Research Article

# Trust in Digital Voice Assistants: A Fundamental Determinant for Companies' and Customers' Engagement in Voice Commerce

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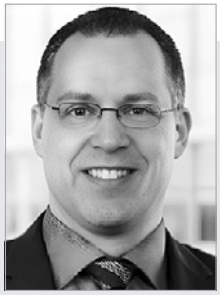
Voice shopping, i.e., shopping via conversational interactions with digital voice assistants, is currently on the rise but still in its infancy in Germany. In the context of voice commerce, companies may utilize digital voice assistants as an additional communication and distribution channel. However, users' entry into voice shopping is crucially determined by their adoption of digital voice assistants. In this context, privacy concerns are the primary challenge for the dissemination and acceptance of digital voice assistants impeding the advancement of voice shopping. Similar to the past emergence of electronic commerce, trust seems to be the ultimate and decisive factor for the willingness to use digital voice assistants and engage in voice-based interactions and transactions. We set up a model by combining the typology of trust with the established technology acceptance model applied to the context of digital voice assistants. In an empirical study, we test our model and found that, e.g., trust reduces perceived privacy risks and positively influences users' attitudes and intentions towards and subsequently use of digital voice assistants. We found various routes of trust in the use of digital voice assistants as a necessary condition for users' adoption. Our results provide insights into important antecedents for the dissemination of digital voice assistants and subsequently for the adoption of voice commerce into companies' business models.



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## 1. Introduction

Nowadays, digital voice assistants like Amazon's Alexa are well-known and widely used. In 2021, 1.8 billion people are said to use digital voice assistants (Tractica 2016) and forecasts suggest that the number of digital voice assistants will exceed 8.4 billion in 2024 (Juniper Research 2020). This megatrend provides great opportunities for entrepreneurial activities, both for providers of digital voice assistants, e.g., Google and Amazon, and for companies who conduct voice commerce by utilizing digital voice assistants through dedicated applications. Hence, due to the increasing dissemination of digital voice assistants, entrepreneurs should embrace this pervasive technology and seize these opportunities for their business activities.

Voice shopping, i.e., shopping via conversational interactions with digital voice assistants, will increase its importance in the near future (Halbauer & Klarmann, 2022; Hu et al., 2023). While voice shopping is nowadays commonplace in the US, it is still in its infancy in Germany. Hence, companies may utilize digital voice assistants as an additional communication and distribution channel. The buzzword "Voice Marketing" comprises four areas, i.e., voice search, voice assistance, voice entertainment, and voice commerce. While voice search is used for voice-controlled information retrieval from the Internet, e.g., weather forecast for tomorrow, voice assistance offers the possibility to operate smart home applications, e.g. regulation of the radiators, by voice. Voice entertainment – as the name suggests – includes voice-controlled

entertainment, e.g., playlists from Spotify are played via voice command. In the context of voice commerce, integrated shopping functions like Amazon's "buy-it-again" are used to proceed with a transaction (Paluch & Wittkop 2020). From a marketing point of view, all four areas are of interest to companies, since companies can make direct or indirect contact with customers in all areas. However, "voice commerce" seems to be the most challenging because it necessitates changes respectively enhancements in their marketing strategies and business models. The inhibition threshold for users and, thus, customers to participate in voice commerce by using digital voice assistants is certainly the highest among all four areas. Recent literature found, that German customers are reluctant to use of digital voice assistants for (voice) shopping (Rzepka et al., 2020). One main reason constitutes that voice shopping necessitates the storage of personal and payment information. In this context, the (perceived privacy) risk of unrelated and improper use by companies and unauthorized third-parties may result in extensive personal and financial risks for users of digital voice assistants. In turn, customers perceived high privacy risks hamper the development of voice shopping and, thus, voice commerce via digital voice assistants.

A central entrepreneurial issue is the understanding of determinants that affect users' adoption of voice shopping. It can be assumed that users' inhibition threshold for voice shopping can be lowered by trust in digital voice assistants (e.g., Choung et al., 2022; Lucia-Palacios & Pérez-López, 2021, Rzepka et al., 2020). Hence, (technology) trust can be seen as an important determinant for the use of digital voice assistants per se and subsequently for the adaption of voice shopping. Conversely, if customers are generally willing to use digital voice assistants for (voice) shopping, this technology has the potential to spark entrepreneurial activities and (re-) shape entire business models, creating entire voice commerce. This abovementioned assumption is based on the developments in electronic commerce that found trust to be a critical success factor in electronic commerce (Pavlou, 2003). McKnight et al. (2011), for example, outline the importance of technology trust and McKnight and Chervany (2001) point out four trust dimensions for electronic commerce success. The past emergence of electronic commerce culminates in trust as the ultimate and decisive factor. Similarly, following existing research on trust in digital voice assistants (see *Tab. 1*), the present study proposes trust as the fundamental determinant for users' willingness to engage in voice-based interactions and transactions and to use digital voice assistants. Whereas the general importance of trust is acknowledged, no study so far has researched the assumption of trust as an ultimate and decisive factor for the willingness to use digital voice assistants and engage in voice-based interactions and transactions in an all-encompassing way.

Our study, therefore, contributes to two research fields, i.e., digital voice assistants and trust, by investigating the antecedents for the use of digital voice assistants per se and a successful application of voice commerce by companies. In particular, we scrutinize whether (similar to the past emergence of electronic commerce) trust is the fundamental determinant for the willingness to use digital voice assistants and engage in voice-based interactions and transactions. In particular, we focus on the following research questions:

1) Does trust reduce perceived privacy risks towards digital voice assistants and subsequently increase their use?
2) Does trust increase users' attitudes and intentions towards digital voice assistants?
3) Does trust have a positive impact on users' perceived ease of use and usefulness of digital voice assistants?

Obviously, we examine different routes of trust towards the actual use of digital voice assistants. Once more, the use of digital voice assistants is a necessary condition for users' intention for voice shopping. The knowledge of trust as a fundamental determinant for the use of digital voice assistants is therefore of upmost importance for entrepreneurial actions respective the implementation of voice marketing and voice commerce.

Our study reveals that trusting intentions have a positive impact on users' perceived ease of use, usefulness, and attitudes towards digital voice assistants as well as a negative influence on perceived privacy risks. Most importantly, we reveal the importance of institution-based trust and trusting intentions in this context of digital innovations, whereas disposition to trust based on human trust showed no significant effect. While privacy risks negatively impact behavioral intentions, attitudes positively influence behavioral intentions, which in turn positively affect the actual use of digital voice assistants. In addition, digital voice assistants' ease of use as well as their usefulness positively influence attitudes towards them. Hence, we are able to reveal various routes of trust in the use of digital voice assistants. These results provide a sound basis for managerial implications both for providers of digital voice assistants as well as for companies who (plan to) use voice commerce.

The remainder of our study is organized as follows: In section 2 we highlight the research background by discussing digital voice assistants, the technology acceptance model, and trust in digital voice assistants. In section 3, we derive the research hypotheses based on the results from relevant literature and illustrate our focal model. In section 4, we present our used methodology and our empirical study. Hereby, we provide details on the measurement of items, the data collection, and the data sample as well as present the empirical results. In section 5, we discuss our results in the context of the findings from relevant literature by deriving theoretical and managerial implication. Furthermore, we provide limitations of our study and issues for future research. We conclude in section 6.

