How is the level of trust in smart speakers related to the usage behaviour?

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Abstract

Smart speakers are rising in popularity and offer many skills aimed at making the user's life more convenient. But these devices are not perfect and still bear privacy and safety risks. In this study, the role of trust in the usage of smart speakers is investigated. Therefore, a survey was designed to collect information about the usage behaviour of users and non-users, as well as their trust towards smart speakers and trust in general. It was found that the trust towards smart speakers does have an effect on the usage behaviour of people. In fact, the more personal the commands for the devices are, the more relevant trust becomes. The findings of this study suggest an extension of the TAM and, finally, a recommendation to do further trust-related research towards smart technologies is given.

Introduction

In today's steadily growing and changing world, the frequent introduction of new smart technologies is no longer unusual. Devices designed to make life tasks more convenient and easier to accomplish are getting more and more popular. The wide-spread acceptance of these devices can be linked to the introduction of smartphones, which first enabled people to quickly access the internet and stay in touch with close ones with just a few swipes on the screen (Wilson, 2017). Yet, smartphones were just the beginning of the even bigger picture when it comes to making life more comfortable as people are now also able to transform their homes into smart homes. The features of a smart home cover many convenience aspects such as energy efficiency, renewable energy management, health care, advanced multimedia, and lastly, surveillance and security (Batalla et al., 2017).

However, nowadays so-called "smart speakers" are rising in popularity. It was estimated that the worldwide spending on them will reach $2 billion by this year, 2020, already making them part of millions of households (Lau et al., 2018). Other than a fully functioning smart home, these devices are small, their installation takes little to no effort, and they are easy to use (Noda, 2018). On top of that, they are much cheaper and offer almost the same functions than a smart home. Amazon's smart speaker "Alexa", for instance, has up to 10,000 available skills which distinguishes it from its competitors and makes the device so successful (Lei et al., 2017). Yet, when doing research on these devices, especially on their privacy, one quickly comes across articles with titles such as "Is Amazon's Alexa safe?" or "Alexa, are you invading my privacy?" (Conklin, 2020; Lynskey, 2019). Thus, it becomes clear that there are people who have concerns and question the devices' safety. Considering that smart speakers invade a person's privacy and, on top of that, show security lacks, one could argue that the trust towards these devices affects its usage (Holt & Seminar, 2018). Building up on this, the purpose of this paper is to answer the research question "How is the level of trust in smart speakers related to the usage behaviour?". First, privacy and safety issues of smart speakers will be examined. Then, general trust and its connection to technologies will be analyzed, followed by the TAM and, finally, the hypotheses are being introduced.

Theoretical Framework

Privacy and safety issues of smart speakers. Despite the high convenience of smart speakers, these devices also bear risks. One of the risks is linked to the convenience aspect of the hands-free control. As the word suggests, hands-free control means that the device turns on and follows orders once it hears its "wake word". Depending on the type of device this word

can differ but remains short and easy. Amazon's Alexa devices, for instance, awake when they hear one out of four activation words, namely either "Alexa", "Echo", "Amazon", or "Computer" (Lei et al., 2017). Yet, taking this into consideration, one could argue that this is a rather weak authentication method as it only requires a single factor, namely the matching wake word, in order to get access and control the device. Further, the user has a very limited range of activation word options to choose from (Lei et al., 2017).

Additionally, the given comfort of activating the device with a simple word implies that they work with a mechanism that is always listening as it is waiting for it to be needed (Zeng et al., 2017). This especially, might be perceived as an intense invasion of privacy as studies showed that microphones placed in private homes are viewed as the "most privacy-invasive sensors" (Lau et al., 2018). Thus, more and more people also tend to question the privacy of smart speakers and ask themselves what the device actually records. Is it just what is said after the wake word was spoken or also every background noise or conversation that is held in hearing distance of the device? The answer big companies such as Amazon and Google give is rather vague as they state that smart speakers *technically* only listen to the user when they are being activated by the wake word. On top of that, despite the assurance that the collected data is being encrypted, it remains unclear what happens to the stored data. The company's privacy policies do not give away with whom it will be shared and what they are planning on doing with it (Holt & Seminar, 2018). The concern people have about their security when using smart speakers might, therefore, be linked to the lack of knowledge about their data privacy (Holt & Seminar, 2018).

The given "wake word" implications, however, are not the only issues which question the device's safety and privacy. A study from Maita (2018), for instance, showed that the majority of people do not place their smart speaker in the bedroom or bathroom but in the living room, followed by the kitchen (Maita, 2018). This finding suggests that despite the confident use of such a device and the willingness to place it within the private home, people are not trusting it completely. A possible link to this behaviour can be made when looking at the many concerns people still have about this device. As stated earlier, people question what the device truly records and collects.

A certain degree of cautiousness might also be related to the reported errors of smart speakers which sparked worldwide attention. The smart speaker Alexa, for example, gained huge unwanted attention as multiple users reported that their device turned on by itself and randomly began laughing. Although Amazon's statement that these rare incidents happen because Alexa hears accidental orders, many people felt uneasiness (Chu, 2019). On top of that,

there are users who complained that their Alexa device followed wrong or not given orders (Holt & Seminar, 2018). Taking this into consideration it becomes clear that smart speakers are not perfect and still bear many risks such as financial losses as a result of a wrong order, security breaches, the risk of unwanted advertisements, misuse and so on (Bhatt, 2019).

Yet, despite the findings of multiple studies that people do question certain safety and privacy implications of smart speakers, the popularity of smart speakers is still on the rise. But how can this be explained? To some extent it can be linked to various human aspects such as the different knowledge levels of the possible risks or the social influence people are surrounded with (Chu, 2019). People like to follow trends, if they witness their family, friends or other people who stand in public owing a smart speaker they are more likely adopt (Chu, 2019). The most important aspect, however, is that the convenience of smart technology outweighs the concerns of privacy (Abdi et al., 2019).

Trust. According to Siau and Shen (2003), trust can be defined in many different ways and the perspectives of it vary according to the field it is studied in. Defined loosely, however, trust is said to be "a state involving confident positive expectations about another's motives with respect to oneself in situations entailing risk" (Siau & Shen, 2003). The three characteristics this definition entails are that (1) any trust relationship consists of a trustor and a trustee, (2) that it involves risks and uncertainties, and (3) that the trustor believes in the trustee's honesty and benevolence and that he expects the trustee to not break this faith. Important to note here, however, is that the trust between humans is different than the trust towards smart devices or technologies in general. The reason for this is that the usual "human-to-human trust relationship" is not given, but instead a "human-to-technology" one. This relationship is similar as, just as it is with other humans, it is also expected that the technology has good attributes and that it does not take advantage of us in a situation of need (Lankton et al., 2015). On top of that, when a technology shows behaviour which closely resembles those of a human, in case of the smart speaker "talking", people automatically treat the device like another human (Lee & Nass, 2010). This is due to the fact that humans socially respond to technologies and allocate human-like attributes such as gender or even personality characteristics to them (Katagiri et al., 2001). Smart technologies such as smart speakers are designed to sound human-like as their voice displays emotions (Shulevitz, 2018). Thus, this feature further adds to this allocation and possibly enhances the humanness of the device. Finally, considering that trust is a part of an interpersonal communication, and that the

humanness of smart speakers supports a strong social link, one could argue that people are convinced that the device is just as trustworthy as a human.

TAM. Taking the above-mentioned aspects into consideration, it becomes clear that a lack of privacy does affect people, yet factors such as convenience are still convincing enough for people to make use of smart speakers. This was also highlighted by Davis (1989), who explained that a person's attitude towards the intention of use is influenced by two factors, namely (1) the perceived usefulness and (2) the perceived ease of use. A person's belief that a certain device does, for instance, significantly improve his or her performance and that it is effortlessly to use makes the device more attractive and, thus, the intention to use it is higher. These assumptions are based on Davis' Technology acceptance model or in short TAM.

During extensive research, Legris et al. (2003) took the model a step further and stated that the TAM needs to be extended due to the characteristics of the analyzed technology and for the reason that people's objectives for adopting information and communication technologies differ depending on the device. Consequently, Shin et al. (2018) decided to extend the already existing and basic TAM by adding the variables compatibility and privacy as factors which have a direct influence on a person's attitude and, thus, intention to use. This can be explained by looking at the complexity of technologies nowadays and the amount of data that is being stored on servers. A person who is confident that a computer, for instance, keeps his data safe and private is more likely to use the device than someone who doubts data privacy. Therefore, the extended TAM was created (see Figure 1). The added moderators of the model are age, sex, income and lastly education (Shin et al., 2018). As the TAM focuses on the humans' attitudes towards the usage behaviour of technology, it can also be linked to smart speakers. This again makes it relevant for this research.

