EVOLUTION OF TRUST IN VOICE ASSISTANT SYSTEMS

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

Voice Assistant technologies were first introduced in 1990s by IBM's virtual assistant tool Simon (Afshar, 2021). Although, many similar virtual assistant tools have been implemented and presented to the public, such tools have become popular after the release of Siri, the voice assistant tool designed by Apple. A study shows that 70% of iPhone users use Siri sometimes or very rarely (Sun & Ng, 2016). With the release of Siri there was a huge change in the perception for voice technologies and the popularity Siri received allowed the technology to advance. 2010s is seen as the decade that technology learned to talk (Charlton, 2021). Voice assistants have major security risks because they are able to read highly personal information like emails and calendar contents (Hoy, 2018). Many people are having a hard time trusting voice assistance tools for private uses, as they are afraid that technology firms might be tracking their data.

Privacy is one of the biggest barriers in front of the voice technologies. People also abstain from voice technologies because they are having a hard time to express what they really want. Natural language processing is a really advanced technology that increase the accuracy of voice technologies, but it is a known fact that communicating with a voice assistant tool can be hard sometimes. Everyone has their own way of speaking: this makes it harder for the voice technologies to process the real meaning in the input received from the user. With increasing integration of AI in voice assistants, the assistant is aimed to learn from its own experience to increase its accuracy (LLP, 2022). Although voice technologies have obstacles that prevent them from being widely used, they have a promising potential in increasing the user experience in online applications. With the increasing number of open source Voice Assistant API's available in the internet, many companies have started to adopt these technologies to their

systems, either by implementing voice assistants or chatbot assistants. Available APIs also allow access to their vocabulary pool which expands with every new user, and increases the accuracy of the assistant. Although, increasing technological capabilities make them more accessible and desirable, the privacy concern behind these technologies is yet to be solved. This research paper aims to analyze the relationship between voice assistant usage and trust from a sociotechnical perspective.

Introduction of STS Frameworks

Pacey's Triangle is an STS framework that aims to analyze technologies from three main perspectives: cultural, organizational and technical. This framework was discovered by Arnold Pacey. Pacey argues that the term "technology" has served as a barrier for meaningful dialogue about the role of technology in society (Sweeney, 2011). Technology-practice can be understood as "the application of scientific and other knowledge to practical tasks by ordered systems that involve people and organizations, living things and machines" (Pacey, 1985). By combining his opinions about technologies place in the society Pacey constructs this framework. Pacey states that technologies cannot be efficient if they are just functioning, every technology should be analyzed and social groups attached to that technology should be determined. By using this framework, one is able to identify the affects the technology will have on different fields.

Social Construction of Technology (SCOT), is another STS framework used to analyze different stakeholders attached to a technology. Founders of SCOT, Trevor Pinch and Wiebe Bijker, argue that technology doesn't determine human action but human action shapes technology (Pinch & Bijker, 1984). People don't shape their lives according new technologies, but new technologies emerge to accommodate and make people's lives easier. That's why when a new technological artifact is developing it is crucial to understand the social groups that are

going to be affected by this technology. An accurate social group analysis using the SCOT methodology enables to understand the real needs of people, and accommodating that problems makes that technology permanent.

Link Between STS Frameworks and the topic

Iteration is a really important step of the engineering lifecycle; no technology or product is perfect at the initial stage and it needs feedback and iteration to improve. Pacey's triangle is a framework that allows to look at the needs of the technology from three different perspectives. Voice assistants lack trust from its users which serves as a barrier for the real usage of the technology and its role in the society (Sweeney, 1985). Looking from the cultural perspectives demonstrates why people don't trust this technology, and the historical context behind this reason. Cultural aspect aims to answer questions like: how can you trust a robot that listens to every word you say? And how can you share private information about your company with this robot?. Organizational perspective explains the legislations and past lawsuits that affect this problem and looking from the technical perspectives clarifies the backend infrastructure of these technologies that might be causing this problem and any technical solutions that might solve it.

