, 2018).

**Amazon’s Alexa**

Alexa is one of the most popular voice-assistants on today’s market, developed by Amazon.com INC and initially released in 2014 (Amazon, 2018). Alexa’s main purpose is to reach out to a wider platform by being non-restricted and used in various products within various areas (Van der Velde, 2018).
Microsoft’s Cortana
Cortana debuted in 2014 as part of Windows Phone 8.1, developed by Microsoft INC. Microsoft announced, in late 2017, that Cortana’s conversational speech recognition system reached a 5.1% error rate, making it the lowest at that time (Microsoft, 2017).

Cortana is based upon real, human personal assistants. Data from devices, such as your search history and cookie trails, is located by rival services making the smart system find and register information about its users (Microsoft, 2018).

Google Assistant
The Google Assistant was developed by Google LLC and initially released in 2016. It is primarily available on mobile and smart home device and it can engage in two-way conversations. The assistant not only answers your questions correctly, but also gives some additional context and cites the source website for given information, as expected since it’s backed by Google’s powerful search technology (Whitwam, 2016).

Google Assistant has made great strides in catching up with Alexa in such a short time, boasting a 95%-word accuracy rate for U.S. English. This translates to a 4.9% error rate, making it the lowest of all the voice-assistants currently out there (Van der Velde, 2018).

3.5 Voice command – main areas of use
Today’s voice command devices stretch over several different market fields. It can be found in devices such as phones or tablets, as well as in the car or TV-remote.

According to a study by J. Walter Thompson, Kantar and Mindshare, 2017, almost 60% today’s smartphone users interact with their voice assistant to do online searches. While merely 16% use it to conduct home management tasks. The study explains that voice command can be divided into two different main types of questions; Tasks that are completed exclusively through voice and tasks that are initiated by voice and completed on screen. Today’s voice assistant is designed to answer more simple questions or tasks, such as asking about the weather or setting an alarm. More advanced tasks or conversations have shown lack in the machine learning. 71% of the users say they will check their question on screen, to confirm, showing a lack of trust towards their voice assistant (Thompson, Kantar and Mindshare, 2017).
According to Wavestone, the main reason for usage of smart speakers and voice command is due to situations where the user’s hands or eyes are busy. For example, when driving or walking. Other reasons include it producing faster results as well as difficulties to use written commands on some devices. However, a vast majority are still using their voice assistants within the home, 43% or in the car, 36%. Only three percent states that they use it at work (Pestanes & Gautier, 2017).

As machine learning becomes more advanced within the voice assistants the main usage will likely change to more sophisticated usage. Although the Amazon Echo has a “Johnnie Walker-skill”, initiating back and forth conversation in order to provide near perfect whisky recommendation, (johnniewalker.com). A further advanced AI will provide more extensive usage, however, the interaction between the voice assistant and a screen is however most likely to remain even with more advanced machine learning (Thompson, Kantar and Mindshare, 2017). An approximation of the global regular voice tech users and the usage areas is presented in figure 1.

![Figure 1. Approximation of the global areas of usage - voice technologies.](image)

The study by J. Walter Thompson, Kantar and Mindshare furthermore shows that most users of voice assistants prefer to use voice command in private spaces, such as the home or in the car. Several car manufactures have already implemented voice command, such as Ford and Volkswagen. According to the study, 65% of regular voice users in the United states continue their habits in the car, while only 40% globally.
3.5.1 Potential Marketing benefits of Voice Command

The study by J. Walter Thompson, Kantar and Mindshare, furthermore implies that users, when asking questions involving brand names, show a substantially more emotional response when talking to their voice command assistant, than if they type it. The potential possibilities that voice control withholds are unlimited, making the manufacturers of the assistants an important actor, holding big data and acting as gatekeepers to this information. In 2016 it was estimated that USD 2 billion worth of sales were driven by digital assistants (Toesland, 2016).