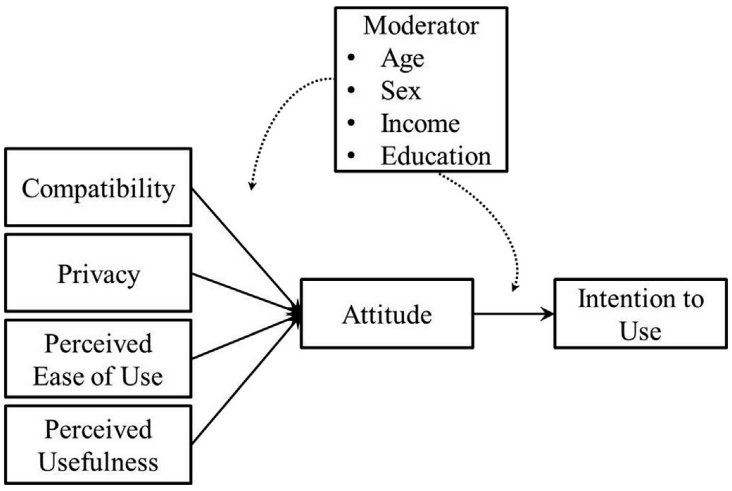

Figure 1. The extended TAM according to Shin et al.

The current study

When combining all of the findings of the existing literature of smart speakers, it becomes evident that the level of trust in smart devices and its influence on the usage is not yet fully explored. Trust, however, showed to be an important value and some researchers did touch on this in their studies. Chu (2019) did, for instance, integrate trust into his „User Characteristics" and, hence, stated that the adoption of smart speakers is also dependent on the belief that the collected private data is safe and thus stays confidential. As a consequence, it is said that companies must put effort into gaining the trust of potential customers as it is an important value for success (Maita, 2018). However, many privacy and security concerns still act as a blockade for the adoption of smart speakers (Wilson et al., 2017). Nonetheless, this blockade does not affect everyone to the same extend as users of smart speakers showed to have less concerns about privacy and other risks (Lau et al., 2018). They seem to perceive the device as more trustworthy as they do not fear that it would intentionally harm them in any way. Thus, they might also show a different usage behaviour towards the device. As a consequence, these two hypotheses were formulated:

H1: "The trust in smart speakers influences the intention to use a smart speaker."
H2: "For those who possess smart speakers, trust influences the decision to use smart-speaker functionalities."

Further, studies which investigated the difference between trust in humans and trust in technologies highlighted that the trust relationships between the two are similar (Lankton et al., 2015). As described above, when we trust another person, we expect that this person has good intentions and does not take advantage of us. That is the same with technologies, especially because technologies are becoming more and more human-like. Due to this similarity in trust, it is expected that people who trust other people also trust smart speakers.

H3: "General trust influences the trust in smart speakers."

Combining all of the hypotheses enables a direct link to the research question and, thus, to the research model (see figure 2). As can be seen, the research model suggests that the factor "trust" is directly linked to the intention to use. Getting insides into how the trust in smart speakers is

related to the usage behaviour of users and non-users reveals how often the given skill groups are used. In other words, these insights show how high the intention to use these skills is and how this is subsequently related to trust. Given that the research focuses on smart speakers and not on technologies in general, the smart speaker skill groups are used as usage examples. As stated earlier, due to the outstanding variety of available functions, Batalla et al. (2017) did the first attempt of ordering those of smart homes into groups. When looking at the number of skills smart speakers offer these days, one could argue that these functions overlap or even exceed the functions of a smart home. Therefore, it could be interesting to see whether certain skills areas are more used than others and how this usage is then related to trust. Later on, a found relation could then be added to the already existing TAM, making the model even more precise see figure 3).

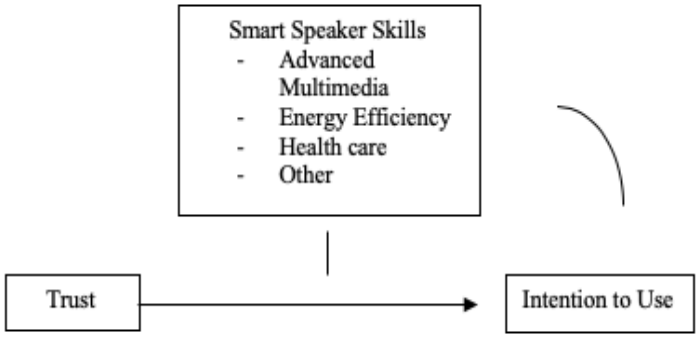

Figure 2. The research model.

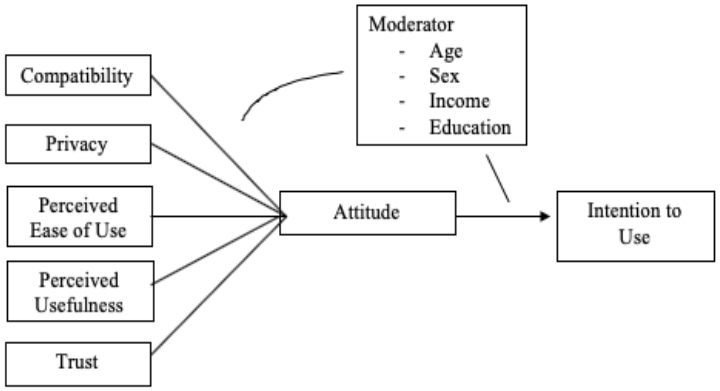

Figure 3. The research model integrated into the extended TAM.

Method

Participants

For this research, a self-designed online survey was conducted, and users and non-users of smart speakers were asked to participate. The research itself was authorised by the Ethics Committee of the Faculty of the Behavioural Sciences (ECBMS) at the University of Twente.

The type of sampling method that was used was a convenience sampling (McCombes, 2019). Individuals who were easily accessible were asked to participate either via online platforms or personally by the researcher. Further, the participants had to fulfil the following inclusion criteria: (1) they had to know what a smart speaker is (2) and they had to be 16 years of age or older. Taking this into consideration, the population size was large (more than 5000) and not clearly definable. Accepting a margin of error of 7.5 % the ideal sample size consists of 171 participants (Conroy, 2015). Consequently, the aim was to get 100-200 participants to complete the questionnaire.

The research sample consisted of 101 participants from which 75 (74.3%) were women and 25 (24.8%) were men. One participant chose "other" as the answer option (1.0%). Their ages ranged between 16 years old and 52 years old. The mean age of the participants is 23.2 with a standard deviation of 4.3, and the majority of the participants were 22 years old (22.8%). The nationalities of the participants were widespread as people from 32 different nationalities took part in this research. The most frequent nationality was German (31.7%), followed by the United Kingdom of Great Britain and Northern Ireland (12.9%). A complete list of all nationalities can be found in the appendix (see Appendix 3). Lastly, the most owned smart speaker was Alexa Echo (17.8%), followed by Siri (16.8%).

Measures

The research consisted of a self-designed online questionnaire, created to collect the necessary data to answer the research question "How is the level of trust in smart speakers related to the usage behaviour?", along with four hypotheses. Considering the self-designed background of the questionnaire, the reliability and validity for all of the scales will be tested later on.

The extended technology acceptance model (TAM) which describes the factors compatibility, privacy, ease of use and perceived usefulness as being critical for influencing the attitude of an individual and, thus, the person's intention to use a specific technology acted as the basis of this (Shin et al., 2018). Here, the factor trust is taken into consideration to see if there are relations between the trust towards smart speakers and a person's intention to use certain smart speaker skills.

For the questionnaire, a five-point Likert-scale was used, ranging from strongly disagree to strongly agree. This particular type of scale was chosen as it is ideal for measuring attitudes and its multi-item design can help to improve the inherent stability of the research and reduce random variability (Rimsevica, 2017).

Overall, the questionnaire consisted of three constructs: “Demographics”, “Trust”, and “Smart Speakers”. The questionnaire was self-designed and to create the parts along with the matching items, multiple sources were used. The different parts also varied in complexity. To get a detailed look at the smart speaker skills, for example, more items were used to cover this rather multi-faced field. Further, due to the number of items, it was possible to create the option to delete items for better internal reliability. Overall, all of the statements were designed in a similar style to increase the quality of the responses (Steyn, 2017).

Trust. The construct “Trust” had two sub-parts, namely “General trust” which consisted of the two scales “Being trusted”, “Trusting others”, and “General trust towards smart speakers”. Due to the above-mentioned difference between the trust in humans and technologies, the two different trust scales were created to get further insights. Moreover, the labelling of the first two general trust scales was related to Kipnis (1996), who stated that mutual trust is composed of two categories. The first one is about how a person feels about being trusted by others and the second category concerns how a person feels about having in trust others.

The ”Being trusted” scale consisted of seven items and the items were based on two different sources. In the first source, the researcher Kipnis (1996) said that “to be trusted” means that one is able of taking care of the valued belongings of other people and that one can consider himself to be a good person (Kipnis, 1996). As a result, items such as “I often take care of my friends belongings” were created. Secondly, Beierlein, Kemper, Kovaleva, and Rammstedt (2012) did a study to measure trust and published a short scale of interpersonal trust or in short “KUSIV3”. One of the items they used for their questionnaire was “You can’t rely on anyone these days”. To create an item which fits the context of being trusted, the original item was reversed and turned into the item “Others can rely on me”.

