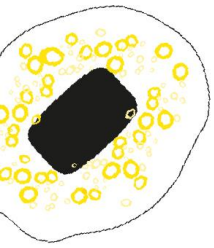
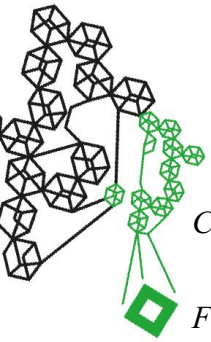
UNIVERSITY OF TWENTE.



Master's Thesis

Virtual Architects: An exploratory field study into the acceptance of Virtual Agents in an Architecture Startup

Julian Schwieren, s1877828



Communication Science (MSc)

Faculty of Behavioral, Management and Social Sciences (BMS)

Supervised by Dr. Joyce Karreman & Dr. Ardion Beldad

30th of January 2023

Abstract

Objective: Artificial intelligence (AI) transforms the architecture, engineering, and construction (AEC) industry. To ensure employees accept AI, it can be merged with virtual agents (VAs). However, current literature lacks research on VA acceptance in workplaces, the combination of social psychological with contextual factors, and using exploratory approaches. Therefore, the present study combines all three. The research addresses how an acceptable VA in the AEC industry should behave and look while shedding light on how management and colleagues influence employees' acceptance of the technology.

Method: During semi-structured interviews, 21 employees of an architecture start-up discussed the research questions. On that occasion, data on socio-demographics, experiences, and opinions on VAs were collected. The participants were mainly acknowledged and aspiring architects or owned a thematically related degree. The data were analyzed through qualitative content analysis.

Results: Participants demand that the VA is verbally fluent, speaks precisely, and is a polyglot. Human-like traits should be minimized except those necessary for communication, such as a human-like voice. Especially in AEC, VAs should be able to display and allow for interaction with architectural models. Also, an embodiment provides low value in a task-related context. Additionally, management should provide training and foster an organizational culture that allows for honesty and like-mindedness to facilitate the acceptance of VAs.

Conclusion: The study shows that participants view VAs as tools, not colleagues. To be accepted, the technology's design must align. In addition, the VA's acceptance is influenced by the organizational culture, which is built by management and colleagues. Future research must validate the findings, for instance, by clarifying which design implications are decisive over others. Also, the interplay of the acceptance object and -context must be investigated.

Keywords: Virtual Agents, Artificial Intelligence, Acceptance, AEC

Table of Contents

1. Introduction

Architecture Engineering and Construction (AEC) industry must deal with rising competitive pressure, value for capital, and ecological requirements. Therefore, it needs to be comprehensively automated (Shehzad et al., 2021). Artificially intelligent technology (AI technology) can fulfill that need as it leads to heightened automation and robotization of work (Ågnes, 2022; Emaminejad & Akhavian, 2022; García de Soto, 2022). In architecture, AI-assisted planning software, can substantially speed up planning processes while using a minimum of resources and providing a nearly infinite array of variant outcomes (As & Basu, 2021). As the success of new technology requires its acceptance by employees, it is essential to facilitate it (Rogers, 1963). A potential way to facilitate acceptance of AI technology is merging it with virtual agents (VAs).

VAs can function as social and communicative interlocuters equipped with human-like features (Pelachaud, 2009). A popular example of a VA is Chat GPT from OpenAI (2023), which is a natural language processing model that allows users to ask complex questions and let it perform assignments in dialogue format. When a VA has a visual representation, researchers also speak of embodied conversational agents (ECAs). These are lifelike animated characters that can engage in direct conversation with human users (Cassel et al., 2000; Huang 2018). Because such a VA may facilitate quasi-social relationships between AI technology and human employees (Fortunati, Cavallo, & Sarrica, 2020), it is vital to research the users' acceptance of it.