SCOT methodology allows us to understand different social groups attached to the technology we're analyzing. Knowing different social groups and understanding the needs of each social groups allows to understand and target specific needs of each. Pinch and Bijker claim that the evolution of the technological artefacts depends on the shifts in meanings attached to them by social groups (Pinch & Bijker, 1984). It is important to grasp how each social group sees the artefact and analyze their usage of that product, before trying to further develop the product. Technological development can be understood as a process of variation and selection of problems and solutions (Pinch & Bijker, 1984). There are different social groups attached to

voice assistants but the main ones can be listed as the end-users (has other sub groups), companies, and engineers. It is also key to analyze the relationship between each social group to analyze the situation. Using SCOT methodology in this research paper will allow us to analyze trust in voice assistance and different social groups attached to this product and this problem. Understanding the relationship between the social groups will allow to develop functioning solutions to will tackle this problem.

Historical Context

There is an obvious consumer shift to voice, which is causing a change across the customer service space. With the developing voice technologies, user become more comfortable with digital interactions in real-time, which allows companies to receive more valuable data to work with (MOC, 2021). Increasing data flow in voice assistants allow the companies to improve their machine learning algorithms which provides a better voice interaction to the user. This endless loop benefits both the company and the user. Due to these reasons, voice assistant technologies have been growing tremendously and it is likely that mostly every app will be using AI-based voice technology in some capacity in the next couple of years (MOC, 2021). It is obvious that the infrastructure behind these technologies is rapidly developing, but what is their biggest source? The easiest and most straightforward way to improve machine learning model's performance and increase its accuracy is to add more data samples to the training data (Metwalli, 2021). So, the biggest source companies are using to enhance their voice technologies is by having more users, which means generating more data to feed their algorithms. This brings up the main question that causes a barrier for voice technologies to accelerate, what's needed in order for consumers to trust this technology and use it with confidence?

Trust can be seen as a social barrier against voice assistant technologies. There are several reasons why this barrier has formed. One of the reasons is that people tend to feel weird because they are talking to a robot, they avoid communicating with the assistant the way they are talking to a friend or a family relative. A research study in the UK has shown that people who have never used a voice assistant reported that they were feeling uncomfortable with talking to their technology particularly in public (Liberatore, 2016). Although, this is a factor that decreases trust in voice assistant technologies, it is related to being familiar to the technology. As voice technologies become more common and widely used people will start feeling comfortable talking to a robot. The most important factor that causes lack of trust in voice technologies is related to a bigger problem that is present in the technology world, data privacy.

Digital revolution refers to the advancement of technology from analog electronic and mechanical devices to the digital technology available today. The new era started around the 1980s and is also known as the beginning of the information era (Techopedia, 2017). Digital revolution led to big advancements in the data field. People realized how important data analytics, collection, engineering etc. are, so they started investing in these fields. As technology developed companies began researching more in these fields and created big companies as we know as the "Big Tech" companies today. Developing technologies allowed the data flow to increase at a tremendous rate and tech companies started collecting data without users understanding. There were no regulations in the early 1990's, because everything was developing so rapidly regulations failed to keep up with their pace. This regulation free zone allowed companies to freely collect and use data. Data privacy and regulations regarding data privacy has been present since 1970s when Sweden created the first national privacy law called the Data Act. This law aimed to criminalize data theft and gave data subjects freedom to access

their records (Eperi, 2018). Although regulations have been around for almost 50 years, data privacy caught serious attention after Facebook became embroiled in the Cambridge Analytica scandal.

Cambridge Analytica was a data privacy scandal that was mainly caused by the data collection violations made by Facebook, which has harsh consequences for the tech giant. The ICO (Information Commissioner's Office) found that Facebook breached data protection laws by failing to keep users' personal information secure, allowing Cambridge Analytica to harvest data of up to 87 million people without their consent worldwide (Zialcita, 2019). This scandal allowed people to realize that tech companies were collecting personal data from most of their users to boost their algorithms, but there were also some cases where these companies actually sold their users' data to other companies to boost their revenues.