The items for “Trusting others” were constructed with the help of three different sources and the scale consisted of a total of eight items. Some of the items were taken from a survey aimed at measuring trust and trustworthiness from students of the Harvard Introductory Economics course (Glaeser, Laibson, Scheinkman, & Soutter. 2000). Slight changes to the original items were made to ensure a fit into the self-designed questionnaire. The original item “How often do you lend money to your friends?” was, for instance, turned into the statement “I

often lend money to my friends". There were also items taken from the short scale of interpersonal trust (KUSIV3) (Beierlein et al., 2012). No changes were made to these items. Lastly, a few items were taken out of a survey about social empowerment created by Meyer, Luong, Ward, and Tsourtos (2010). Despite the main topic being on social empowerment, the researcher took trust into account and included trust-related items into his survey. Thus, the items which were taken from the survey were changed and turned into statements to ensure a fit.

The items for the sub-part "General trust towards smart speakers" were taken out of a study of Lankton, McKnight, and Tripp (2015) who did a study which aimed at investigating human-like and system-like natures of technologies and how they affect the trust of humans. Further support for the selection of these items was found in the study of Chu (2019). In his survey on customers intention to adopt smart speakers, he used almost identical items. In total, four areas and their three matching items were selected out of the survey of the study of Lankton et al. (2015). The first area was "Functionality", followed by "Helpfulness", "Reliability", and "Benevolence". Slight adjustments were made to the items as the statements were changed to match the topic "smart speakers".

For the general trust scale, the Cronbach's alpha is unacceptable at .32. Also, the Guttman's Lambda 2 showed that this scale has an unacceptable reliability value (.42). The scale for the general trust towards smart speakers, on the other hand, has a good reliability of .87. The Lambda 2 supported this as it showed a reliability of .86.

Smart Speakers. At this part of the questionnaire, the participants had to indicate if they have a smart speaker or not. After this question, the questionnaire was split into two separate parts. One part was only for users and the other part only for non-users of smart speakers.

The non-users were immediately directed to the next sub-part. Those who said that they own a smart speaker, however, were asked to select what kind of smart speaker they own before they were directed to the sub-part "smart speaker skills".

The number of smart speaker skills that are available to the user are very widespread. Thus, to create a more ordered view of the different smart speaker skills for the smart speaker skills scale, the skills were divided into different groups, namely "*advanced multimedia*", *energy efficiency*", "*health care*" and "*other*". The division of the skills was inspired by Batalla et al. (2017) who divided the application areas of smart homes into five different groups (Energy Efficiency and Management, Renewable Energy Management, Health Care Systems, Advanced

Multimedia Services and Surveillance and Security). The division of Batalla et al. (2017) seemed fitting as it not only contributed to a clearer overview but also because the groups matched the selected smart speaker skills to a great extent.

The items chosen for each group were randomly taken from webpages on smart speakers and their available skills. Here, the smart speaker users were asked to indicate how often they use certain skills of their smart speaker. Non-users, on the other hand, were asked to indicate how often they would make use certain skills. However, all the items remained the same. Energy efficacy consisted, for instance, of the items "turn your light on/ off", and "control your thermostat".

Here, also the five-point Likert-scale was used, however, the answer options were changed according to the task of indicating how often the skills were used ("Never, Rarely, Moderate, Often, Daily").

Here, the scales of energy efficiency and health care for both, users and non-users, have a good reliability (>.8). The Guttman's Lambda 2 also confirmed the good reliability of the scales. For the users the energy efficacy scale is at .86 and the health care scale at .88, whereas for the non-users the energy efficacy scale is at .90 and the health care scale at .89. The scale of the advanced multimedia skills of the users had to be adjusted and two items had to be deleted to reach an acceptable reliability (.71). This way, also the Lambda 2 showed a reliability of .72. The deleted items were "How often do use your smart speaker to play music?" and "How often do you use your smart speaker to listen to podcasts?". The advanced multimedia skills for the non-users did not have to be adjusted as the Alpha showed an acceptable reliability of .71, and the Lambda 2 one of .73. For the scale "Other", one item was deleted for both users and non-users, namely "How often would/ do you use your smart speaker to call someone?". This way, the reliability of the scales is good (>.8). Here, the Lambda 2 showed that the scale other for the user has a reliability of .85, whereas the non-user scale has a reliability of .86.

Procedure and design

Each participant needed to fill out an online survey. They could do this with the help of any internet-capable device (e.g. phone, computer). The questionnaire itself was spread on social media platforms (WhatsApp, Facebook) and on "Sona" which is the psychology test subject pool BMS of the University of Twente. Thus, the participants were either directly messaged and asked to participate via a text message or they could find the survey by themselves by scrolling through online platforms. To further increase the spread, snowball sampling was used.

On social media platforms, the questionnaire request was shown in the form of a link.

A short text was added to inform the participants about the topic of the study and the time it takes to complete the questionnaire. On Sona, the questionnaire was shown after clicking on "view available studies" and scrolling through the offered studies. Once the participants found the study and clicked on it, they were directed to a site which entailed the study's name, type, the credits they could earn, the duration, a short description, the eligibility requirements and the researcher's name. All participants were informed that the questionnaire was not supposed to take more than 20 minutes of their time. The reasoning behind the length of the questionnaire can be traced back to two aspects. On the one hand, the questionnaire was supposed to take only a relatively short amount of the participants free time to ensure concentration. On the other hand, long questionnaires produce higher reliability and, thus, add to the questionnaire's quality (Steyn, 2017). Therefore, the questionnaire was designed to take a moderate time of 20 minutes to be completed. However, the participants were not under time-pressure as they could take as much time as needed.

Those who were asked to participate via social media platforms were directed to the first site of the questionnaire by clicking on the questionnaire link, whereas those who found the study on Sona were directed to the first site after signing up for the study. On the first site of the questionnaire, the participants were informed about the study in a short text which entailed the most relevant information such as the main goal of the study and the inclusion criteria. Next, they were directed to the informed consent (see Appendix 1).

Those who agreed and completed this step were then introduced to the first part of the questionnaire, to the construct "demographics". Here, they were asked about their gender, age and nationality. The participants had to manually type in their age, yet in all of the other parts of the questionnaire, they simply had to click on the most fitting given answer options. They were, for instance, asked to indicate how often they use a certain skill of their smart speaker. Depending on the question, the answer options changed. In this case, they ranged from "Never" to "Daily". The construct "trust" consisted of two sub-parts, namely "general trust" and "general trust towards smart speakers". The third and last construct "smart speakers" consisted of one sub-part, namely "smart speaker skills". Users and non-users of smart speakers were welcomed to participate as their answers were being compared in this research. The questions remained similar for both and only changed in terms of formulation. Users, for example, were asked what skills they actually use whereas non-users were asked what skills they would use.

Once the participants reached the end of the questionnaire they were thanked for their participation.

For the research, a survey was designed, and this survey design was based on the research question "How is the level of trust in smart speakers related to the usage behaviour?". Here, "trust" was determined as the independent variable and "usage behaviour" was determined as the dependent variable. The complete survey can be found in the appendix (see Appendix 1).

Data analysis

To analyze the collected data, the software of "IBM SPSS Statistics 24" was used to measure possible relations. Due to the self-designed background of the questionnaire, the Cronbach's Alpha and the Guttman's Lambda 2 were used to measure the internal consistency of the items. The results after running the Cronbach's Alpha and the Lambda 2 should be higher than .7 to be acceptable (Gliem & Gliem, 2003). This, however, was not the case for all of the sub-parts of the questionnaire. The two scales which aimed at measuring a person's general trust showed an unacceptable reliability of .32, and also the Guttman's Lambda 2 did not show a big difference in reliability (.42). Also, the attempts to delete items did not contribute to an improved internal consistency and therefore a factor analysis was conducted. First, to test whether the collected data is appropriate for the factor analysis, it was decided to conduct a KMO and a Barrett-test. The results of the Barrett-test should be significant and the KMO should be between .5 or .6 to be acceptable (Williams et al., 2010). This was the case as the KMO test showed a correlation of .594 which is acceptable. Also, the Barrett-test proofed that the correlation was significant (.00). Finally, it was required that the correlation matrix displays that some of the items were above .30 as this indicates correlations between the items. This was the case and, therefore, a factor analysis was conducted. The total variance showed that five factors explain 60% of the variance in the 15 trust items. Next, the rotated factor loadings were interpreted. As can be seen in Table 1, the rotated factor solutions varied between -.464 and .794.