| Study | Method | | Type of Trust | | | | | Trust Results | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | DT | IT | TB | TI | other | | |
| Liao et al. 2019 | Survey (N = 1160) | binary logistic regression | | | | | Data confidence | Users' confidence in data handling positively impacts the use of smart phones and home speaker assistants. | Trust is very narrowly captured in data confidence. |
| Bawack et al. 2021 | Survey (N = 224) | variance-based SEM | | | X | | | Trust in the manufacturer positively affects the perceived customer experience performance. | Privacy concerns are considered as an antecedent of trust in smart speaker manufacturers. |
| Fernandes & Oliveira 2021 | Survey (N = 238) | variance-based SEM | | | | X | | Trust positively drives customer acceptance of DVAs. | The results suggest that the effect of trust is based on participants' preferences for interaction with technology. |
| Hasan et al. 2021 | Survey (N = 675) | variance-based SEM | | | | X | | Trust towards the voice assistants increases loyalty towards the parent brand. | Authors consider no interactions between trust and perceived risks (but found them equally important as antecedences). |
| Lee et al. 2021 | Survey (N = 221) | variance-based SEM | | | X | | | Interaction quality positively affects trust that subsequently influences the use of digital voice assistants. | Information and system quality (similar to ease of use) constitute interaction quality. |
| Liu et al. 2021 | Survey (N = 475) | covariance-based SEM | | X | | | | Perceived trust is significantly positively affected by system quality, subjective norm, and perceived enjoyment. | Trust is the outcome variable. Familiarity with voice-enabled smart home systems has no effect on perceived trust of these systems. |
| Mari & Algesheimer 2021 | Experiment (N = 180) | PROCESS model 4 | | | X | | | Results show a positive direct effect of trust on customer's satisfaction and a mediating role of set size. | High (low) level of trust were conditioned on positively (negatively) connoted consumer reports on the DVA's assistive ability. |
| Lucia-Palacios & Pérez-López 2021 | Survey (N = 607) | variance-based SEM | | | | X | | Trust in the provider reduces the perceived intrusiveness of home voice assistants. | Trust is further positively affected by the degree to which the user perceives the interaction with the DVA is two way, controllable, and responsive. |
| Pitardi & Marriot 2021 | Survey (N = 466) | covariance-based SEM | | | | X | | Trust affects users' attitude and behavioral attention. | Perceived ease of use, social presence, and social cognition affect trust but not privacy concerns. |
| Vimalkumar et al. 2021 | Survey (N = 252) | covariance-based SEM | | X | | | | Perceived trust positively impacts performance expectancy and behavioral intention. | Perceived privacy risks are an antecedent of trust. |
| Choung et al. 2022 | Survey (N = 312 and 640) | covariance-based SEM | | | | X | Human-like and technology trust | Human-like and technology trust are positively affected by perceived ease of use and impact perceived usefulness, attitude, and behavioral intention. | Human-like trust combines the benevolence and integrity, whereas technology trust refers to the competence of voice assistants. |
| Popp et al. 2022 | Survey (N = 348) | variance-based SEM | | X | | | | Trust in the operator has a positive effect on users' attitude. | Trust is influenced by the identification with the operator suggesting brand effects. |
| Reinkemeier & Gnewuch 2022 | Survey (N = 380) | variance-based SEM | | | | | Trust in integrity, competence, and benevolence | A matching personality positively affects all three trust dimensions. | Multidimensional trust is the outcome variable. |
| Song et al. 2022 | Survey (N = 420) | covariance-based SEM | | | | | Data trust | Perceived trust positively impacts senior citizens' use intention. | Trust is narrowly captured in data security and behavioral intent refers to voice-based interaction. |
| Hu et al. 2023 | Survey (N = 407) Longitudinal survey (N = 615) | polynomial regression | X | | | X | | Trust intentions are positively affected by human likeness. | Consumer trust in voice assistants is an endogenous variable affected by privacy concerns. |
| This study | Survey (N = 585) | covariance-based SEM | X | X | | X | | Trust takes various effective routes and reduces privacy risks and increase adoption and use of digital voice assistants. | A general trusting stance towards people does not completely transfer to predispositional trust in technologies. |

*Note:* DT – Disposition to Trust; IT – Institution-based Trust; TB – Trusting Beliefs; TI – Trusting Intentions; DVA – Digital Voice Assistant.

*Tab. 1: Overview of empirical studies on trust in digital voice assistants*

## 2. Research Background

### 2.1. Digital Voice Assistants

Digital voice assistants are smart devices that "can interpret human speech and respond via synthesized voices" (Hoy, 2018, p. 81). They are used in varying digital devices like smartphones, smart speakers, or car control devices, e.g., navigation devices. Well-known and widely used examples of digital voice assistants are Amazon's Alexa, Google's Assistant, and Apple's Siri. The use of digital voice assistants, i.e., the use of voice recognition and control are predicted to be the primary mode of operation for tasks in the future (Easwara Moorthy & Vu, 2015). This comes not unexpected since digital voice assistants provide, for example, the opportunity for users to make phone calls (and potentially fully relegate the call to the assistant) without haptic operation of the device – creating generally perceived usefulness of such assistants. Furthermore, verbal interaction is easy to use for people with mobility handicaps, i.e., older people who have difficulties standing up and walking to their device, or for people who are currently working with their hands, i.e., people who knead a dough. The list of examples can certainly be continued at will.

The verbal way of interaction with technical devices, such as digital voice assistants is quite intuitive and natural (Burbach et al., 2019*)*. This kind of interaction necessitates the integration of microphones in digital voice assistants that continuously monitor the acoustical environment. Digital voice assistants process all acoustical inputs via an active Internet connection (Lau et al., 2018). Especially, when voice assistants are placed within the personal environment, i.e., in-home devices, users are sensitive to what is recorded from private conversations beyond voice commands.

This circumstance is often malignantly perceived as "Digital voice assistants are spying on me" (Chalhoub & Flechais, 2020). Correspondingly, one central determinant of users' behavioral intention to use digital voice assistants is their perceived privacy risks (Burbach et al., 2019; Javed et al., 2019; Liao et al., 2019; Vimalkumar et al., 2021). In addition, privacy risks encompass questions on how the collected information is used and protected, and whether the information is used to pursue unsolicited business purposes or provided to third parties. In the context of the possibility of (voice) shopping via digital voice assistants, privacy concerns spill-over to the protection of personal payment information.

### 2.2. Technology Acceptance Model

Similar to (technology) diffusion and adaptation research, acceptance research aims to explain behavioral responses to technology use and the factors that influence the underlying processes. Acceptance generally encompasses a form of a subject's willingness, consent, and liking towards the (accepted) object that is perceived as adequate or sufficient for an intended purpose on one's responsibility. In the present study, acceptance particularly refers to consumers' attitudinal route of technology use, specifically using digital voice assistants.

Following Fishbein and Ajzen's theory of reasoned action (Ajzen & Fishbein, 1980), Davis (1989) proposed the technology acceptance model on the relationship of attitudes towards using, use intentions, and actual use. Besides the further development of the original approach (Venkatesh & Bala, 2008), Venkatesh et al. (2003) developed the 'unified theory of acceptance and use of technology' (UTAUT) based on numerous applications and extensions of the technology acceptance model. Venkatesh et al. (2016) provide a comprehensive overview of this development. Adaptability, simplicity, and soundness led to the original technology acceptance model becoming a commonly used approach for measuring the acceptance of innovative information systems (King & He, 2006). Bagozzi (2007) also offers a critical examination of the model and even calls for a paradigm shift. In particular, recent approaches abandon the role of user attitudes, which are originally grounded in the theory of planned behavior. In light of consumer behavior research, we also keep the attitudinal component. Furthermore, the technology acceptance model is perceived as "a robust and parsimonious framework for understanding user acceptance of technology in a variety of contexts" (Manis & Choi, 2019, p. 504). The present study utilizes the robust and parsimonious framework of the original technology acceptance model (Davis, 1989) that allows us the implementation of the typology of trust without inflating the complexity of the trust-related behavior (the adoption of digital voice assistants) in a rather inflexible, comprehensive alternative technology acceptance or UTAUT approach.

### 2.3. Trust in Digital Voice Assistants

Trust is one of the key success factors in customer relationships and electronic commerce, and therefore in voice commerce (Foehr & Germelmann, 2020). Trust generally relates to concepts such as confidence, honesty, and reliability in relationships and transactions (Liu et al., 2011; Morgan & Hunt, 1994) with a direct relationship to perceived risk (Pavlou, 2003). Trust has thus been widely studied by researchers in numerous disciplines, viewing trust from unique disciplinary perspectives and creating various definitions of trust. Mayer et al. (1995, p. 712) define trust as the "willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party". A cross-disciplinary meta-analysis summarizes that scholars fundamentally agree on the meaning of trust and defines trust as "a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another" (Rousseau et al., 1998, p. 395). This definition emphasizes that trust is not a behavior or a choice, but an underlying psychological condi-

tion that can cause or result from such actions. Trust is based on individuals' beliefs and confidence in the capability and willingness of another party in a situation, thereby adhering to the relationship norms and keeping promises (Ba & Pavlou, 2002; Schurr & Ozanne, 1985). Consequently, two conditions are prerequisites for trust to arise: (a) The trustor needs a confident expectation about an interdependent beneficial outcome and (b) relies on a trustee in an underlying situation characterized by risk and uncertainty.

McKnight and colleagues conceptualized a typology of trust including the four trust constructs disposition to trust, institution-based trust, trusting beliefs, and trusting intentions. For example, McKnight et al. (1998) discuss personality-based, institution-based, and cognition-based foundations for initial trust formation and the corresponding model. Whereas cognition-based trust formation refers to cognitive cues, personality- and institution-based trust are based on externalities that lead to trusting beliefs and trusting intentions. The personality-based trust argues for trust development during childhood as an infant seeks and receives help from his or her benevolent caregiver. This understanding is rooted in psychology economics and results in a general disposition to trust others (McKnight & Chervany, 2001). Institution-based trust is instead anchored in sociology and refers to trust in situational structures. For example, a person may trust because of guarantees, insurance, and other safety mechanisms (McKnight et al., 1998). Trusting beliefs refer to the specific beliefs about another party being benevolent, competent, honest, or predictable in a situation (Mayer et al., 1995). Lastly, trusting intentions refer to the willingness of a person to depend on another party in a given situation (McKnight et al., 1998; McKnight et al., 2002a). *Fig. 1* displays the interdisciplinary model of the trust typology. Obviously, while dispositional trust is a psychological state, institutional-based trust refers to the sociological category. Both concepts culminate in interpersonal trust, i.e., trusting intentions, which is a state of social psychology.