However, acceptance of artificial entities, such as VAs, has not often been in focus in human-agent interaction research. Krämer and Bente (2021) hypothesize that acceptance is often not relevant enough when trying to scrutinize the psychological effects of interaction. Nonetheless, they stress it as a crucial dependent factor in human-agent interaction. From a social psychological perspective, behavior and appearance are most influential on the acceptance of artificial entities among human users. In that manner, it is interesting what traits employees in the AEC sector seek in a VA's behavior and appearance that makes them accept it.

In addition, several authors stress that contextual factors, such as those of a group and social nature, are underrepresented in technology acceptance research (Bagozzi, 2007; Fitriani et al., 2020; Harth & Hofmann, 2021; Meissner et al., 2021). Bagozzi (2007) annotates that much of human behavior cannot be explained by looking at actors in isolation. He states that they act interpersonally, for instance, in relation to the management and colleagues, and thus as agents of organizations. Therefore, it is also relevant to investigate contextual factors'

influence on the employees' acceptance of VAs in the AEC industry (Schäfer & Keppler, 2013).

Even though there is acceptance research on collaborative robots at the workplace (e.g., Meissner et al., 2021; Paluch et al., 2021) that mostly differ from VAs through a physical embodiment, research on VAs at the workplace is missing. Subsequently, there is a need for such a pursuit. Also, existing ICT acceptance studies focus primarily on the technology acceptance model (TAM) and its expansions, which withholds the dangers of replicating known factors while overlooking others (Vogelsang, 2012). Quantitative approaches are appropriate to test theories; however, they forbid to find new theories or constructs. In that manner, Vogelsang et al. (2013) postulate that work on ICT acceptance should further emphasize exploratory approaches.

Altogether, research into the acceptance of VAs in the AEC sector may positively affect research and industry. Combining a social psychological perspective (behavior and appearance of a VA) and contextual factors (group and social factors concerning employees) may withhold fruitful additions to the field of human-agent interaction in the AEC sector and beyond. At the same time, it can further inform the management of AEC organizations about employees' preferred design choices for VAs, plus contextual implications of its implementation, all by focusing on technology acceptance. The study will follow an exploratory approach. Thus, the focus of the present study lies in shedding light on the following set of research questions:

RQ1*: What are the desired traits of a VA that facilitate its acceptance among employees in the AEC sector?*

> ***RQ1.1****: What are desired traits in the behavior of a VA that facilitate its acceptance among employees in the AEC sector?*
>
> ***RQ1.2****: What are desired traits in the appearance of a VA that facilitate its acceptance among employees in the AEC sector?*

RQ2*: What contextual factors facilitate acceptance of VAs among employees in the AEC sector?*

> ***RQ2.1****: Does management impact the acceptance of a VA in the AEC sector?*
>
> ***RQ2.2****: Do colleagues impact the acceptance of a VA in the AEC sector?*

The research has been conducted in collaboration with the companies REHUB digitale Planer - an architectural studio with a strong emphasis on digitization, and REHUB FORGE - a subsidiary company, providing innovative software solutions for the AEC sector (both referred to as “REHUB”). To answer the research questions, 21 employees of either one of the organizations, all with a background in architecture or similar, were interviewed. The architectural planning and designing software SOCRATES (Sophisticated Creation of Architectural Templates), developed by REHUB FORGE, serves as AI technology that is combined with a VA in a hypothetical scenario. After the data collection, the data were analyzed according to Qualitative Data Analysis. The paper is structured as follows. Firstly, a literature review was conducted to provide context and depict the state of the relevant work. Secondly, the type of data collection and further proceedings were outlined in the method section. Thirdly, the findings were presented in the results section. Fourthly, the discussion served to integrate the findings in the previously defined context.

2. Literature Review

2.1 Dimensions of Acceptance

Technology acceptance makes up for the successful adoption of technologies (Shehzad, 2021). Especially when a technology is new, acceptance gets researched (see literature on AI (Occhipinti et al., 2022)). Also, in the context of interaction between VAs and human users, acceptance has been proposed as a crucial dependent variable, next to efficiency and user behavior (Krämer & Bente, 2021). Following the analysis of Schäfer and Keppler (2013), there are three dimensions to acceptance: acceptance subject, acceptance object, and acceptance context. Taking up their definition, acceptance means that someone (subject) must accept something (object) within a specific frame or context (context). They sum up that all three dimensions interact and influence the other dimensions and should be studied in relation to each other.