Table 1

Rotated Factor Loadings and Communalities of the General Trust scale

	Loadings					
Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Communality
I often take care of my friends' belongings.	.543	.466	.049	.007	.412	.685

Generally speaking, I would say that I am a good person.	.387	-.158	.257	.618	-.196	.661
Others can rely on me.	.713	-.202	.274	-.242	-.102	.694
I am good at keeping secrets.	.082	-.245	-.371	.418	-.105	.391
I have only good intentions.	.086	-.061	.047	.747	.041	.573
My friends would say that I am a trustworthy person.	.794	-.059	-.030	.264	.072	.710
I take advantage of people when I get the chance.	-.464	.467	.312	-.206	.140	.593
I often lend money to my friends.	.101	.119	-.157	.016	.642	.461
I am convinced that most people have good intentions.	.171	-.128	.810	.267	-.103	.783
In general, people can be trusted.	.015	-.330	.789	-.032	.095	.742
I often lend personal possessions to my friends.	.197	-.075	.076	-.061	.730	.586
You can't truly rely on anyone.	.018	.776	-.250	-.094	-.074	.679
I think that most people would take advantage of me, if they had the chance.	-.223	.661	-.197	.145	-.127	.562
I tend to doubt information from the media.	-.148	.244	.026	.604	.053	.450
I would ask a stranger to look after my belongings when I leave for a few minutes.	-.181	-.192	.140	.012	.575	.420

In the next step, a scree plot was plotted to determine how many factors there are, based on the number of eigenvalues (see figure 4). The typical elbow shape, however, is not clearly visible in this case. Yet, based on the Kaiser's criterion which states that eigenvalues over 1.0 are stable, a total of five factors were found. Further, it was tried to group the items into new sub-scales to increase the reliability. Nonetheless, all of the attempts to create new sub-scales did

not lead to an acceptable reliability. Consequently, the sub-part "General Trust" of the questionnaire was excluded, and the matching hypothesis could not be taken into further consideration.

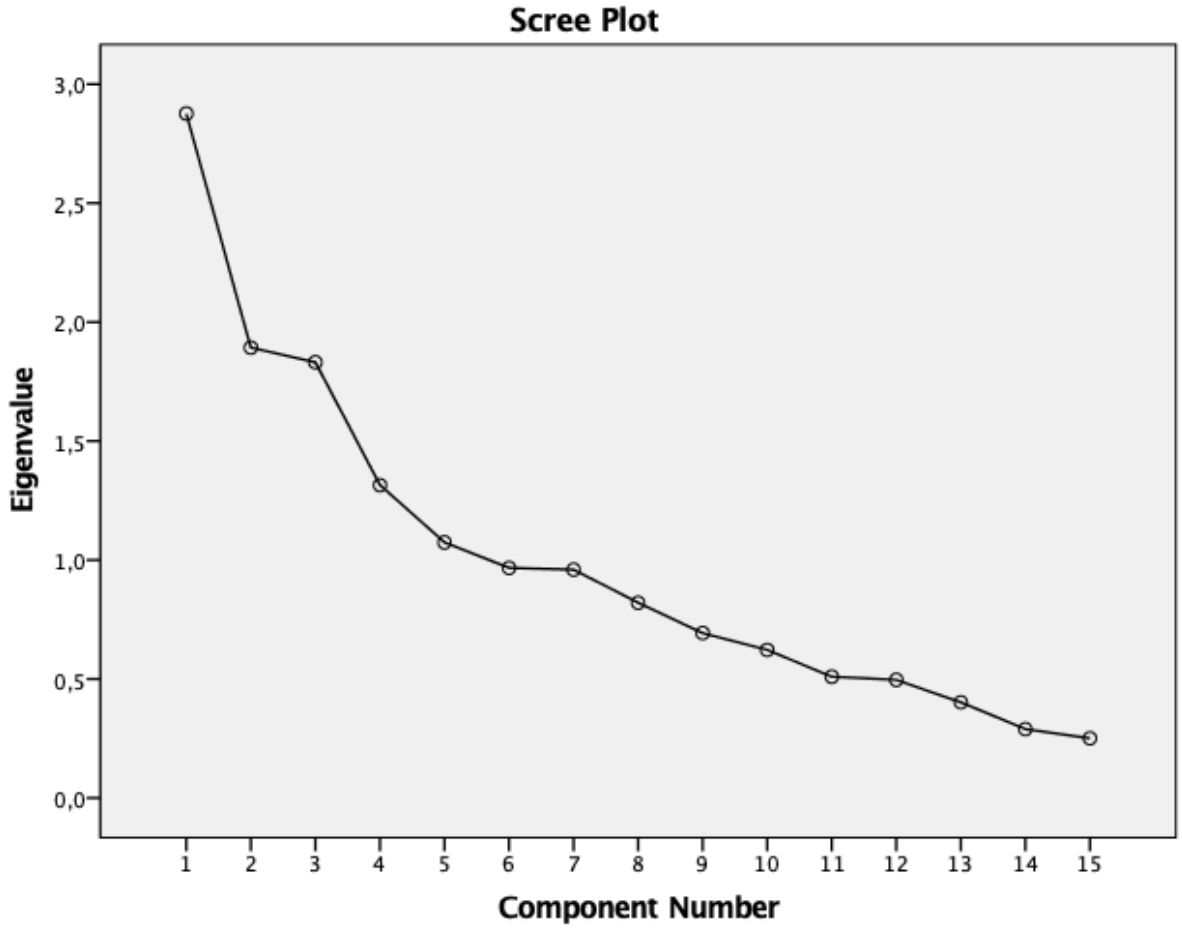

Figure 4. Scree plot of Eigenvalues of the general trust scales (being trusted and trusting others)

With SPSS, the frequencies of the collected data were analyzed. Further, a Spearman's Rho was conducted to determine possible correlations. In order for the results to be significant, the Spearman's Rho should not display a p-value above .05. Further, an independent t-test will be conducted to check whether the data show equal variances. This way, it can be seen if there is a significant difference between the mean values. These tests will be conducted to be able to answer the research question along with the hypotheses.

Results

In this section, the final results of the statistical tests are being presented. First, as can be seen in table 2, it was checked whether the variables of the constructs of the questionnaire correlate, and their means and standard deviations were calculated. As displayed in the table, there is a significant correlation between nationality and age, trust in smart speakers and nationality, and health care and trust in smart speakers ($p < .05$). Further, the variables which were aimed at collecting information about the smart speaker skill usage (Advanced multimedia, Energy efficiency, Health care, Other) significantly correlate ($p < .01$).

Table 2

Means (M), Standard Deviation (SD), and Correlation between the Variables [a]

Variables	M	SD	1	2	3	4	5	6	7	8
1. Age	23.21	4.350								
2. Gender	1.76	.451	.379							
3. Nationality	107.5	51.943	.039*	.001**						
4. Smart Speaker Trust	3.31	.547	.269	.909	.027*					
5. Advanced multimedia	2.6	.836	.643	.090	.361	.856				
6. Energy efficiency	2.6	1.23	.319	.654	.741	.937	.000**			
7. Health care	2.5	1.01	.569	.588	.915	.012*	.000**	.000**		
8. Other	2.7	.85	.661	.684	.815	.065	.000**	.000**	.000**	

**p < 0.01; *p < 0.05

[a]N=101

Inferential statistics

Spearman's Rho correlation. The below-displayed table shows how the level of trust in smart speakers is related to the skill usage of a smart speaker. Here, the results are directly linked to the research question "How is the level of trust in smart speakers related to the usage behaviour?".

As can be seen, two significant yet weak positive correlations were found between the trust in smart speakers and the usage of health care skills (r=.251; p=.012) and the trust in smart speaker and the usage of the skills that fall under "other" (r=.198; p=.050). The skills that were related to "other" were skills which did not fit into the other function groups Batalla et al. (2017) originally created. The skills ranged from "How often would/ do you use your smart speaker to get a weather report?" to "How often would/ do you use your smart speaker to set important reminders?". The correlation between the trust towards smart speakers and the advanced multimedia skills (r=-.051; p=.615) and the energy efficiency skills (r=.008; p=.937) were both non-significant.

These results show that the level of trust in smart speakers, of both users and non-users, is positively related to the usage of the skills "health care", and "other".

Table 3

Spearman's Rho correlations between the trust in smart speakers of users and non-users, the usage of the advanced multimedia, energy efficiency, health care and other smart speaker skills of users and non-users

	Trust in smart speaker (Users and Non-Users)	
Variable assessed	Rho	p value
Advanced multimedia	-.051	.615
Energy efficiency	.008	.937
Health care	.252	.012
Other	.198	.050

Independent t-tests. First, the level of trust in smart speakers of users and non-users were compared. This comparison is linked to the hypothesis "The trust in smart speakers influences the intention to use a smart speaker". The calculation revealed that the users (M=3.5;

SD=0.42) have a slightly higher mean than the non-users (M=3.2; SD=0.59) of smart speakers. Further, the independent t-test revealed that this difference is significant, at .017. The results show that hypothesis 1 can be supported. Despite the small difference, users trust smart speakers more than non-users.

Table 4 shows the comparison of users and non-users of smart speakers and the skills they use. Thus, this table is linked to the hypothesis "For those who possess smart speakers, trust influences the decision to use smart-speaker functionalities." The findings show that all of the compared mean values are of significant difference ($p < .05$). Overall, the mean values between all of the skill groups and the non-users and users are higher on the side of the non-users. The biggest mean difference is between the usage behaviour of the energy efficiency skills. Non-users would be using these skills almost double as likely than users do (User=1.7/Non-User=3.1). Taking these results into consideration, the hypothesis 2 can be rejected.