McKnight et al. (2011) clarify that, in the case of trust in technologies, such as digital voice assistants, users face the risk of unfulfilled expectations and responsibilities. While we capture trust in digital voice assistants, we concentrate on the psychological and sociological foundations, namely disposition to trust and institution-based trust. This initial study does not capture trusting beliefs about specific digital voice assistants. Trusting beliefs in digital voice assistants would warrant data on brand-specific users of digital voice assistants – most prominently Amazon Alexa, Google Home Assistant, and Apple Siri in Germany (Paetz & Schultz, 2022). However, this approach to capturing trusting beliefs would undermine the research objective of the present study to link trust and the use (and not use) of digital voice assistants.

We however acknowledge the potential for varying trusting beliefs, similar to brand effects across smart speakers (Paetz & Schultz, 2022). The authors explicitly examined the impact of psychological variables on users' preferences for certain smart speaker brands and combined parallels between certain brand effects, i.e., brand personalities, and user personalities. So quite important, the present study focuses on the trust formation towards digital voice assistants in general, not registering users' specific trusting beliefs. Even though potential brand differences exist, the authors also show the general importance of data security (Paetz & Schultz, 2022). Following our research objective, we concentrate on the psychological and sociological trust elements concerning digital voice assistants as an underlying situation. Consequently, this constitutes the situational foundation resulting in trusting intentions in our study. The study thus concentrates on disposition to trust, institution-based trust, and trusting intentions towards digital voice assistants.

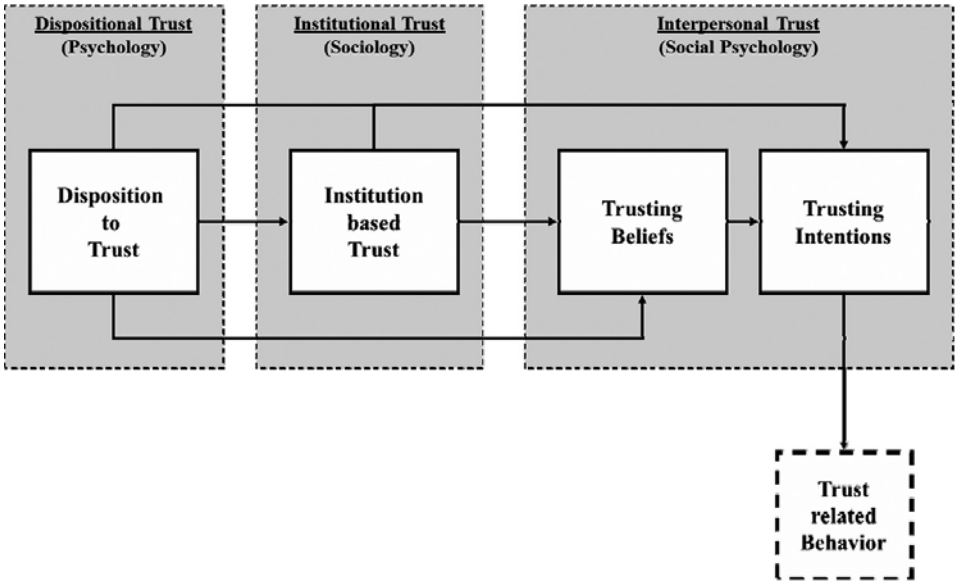


*Fig. 1: An interdisciplinary model of trust*

Digital voice assistants always listen to be able to react to users' voice commands. Their microphones register naturally voiced requests through speech recognition. Artificial intelligence, in particular natural language processing, combined with online databases is then used to answer the user's request. Beyond the technical details of digital voice assistants (Hoy 2018; Sarikaya 2017), previous research addresses, for example, consumer value dimensions (Ashfaq et al., 2021), anthropomorphic, social presence (Li & Suh, 2022; Whang & Im, 2021), and consumers' acceptance (Fernandes & Oliveira, 2021; McLean & Osei-Frimpong, 2019) of digital voice assistants.

Despite their benefits, privacy concerns are said to be the central obstacle to the widespread adoption of digital voice assistants (e.g., Easwara Moorthy & Vu, 2015, Foehr & Germelmann, 2020, Lau et al., 2018). Trust has been proposed to overcome risks and privacy concerns most notably in electronic commerce (Pavlou, 2003, Schultz, 2007). In a way, digital voice assistants – now with the power of natural language processing and speech recognition – are the consequent development of early avatars that can take on the role of trust intermediaries in electronic commerce (Bauer et al., 2005). Naturally, instead of visual appeals (e.g., Messer et al., 2019; Schultz, 2007), digital voice assistants need to communicate trust based on acoustic features (Hildebrand et al., 2020). Correspondingly, researchers have already investigated some roles of trust in digital voice assistants building the foundation for successful voice commerce. However, previous research has neglected to comprehensively capture trust and its various dimensions towards the use of digital voice assistants and voice-based interactions and transactions. *Tab. 1* provides an overview of empirical studies considering trust in digital voice assistants.

We note three relevant observations based on the literature overview. Firstly, the role of trust across the studies presented in *Tab. 1* relates to the complexity of the trust construct. Various studies use different trust concepts in the research context. Secondly, multiple aspects of trust are only started to be captured (Reinkemeier & Gnewuch, 2022; Choung et al., 2022). Most closely related to the present study, Reinkemeier and Gnewuch (2022) capture the three trust conceptualizations, competence, integrity, and benevolence. However, the authors use trust as the outcome variable. The match between the user's personality and the voice assistant's personality increases these underlying concepts of trust. We cannot infer the effects of trust for digital voice assistant adoption and use. Similarly, Choung et al. (2022) consider competence, integrity, and benevolence. Based on a preliminary principal component analysis, the authors derive two components: human-like trust combining integrity and benevolence and technology trust referring to digital voice assistants' competence. The findings reveal positive effects of perceived trust on perceived usefulness, attitude, and usage intention. Thirdly, previous research illustrates the dynamic relationship between trust and risk (Rousseau et al., 2008). Researchers consider trust as an antecedent of perceived risks (Vimalkumar et al., 2021), and trust directly affects users' perceived risks (Lucia-Palacios & Pérez-López, 2021).

Following the literature overview, we concentrate on a comprehensive understanding of trust following a trust typology by McKnight and colleagues. Similar to the emergence of electronic commerce, trust is considered the fundamental determinant for users' willingness to use digital voice assistants. To capture an all-encompassing understanding of trust, this study considers disposition to trust, institution-based trust, and trusting intentions. Following the overview, we consider different routes of trust towards the use of digital voice assistants. Section 3 outlines the corresponding research model that integrates the typology of trust in the adoption of innovative technologies through the technology acceptance model.

## 3. Research Hypotheses and Model

For the development of the research model, we concentrate the discussion on the integration of the trust typology into the context of the technology acceptance model. The present study adopts McKnight's trust typology regarding the use of digital voice assistants. For the general use of these assistants, we concentrate on users' disposition to trust, voice assistants' institution-based trust, and users' trusting intentions towards digital voice assistants. We focus on the relevance of trust intentions, which are formed by the disposition of trust and institution-based trust. Regarding the trust formation towards digital voice assistants in general, this study follows the underlying conceptualization and findings for Hypothesis 1 through Hypothesis 3 (McKnight et al., 1998; McKnight et al., 2002a). The typology is based on research streams of knowledge-based, calculative-based, personality-based, institution-based, and cognition-based trust (McKnight et al., 1998). Whereas disposition to trust relates to personality trust, e.g., faith in humanity, institution-based trust relates to the security and mechanisms, e.g., guarantees, of the underlying structure. Personality-based trust naturally exerts an overall effect on subsequent trust formation, such as towards the institution – the digital structure of digital voice assistants. Trusting intentions are then formed regarding the specific situation at hand which is the interaction with digital voice assistants. The specific situation and, thus, trusting intentions, directly depend on the underlying personal disposition to trust and the institutional level of trust. In particular, introducing a listening device into personal space warrants questions of trust, similar to digital contact tracing (Heimann et al., 2023) and wearables (Arfi et al., 2021). For example, a couple in expectation discusses the design of a children's room at dinner. They do not want the digital voice assistant to be listening in and particularly do not want unsolicited advertising for the children's room and most certainly do not want the voice assistant to share the

information about the pregnancy with, for example, banks and insurance companies. Following the typology of trust (McKnight et al., 1998; McKnight et al., 2002a), we hypothesize:

*H1: Disposition to trust has a positive effect on the institution-based trust towards digital voice assistants.*

*H2: Disposition to trust has a positive effect on the trusting intentions towards digital voice assistants.*

*H3: Institution-based trust has a positive effect on the trusting intentions towards digital voice assistants.*

Next, we discuss the effects of trust on the technology acceptance model. Following e-commerce studies of technology acceptance, trust influences users' perceived ease of use, usefulness, and attitude (Pavlou, 2003). Perceived ease of use is the degree to which consumers believe that using technology is effortless (Davis, 1989). Let us deepen the above-mentioned example: A father is kneading dough for cookies and – fully in a baking mood – thinks about the upcoming birthday of his daughter for which he wants to create a fabulous birthday cake. He realizes that he needs cake decoration, such as fondant, which he can order immediately via the digital voice assistant. This is very effortless, e.g., saves time, because he can continue with the cookie dough without cleaning his hands before placing the order via a laptop. However, the underlying assumption is that he engages in voice commerce because he trusts the system to understand the buying intent, i.e., cake decoration, and the transaction is subsequently fulfilled through the service provider and the vendor.