First, the subject dimension can be any instance that accepts something. It does not matter whether it is an individual, a group, or society. Regarding technology acceptance, Schäfer and Keppler (2013) find that most studied subjects are individuals. Different actors are considered depending on the type of technology and the differing responsibilities of workers. For instance, it does matter whether subjects are only users of the technology or whether they decide about or are affected by its use (Hüsing, 2002). As modern organizational hierarchies are often flatter than in the past, AEC workers are not only users but also have a say in a technology's implementation. Also, decisions are seldom made in isolation by a single employee because they are interpersonal processes (Bagozzi, 2007).

Second, an object of acceptance can or cannot be physical. As a VA and the connected AI technology is software, they are not physical. However, a software's responsiveness decides whether it is usable on different devices. That means physical hardware may influence the acceptance of the VA, but whether the software works on it is influenced by its responsiveness. A VA applied in the AEC industry can also be classified as work-technology (Renn, 2005).

Third is the social and cultural acceptance context, in which the acceptance subject accepts the acceptance object. Schäfer and Keppler (2013) explain this dimension with factors that influence acceptance but are neither directly related to the acceptance subject nor the object, such as their social or cultural environment. The acceptance subject and the acceptance object characterize the acceptance context. Therefore, management and employees' colleagues can influence the social acceptance context regarding the AEC industry.

2.2 ICT Acceptance

Most research into the acceptance of ICT is focused on the technology acceptance model (TAM) and its many expansions (Bagozzi, 2007), focusing on the effects of perceived usefulness (PU) and perceived ease of use (PEU) on attitude toward use, behavioral intention to use and finally system use. The model is based on the theory of planned behavior (TPB) (Ajzen, 1985), which is itself based on the theory of reasoned action (TRA) (Ajzen & Fishbein, 1975). Models following this tradition postulate a causal relationship between intention and behavior (Vogelsang, 2012).

Early extensions of the TAM (Davis, 1989), such as TAM2 and TAM3 (Venkatesh & Davis, 2000), incorporate additional precursors to PU and PEU. Despite their frequent use, they have been criticized for lacking group, social, and cultural aspects (Bagozzi, 2007). Later extensions, such as the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) and UTAUT2 (Venkatesh, 2012), also incorporate social influence. Nonetheless, all versions of the TAM are static, ignoring that acceptance and adoption are processes (Bagozzi, 2007).

Meissner et al. (2021) confirm the critique by stressing that the acceptance of human-robot collaboration is a change process whose antecedents go beyond technological design. They found that organizational-change-related dimensions of anxiety about future consequences and disappointment about lack of participation outweighed rational considerations that are in the focus of traditional TAM research. Additionally, a recent meta-analysis stresses that technology acceptance research mainly leaves out the relationship between users and agents (Fitrianie, et al., 2020). It appears that “the social dimension of interaction is overlooked by the predominantly psychologically motivated research on human-agent interaction” (Harth & Hofmann, 2021, p.2).

In addition, technology acceptance studies have mainly been studied quantitively. According to Vogelsang et al. (2012), this makes authors unable to understand the comprehensive relationships between man and technology. Especially with new technologies, these studies may miss out on relevant constructs that are likely to be overseen in theory-based argumentation.

2.3 ICT Acceptance in the AEC industry

Effective organizational change has become a core competency in the field of AEC to make it adopt technologies (Lines & Vardireddy, 2017). Unfortunately, the industry is known

for being conservative and reluctant to change (Anumba & Evbuomwan, 1997; Shezahd et al., 2021). Nevertheless, AI technology is rising to pervade the industry and transform it. Accordingly, successful change adoption is necessary, especially due to an expected labor and job market disruption. It is expected that automation causes job loss on the one hand (Berriman, 2017), while leading to an increase in new roles on the other hand (García de Soto et al., 2022).