There are already several sectors where implementations of voice command have transformed the workplace to a more digital future. Several insurance companies, such as Safeco use Amazon Alexa to differentiate themselves. The voice command is mostly used to answer customer questions in an otherwise complicated business sector. Johnnie Walker is another company using voice command to promote itself and simultaneously educate its customers about whiskey. Working through the Amazon Echo the users can ask questions to which the voice assistant replies. (Stephanie Miles, Senior editor Street Flight, 2017)

3.5.2 Automatic Speech Recognition (ASR) applications

There are three major categories in which the systems are used: Automated serving, call routing and Value-added services. Research and developments are currently ongoing, within most fields.

In a study where the participants were asked which household equipment they would want to control the most by solely using their voice, the user survey resulted in the biggest interest being controlling lighting, indoor climate and music system being the biggest followed by blinds, television and kitchen appliances (Hansson, Johansson, Lundberg, Otterberg, 2013).

When asked what functionalities the participants would want to have in a smart home system, scheduling events, reducing energy consumption and ability to control remotely got the highest rate followed by temperature reading and question answering (Hansson, Johansson, Lundberg, Otterberg, 2013).
3.6 Emotional Attachment towards voice assistants

Humans have throughout history always craved intimacy and connection. In order to find these connections, the art of language has played a crucial part. Hence, people could most likely become emotionally attached to their voice command assistants (Thompson Kantar and Mindshare, 2017). The assistant will be able to “understand” its users, taking the experience to new altitudes and create almost a relationship to its user. The report furthermore conducted that 73% of today’s global smartphone users would use their voice assistant more if it were able to replay to commands and questions in the same way as a human. In order to achieve a more sophisticated voice command, the study imply that more advanced machine learning has to be developed.

With more advanced AI, the emotional intelligence will be a significant differentiator among developers. As AI becomes more available, organizations will look towards developing emotional understanding to fully compete with the human interaction. An important step for companies will be to define how the voice of their company will be presented. Furthermore, the importance of transparency to the users and clients will play an essential role, as well as the protection of the users. In a field where personal data is significant, trust is the key to a more successful development (Accenture, 2017).

In store background music has been used for decades in order to increase sales. Music has an ability to change customer behavior, depending on what kind of music is played and at what tempo it is played. Different stores and companies use different music to market and highlight their company or products. Moreover, companies could use a certain music or melody to create an emotional attachment with their product, creating a marketing platform which reaches beyond the requirement for customers of seeing the brand name. Several studies conclude that music have the effect of changing the behavior of people making it an important tool in both marketing and sales (Millian, 2010). An example of the measured brain activity and the emotional response by music is presented in figure 2.
3.6.1 Privacy issues generated by voice assistants

With new technology appears not exclusively new business opportunities, but also privacy questions. Constantly talking to a voice assistant will generate vast big data possibilities. The user’s interactions with the voice assistant will provide companies with information that can be used for marketing research and advertisement based on its user. It is likely to expect companies to capitalize on these opportunities, leaving an uncertainty in privacy policies. The tech industry is already experiencing complications and criticism regarding their privacy policies (Symantec, 2017). Although google, Amazon and Apple states they are not selling user information to third parties, however users should be caution about their data since new technology is often prone to privacy subjects (Nicholson, 2017).

As well as privacy issues, reports about children spending large sums of money by purchasing through e.g. Amazon Alexa has occurred. Since the smart speaker doesn’t determine who is ordering, children can easily order products online. (Andrew Liptak, 2017) Reports about voice assistants failing to call an ambulance or the police has shown to be problematic. However, in some cases it has shown to support police in investigations (Jefferson Graham, 2017)
3.7 The Nudge Theory – Human interaction, voice command & smart homes

Although smart homes are effective in both economic benefits (Jerasoft, 2017), as well as environmental (Kastner, Kofler, Reinisch, 2010) Smart homes are powered by the artificial intelligence operating it, making them as good as their AI. (Augusto, Nugent, 2006)

To interact humans with technology, the nudge theory can be used. It is a concept in behavioral science, economics, political theory where positive feedback and indirect advices aim to stimulate positive behavior and decisions. A nudge is defined as “any aspect of the choice architecture that alters people’s behavior in a predictable way without forbidding any options or significantly their economic incentives” (Thaler and Sunstein, 2008)

In contrast to nudging, is boosting which aims to boost its user when something is done in an effective way through positive feedback. By encouraging the user to make their own choices that is beneficial for the smart home (Nudging and Boosting: Steering or Empowering Good Decisions, 2017). The boosts are defined into long-term boosts and short-term boosts, aiming toward short respectively long-term objectives (Sunstein, 2016, p32).