In general, trust reduces the need for users to understand, monitor, and control the functionality of the systems. Trust can thus reduce time and effort in handling the system and, subsequently, increase the perceived ease of use. Perceived usefulness is the degree to which consumers believe that technology will facilitate the target situation (Davis, 1989). In electronic commerce, consumers are willing to be vulnerable based on their expectations towards the utility provided by the service providers (Gefen & Straub, 2002). Trust allows consumers to become vulnerable and belief that online vendors provide the expected products and services (Pavlou, 2003). Choung et al. (2022) provide support for this positive effect of trust on perceived usefulness in the context of digital voice assistants. Beyond trust's indirect effect through perceived ease of use and usefulness, we also include the direct effect of trust on attitude towards digital voice assistants in our research model. In the case of innovative and emerging technologies, users must possess a certain level of trust overcoming perceptions of risks and, in consequence, form a positive attitude towards using the technology (Zhang et al., 2019). The perspective of voice shopping requires an even higher level of trust as directing our attention to digital buying behavior involves higher risks. Insights from digital voice assistant research also show that a higher level of trust increases attitude towards digital voice assistants (Choung et al., 2022; Pitardi & Marriot, 2021; Popp et al., 2022). We note, however, that these previous studies consider various dimensions of trust (see *Tab. 1*). Hence, we propose the following positive effects of users' trusting intentions.

*H4: Trusting intentions towards digital voice assistants increase the perceived ease of use of these assistants.*

*H5: Trusting intentions towards digital voice assistants increase the perceived usefulness of these assistants.*

*H6: Trusting intentions towards digital voice assistants increase the attitudes towards these assistants.*

Whereas previous research concentrates on the role of perceived risks on trust (e.g., Bawack et al. 2021; Vimalkumar et al., 2021), our research objective is to answer whether trust mitigates the perceived risks regarding digital voice assistants. In the dynamic relationship of trust and risk (Rousseau et al., 1998; Schultz, 2007), we follow the focal role of trust and are interested in its effect on perceived risk. In general, trust mitigates risky situations since individuals become vulnerable to trusted parties (Mayer et al., 1995). For example, trust is central in commercial activities because it reduces the risk of opportunistic behavior (Pavlou, 2003). Privacy risks are threats that potentially arise through digital voice assistants due to listening in on private conversations (Foehr & Germelmann, 2020). In the context of smart home speakers, trusting intentions are found to reduce the perceived intrusiveness of home voice assistants and trust relaxes users' needs to fully understand these digital systems (Lucia-Palacios & Pérez-López, 2021). The underlying intrusion on private space naturally harms potential avenues for voice commerce. Based on these findings for home voice assistants, we hypothesize the mitigating effect of trust on the perceived privacy risks against digital voice assistants.

*H7: Trusting intentions towards digital voice assistants reduce the perceived privacy risks against these assistants.*

Previous research considers various effects of perceived risks on the elements of the technology acceptance model, for example, attitudes and behavioral intention (Schultz & Brüggemann, 2022). One dominant route in the context of digital voice assistants seems to be the effect on behavioral intention (Kowalczuk, 2018; Liao et al., 2019), similar to electronic commerce (Pavlou, 2003). For example, privacy risks in combination with surveillance anxiety negatively affect the use intention of smart speakers (Kowalczuk, 2018). This negative finding is particularly present for smart home services that invade home privacy. Liao et al. (2019) consequently find that people consider buying digital voice assistants for home use have lower general privacy concerns. Hence, we propose a negative effect of perceived privacy risks on the intention to use digital voice assistants.

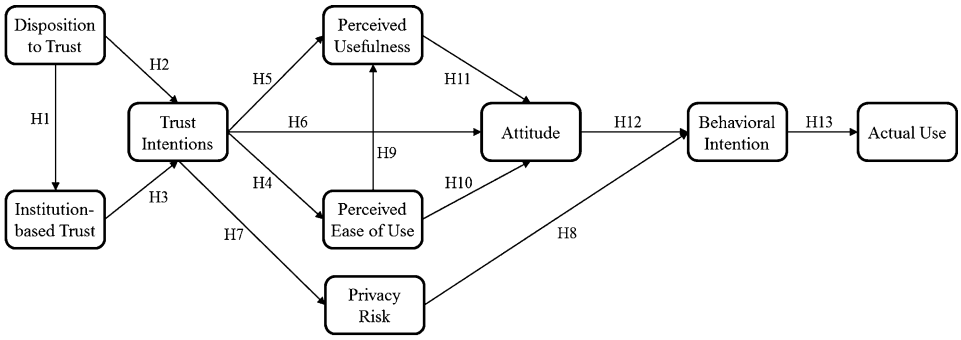


*Fig. 2: Research Model*

*H8: Perceived privacy risks regarding digital voice assistants reduce the behavioral intention to use these assistants.*

Digital voice assistants are a disruptive, innovative technology (e.g., Halbauer & Klarmann, 2022). An established basis for studying the acceptance and use of such technologies is the technology acceptance model (Manis & Choi, 2019). This study thus follows the established argumentation for Hypothesis 9 through Hypothesis 13 (Davis, 1989; Davis et al., 1989) adapted to the context of digital voice assistants. Hence, we propose:

*H9: Perceived ease of use of digital voice assistants has a positive effect on their perceived usefulness.*

*H10: Perceived ease of use of digital voice assistants has a positive effect on the attitude towards using these assistants.*

*H11: Perceived usefulness of digital voice assistants has a positive effect on the attitude towards using these assistants.*

*H12: Attitude towards using digital voice assistants has a positive effect on the behavioral intention to use these assistants.*

*H13: Behavioral intention to use digital voice assistants has a positive effect on their actual use.*

*Fig. 2* presents the resulting research model.

## 4. Methodology and Empirical Study

### 4.1. Measurement

For data collection, we developed an online questionnaire with all measurement items based on multi-item measurement scales from the literature. We slightly modified the measurement items to the present research context of digital voice assistants. All items were measured reflectively on a 7-point rating scale, ranging from 1 ("strongly disagree") to 7 ("strongly agree"). Similar to Pavlou (2003), we measured the user experience with digital voice assistants for participants' actual use. We extended the scale measurement using a 101 slider, ranging from 1 ("no experience at all") to 101 ("a lot of experience").

For the trust dimensions, we utilized the conceptualization by McKnight et al. (2002a) and adapted items from the corresponding empirical validation in McKnight et al. (2002b). The general disposition to trust and institution-based trust are measured each by 3 items based on personal trusting stance and situational normality (McKnight et al., 2002a). McKnight et al. (2002b) provided a 5-item scale to measure the trusting intentions adapted towards digital voice assistants.

Davis (1985, 1989) provides the measurement foundation for the elements of the technology acceptance model. Moriuchi (2019) added some insights towards the item adaptation regarding digital voice assistants. Perceived ease of use, perceived usefulness, attitude, and behavioral intention are correspondingly measured with 7, 9, 3, and 4 items respectively. Lastly, we derived 7 items for perceived privacy risks from Padyab and Ståhlbröst (2018) regarding data collection and secondary data usage.

Beyond these measurement items, the questionnaire included variables on demographics, such as age, gender, education, occupation, as well as ownership of digital voice assistants.