Table 4

Comparison of the skill usage behavior of users and non-users of smart speakers

	Frequency of skill usage				
	Mean	SD	F	t	Sig.
Advanced multimedia			1.123	-5.305	.000
- User	2.1	0.78			
- Non-user	2.9	0.72			
Energy efficiency			3.063	-6.447	.000
- User	1.7	0.84			
- Non-User	3.1	1.12			
Health care			0.243	-3.562	.001
- User	2.0	0.92			
- Non-User	2.8	0.99			
Other			0.005	-2.621	.010
- User	2.4	0.81			
- Non-User	3.0	0.84			

Discussion

In this section, the results of the study are summarized and discussed against the background of existing research on smart speakers. In addition, the limitations of the study are highlighted and an outlook on the implications for future research and the practical implications of the study results are given.

Trust of Users and Non-Users towards Smart Speakers. First, looking at the findings of the hypothesis "The trust in smart speakers influences the intention to use a smart speaker" revealed that users have a higher trust in smart speakers than non-users. Despite the findings being of significant relevance, the difference between users and non-users is relatively small and both participant groups stayed neutral in their answers.

Here, the finding was expected as the majority of neutral answers matched the two-sided literature that was found about the topic of trust in smart speakers. Shulevitz (2018) highlighted that the trust in smart speakers is essential, especially since the device is not a basic search engine but an "action engine". Along with the example of Alexa, it is explained that the device tells the user what it thinks the user wants to hear instead of giving a variety of possible answers (Shulevitz, 2018). This suggests that the user must trust the smart speaker to give him the right fitting answers. Coming back to the safety issues, however, it becomes clear that a lot of people might have heard or even experienced privacy implications with smart speakers. Smart technologies are not perfect, and errors are unpreventable and also have been reported before (Holt & Seminar, 2018). The neutral level of trust might therefore partly be related to negative experiences of a falsely executed command or a wrong given answer of the device.

Further, there is literature which states that the trust between humans and technology is different as the latter would not purposely mislead the user (Bhatt, 2019). To achieve this trust, however, the device must have a certain level of convenience. When assuming that users get a smart speaker to make their life more comfortable, it is possible that they also believe in the device's capabilities and, thus, trust it more. Contrarily, non-users think that smart speakers have a lack in utility and, therefore, show distrust (Lau et al., 2018). On top of that, research showed that people are more likely to share deep emotions, such as the feeling of being sad or depressed with voice assistants like Alexa (Shulevitz, 2018). This reason behind this is that "machines give us a way to reveal shameful feelings without feeling shame" (Shulevitz, 2018, p. 10). A part of this might also be linked to the fact that smart speakers, as the name suggest, are devices that use a voice to speak with the user and voices are found to create intimacy. Companies are aware of that and programmed the smart speakers' voice to sound a specific way. The voice of Alexa, for instance, is programmed to display emotions that are linked to the

attributes of intelligence, humour and being humble. Further, Alexa has a fixed response that it gives when it hears a statement such as "Alexa, I am feeling depressed lately". It tries to help the person in need by saying: "I'm so sorry you are feeling that way. Please know that you're not alone. There are people who can help you. You could try talking with a friend, or your doctor. You can also reach out to the Depression and Bipolar Support Alliance at 1-800-826-3632 for more resources" (Shulevitz, 2018). These human-like qualities might even improve in the future, which could in turn lead to an increased trust towards the device. This is based on the fact that the more human-like the technology, the higher the trust towards it is (Lankton et al., 2015).

Coming back to the connection with the results of the hypothesis and the majority of neutral answers, it can be said that people might be torn between trusting the smart speaker with emotions and specific commands and mistrusting it due to the risk of errors and imperfect answers of the device.

The Influence of the Trust of Users and Non-Users to use Smart Speaker functionalities. Surprising, however, were the findings of the hypothesis "For those who possess smart speakers, trust influences the decision to use smart-speaker functionalities." The analysis of the data revealed that it is actually the other way around and that non-users would use more skills of their smart speaker if they have one. This finding was contradictory to the literature which stated that non-users generally show more privacy concerns, have a distrust towards smart speaker companies and do not perceive the utility of the devices (Lau et al., 2018). Therefore, it was expected that non-users would not be interested in interacting and, thus, using the skills of smart speakers. Users, on the other hand, are found to show fewer concerns about privacy and do not properly understand the risks that smart speakers bear (Lau et at., 2018). This was also not in line with the findings. The overall usage behaviour of all skill groups is held moderately or lower which indicates that privacy and safety concerns are present for both users and non-users. Yet, one could also argue that users might be used to the skills their smart speaker has to offer and stick to those which give them the most convenience. In other words, the usage of the device becomes more normal to them and the active use of available skills slowly decreases. Non-users might be new to the technology, find it more interesting at first and expect to use it a lot. They also might be more curious in trying out skills they have never used or heard of before. This can further be connected to the study which showed that people do not change their usage behaviour over time and stick to a handful of popular commands such as "playing music" (Bentley et al., 2018).

General Trust and the Trust towards Smart Speakers. Hypothesis 3 "General trust influences the trust in smart speakers" could not be taken into further consideration due to an unacceptable reliability. Nonetheless, based on the existing literature, it was expected that the general trust of the participants is similar to the trust towards smart speakers. As discussed before, smart speakers are getting more and more human and are now even able to show emotions with their voice. Moreover, these human-like features are probably even getting improved in the future, diffusing the distinction between humans and technologies more and more (Shulevitz, 2018). Already today, people speak to technologies the same way they speak to other people which further supports that we treat technologies socially (Lee & Nass, 2010). Some argue that people even have a more intimate relationship with talking devices such as smart speakers as people already start talking about things they would not talk with others about (Shulevitz, 2018). All of these findings support the high chance of a significant influence of general trust towards smart speakers.

Trust and Usage Behaviour – the Research question. Finally, the main goal of this study was to find an answer to the research question "How is the level of trust in smart speakers related to the usage behaviour?". Therefore, the four different groups of smart speaker skills, namely "advanced multimedia", "energy efficiency", "health care" and "other", were related to the trust users and non-users of smart speakers have towards these smart devices.

The found correlation showed that the trust towards smart speakers affects the usage of the skills of "health care" and "other". Again, the skills that fall under "other" represented skills which did not fit into one of the other given groups. The "health care" skills, on the other hand, covered different health aspects such as fitness. This correlation can, hence, be interpreted as that the trust in smart speakers is of importance when the user shares more personal details with the device. When asking the device to set an important timer or ask for health advice, the user needs to trust the device to give accurate and trustworthy answers. Skills such as advanced multimedia or energy efficiency do not require a specific form of trust as these do not affect the users' well-being even if the device fails. This result, however, did not surprise. A study from Bentley at al. (2018), for instance, investigated the long-term use of smart speakers. In their findings, they showed that all users of „Google Home" use the skill "play music" daily, followed by controlling the lights of the house, checking the thermostat and other skills that fall under typical nightly routines. Moreover, they revealed that despite the frequent introduction of new smart speaker skills, people stick to their usual behaviour patterns and do not change their usage behaviour over time (Bentley et al., 2018). The daily use combined with the stable usage behaviour is a strong indicator that advanced multimedia skills are part of people's

routines and not much thought is put into whether they should trust the device with it.

Overall, it is safe to say that trust does play a role in the usage behaviour of smart speakers and, therefore, also the previous link to the TAM was created. Now when combining all of the findings, it becomes evident that factors such as privacy and convenience of smart speakers are important and have an influence on how we perceive the device. The trust towards the device and its influence on the usage behaviour, however, should also be taken into consideration.

Limitations

The research also consisted of some limitations and these should be taken into account. The first limitation concerns the number of survey respondents. Due to the current COVID-19 crisis and personal challenges of potential respondents, people's motivation to respond to surveys was affected. The survey involved a large number of questions and required a certain degree of concentration, which could have further reduced the motivation to complete the survey. The resulting restriction policies of COVID-19 further eliminated the option to physically approach people to collect answers.

The next limitation concerns the reliability of some of the sub-scales of the questionnaire. The sub-scale which was supposed to collect data about the general trust of the participants proofed to be unacceptable in terms of reliability. Hence, the matching hypothesis "General trust influences the trust in smart speakers" could not be answered. Further, the scale "Trust and usage behaviour of smart speakers around friends" had a similar weak reliability. This also affected the usage of the scale "Trust and usage behaviour of smart speakers around family" as they were both connected to collect information about the two social factors family and friends. Consequently, social factors could not be taken into further consideration and were completely excluded from the study. The entire scales and their method can be found in the appendix (see Appendix 2). All of the items of all three of the scales were, however, completely backed up by academic literature. Consequently, there is no clear derivation for the root cause of this issue.

Another limitation involves the lack of diversity of different smart speakers in today's literature about voice assistants. Most studies about smart speakers take "Alexa" or "Google Home" as examples of smart speakers or even build an entire research project based on the example of these. Other brands, such as Sonos are not incorporated. Here, the smart speaker Sonos One was incorporated and even selected by a few participants. Further, the participants were invited to also state that they use other brands than those they were shown. The lack of

literature, however, did affect the skills that were used in this study. The different function groups were filled with skills that are specifically linked to “Alexa” and “Google Home” smart speakers. This way, some participants might not have been familiar with some of the skills they were shown. Therefore, they might have stayed neutral in their answers or simply guessed how often they would use the unknown skill.