As well as in economics and political theory, the nudge theory can be implemented into smart homes, creating a synergy resulting in further efficiency (Oksana Mont, Matthias Lehner and Eva Heiskanen, 2014).

In a recent study, conducted in Stockholm (Linder, Lindahl, Borgström, 2018) displayed the benefits of implementing nudging into a household. According to the study, food waste showed a significant decrease over the time of two years. However, the report states that the immediate positive effects were greater than the long-term effects. The nudging therefore had a slightly declining effect, making the long-term goals to be less effective than first expected

Dr. Adam Oliver, professor at London School of Economics and Political Science, are suggesting that nudging is merely a short-term solution. Dr. Oliver states that few nudging initiatives have a long-term effect, which undermine the purpose of the initiative. In an example, Dr. Oliver argues for the incentive by economic nudging to help smokers quit smoking is not having the anticipated results. Dr. Oliver implies that many of the incentives does not have a long-term potential and instead use ‘deposit contracts’, which would offer a more financially covet solution in long-term (Oliver, 2011).
3.8 Home Automation

Home automation is defined by the technique of making the users residence more automated. Multiple functions are connected to a centralized computer. These are functions like air conditioning, door locking and heating. When automation is implemented, all chosen functions should be accessed by the user from a control panel. The control panel can be a manual control otherwise controlled automatically by the system itself. Some developed systems offer the enabling of access from any device connected through the internet.

One of the first automated home systems was built in 1966 by Jim Sutherland (Saraf, Jakkan, 2016). A smart home monitor the behavior of the occupant and provide support in an autonomous fashion by activating the supported devices (John Wiley & Sons, Inc. 2012)

There are several smart home key equipment’s: energy-, home amenity-, security- mobile-, and remote appliance services (Min, Wenbin, Wei, Yeshen, Yannian and Yiyin, 2018). The interaction between the user and power grid enterprise makes it possible to obtain information of electricity consumption and electricity price (Chan, Champo, Estéve and Fourniols, 2009). According to user needs, the analysis of the household in accordance with the request of the user to carry out hosting services, automatic management of households’ appliances and amenities are possible. A variety of security models can be set to achieve management control over an unexpected situation at home by alarm functions, smoke and gas sensors and smart locks. Min, Wenbin, Wei, Yeshen, Yannian and Yiyin, 2018). Remote communication using public- and local network- and telecommunications connected to the house’s network makes remote appliance services possible as communication and controlling by remote becomes possible. (Kaneko, Arima, Murakami, Isshiki and Sugimura,2017)

3.9 Voice Recognition in Smart Homes

Applications of speech recognition is classified by three broad groups (Rabiner, 1994) of isolated word recognition systems.

- Small-vocabulary
- Command-and-control
- Large-vocabulary

continuous speech systems.

An isolated word recognition system implies one where each word is spoken with pauses before and afterwards (Ananthi, Dhanalakshmi, 2013).
A combination of the second and third group would be suitable for a smart home- if the ASR point of view to be taken into account. A grammar- contained command and control vocabulary enables the performance of predefined commands and menu navigation. Email dictation and comparable applications would instead involve large vocabulary continuous speech recognition. ASR systems in a smart home would be classified with specific applications, forming the essence of the smart home followed by general vocal applications which characterizes an ASR system (McLoughlin, Sharifzadeh, 2008).