### 4.2. Data Collection and Data Sample

We deployed a cross-sectional survey research design to explore the modeled associations in the context of digital voice assistants. A pretest with 14 participants suggested minor changes in question phrasing. Using the input parameters ($f^2 = 0.15$, $\alpha = 0.05$, power = 0.95, and predictors = 3), we applied G*power analysis to determine the minimum required sample size to explore our modeled associations at a 0.05 significance level and effect size = 0.15 (Faul et al., 2007), which suggested a minimum n = 119 to perform our structural equation modeling-based analyses. The online survey was then carried out at the beginning of 2022 through a voluntary German research panel. We sent an initial invitation in January and then one reminder three weeks afterwards in February. In order to ensure data quality, we collected participants' consent for the study at the beginning of the survey and directly asked about the seriousness of their participation at the end of the survey. Furthermore, the survey used items from established scales, and the items were randomly rotated in each questionnaire. We also controlled for

straightlining behavior but found none in the final sample.

The questionnaire was opened 820 times. All but 4 participants consented to anonymously and voluntarily participate in the study being able to terminate the study at any time without negative consequences. Using the threshold of 80 % completion, 216 incomplete questionnaires were excluded from further analysis. Missing data were estimated first based on the intra-construct measurement items mean and second on the column item mean. Next, we removed 10 questionnaires based on a seriousness check. Lastly, we controlled for answering behavior by the relative speed index below 2 (Leiner, 2019) leading to the exclusion of 5 questionnaires. Participants answered the questionnaire in about 10 minutes on average (sd = 228 seconds). Thus, the final sample includes 585 questionnaires.

Participants were 54.9 % (321) female and on average 44.9 (sd = 12. 9) years old, resembling well the gender distribution (50.66 %, Statistisches Bundesamt, 2022a) and mean age (44.7 years, Statistische Ämter, 2022) in the German population. The majority of the participants were (self-)employed 74.2 % (434), students 14.5 % (85), retired 8.4 % (49), and others 2.9 % (17). Education was diverse with 40.3 % (236) of school graduates, 52.1 % (305) university degrees, 5.5 % (32) PhDs, and 2.1 % (12) other educational degrees. These two variables differ from the distribution in the German population with a share of 53.9 % (Sozialpolitik, 2021) of people being (self-)employed and 18.7 % holding an academic degree (Statistisches Bundesamt, 2022b). A little bit more than half of the participants 53.0 % (310) had never used digital voice assistants, which mirrors representativity (50.0 % in the entire German population, Statistisches Bundesamt, 2022b), whereas the other half (275) have used digital voice assistants at least once. A fitting distribution for our objective is to study major impediments to digital voice assistant adoption. Accordingly, 60.9 % (355) of participants do not own a digital voice assistant, whereas 3.6 % (21) plan on purchasing one, and 35.7 % (209) already own a digital voice assistant.

### 4.3. Empirical Results

Data collection stems from a single source (survey participants). Therefore, the research instrument may induce data variance. Thus, we tested for potential common method bias. Herman's single factor explained 37.30 % of the observed variance remaining below the threshold of 50 %. Additionally, the full collinearity variance inflation factors (FVIFs) are calculated which is a conservative approach for assessing common method bias (Kock & Lynn, 2012). FVIF for Attitude (3.33), Behavioral Intention (3.53), and Usefulness (3.84) are below the threshold of 5, whereas all other FVIFs are below the conservative threshold of 3.3.

We conducted covariance-based structural equation modeling to analyze the associations depicted in the research model (*Fig. 2*). Calculations are done with the lavaan package in R (Rosseel, 2012). We used the robust maximum likelihood estimator for model estimation. We first control all measurement models before assessing the quality of the structural model. Afterwards, we present the results for the hypotheses.

An initial confirmatory factor analysis controls the measurement model. All measurement models are reflectively based on the underlying measurement in the literature. Furthermore, all but three item loadings (PE3, PE4, and PR6) exceed the 0.70 level for indicator reliability. These items are consequently dropped from further analysis (see *Tab. 2*). All remaining items are significant at the .001 level. The measurement items also lead to composite reliability with Cronbach's Alpha and Omega above the 0.70 level. Also, the average variance extracted (AVE) is at least 0.50 for all constructs establishing convergent validity (see *Tab. 3*). The quality measures suggest that the measurement models represent reliable and valid constructs. We use heterotrait-monotrait ratios (HTMT) to evaluate discriminant validity. All HTMT ratios [0.032; 0.730] are below the 0.85 level (Henseler et al., 2015) (see *Tab. 4*). *Tab. 4* summarizes $R^2$ and FVIF, whereas *Tab. 5* includes HTMT values with lower and upper confidence intervals. Lastly, the global fit indices also suggest that the measurement model provides an overall good fit to the data ($\chi^2$ = 1239.30, df = 655, $\chi^2$/df = 1.892, RMSEA = 0.039, NFI = 0.948, CFI = 0.975, TLI = 0.972, SRMR = 0.038).

After establishing the reliability and validity of the measurement models, we evaluate the structural model. The global fit measures again indicate an overall adequate fit for the structural model ($\chi^2$ = 1625.17, df = 678, $\chi^2$/df = 2.397, RMSEA = 0.049, NFI = 0.933, CFI = 0.959, TLI = 0.956, SRMR = 0.089). All but two path coefficients are significant at the 0.05 level and support the underlying hypotheses. Disposition to trust had a non-significant effect on institution-based trust (H1: $\beta$ = 0.081, $p$ = 0.074), thus rejecting H1. Similarly, disposition to trust was not significant on trust intentions towards digital voice assistants (H2: $\beta$ = -0.052, $p$ = 0.266), also rejecting H2. The general trusting stance may not capture the entirety of individuals trusting disposition. However, these results also warrant the follow-up question of how effectively the general predisposition affects the digital world.

Institution-based trust positively impacts people trusting intentions (H3: $\beta$ = 0.490, $p$ < 0.001), supporting H3. Thus, the general expectancy towards digital voice assistants creates a positive willingness to rely on the information provided by digital voice assistants. These trusting intentions then help to overcome some portion of privacy risks (H7: $\beta$ = -0.412, $p$ < 0.001). Building people's trustworthiness in digital voice assistants reduces significantly the fear of (unwanted) data collection and secondary data use. Trusting intentions further increase the perceived ease of use (H4: $\beta$ = 0.397, $p$ < 0.001) and per-

| Variable | Item | Statement | Loading |
|---|---|---|---|
| Disposition to Trust | | | |
| | DT1 | I generally have faith in humanity. | 0.875 |
| | DT2 | I think that people as a whole are reliable. | 0.868 |
| | DT3 | Generally, I trust other people unless they give me a reason not to trust them. | 0.769 |
| Institution-based Trust | | | |
| | IBT1 | Voice assistant providers are trustworthy when it comes to handling data. | 0.825 |
| | IBT2 | Voice assistant providers are honest and meet the expectations in terms of my data. | 0.932 |
| | IBT3 | Voice assistant providers are honest about how they handle my data. | 0.945 |
| Trust Intentions | | | |
| | TI1 | If a problem should arise, I feel comfortable with the information provided by voice assistants. | 0.873 |
| | TI2 | When problems occur, I can always rely on the information provided by the voice assistants. | 0.763 |
| | TI3 | I think I can count on voice assistant information in a problem situation. | 0.772 |
| | TI4 | In a problem situation that requires information, I rely on the information from voice assistants. | 0.811 |
| | TI5 | When a new problem arises, I again rely on the voice assistants information. | 0.827 |
| Privacy Risk (I have concerns …) | | | |
| | PR1 | … about voice assistants collecting information that may lead to identification of me/other users. | 0.826 |
| | PR2 | … about who might collect information from voice assistants. | 0.862 |
| | PR3 | … about voice assistants continuously collecting data about people and the device's environment. | 0.892 |
| | PR4 | … about not knowing what information is being collected by voice assistants. | 0.780 |
| | *PR5* | *... that data about me will be passed on unchanged and directly to third parties without my knowledge.* | *0.677* |
| | PR6 | … that data about me will be further processed and passed on to third parties without my knowledge. | 0.708 |
| | PR7 | … that the data collected about me will be used for other purposes (for example, to create a user profile). | 0.766 |
| Perceived Ease of Use | | | |
| | PE1 | Interacting with a voice assistant is clear and understandable for me. | 0.796 |
| | PE2 | Interacting with a voice assistant is easy for me to understand. | 0.765 |
| | *PE3* | *Interacting with a voice assistant is often frustrating for me.* | *0.465* |
| | *PE4* | *Interacting with a voice assistant involves a lot of mental effort for me.* | *0.527* |
| | PE5 | I find that voice assistants are easy to use. | 0.807 |
| | PE6 | I find it easy to use voice assistants to run voice-controlled applications or access information. | 0.863 |
| | PE7 | I find it easy to use voice assistants the way I want. | 0.777 |
| Perceived Usefulness | | | |
| | PU1 | Overall, I find voice assistants useful. | 0.911 |
| | PU2 | Voice assistants are valuable tools for me. | 0.932 |
| | PU3 | Using voice assistants to run voice-controlled applications or access general information is useful to me. | 0.910 |
| | PU4 | Voice assistants are useful to me in terms of functionality. | 0.952 |
| | PU5 | Voice assistants are helpful to me in terms of functionality. | 0.951 |
| | PU6 | Voice assistants save me time. | 0.810 |
| | PU7 | Voice assistants make me waste less time. | 0.722 |
| | PU8 | With voice assistants, I am more effective than I could be otherwise. | 0.793 |
| | PU9 | Using voice assistants increases my effectiveness. | 0.823 |
| Attitude | | | |
| | ATT1 | I think that when I use a voice assistant, I can get insightful information. | 0.928 |
| | ATT2 | I think that when I use a voice assistant, I can get concrete information. | 0.879 |
| | ATT3 | I think that when I use a voice assistant, I can get credible information. | 0.856 |
| Behavioral Intention | | | |
| | BI1 | I intend to use voice assistants in my personal environment in the future. | 0.972 |
| | BI2 | I expect to use voice assistants in my personal environment when given the opportunity. | 0.941 |
| | BI3 | It is likely that I will use voice assistants within my personal environment in the near future. | 0.966 |
| | BI4 | I intend to use voice assistants in my personal environment as often as possible. | 0.905 |
| Actual Use | | | |
| | AU | How would you rate your experience with voice assistants? | 1.000 |