Conclusion

The key finding of this study demonstrated that the trust in smart speakers does have an effect on the skill usage behaviour of people. In fact, the more personal the skill command for the device is, the more trust must be given. Thus, adding the factor trust to the earlier mentioned TAM could help to further improve the model. As already explained, the TAM shows that the factors compatibility, privacy, perceived ease of use, and perceived usefulness have an effect on a person’s attitude. This attitude is then linked to a person’s intention to use the device. The addition of trust, as it is presented in the research model, could help to increase precision and should, therefore, be taken into account.

Future research

As stated above, the addition of trust to the already existing TAM could be a noteworthy way to improve the model. Nonetheless, further research in the field of trust in smart speakers and the connection to skill usage could be taken as the found correlation between trust and usage was only linked to the groups of “other” and “health care”. Thus, a finding which states that the usage of other skill groups is also related to the trust in the device could be used to get even more precise results and support for the adjustment of the TAM.

Furthermore, a better tool for assessing trust in technologies could be developed. The survey for this research was self-designed and for the creation of the trust scales, many pieces of literature had to be combined and matched to ensure a fit. Since no previous studies have created a reliable tool one could use for other studies of this kind, future research could elaborate on this.

In addition, the hypothesis “General trust influences the trust in smart speakers” could not be answered due to the unacceptable reliability. Therefore, a study could try to find answers to this and, thus, try to see if there is an underlying connection between the trust in smart speakers and trust in general. This could be especially of interest as smart technologies, such as smart speakers, become more and more human. Next to that, the scales which were supposed to collect information about the social factors family and friends were excluded. Thus, future

research could develop a better scale to determine the influence of these two factors on the usage of smart technologies.

Moreover, especially in fields that deal with technologies, there is always room for future research and improvement of studies. This can be traced back to the ever-developing and changing nature of technologies. As stated earlier, companies do not only try to improve and increase the available smart speaker skills but also their privacy and safety features on a regular basis. The overall adoption of smart devices, including smart speakers, is also constantly on the rise. Thus, future research can, for instance, focus on the investigation of how new smart speaker skills affect the usage behaviour of users and non-users. Further, it can be tested if the trust towards smart technologies increases or decreases in the future and how this affects society. The number of open possibilities for this field promises many research opportunities.

Lastly, the fact that many smart speaker users and non-users are not aware of the risks of smart speakers could be tackled. Due to the increasing numbers of cyber criminality also smart speakers are affected and a cyberattack on the server could lead to severe consequences for the user. Therefore, an awareness campaign for smart speaker usage could be developed. This way people could get the opportunity to learn about safety and privacy implications and they could get an idea of how much they should actually trust their smart speaker.

To come to a conclusion, the findings of this research helped to investigate some gaps in the existing literature of smart speakers. Nonetheless, the ever-changing field of technologies and, thus, smart speakers gives other researchers many opportunities to make further interesting discoveries.

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Appendix 1 – The survey

Smart speakers survey

Start of Block: The Influence of the Level of Trust on the Skill Usage of Smart Speakers

Q25 The main aim of this study is to find out how the level of trust in smart speakers is related to the usage behaviour of people. Thus, it will examine several factors which are linked to the research question. It will focus specifically on trust and on the usage of certain skills of smart speakers.

All of the collected data of this study will be anonymized, and nothing can be traced back to you. You can stop and refuse this survey at any time without stating reasons or fearing consequences. Please answer every question on your own and be honest. There are no right or wrong answers.

The inclusion criteria for this study is that you are older than 16 and are aware of what a smart speaker is.

End of Block: The Influence of the Level of Trust on the Skill Usage of Smart Speakers

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Start of Block: Informed Consent

Q24 'I hereby declare that I have been informed in a manner which is clear to me about the nature and aim of the research. My questions have been answered to my satisfaction. I agree of my own free will to participate in this research. I reserve the right to withdraw this consent without the need to give any reason and I am aware that I may withdraw from the experiment at any time. If my research results are to be used in scientific publications or made public in any other manner, then they will be made completely anonymous. My personal data will not be disclosed to third parties without my express permission. I am older than 16 years old. If I request further information about the research, now or in the future, I may contact the researcher Alina Schmuck;
email: a.schmuck@student.utwente.nl. If you have any complaints about this research, please direct them to the secretary of the Ethics Committee of the Faculty of Behavioural, Management and Social Sciences at the University of Twente, Drs. L. Kamphuis-Blikman P.O. Box 217, 7500 AE Enschede (NL), telephone: +31 (0)53 489 3399;
email: l.j.m.blikman@utwente.nl).

- ○ Agree
- ○ Disagree

Skip To: End of Survey If 'I hereby declare that I have been informed in a manner which is clear to me about the nature and... = Disagree

End of Block: Informed Consent

Start of Block: Demographics

Q1 What is your gender?

- ○ Male
- ○ Female
- ○ Other

Q2 How old are you?

_____

Q4 What is your nationality?

▼ Afghanistan ... Zimbabwe

End of Block: Demographics

Start of Block: Trust

Q5 Please read the statements below carefully and rank them on a scale from 1 (strongly disagree) to 5 (strongly agree).

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I often take care of my friends' belongings.	○	○	○	○	○
Generally speaking, I would say that I am a good person.	○	○	○	○	○
Others can rely on me.	○	○	○	○	○
I am good at keeping secrets.	○	○	○	○	○
I have only good intentions.	○	○	○	○	○
My friends would say that I am a trustworthy person.	○	○	○	○	○
I take advantage of people when I get the chance.	○	○	○	○	○

Q6 Please read the statements below carefully and rank them on a scale from 1 (strongly disagree) to 5 (strongly agree).

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I often lend money to my friends.	○	○	○	○	○
I am convinced that most people have good intentions.	○	○	○	○	○
In general, people can be trusted.	○	○	○	○	○
I often lend personal possessions to my friends.	○	○	○	○	○
You can't truly rely on anyone.	○	○	○	○	○
I think that most people would take advantage of me, if they had the chance.	○	○	○	○	○
I tend to doubt information from the media.	○	○	○	○	○
I would ask a stranger to look after my belongings when I leave for a few minutes.	○	○	○	○	○

Q7 Please rank the statements about smart speakers on a scale from 1 (strongly disagree) to 5 (strongly agree).

A smart speaker...

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
... has good functionalities.	○	○	○	○	○
... has features that are helpful to complete everyday tasks.	○	○	○	○	○
... has the ability to do what I want it to do.	○	○	○	○	○
... can help me with available help-functions.	○	○	○	○	○
... provides competent guidance.	○	○	○	○	○
... provides whatever help I need.	○	○	○	○	○
... is very reliable.	○	○	○	○	○
... does not fail me.	○	○	○	○	○
... is very dependable	○	○	○	○	○
... acts only in my best interest.	○	○	○	○	○
... does its best to help me if I need help.	○	○	○	○	○
... is only interested in my well-being.	○	○	○	○	○

End of Block: Trust

Start of Block: Smart Speakers

Q8 Do you have a smart speaker?

- ○ Yes
- ○ No

Display This Question:

If Do you have a smart speaker? = Yes

Q9 Please select what kind of smart speakers you own.

- ☐ Alexa Echo
- ☐ Google Home
- ☐ Sonos One
- ☐ Siri
- ☐ Other _____

End of Block: Smart Speakers

Start of Block: Smart Speaker Skills

Display This Question:

If Do you have a smart speaker? = Yes

Q11
In this section, you will be asked how often you use certain skills of your smart speaker. Please pick the most fitting answer.

Advanced Multimedia

How often do you use your smart speaker to...

	Never	Rarely	Moderate	Often	Daily
... play music?	○	○	○	○	○
... play games?	○	○	○	○	○
... control other smart technologies (e.g. smart vacuum cleaner)?	○	○	○	○	○
... listen to audiobooks?	○	○	○	○	○
... watch TV?	○	○	○	○	○
... listen to a podcast?	○	○	○	○	○
... open apps?	○	○	○	○	○
... do online shopping?	○	○	○	○	○

Display This Question:

If Do you have a smart speaker? = Yes

Q12 **Energy Efficiency**

How often do you use your smart speaker to...

	Never	Rarely	Moderate	Often	Daily
... turn your lights on/ off?	○	○	○	○	○
... control your thermostat?	○	○	○	○	○
... turn on/ off other smart devices in your house?	○	○	○	○	○
... get insights into your home's energy consumption?	○	○	○	○	○
... ask general questions about energy efficiency?	○	○	○	○	○

Display This Question:

If Do you have a smart speaker? = Yes

Q13 **Health Care**

How often do you use your smart speaker to...