3.9.1 Available Voice Command services targeting Smart Homes
Existing relations between different smart home service techniques and available virtual assistants are of great interest whilst inspecting possible effects generated on both home and living. As conducted in section 3.8, several different service areas are available within a smart home. These are a few relations between service techniques and current available virtual assistants - that can be found on the market today.

Energy Services
Monitoring of power consumption and electric bill: powered by Amazon Echo devices and virtual assistance of Alexa (Edfenergy, 2018).

Energy-conserving operation of air conditioners: powered by both Amazon Echo and Google Home, making both Alexa and Google assistant the current virtual assistants (Chang, 2018).

Lightning – switching on/off or adjusting the lights and energy consumption: powered by Amazon Echo, Google Home and Apple HomeKit, showing no limitations to the choosing of virtual assistants. All assistants are compatible with the Philips Hue lamps produced by Philips (Philips, 2018).

Window blinds – pull up/down or adjusting of the blinds hence affecting the indoor temperature: powered by Brunt Skills, that lets you control Brunt Home Appliances with Amazon Echo, making Alexa the current assistant (Walton, 2017).
**Mobile Services**
Remote monitors for home appliances: powered by Amazon Echo, Google Home and Apple HomeKit, showing no limitations to the choosing of virtual assistants, as noted in section 3.4.

Remote operations of home appliances and locking doors: powered by Amazon Echo, Google Home and Apple HomeKit, showing no limitations to the choosing. All assistants are compatible with the August Smart Lock produced by August Home (Hufish, 2018).

**Home amenity Services**
Central operation of window blinds and lightning: powered by the same as mentioned above in the energy-section:

Lightning – switching on/off or adjusting the lights: powered by Amazon Echo, Google Home and Apple HomeKit, showing no limitations to the choosing of virtual assistants. All assistants are compatible with the Philips Hue lamps produced by Philips (Philips, 2018).

Window blinds – pull up/down or adjusting of the blinds: powered by Brunt Skills, that lets you control Brunt Home Appliances with Amazon Echo, making Alexa the current assistant (Walton, 2017).

Schedule operation of home appliances: powered by Amazon Echo (Home Connect, 2018).

**Security services**
Crime prevention (monitoring of visitors burglar alarm system): powered by Amazon’s Echo devices with virtual assistance of Alexa (Protectamerica, 2017).

**Remote appliance maintenance services**
Remote diagnosis and maintenance of home appliances: powered by Amazon Echo with virtual assistance of Alexa. The assistant is compatible with Bosch Home connect, created by Bosch (Bosch, 2018).
3.10 Effects of Voice Command

3.10.1 Smart Home Security

Different types of safety systems for smart homes are available on the market today. One example would be the ZipaTile, brought by Zipato (Zipato, 2018). The ZipaTile is a complete home control system in form of a single centralized device that will replace and bring together numerous home devices such as a security system, thermostat, automation controller, IP camera, alarm siren or intercom.

By commanding the device with voice, one can control the home security system and perform actions like telling the smart house to remotely lock or unlock the door without any key. The residents are given an opportunity to protect and keep track of what’s going on. Although this may seem great, attackers can manipulate smart devices to cause harm. Burglars can plant hidden access code and target someone’s connected door, arsonists can target the victim’s smart oven to cause a fire amongst other things (Denning, Kohno, Levy, 2013).

3.10.2 Voice commands affecting the Job Market

There is a possibility that numerous jobs will be substituted by voice command assistants, affecting the job market. It is yet difficult to say however the “assistants-industry” will become a new source employment, through manufacturing and other work areas. Although the major factor will be the development of AI, voice command will play a significant role. More advanced machine learning will affect different areas of employment. HR departments will likely be managed by AI end many services will be handled by voice assistants. The financial sector is one area that can be widely affected by AI and through voice command. More simple tasks, such as executing trades, cold calls etc. can easily be made through machine learning software. While more customer related roles are yet to need the human interaction (Simon Chadbury, 2017). Domino’s pizza has developed a platform which allows its customers to order pizza via Amazon Echo, making it easier for both parties. GE has likewise allowed its users to control dishwasher, ovens, and refrigerators through Amazon Echo, allowing the user for example to set a timer with their voice (Miles, 2017).