Data privacy issues led to a bias against technological systems in the society, especially toward systems that frequently collected user data to make their system more efficient. Voice assistant technologies are one of these technologies that were affected by this privacy seclusion. A study conducted by PWC in 2018 proved that trust was a big concern against voice assistant usage. The study identified three main factors that inhibit voice technology experimentation: limited knowledge of the full breadth of capabilities, a lack of trust and hesitation due to complexity or price (PWC, 2018). 38% of users stated that they don't want something "listening in" their life all the time, while 28% stated that they are concerned about privacy issues with their data security (PWC, 2018). Some people even fear that the microphones are always listening, although it is likely a coincidence. Baader-Meinhof phenomenon is an act to see things only after you start thinking of them (Kershner, 2021). For example, once you are in the market for a new red car, all you seem to see are shiny red cars on the road (Kelly & Letheren, 2018).

Analysis by STS Frameworks

Pacey's triangle (Figure 1) will be used to better understand how the trust problem arose as a consequence of the big tech privacy conflict. Voice assistant users tend to use the technology for simple tasks. The main usages of voice assistants are searching for something when using a search engine, asking a quick question and checking weather/news (PWC, 2018). These simple tasks don't require a strong trust between the technology and the user, but as the tasks become more confidential and complex the trust conflict is present. Financial industry is the industry that trust creates a big problem, many financial tools offer voice assistance but most of their users avoid using this product because they don't feel safe sharing their financial information with the voice assistant. Using Pacey's Triangle (Figure 1) to analyze trust in voice assistants allows to take a broader look at the problem. In the cultural aspect the framework dives deep on society's perception of voice assistant technologies. Why are people not trusting voice assistants and what can be done to change this? Google says its virtual assistant only listens for

specific words and that you can delete any recordings afterwards (Kelly & Letheren, 2018). Are big tech companies

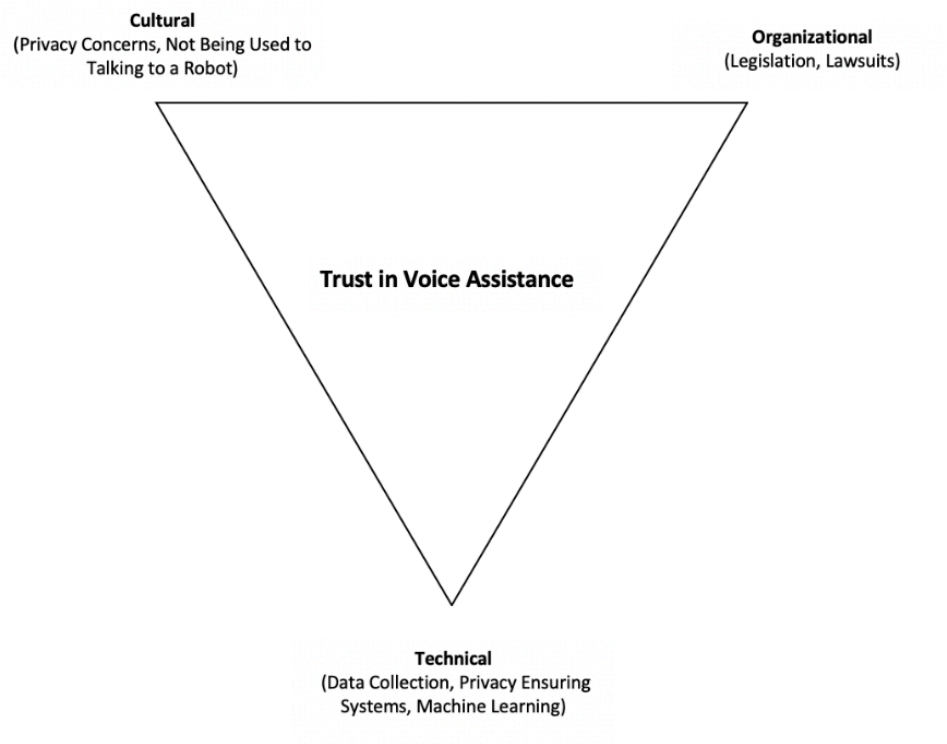

Figure 1: Adaptation of Pacey's Triangle of Technology. Figure utilizes Pacey's Triangle of Technology with Voice Assistant Technologies. Adapted by Toker (2021) from Pacey (1983, p. 6)