	Never	Rarely	Moderate	Often	Daily
... get recipe ideas?	○	○	○	○	○
... connect it to fitness equipment (e.g. Fitbit)?	○	○	○	○	○
... get advice on what to eat or drink.?	○	○	○	○	○
... get motivation (e.g. listening to motivational quotes)?	○	○	○	○	○
... do a workout?	○	○	○	○	○
... ask for general health tips/ advices?	○	○	○	○	○
... trun on relaxing melodies?	○	○	○	○	○

Display This Question:

If Do you have a smart speaker? = Yes

Q14 **Other**

How often do you use your smart speaker to...

	Never	Rarely	Moderate	Often	Daily
... get a weather report?	○	○	○	○	○
... check your credit-card balance?	○	○	○	○	○
... schedule a meeting?	○	○	○	○	○
... get help in emergencies?	○	○	○	○	○
... have a text read out loud?	○	○	○	○	○
... get a news report (e.g. on sports)?	○	○	○	○	○
... set important reminders?	○	○	○	○	○
... set an alarm?	○	○	○	○	○
... ask general questions of interest?	○	○	○	○	○
... call someone?	○	○	○	○	○

End of Block: Smart Speaker Skills

Start of Block: Smart Speaker Skills

Display This Question:

If Do you have a smart speaker? = No

Q15
Please imagine that you own a smart speaker and indicate how often you would use the following skills.

Advanced Multimedia

How often would you use your smart speaker to...

	Never	Rarely	Moderate	Often	Daily
... play music?	○	○	○	○	○
... play games?	○	○	○	○	○
... control other smart technologies (e.g. smart vacuum cleaner)?	○	○	○	○	○
... listen to audiobooks?	○	○	○	○	○
... watch TV?	○	○	○	○	○
... listen to a podcast?	○	○	○	○	○
... open apps?	○	○	○	○	○
... do online shopping?	○	○	○	○	○

Display This Question:

If Do you have a smart speaker? = No

Q16 **Energy Efficiency**

How often would you use your smart speaker to...

	Never	Rarely	Moderate	Often	Daily
... turn your light on/ off?	○	○	○	○	○
... control your thermostat?	○	○	○	○	○
... turn on/ off other smart devices in the house?	○	○	○	○	○
... get insights into your home's energy consumption?	○	○	○	○	○
... ask general questions about energy efficiency?	○	○	○	○	○

Display This Question:

If Do you have a smart speaker? = No

Q17 **Health Care**

How often would you use your smart speaker to...

	Never	Rarely	Moderate	Often	Daily
... get recipe ideas?	○	○	○	○	○
... connect it to fitness equipment (e.g. Fitbit)?	○	○	○	○	○
... get advice on what to eat or drink?	○	○	○	○	○
... get motivation (e.g. listening to motivational quotes)?	○	○	○	○	○
... do a workout?	○	○	○	○	○
... ask for general health tips/ advices?	○	○	○	○	○
... turn on relaxing melodies?	○	○	○	○	○

Display This Question:

If Do you have a smart speaker? = No

Q18 **Other**

How often would you use your smart speaker to...

	Never	Rarely	Moderate	Often	Daily
... get a weather report?	○	○	○	○	○
... check your credit-card balance?	○	○	○	○	○
... schedule a meeting?	○	○	○	○	○
... get help in emergencies?	○	○	○	○	○
... have a text read out loud?	○	○	○	○	○
... get a news report (e.g. on sports)?	○	○	○	○	○
... set important reminders?	○	○	○	○	○
... set an alarm?	○	○	○	○	○
... ask general questions of interest?	○	○	○	○	○
... call someone?	○	○	○	○	○

End of Block: Smart Speaker Skills

Start of Block: Trust and usage behaviour of smart speakers around friends and family

Display This Question:

If Do you have a smart speaker? = Yes

Q19 Please read the statements below carefully and rank them on a scale from 1 (strongly disagree) to 5 (strongly agree).

Please keep in mind that this section focuses only on your friends.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am okay with my friends knowing the wake word(s) for my smart speaker.	○	○	○	○	○
I allow my friends to use my smart speaker without me being present.	○	○	○	○	○
There are certain skills of my smart speaker that I only use with my friends.	○	○	○	○	○
There are certain skills of my smart speaker that I do not use when my friends are with me.	○	○	○	○	○
I use my smart speaker more often when I am with my friends.	○	○	○	○	○

Display This Question:

If Do you have a smart speaker? = Yes

Q20 Please keep in mind that this section focuses only on your family.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I allow my family to use my smart speaker without me being present.	○	○	○	○	○
There are certain skills of my smart speaker that I do not use when my family is with me.	○	○	○	○	○
I am okay with my family knowing the wake word(s) of my smart speaker.	○	○	○	○	○
There are certain skills of my smart speaker that I only use with my family.	○	○	○	○	○
I use my smart speaker more often when my family is with me.	○	○	○	○	○

End of Block: Trust and usage behaviour of smart speakers around friends and family

Start of Block: Trust and usage behaviour of smart speakers around friends and family

Display This Question:

If Do you have a smart speaker? = No

Q21 Please read the statements below carefully and rank them on a scale from 1 (strongly disagree) to 5 (strongly agree).

Please keep in mind that this section focuses only on your friends.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I would tell my friends the wake word(s) for my smart speaker.	○	○	○	○	○
I would allow my friends to use my smart speaker without me being present.	○	○	○	○	○
There are certain skills of my smart speaker that I would only use with my friends.	○	○	○	○	○
There are certain skills of my smart speaker that I would not use when my friends are with me.	○	○	○	○	○
I would use my smart speaker more often when I am with my friends.	○	○	○	○	○

Display This Question:

If Do you have a smart speaker? = No

Q22 Please keep in mind that this section focuses only on your family.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I would allow my family to use my smart speaker without me being present.	○	○	○	○	○
There are certain skills of my smart speaker that I would not use when my family is around.	○	○	○	○	○
I would tell my family the wake word(s) of my smart speaker.	○	○	○	○	○
There are certain skills of my smart speaker that I would only use with my family.	○	○	○	○	○
I use my smart speaker more often when my family is with me.	○	○	○	○	○

End of Block: Trust and usage behaviour of smart speakers around friends and family

Start of Block: The End

Q23 You have reached the end of this questionnaire. Thank you for your participation! :)

End of Block: The End

Appendix 2 – The excluded friends and family scales

Friends and family scales method section

The last sub-part of the questionnaire consisted of statements regarding the trust and the usage behaviour of smart speakers with regards to one's family and friends. Here, the statements were formulated by the researcher, based on the background of the research from Chu (2019). In his survey, which dealt with the intention to adopt smart speakers, he was interested in the effect of the social influence of people. The items he created for this were, for instance, "People who are important to me use my smart speaker". On the basis of this, this sub-part and its items were created. Instead of focusing on the social influence in general, however, a division was made between family and friends.

The statements remained the same, yet there were different tables for family and friends to ensure a clear distinction between the two. Each table consisted of five items. The table which focused only on friends consisted of the items "I am okay with my friends knowing the wake word(s) for my smart speaker", "I allow my friends to use my smart speaker", "There are certain skills of my smart speaker that I only use with my friends", "There are certain skills of my smart speaker that I do not use when my friends are with me", and "I use my smart speaker more often when I am with my friends".

The table which focused on family consisted of the items "I allow my family to use my smart speaker without me being present", "There are certain skills of my smart speaker that I do not use when my family is with me", "I am okay with my family knowing the wake word(s) of my smart speaker", "There are certain skills of my smart speaker that I only use with my family", and "I use my smart speaker more often when my family is with me".

Also, for this sub-part, the answer options were shown on a five-point Likert-scale (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree).

Appendix 3 – List of all Nationalities

List of Countries

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bangladesh	1	1,0	1,0	1,0
	Belgium	1	1,0	1,0	2,0
	China	2	2,0	2,0	4,0
	Colombia	1	1,0	1,0	5,0
	Czech Republic	1	1,0	1,0	5,9
	Egypt	1	1,0	1,0	6,9
	El Salvador	1	1,0	1,0	7,9
	Ethiopia	1	1,0	1,0	8,9
	Finland	1	1,0	1,0	9,9
	Germany	32	31,7	31,7	41,6
	Greece	1	1,0	1,0	42,6
	Hong Kong (S.A.R.)	1	1,0	1,0	43,6
	Hungary	3	3,0	3,0	46,5
	Ireland	1	1,0	1,0	47,5
	Italy	2	2,0	2,0	49,5
	Japan	1	1,0	1,0	50,5
	Kenya	1	1,0	1,0	51,5
	Lithuania	1	1,0	1,0	52,5
	Malaysia	1	1,0	1,0	53,5
	Malta	1	1,0	1,0	54,5
	Mexico	2	2,0	2,0	56,4
	Nepal	1	1,0	1,0	57,4
	Netherlands	10	9,9	9,9	67,3
	Peru	3	3,0	3,0	70,3
	Poland	3	3,0	3,0	73,3
	Portugal	2	2,0	2,0	75,2
	Sri Lanka	1	1,0	1,0	76,2
	Thailand	1	1,0	1,0	77,2
	Turkey	1	1,0	1,0	78,2
	United Kingdom of Great Britain and Northern Ireland	13	12,9	12,9	91,1
	United States of America	8	7,9	7,9	99,0
	Venezuela, Bolivarian Republic of...	1	1,0	1,0	100,0