3.10.3 Quality of life

People have different needs and usage of artificial means for physical support is widely spread around the world. It could be due to illness or accidents. Means like this have to be increasingly sophisticated, taking advantage of the technical evolution in order to always keep increasing
the quality of life for the people in need at the same time as it should be as simple and vigorous as possible. Thus, making the lifestyle similar to that of people not currently suffering deficiencies (Singh, Thakur, 2013).

The field of voice recognition combined with home automation has been shown to be very useful (Singh and Thakur, 2013). One study shows the field of voice recognition combined with home automation was a very useful project for the adults and physically disabled people. Complications of writing and physically moving around showed to be eliminated thus resulting in the conclusion of usefulness.

Different European projects have concentrated on independent living in one’s own home (Lansley, 2011). A multitude of technical aids for improving one’s quality of life, in different ways, have been developed. Some of these are safety alarms and smart sensors (Hagen, et al, 2005), (Sixsmith, 2000), remotely monitored devices (Aldred, et al, 2005) and reminders. Much work is commenced from a medical perspective, showing positive and helpful impacts (McCreadie, et, al, 2001).

4 Possible inadequacies & self-critique

Due to the relatively new field of voice command and voice assistants and its implementation in modern society, several complications in finding relevant and reliable data and thoroughly conducted studies were experienced. Furthermore, many of the companies of which develop and produce voice command products or services have been problematic to reach or not willing to share information about their product development. These difficulties are not an exception from the tech industries, where newly developed technology and partnership are not always shared liberally between competitors or the general public.

The reason why manufacturers have been hard to get a hold of, could be due to difficulties in finding people with knowledge of relevant information for our study.

The explanations to these obstructions could be many, companies are not keen to leave information about development, clients, or partners as they are considered company secrets in many cases. As they do not see any benefits in leaving information to someone that is not a potential client or partner. Furthermore, few public studies are conducted, compared to other
fields, such as telecom or artificial intelligence. Many of the conducted studies are made by manufactures or other companies aiming to promote their products or as marketing in general.

Due to the shortage of available studies and reports regarding the field of voice command, the studies that have been referred to in this report, the constitutes a significant part of the provided data. Since a greater number of studies would be more desirable, the report is limited by this shortcoming, which should be taking into count.

5 Results

5.1.1 Existing- or possible smart home services implemented by voice control

Based on the literature study, following information was retrieved whilst investigating existing- or possible smart home services implemented by voice control. The results present different smart home service techniques and available virtual assistants henceforth presented below in \textit{table 1-5}.

\textit{Table 1 Existing smart home service techniques and available virtual assistants- Energy Services}

<table>
<thead>
<tr>
<th>Energy Services</th>
<th>Virtual Assistants</th>
<th>Compatible devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring power consumption</td>
<td>Alexa</td>
<td>Amazon’s Echo</td>
</tr>
<tr>
<td>Energy-conserving air-conditioners</td>
<td>Alexa, Google Assistant</td>
<td>Amazon’s Echo, Google Home</td>
</tr>
<tr>
<td>Lighting</td>
<td>Alexa, Google Assistant, Siri</td>
<td>Amazon’s Echo, Google Home, Apple HomeKit</td>
</tr>
<tr>
<td>Window blinds</td>
<td>Alexa</td>
<td>Amazon’s Echo, Powered by Brunt skills with Brunt Home Appliances</td>
</tr>
</tbody>
</table>

\textit{Table 2 Existing smart home service techniques and available virtual assistants- Mobile Services}