*Note:* Items in italic dropped from the analysis. All remaining loadings are significant at the 0.001 level.

*Tab. 2: Overview of the measurement items and item reliability*

| Latent Variable | Cronbach's α | Omega | AVE |
|---|---|---|---|
| Disposition to Trust | 0.873 | 0.876 | 0.703 |
| Institution-based Trust | 0.953 | 0.953 | 0.872 |
| Trusting Intentions | 0.914 | 0.881 | 0.659 |
| Privacy Risks | 0.922 | 0.902 | 0.658 |
| Perceived Ease of Use | 0.907 | 0.880 | 0.644 |
| Perceived Usefulness | 0.969 | 0.940 | 0.765 |
| Attitude | 0.918 | 0.919 | 0.791 |
| Behavioral Intention | 0.968 | 0.978 | 0.902 |
| Actual Use | -- | -- | -- |

*Tab. 3: Construct reliability and convergence validity*

ceived usefulness (H5: $\beta = 0.493$, $p < 0.001$) of digital voice assistants. Perceived ease of use confirms its positive effect on perceived usefulness (H9: $\beta = 0.348$, $p < 0.001$). The empirical results also support the positive impact of trusting intentions (H6: $\beta = 0.309$, $p < 0.001$), perceived ease of use (H10: $\beta = 0.133$, $p < 0.001$), and perceived usefulness (H11: $\beta = 0.,491$ $p < 0.001$) on attitude towards digital voice assistants. Whereas perceived privacy risks reduce (H8: $\beta = -0.346$, $p < 0.001$), attitudes increase the behavioral intention to use voice assistants (H12: $\beta = 0.482$, $p < 0.001$). Lastly, users' positive intentions also intensify their actual use of digital voice assistants (H13: $\beta = 0.693$, $p < 0.001$). *Tab. 6* summarizes path coefficients and the hypotheses results.

Beyond the direct effects, *Tab. 7* reports the total indirect effects. The results for the reported indirect path coefficients are based on 10,000 bootstrap samples because the indirect effects are unlikely to adhere to the normal distribution assumption. The results show significant results for all total indirect effects but the disposition to trust. This is consistent with the presented direct path results. For completeness, *Tab. 8* reports the total effects results.

Next, we report the coefficient of determination $R^2$ values. For endogenous latent variables, Chin (1998) considers $R^2$ values of 0.67, 0.33, and 0.19 as substantial, moderate, and weak respectively. $R^2$ for institution-based trust is negligible at 0.007. Perceived privacy risk ($R^2 = 0.170$) and perceived ease of use ($R^2 = 0.158$) are below Chin's weak level, whereas $R^2$ values for trust intentions ($R^2 = 0.239$), perceived usefulness ($R^2 = 0.501$), attitude ($R^2 = 0.649$), behavioral intention ($R^2 = 0.444$), and actual use ($R^2 = 0.481$) are between Chin's moderate and substantial level of explained variance.

Lastly, we analyze potential differences across our control variables. Therefore, we calculate binary group differences. For age, we use a mean age split of 45 but found no significant differences. Regarding gender, the effect of perceived ease of use on perceived usefulness is lower for women than for men ($b_{women} = 0.361$, $b_{men} = 0.588$, $p = 0.048$). We also find one significant difference due to the educational level of our participants. We consider participants with a bachelor, master, or phd as academics and all others as non-academics. Whereas

| | DT | IBT | TI | PR | PE | PU | ATT | BI | AU |
|---|---|---|---|---|---|---|---|---|---|
| **FVIF** | 1.080 | 1.870 | 2.580 | 1.767 | 1.695 | 3.835 | 3.331 | 3.527 | 2.156 |
| **$R^2$** | **--** | 0.007 | 0.239 | 0.170 | 0.158 | 0.501 | 0.649 | 0.443 | 0.481 |

*Tab. 4: $R^2$ and full collinearity variance inflation factors (FVIF)*

*Note:* DT – Disposition to Trust; IT – Institution-based Trust; TI – Trusting Intentions; PR – Privacy Risks; PE – Perceived Ease of Use; PU – Perceived Usefulness; ATT – Attitude; BI – Behavioral Intention; AU – Actual Use.

| | TD | IBT | TI | PR | PE | PU | ATT | BI |
|---|---|---|---|---|---|---|---|---|
| TD | | | | | | | | |
| IBT | 0.081 [0.023; 0.169] | | | | | | | |
| TI | 0.045 [0.033; 0.140] | 0.451 [0.363; 0.535] | | | | | | |
| PR | 0.058 [0.042; 0.141] | 0.585 [0.501; 0.665] | 0.357 [0.267; 0.446] | | | | | |
| PE | 0.070 [0.045; 0.161] | 0.173 [0.085; 0.259] | 0.363 [0.287; 0.435] | 0.163 [0.083; 0.253] | | | | |
| PU | 0.032 [0.030; 0.105] | 0.326 [0.236; 0.414] | 0.626 [0.564; 0.685] | 0.342 [0.257; 0.425] | 0.511 [0.443; 0.575] | | | |
| ATT | 0.099 [0.048; 0.197] | 0.381 [0.287; 0.470] | 0.649 [0.593; 0.699] | 0.283 [0.193; 0.371] | 0.478 [0.397; 0.555] | 0.730 [0.677; 0.778] | | |
| BI | 0.090 [0.032; 0.183] | 0.466 [0.383; 0.546] | 0.600 [0.534; 0.661] | 0.475 [0.395; 0.552] | 0.400 [0.335; 0.462] | 0.714 [0.663; 0.762] | 0.543 [0.478; 0.605] | |
| AU | -- | -- | -- | -- | -- | -- | -- | -- |

*Tab. 5: Heterotrait-Monotrait Ratio (HTMT)*

| Independant | Dependant | Hypo-thesis | Path | *p*-value | Support |
|---|---|---|---|---|---|
| Trust Disposition | Institution-based Trust | H1 (+) | 0.081 | 0.074 | no |
| Trust Disposition | Trust Intentions | H2 (+) | -0.052 | 0.266 | no |
| Institution-based Trust | Trust Intentions | H3 (+) | 0.490 | < 0.001 | yes |
| Trust Intentions | Ease of Use | H4 (+) | 0.397 | < 0.001 | yes |
| Trust Intentions | Usefulness | H5 (+) | 0.493 | < 0.001 | yes |
| Trust Intentions | Attitude | H6 (+) | 0.348 | < 0.001 | yes |
| Trust Intentions | Privacy Risk | H7 (–) | -0.412 | < 0.001 | yes |
| Privacy Risk | Behavioral Intention | H8 (–) | -0.346 | < 0.001 | yes |
| Ease of Use | Usefulness | H9 (+) | 0.309 | < 0.001 | yes |
| Ease of Use | Attitude | H10 (+) | 0.133 | 0.001 | yes |
| Usefulness | Attitude | H11 (+) | 0.491 | < 0.001 | yes |
| Attitude | Behavioral Intention | H12 (+) | 0.482 | < 0.001 | yes |
| Behavioral Intention | Actual Use | H13 (+) | 0.693 | < 0.001 | yes |

*Note:* Model fit $\chi^2$ = 1625.17, df = 678, $\chi^2$/df = 2.397, RMSEA = 0.049, CFI = 0.959, TLI = 0.956, SRMR = 0.089.