using private data for their own good, or can we believe that it's just used to give us a better service? After some time, perhaps we will come to take this personalization for granted, always expecting ads to be targeted to us based on what we want right now (Kelly & Letheren, 2018). Organizational aspect mainly focuses on the legislations and past lawsuits regarding data privacy. Are current legislations regarding data privacy effective and enough, how are these legislations affecting the usage and implementation of voice assistant technologies? Many people argue that current legislations and laws aren't sufficient enough. A handful of large business entities hold all the cards when it comes to personal data, and more steps are needed to put the

power over that data back into the hands of the consumers that created it (Vallee, 2021). The technical aspect focuses on current data collection techniques and their effectiveness and how different methodologies are used to ensure privacy in these technologies. Facebook is now developing ways to target people with ads using insights gathered on their devices, without allowing personal data to be shared with third parties (Chen, 2021). Pacey's Triangle (Figure 1) allows to tackle the problem from three different perspectives and looking at each individual side to better understand the obstacles they might be facing and any solutions that might be used to solve these problems.

SCOT methodology will be used to analyze the evolution of voice technologies and privacy related concerns for voice technologies in the society. 41% of voice assistant users have concerns about trust, privacy and passive listening (Perez, 2019). SCOT framework (Figure 2) allows to understand the social groups attached to voice technology. There are four different social groups identified in the graph, these are end-users, engineers, product designers and companies. Product designers, engineers and companies work together to provide a fully functioning end product to the user that satisfies all the needs. When trying to understand the relationship between these social groups we can see product designers and engineers as the initial contributors of the product and company as the initial client. Product designers and engineers should accommodate the needs of the companies and companies should buy the product if they think their customers would use the product. Since technology is socially constructed each social group should fully understand the needs of the society and design the product accordingly.

Figure 2: Social Construction of Technologies. This is a representation of different social groups that use voice assistance (Toker, 2021).

Discussion

Voice assistants were developed with the aim of increasing the interaction between humans and computers. Voice technologies also aim to solve accessibility issues with technological devices, by allowing the user to be able to control any technological by giving voice commands. Technological development can be understood as a process of variation and selection of problems and solutions (Pinch & Bijker, 1984). So, although there are some current conflicts against voice assistant technologies, the purpose and solutions they provide are really

valuable. Voice technologies have pros and cons, but will the benefits overweigh the challenges, who is responsible for making this decision and how are these compared?

Governments are normally seen as the authorities that make the legislations, but tech companies often affect their decisions because of their economic power. As bigger problems arose, the violations tech companies were causing became more visible, which made it more obvious that there is a need for more effective legislations regarding these companies. Because of the scandals and privacy awareness in the public arose, tech companies were forced to change their technology to rely less on personal data. This transition tech companies had in using personal data was mainly forced by legislations made by the authorities, the biggest authority in this case is the US government. The head of IBM Watson Advertising, warned that the privacy shifts meant that relying solely on advertising for revenue was at risk (Chen, 2021). Although these shifts are causing a hard time for the tech companies, it is a good sign for the voice assistant users. By the end of this shift, it is accurate to expect more people to start using voice assistance, and building a trustworthy relationship with their technology.

Main Points vs Strongest Counterarguments

Biggest barrier against the development and popularity of voice assistance is the lack of trust consumers have in the technology. This problem is caused by the data privacy issues we have seen in the near past that happened because of the scandals caused by the big tech companies. Although, these scandals have caused biases against voice technologies, increasing user experience studies and data collection technologies allowed major developments. People may argue that tech companies might be using their data for their own good but if we believe the best possible outcome, it is possible that tech companies are just using the data to give people the best possible service and best possible recommendation that suits their needs. This is an ethical

conflict and people should be allowed to choose how they want their information to be used. We have seen new updates like this in Apple where the company started asking the user if they want their data to be tracked or not.

Conclusion

STS approach to trust problems in voice technologies allows to understand the problem from different perspectives and analyze different social problems that are attached to this dilemma. There are current solution suggestions that aim to minimize personal data usage to build a trustworthy relationship between the user and the technology. This paper aimed to address this conflict by giving historical background, analyzing with STS frameworks like Pacey's Triangle and SCOT methodology, as well as giving strong arguments and counterarguments about the topic. The problem doesn't currently have a definite solution, but with possible solutions that currently exist and developing studies in this area, it is clear to expect that users will start trusting voice technologies in the future.

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