<table>
<thead>
<tr>
<th>Mobile Services</th>
<th>Virtual Assistants</th>
<th>Compatible devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote monitors home appliances</td>
<td>Alexa, Google Assistant, Siri</td>
<td>Amazon’s Echo, Google Home, Apple HomeKit</td>
</tr>
<tr>
<td>Remote operations home appliances and locking doors</td>
<td>Alexa, Google Assistant, Siri</td>
<td>Amazon’s Echo, Google Home, Apple HomeKit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No limitations in choosing VI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No limitations. All compatible with the August Smart Lock by August Hom</td>
</tr>
</tbody>
</table>
Table 3 Existing smart home service techniques and available virtual assistants- Security Services

<table>
<thead>
<tr>
<th>Security services</th>
<th>Virtual assistants</th>
<th>Compatible devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crime prevention</td>
<td>Alexa</td>
<td>Amazon’s Echo</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monitoring of visitors/burglar alarm system</td>
</tr>
</tbody>
</table>

Table 4 Existing smart home service techniques and available virtual assistants- Home Amenity Services

<table>
<thead>
<tr>
<th>Home amenity Services</th>
<th>Virtual Assistants</th>
<th>Compatible devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central operation of lightning</td>
<td>Alexa, Google Assistant, Siri</td>
<td>Amazon’s Echo, Google Home, Apple HomeKit</td>
</tr>
<tr>
<td>Schedule operation of home appliances</td>
<td>Alexa</td>
<td>Amazon’s Echo</td>
</tr>
</tbody>
</table>

Table 5 Existing smart home service techniques and available virtual assistants- Remote Appliance

<table>
<thead>
<tr>
<th>Remote appliance maintenance services</th>
<th>Virtual Assistants</th>
<th>Compatible devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote diagnosis and maintenance home appliances</td>
<td>Alexa</td>
<td>Amazon’s Echo</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Compatible with Bosch Home connect by Bosch</td>
</tr>
</tbody>
</table>

5.1.2 Positive Effects with Voice Command

Based on the literature study, it was shown that the implementation of voice command within smart homes increases the quality of life for people in need to move around with help of some artificial means due to illness or accidents. Voice command will simplify living standards for people living with disabilities, such as reduced hearing, seeing or movability. Voice command will simplify living standards for people living with disabilities, such as reduced hearing, seeing or movability. Furthermore, voice command will help to create a more streamline living for the average person, making chores and purchases for examples much easier.

The existence and availability of different safety systems for smart homes on the market gives the resident the opportunity to protect and keep track of what is going on, increasing the control and safety of the person.
A non-sustainable behavior can be changed, for a short term, by the help of a nudge performed by the responsive systems in a Smart Home contributing to a more environmental lifestyle. That same behavior can be changed, for both short and long term, by the help of a boost performed by the responsive systems in a Smart Home.

5.1.3 Negative effects with Voice Command

Based on the literature study, several negative effects with voice command was found. Constantly talking to a voice assistant will generate vast big data possibilities, providing companies with information that might be used wrongfully by the company- contributing to an uncertainty in the privacy policies. Employing algorithms for user profiling and personalization can have a negative effect on the users, making them feel at unease and suspect or expect security threats.

The possibility of numerous jobs at different locations becoming substituted by voice command assistant increases as many simple tasks, such as executing trades, easily could be handled with machine learning software’s as voice assistants and AI.

The user relying on the voice command system serviceability too heavily entails a big risk seeing that the voice control is not developed to assist help in potential danger situations.

6 Discussion

6.1 Voice command’s impact on Smart Homes

This report shows that it is reasonable to assume that voice command could have a positive effect combined with the nudge theory. Meanwhile voice command has shown to have an emotional impact on the user, almost creating a relationship, possibly it will have an effect on the human behavior as well. Studies show a secession in positive behavior from nudging and boosting after some time, results in a decrease in efficiency. By creating a positive environment for a healthy relationship towards the Smart Home. It is therefore possible to assume that voice command could help creating a beneficial attachment and an emotional bond to the smart home and generate a more long-term efficacy. Since studies show that both voice command and music have the ability to affect human behavior when it comes to buying products or creating an emotional attachment to a brand and products. Creating an emotional attachment through voice may prevent the reversal in behavior from nudging and therefore generate synergy effects.
Since smart homes are believed to become more efficient when combining the advantages from AI with a sustainable behavior, vice commands role will most likely become even more important. E.g. the AI will know when it is most effective do run the dishwasher, however it will be furthermore efficient if the dishwasher is fully loaded, something today operated by the user. This is the part where human interaction is essential. In order to create an environment where both man and machine work together with synergy effects, development in AI is crucial. Furthermore, a combination between Voice command, Smart Homes and nudging will be effective is merely an estimation based on several reports and studies. Further studies within Smart Homes are essential in order to fully evaluate the hypothesis.