*Tab. 6: Standardized path estimates and hypotheses summary*

| Independent | Dependent | Effect (95% CI) | LLCI | ULCI |
|---|---|---|---|---|
| Trust Disposition | Trust Intentions | -0.025 | -0.071 | 0.017 |
| Trust Disposition | Privacy Risk | -0.023 | -0.064 | 0.020 |
| Trust Disposition | Ease of Use | -0.009 | -0.026 | 0.008 |
| Trust Disposition | Usefulness | 0.035 | -0.030 | 0.098 |
| Trust Disposition | Attitude | 0.038 | -0.032 | 0.104 |
| Trust Disposition | Behavioral Intention | 0.026 | -0.022 | 0.072 |
| Trust Disposition | Actual Use | 0.018 | -0.015 | 0.050 |
| Institution-based Trust | Privacy Risk | -0.202 | -0.260 | -0.146 |
| Institution-based Trust | Ease of Use | 0.194 | 0.144 | 0.245 |
| Institution-based Trust | Usefulness | 0.309 | 0.248 | 0.370 |
| Institution-based Trust | Attitude | 0.178 | 0.137 | 0.222 |
| Institution-based Trust | Behavioral Intention | 0.155 | 0.119 | 0.193 |
| Institution-based Trust | Actual Use | 0.108 | 0.081 | 0.136 |
| Trust Intentions | Usefulness | 0.138 | 0.098 | 0.182 |
| Trust Intentions | Attitude | 0.363 | 0.303 | 0.425 |
| Trust Intentions | Behavioral Intention | 0.317 | 0.266 | 0.368 |
| Trust Intentions | Actual Use | 0.220 | 0.180 | 0.261 |
| Privacy Risk | Actual Use | -0.240 | -0.295 | -0.185 |
| Ease of Use | Attitude | 0.171 | 0.125 | 0.221 |
| Ease of Use | Behavioral Intention | 0.146 | 0.105 | 0.188 |
| Ease of Use | Actual Use | 0.101 | 0.072 | 0.132 |
| Usefulness | Behavioral Intention | 0.237 | 0.181 | 0.296 |
| Usefulness | Actual Use | 0.164 | 0.122 | 0.210 |
| Attitude | Actual Use | 0.334 | 0.275 | 0.390 |

*Tab. 7: Total Indirect Effects*

academics have no significant effect between their disposition to trust and trusting intentions, this relationship was negative for non-academics ($b_{academics}$ = 0.056, $b_{non\text{-}academics}$ = -0.207, p = 0.012). As expected, we found the most differences with regard of owning a digital voice assistant. Trusting intentions were significantly different for perceived privacy risk ($b_{owner}$ = 0.416, $b_{non\text{-}owner}$ = 0.134, p = 0.003) and ease of use ($b_{owner}$ = 0.438, $b_{non\text{-}owner}$ = 0.238, p = 0.038) between owner and non-owner of digital voice assistants. The relationship coefficients are higher for existing users. The effect of perceived ease of use and attitude is more relevant for non-owners as existing users are already aware of their systems' ease of use ($b_{owner}$ = 0.029, $b_{non\text{-}owner}$ = 0.307,

| Independent | Dependent | Effect (95% CI) | LLCI | ULCI |
|---|---|---|---|---|
| Trust Disposition | Institution-Based Trust | -0.052 | -0.141 | 0.037 |
| Trust Disposition | Trust Intentions | -0.077 | -0.211 | 0.054 |
| Trust Disposition | Privacy Risk | -0.023 | -0.064 | 0.020 |
| Trust Disposition | Ease of Use | -0.009 | -0.026 | 0.008 |
| Trust Disposition | Usefulness | 0.035 | -0.032 | 0.098 |
| Trust Disposition | Attitude | 0.038 | -0.032 | 0.104 |
| Trust Disposition | Behavioral Intention | 0.026 | -0.022 | 0.072 |
| Trust Disposition | Actual Use | 0.018 | -0.015 | 0.050 |
| Institution-based Trust | Trust Intentions | 0.490 | 0.407 | 0.568 |
| Institution-based Trust | Privacy Risk | -0.202 | -0.260 | -0.146 |
| Institution-based Trust | Ease of Use | 0.194 | 0.144 | 0.245 |
| Institution-based Trust | Usefulness | 0.309 | 0.248 | 0.370 |
| Institution-based Trust | Attitude | 0.178 | 0.137 | 0.222 |
| Institution-based Trust | Behavioral Intention | 0.155 | 0.119 | 0.193 |
| Institution-based Trust | Actual Use | 0.108 | 0.081 | 0.136 |
| Trust Intentions | Privacy Risk | -0.412 | -0.495 | -0.324 |
| Trust Intentions | Ease of Use | 0.397 | 0.319 | 0.468 |
| Trust Intentions | Usefulness | 0.631 | 0.571 | 0.685 |
| Trust Intentions | Attitude | 0.671 | 0.615 | 0.722 |
| Trust Intentions | Behavioral Intention | 0.317 | 0.2667 | 0.368 |
| Trust Intentions | Actual Use | 0.220 | 0.180 | 0.261 |
| Privacy Risk | Behavioral Intention | -0.346 | -0.420 | -0.271 |
| Privacy Risk | Actual Use | -0.240 | -0.295 | -0.185 |
| Ease of Use | Usefulness | 0.348 | 0.270 | 0.424 |
| Ease of Use | Attitude | 0.304 | 0.228 | 0.380 |
| Ease of Use | Behavioral Intention | 0.146 | 0.105 | 0.188 |
| Ease of Use | Actual Use | 0.101 | 0.072 | 0.132 |
| Usefulness | Attitude | 0.491 | 0.398 | 0.584 |
| Usefulness | Behavioral Intention | 0.237 | 0.181 | 0.296 |
| Usefulness | Actual Use | 0.164 | 0.122 | 0.210 |
| Attitude | Behavioral Intention | 0.482 | 0.411 | 0.548 |
| Attitude | Actual Use | 0.334 | 0.275 | 0.390 |
| Behavioral Intention | Actual Use | 0.693 | 0.636 | 0.744 |

*Tab. 8: Total Effects*

$p = 0.023$). Consequently, the attitude of digital voice assistant owners has a higher effect on their behavioral intention ($b_{owner} = 0.472$, $b_{non\text{-}owner} = 0.211$, $p < 0.001$) and their behavioral intention on actual use of digital voice assistants ($b_{owner} = 0.575$, $b_{non\text{-}owner} = 0.210$, $p < 0.001$).

## 5. Discussion

### 5.1. Theoretical implications

The empirical results support our research hypotheses. Beyond perceived ease of use and usefulness, the empirical results support the role of attitudes towards digital voice assistants and their usage behavior. For the trust typology, the self-reported results indicate the relevance of institution-based trust and trusting intentions, whereas the disposition to trust yielded no significant results. Further research can look beyond the general trusting stance by looking at the predisposition of benevolence, integrity, and competence (Choung et al. 2022, McKnight et al., 2002a). McKnight et al. (2011) further suggest that there may be an underlying difference in disposition to trust between trust in people and technology. Our empirical results lend some support to this notion. This is similar to Choung et al. (2022) who attribute benevolence and integrity to human-like trust and competence to technology trust. The disposition to trust in technology, that is individuals' trusting stance towards technology and general faith in technology, may differ from the level of dispositional trust towards people.

Institution-based trust towards digital voice assistants in general provides further support for users' trusting intentions. Building up trust in the framing technology and potentially the provider (Lucia-Palacios & Pérez-López, 2021; Popp et al, 2022) increases trust intentions towards the information provided by digital voice assistants. Trusting information voiced by such machines is the foundation for more complex interactions in the future. Whereas institution-based trust is a prime responsibility of digital voice assistants' providers, communicating trustworthiness in the specific application is also a responsibility of the service provider. In the case of Walmart's voice shopping, for example, Walmart needs to establish a trustworthy transaction and Google (Assistant) and Apple (Siri) have to provide a trustworthy environment to conduct grocery shopping via voice.

The present study focused on the trust formation towards digital voice assistants in general, not registering users' specific trusting beliefs. Even though the German market is dominated by a few assistant systems (Amazon's Alexa, Google's Assistant, and Apple's Siri), users may have varying levels of trusting beliefs regarding different digital voice assistants. Such differences may potentially be based on buyers' personalities and subsequent preferences (Paetz & Schultz, 2022).

Trusting intentions most importantly mitigate individuals' perceived privacy risks. Similar to reducing the perceived intrusiveness of smart speakers (Lucia-Palacios & Pérez-López, 2021), trust reduces privacy risks in digital voice assistants. Consequently, system and service providers can benefit from instilling trust in users of digital voice assistants. Thus, trust tackles the privacy elephant for future digital voice assistant adoption and use. The key question for such providers now arises how to communicate trustworthiness through the digital voice assistants' systems and their corresponding applications.