Total	101	100,0	100,0	

Appendix 4 – Spearman's Rho correlation of H1

Table 4

Comparison of the level of trust in smart speakers of user and non-users

	Trust in smart speakers					
	N	Mean	SD	F	t	Sig.
User	36	3.5	0.42	2.857	2.421	.017
Non-User	65	3.2	0.59			

Appendix 5 – Cronbach's Alpha table of all Sub-parts of the Questionnaire

Summary of Cronbach's Alpha of the different sub-parts of the questionnaire

Sub-part	Cronbach's Alpha	N of items
General Trust		
- Being trusted and Trusting others	*.317*	*15*
- Trust towards smart speakers	*.871*	*12*
Smart Speaker Skills		
Advanced multimedia		
- Non-User	*.706*	*8*
- User	*.711*	*6*
- Energy efficiency		
- Non-User	*.887*	*5*
- User	*.851*	*5*
Health care		
- Non-User	*.892*	*7*
- User	*.870*	*7*
Other		
- Non-User	*.860*	*9*
- User	*.846*	*9*

Appendix 6 – Factor Analyses

User and Non-User – Trust in Smart Speakers

KMO and Bartlett's Test[a]

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,820
Bartlett's Test of Sphericity	Approx. Chi-Square	468,479
	df	66
	Sig.	,000

Total Variance Explained[a]

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4,546	37,880	37,880	4,546	37,880	37,880
2	1,967	16,394	54,274	1,967	16,394	54,274
3	1,169	9,741	64,015	1,169	9,741	64,015
4	,814	6,782	70,797			
5	,661	5,508	76,306			
6	,621	5,172	81,477			
7	,513	4,273	85,750			
8	,461	3,844	89,595			
9	,387	3,229	92,824			
10	,354	2,948	95,771			
11	,260	2,167	97,938			
12	,247	2,062	100,000			

Extraction Method: Principal Component Analysis.

User – Avanced Multimedia

KMO and Bartlett's Test[a]

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,708
Bartlett's Test of Sphericity	Approx. Chi-Square	42,817
	df	15
	Sig.	,000

a. Only cases for which Do you have a smart speaker?
= Yes are used in the analysis phase.

Total Variance Explained[a]

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,559	42,646	42,646	2,559	42,646	42,646
2	1,194	19,906	62,552	1,194	19,906	62,552
3	,762	12,701	75,253			
4	,651	10,848	86,101			
5	,500	8,330	94,431			
6	,334	5,569	100,000			

Extraction Method: Principal Component Analysis.
a. Only cases for which Do you have a smart speaker? = Yes are used in the analysis phase.

Non-user – Advanced Multimedia

KMO and Bartlett's Test[a]

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,620
Bartlett's Test of Sphericity	Approx. Chi-Square	118,591
	df	28
	Sig.	,000

a. Only cases for which Do you have a smart speaker?
= No are used in the analysis phase.

Total Variance Explained[a]

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,679	33,487	33,487	2,679	33,487	33,487
2	1,644	20,551	54,039	1,644	20,551	54,039
3	,898	11,227	65,266			
4	,846	10,577	75,843			
5	,748	9,355	85,198			
6	,524	6,552	91,749			

7	,402	5,021	96,771			
8	,258	3,229	100,000			

Extraction Method: Principal Component Analysis.
a. Only cases for which Do you have a smart speaker? = No are used in the analysis phase.

User – Energy Efficiency

KMO and Bartlett's Test[a]

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,758
Bartlett's Test of Sphericity	Approx. Chi-Square	84,487
	df	10
	Sig.	,000

a. Only cases for which Do you have a smart speaker? = Yes are used in the analysis phase.

Total Variance Explained[a]

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,202	64,036	64,036	3,202	64,036	64,036
2	,822	16,450	80,486			
3	,472	9,433	89,919			
4	,313	6,255	96,175			
5	,191	3,825	100,000			

Extraction Method: Principal Component Analysis.
a. Only cases for which Do you have a smart speaker? = Yes are used in the analysis phase.

Non-User – Energy Efficiency

KMO and Bartlett's Test[a]

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,790
Bartlett's Test of Sphericity	Approx. Chi-Square	244,934
	df	10
	Sig.	,000

a. Only cases for which Do you have a smart speaker?
= No are used in the analysis phase.

Total Variance Explained[a]

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,485	69,693	69,693	3,485	69,693	69,693
2	,995	19,909	89,602			
3	,208	4,170	93,771			
4	,167	3,334	97,105			
5	,145	2,895	100,000			

Extraction Method: Principal Component Analysis.
a. Only cases for which Do you have a smart speaker? = No are used in the analysis phase.

User – Health care

KMO and Bartlett's Test[a]

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,799
Bartlett's Test of Sphericity	Approx. Chi-Square	141,895
	df	21
	Sig.	,000

a. Only cases for which Do you have a smart speaker?
= Yes are used in the analysis phase.

Total Variance Explained[a]

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4,109	58,693	58,693	4,109	58,693	58,693
2	1,069	15,270	73,963	1,069	15,270	73,963
3	,670	9,570	83,533			
4	,528	7,544	91,077			
5	,300	4,283	95,360			

6	,201	2,871	98,231			
7	,124	1,769	100,000			

Extraction Method: Principal Component Analysis.
a. Only cases for which Do you have a smart speaker? = Yes are used in the analysis phase.

Non-User – Health Care

KMO and Bartlett's Test[a]

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,877
Bartlett's Test of Sphericity	Approx. Chi-Square	234,775
	df	21
	Sig.	,000

a. Only cases for which Do you have a smart speaker? = No are used in the analysis phase.

Total Variance Explained[a]

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4,283	61,187	61,187	4,283	61,187	61,187
2	,774	11,056	72,243			
3	,578	8,251	80,494			
4	,495	7,077	87,570			
5	,393	5,614	93,185			
6	,301	4,296	97,481			
7	,176	2,519	100,000			

Extraction Method: Principal Component Analysis.
a. Only cases for which Do you have a smart speaker? = No are used in the analysis phase.

User – Other

KMO and Bartlett's Test[a]

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,769

Bartlett's Test of Sphericity	Approx. Chi-Square	182,383
	df	36
	Sig.	,000

a. Only cases for which Do you have a smart speaker? = Yes are used in the analysis phase.

Total Variance Explained[a]

Componen t	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4,173	46,368	46,368	4,173	46,368	46,368
2	1,827	20,303	66,671	1,827	20,303	66,671
3	1,111	12,346	79,017	1,111	12,346	79,017
4	,695	7,720	86,737			
5	,393	4,367	91,104			
6	,352	3,907	95,012			
7	,192	2,137	97,149			
8	,165	1,831	98,980			
9	,092	1,020	100,000			

Extraction Method: Principal Component Analysis.

a. Only cases for which Do you have a smart speaker? = Yes are used in the analysis phase.

Non-User Other

KMO and Bartlett's Test[a]

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,811
Bartlett's Test of Sphericity	Approx. Chi-Square	228,616
	df	36
	Sig.	,000

a. Only cases for which Do you have a smart speaker? = No are used in the analysis phase.

Total Variance Explained[a]

Componen t	Initial Eigenvalues	Extraction Sums of Squared Loadings

	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4,293	47,696	47,696	4,293	47,696	47,696
2	1,170	13,005	60,701	1,170	13,005	60,701
3	,951	10,570	71,271			
4	,715	7,943	79,214			
5	,571	6,348	85,562			
6	,450	4,995	90,557			
7	,320	3,560	94,117			
8	,281	3,117	97,234			
9	,249	2,766	100,000			

Extraction Method: Principal Component Analysis.

a. Only cases for which Do you have a smart speaker? = No are used in the analysis phase.

User – Family Trust

KMO and Bartlett's Test[a]

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,501
Bartlett's Test of Sphericity	Approx. Chi-Square	51,043
	df	6
	Sig.	,000

a. Only cases for which Do you have a smart speaker? = Yes are used in the analysis phase.

Total Variance Explained[a]

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1,924	48,110	48,110	1,924	48,110	48,110
2	1,537	38,414	86,524	1,537	38,414	86,524
3	,304	7,602	94,126			
4	,235	5,874	100,000			

Extraction Method: Principal Component Analysis.

a. Only cases for which Do you have a smart speaker? = Yes are used in the analysis phase.

Non-User – Family Trust

KMO and Bartlett's Test[a]

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,664
Bartlett's Test of Sphericity	Approx. Chi-Square	50,918
	df	6
	Sig.	,000

a. Only cases for which Do you have a smart speaker? = No are used in the analysis phase.

Total Variance Explained[a]

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,138	53,457	53,457	2,138	53,457	53,457
2	,903	22,567	76,023			
3	,554	13,862	89,885			
4	,405	10,115	100,000			

Extraction Method: Principal Component Analysis.

a. Only cases for which Do you have a smart speaker? = No are used in the analysis phase.