6.1.1 Future of voice command
The future holds a promising outlook for voice command, with better and more reliable software and development of AI, creating more humanlike interaction, the communication between users and the product will have a wider spectrum of potential implementations. More advanced AI may generate new possibilities to connect the smart homes different gadgets for e more wholesome smart home. Furthermore, the smart homes are becoming more common, where the voice command will play a major part. as well as in households, voice command will continue to expand within other markets, such as transport, infrastructure, healthcare.

Today’s voice assistants are mostly limited by their AI. With more advanced machine learning being standardized in various products, the implantations are nearly unlimited. Further development in AI will generate a more complex system within the Smart Homes, making it to a development bottleneck. Voice command will therefore never be more advanced than the AI operating it. Today’s Smart home and voice command assistants are still in its early days. The development of the AI system, powering the Smart Home is currently holding a bottleneck towards further expansion within Smart Homes.

6.2 Current voice command products & services
The current voice command products and services, such as smart speakers have experienced a vast development, expanding into several new markets. With new markets and implantations, occur different scenarios where privacy and security may play a significant role. Since the
market is rather diverse, voice command can be found in various sectors, such as Smart Homes and phones. However, most users admit having their voice command products perform simple tasks, such as setting an alarm. This study implies that development in software as AI, would expand the market further, exposing new opportunities for implementations in other markets as well as giving the user an opportunity to do more practical tasks with voice command.

6.2.1 Naive trust as a possible effect
Considering voice commands and smart speakers recent break through, it is possible that user will develop a naive trust towards the assistant. With newly developed technology and there could be several privacy issues that are yet to be discovered, leaving the users in a potential uncertain situation. The user could be relying on its functionality and serviceability too heavily, leading to concerns. Furthermore, since the voice command and smart speakers are primarily developed for household use, such as googling, set reminders or play music and probably not yet developed to help people in potentially dangerous situations. Although they could be used to support in many different circumstances. For instance, the user should not rely on ‘Alexa’ to call for an ambulance, although being told to do such. It might be a possible aspect for future assistants, however today’s speakers seem less suited for such support.

6.3 Source uncertainty
Most of the referred reports and studies are conducted thoroughly, although some reports are conducted by corporation, in this case Accenture. It is important to recognize that these sources may have an own agenda in promoting their own business or product. However, in this report it is considered being a reliable source of information due to the relatively impartial report. Some news articles are being referred to regarding some sections. However, only reliable and non-bias news agencies were used.

Since the technology is relatively new, or at least have had a recent break through, little or no studies are conducted within the field of voice command within smart homes and the effects, as shown by the literature review. Therefore, prognoses about what the future holds are gravelly speculative. The development of new products and implementations is fast and wide hence further studies will most likely enter.
7 Conclusion and Future Work

The report concludes that there are several voice command systems targeting smart homes, which generates positive and negative effects as described in the results. Furthermore, the report states that an implantation of voice command system may have a potential long-term effect when combined with the nag theory.

The authors future recommendations are encouraging further and more thoroughly conducted reports and studies within the field of voice command. More conducted studies on voice commands role upon the human mind would increase understanding of the effects it generate. Due to the continuous development within the field, knowledge of long-term effects on humans are essential.
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**Online websites:**


Zipato, 2018

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**Figures:**
Figure 1, source: Kantar and SONAR, year not present
Figure 2, source: Neuro-Insight, 2017