The integration of the trust typology into the technology acceptance framework establishes various routes of trust in the actual use of digital voice assistants. The total effect of trusting intentions on actual use is 0.220 (see *Tab. 8*) and presents an overall relevant relationship. Trust supports users' attitudes on the one hand side and also reduces perceived privacy risks on the other side. Overall, institution-based trust and more prominently trusting intentions create a positive environment for the use of digital voice assistants. This is promising news for managers (potentially) engaging in voice commerce.

The integration of the trust typology and privacy risks in the technology acceptance model offers multiple insights into the various routes of trust in the adoption and use of innovative technologies, such as digital voice assistants. Trust reduces privacy risks and increases attitudes towards using digital voice assistants with subsequent overall positive effects on the use of these assistants. Trust is a studied prerequisite for innovative technologies. Trust, however, also plays an important role in emerging communication and distribution channels, such as voice commerce. Our results imply that a general trusting stance towards people does not completely transfer to predispositional trust in technologies.

Additionally, the present study concentrates on the effects of trust – most notably reducing perceived privacy risks. In combination with previous findings on the reciprocal relationship between perceived risks on trust (Bawack et al., 2021; Vimalkumar et al., 2021), our results further strengthen the notion of a dynamic relationship between trust and risk. A general disposition towards the actors and situation influences the perceived risks and, afterwards, experiential cues affect ongoing interactions (Schultz, 2007; Swoboda et al., 2021). The specific routes and interactions warrant further (longitudinal) inspections, particularly considering different use scenarios and additional contingencies.

In sum, we can answer our above-mentioned research questions:

1) Yes! We found trust to reduce perceived privacy risks towards digital voice assistants and trust subsequently increases the actual use of digital voice assistants.
2) Yes! Our results support that trust increases users' attitudes and intentions towards digital voice assistants.
3) Yes! Trust also has a positive impact on users' perceived ease of use and usefulness of digital voice assistants.

We conclude that trust is an ultimate and decisive factor for users' general willingness to utilize digital voice assistants and subsequently for customers' willingness to engage in voice-based interactions and transactions.

### 5.2. Managerial Implications

The megatrend of smart speaker dissemination creates manifold opportunities for service providers and companies. Companies may envision themselves introducing or are already engaging in voice commerce. We were able to support our main research hypothesis that trust is a fundamental determinant for the willingness to use digital voice assistants and engage in voice-based interactions and transactions, which offers a sound basis for managerial implications:

A primary challenge for system and service providers is how to communicate trustworthiness and thus establish trust in user interactions. Anthropomorphism has been discussed as one potential avenue to invoke trust, for example leading to appraisal, intention, and behavior (Li & Suh 2022). Both, system and service provider, can communicate privacy regulations but only the technology provider can enable device-specific features (Campagna et al., 2018; Mhaidli et al., 2020). Mhaidli et al. (2020) suggest interpersonal communication cues, such as gaze direction and voice volume level, in order to regulate voice recognition. A fine granularity of privacy controls is another option to invoke trust in digital voice assistants (Campagna et al., 2018). However, providers need to also create awareness towards such options. Most natural-

ly, digital voice assistants can use biometric voice features for authentification ensuring limited system use. Beyond concerns of data collection and secondary data usage (Song et al., 2022), researchers also discuss security issues (Padyab & Ståhlbröst, 2018) of digital voice assistants. In the case of smart speakers, this is of particular concern because they are mostly used in private homes. In some ways, users are trading privacy for their convenience. Liao et al. (2019) indicate that users of digital voice assistants often trust providers to comply with privacy regulations and ensure data security. However, current privacy options are only used to a limited extent and existing measures are rarely aligned with user needs (Lau et al., 2018). Following the concerns of smart home applications, the system security of digital voice assistants should also be at the forefront of both research and management.

A primary challenge for companies that (plan to) introduce voice commerce is certainly the assessment of the economic success. Obviously, several items, e.g., customers' willingness to participate in voice commerce per se, costs for the establishment of an entire voice commerce system, are key in this context. Our study focused on trust as a driver for the adoption of digital voice assistants, which are a necessary condition for voice shopping. Our results provide helpful insights into customers' intentions to use digital voice assistants and subsequently into their likelihood to apply voice commerce. This is important because digital voice assistants impact customer behavior due to their learning ability regarding customer preferences and habits (Simms 2019). Obviously, digital voice assistants have the potential to change entire markets and heavily influence market dynamics. Companies have to be aware of interplays between their brands and customers in voice commerce (Rahwan et al. 2019). In this vein, companies can use their brand strength to create trust in digital voice assistants. Research has for example demonstrated that trust in brands can transfer to the brand architecture (Esch & Rühl, 2015). As, for example, trust and brand equity are interconnected (Swoboda et al., 2021), established brands can utilize positive brand image and trust towards new communication and distribution channels. Furthermore, companies may decouple the storage of customers' behavioral and shopping data from the data storage cloud of providers. A decoupling may reduce customers' negative beliefs about digital voice assistants with respect to privacy risks and therefore lead to an increase in their use and customers' participation in voice commerce. In this context, companies have to be able to compensate customers' negative beliefs about digital voice assistants, e.g., low interaction quality, limited transparency, and limited control, in a way that guarantees the achievement of their expected benefits from the use of digital voice assistants for voice shopping, e.g., convenience, efficiency, enjoyment (Rzepka et al., p. 4085).

### 5.3. Limitations and Future Research

The present study contributes to the understanding of trust in digital voice assistants. Even though the present research methodology is very appropriate for the research objective, the study still has some limitations that present opportunities for further research.

First, we carefully considered a European country with a high awareness of privacy issues and risks. Even though digital voice assistants become increasingly popular, their use beyond daily activities, such as news and weather reports, is still limited. For example, voice shopping is still in its infancy in Germany. Further research may contribute to the role of trust in two ways: For one thing, further research can analyze the effectiveness of various means to communicate the trustworthiness of digital voice assistants. Otherwise, further research needs to address various use scenarios of digital voice assistants, most prominently voice shopping.

Second, voice shopping poses several differences from online shopping. Presentation of product alternatives creates questions about product ordering (Halbauer et al., 2022) and selection. Additionally, product information, such as package size, origin, and ingredients, needs to be communicated. Future research can go beyond habitualized shopping situations and investigate how digital voice assistants influence complex shopping processes and decisions.

Third, our results are tailored to the German population which is characterized by a high level of individualism following Hofstede's dimensions. However, people with a high level of collectivism tend to differ with respect to their adoption of new technologies. For example, people in collectivistic cultures in comparison to individualistic cultures "are more likely to adopt new technology when others in the group decide to do so." (Lee & Wan, 2010, p. 41). This behavior is likely to spill back to different perceptions of trust in varying cultures. Hence, future research may focus on research in countries with highly collectivistic communities that are particularly more tech-savvy, e.g., China, in order to generalize or differentiate our results.

Fourth, similar to privacy concerns (Schultz & Brüggemann, 2022), trust may manifest itself through various mental routes. Further research can contribute to our understanding of trust by clarifying its relationships and whether the central relationship is different for digital innovations and human relationships.

Lastly, future research may naturally expand on our methodological approach. Experimental, neurophysiological, and longitudinal approaches may extend our cross-sectional self-reported data collection. Whereas neurophysiological approaches may uncover unconscious dispositions, longitudinal studies could also address the dynamic nature of trust and capture developments in relevant relationships.

## 6. Conclusion

Nowadays, digital voice assistants are widely used and yield great market potential. This megatrend provides great opportunities for entrepreneurial activities, both for producers of digital voice assistants and for companies that (plan to) sell their products via voice commerce. Since German customers are reluctant to use digital voice assistants for (voice) shopping so far, a central question concerns the understanding of determinants that affect users' adoption of voice shopping. Obviously, the question of customers' drivers using digital voice assistants is closely intertwined, because digital voice assistants are a necessary condition for voice shopping. Based on recent literature in similar research fields, e.g., electronic commerce, customers' trust seems to be the fundamental determinant in this context. This study combines a typology of trust with the established technology acceptance model. Using an empirical study, we estimated a covariance-based SEM based on the data of 585 respondents. Our results support the effect of institution-based trust and users' trusting intentions on the self-reported usage of digital voice assistants. We found that trust reduces users' perceived privacy risks and positively influences users' attitudes and intentions towards and subsequently their use of digital voice assistants. The integration of the trust typology and the technology acceptance framework supports the various routes of trust in the use of digital voice assistants. Based on our results, we are able to derive theoretical and managerial implications for system and service providers as well as companies that (plan to) sell their products via voice commerce over digital voice assistants.

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**Keywords**

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