When speaking of digitization and automation of the AEC industry, the term Building Information Modelling (BIM) is frequently used. BIM is the digital backbone of the industry (Pan et al., 2022) and is handled as an umbrella term for the use of a digital twin of a building and its related environment. It incorporates all the data from planning, design, construction, and operation, which results in heightened project management efficiency and better results (ISO, 2016; Park, Kwon, & Han, 2019; Shehzad et al., 2021). However, according to Shezahd et al. (2021), the actual benefits of BIM are not yet realized in the AEC industry because its adoption is low.

As the integration of BIM and AI will boost smart construction management (Pan et al., 2022), research into methods to improve its acceptance, such as intertwining it with VAs, is crucial. Shezahd et al. (2021) confirm the previous critique of ICT acceptance literature claiming that BIM adoption and awareness are generally discussed with limited technology adoption theories and models. They also stress TAM and its expansions as the most used models, followed by the theory of diffusion of innovation (DOI) (Rogers, 1963).

2.4 Virtual Agents in the AEC industry

Virtual agents in the role of assistants have pervaded society and business. For instance, voice-based virtual agents, such as Amazon's Alexa and Apple's Siri, or chatbots, such as Cleverbot or ManyChat. Next to purely speech-driven agents, agents with graphical representations – so-called embodied conversational agents (ECAs) – increasingly emerge (Cassel et al., 2000; Huang 2018). In addition, agents can be embodied by a physical body, such as the social robot JIBO (Breazeal, 2017). A VA with a graphical body, whether virtual or physical, opens the possibility for non-verbal communication (NVC) (Wang & Ruiz, 2021), which entails communicative cues that are not sent via speech but by the body instead (Watzlawick, 1969).

Eiris & Geihsari (2017) identify three types of human-agent interaction. Firstly, there is the interaction type human to agent, where the human provides the agent with input parameters to fulfill a task. Secondly, there is the interaction type agent to human, where the

human receives pre-loaded information of the human. Thirdly, information can flow both ways. This interaction type is exemplified by the study of Goedert et al. (2013), where a human user feeds information to an agent-based system in a construction-education setting. After analysis, an agent provides the user with the results of an activity sequencing simulation. This interaction type is the most challenging to compute, therefore, the least represented in the literature. Collaborating with a VA intertwined with AI technology falls into that category.

Currently, VAs are already tested and researched in professional fields, such as education (Tamayo-Moreno & Perez-Marin, 2016), healthcare (Martínez-Miranda et al., 2019), e-commerce (Yu, Vahidov, & Saade, 2015), entertainment (Görgü, Campbell, Dragone, & O'Hare, 2010) and also in the AEC industry (Eiris & Geihsari, 2017). As many tasks in the AEC industry can be done within virtual environments and therefore do not need a physical actor, VAs that are intertwined with AI technology will be able to fulfill all kinds of tasks, such as supporting in conceptual architectural design (Abrishami et al., 2020).

Virtual humans, meaning avatars and virtual agents, have also sporadically been involved in research concerning the AEC industry (Eiris & Geihsari, 2017). Eiris and Geihsari (2017) stressed the existing research fields by the method of systematic literature review. They found that there where studies involving virtual humans in fields of cost estimation, site management, scheduling, evaluation and analysis, education, as well as collaboration and communication. A study delivers an example of the latter from Lee et al. (2014), where virtual humans appeared as collaborative design and construction tools. The results indicate that workers' health and safety can be positively influenced using a virtual reality platform where virtual humans exist.

However, robots can be of use whenever automation technology needs to be physically present. Robots for construction purposes have been researched frequently in the past 30 years (e.g., Everett and Slocum 1994; Lim et al. 2012, Sweet 2018). Besides the early research, introducing construction robots failed due to a lack of computational power and partly because of their highly specialized application (Gambao, Balaguer, & Gebhart, 1999). In recent years, however, attempts have been more successful, such as the In situ Fabricator (Gift et al., 2017), a mobile robot with the ability to perform on-site manufacturing, assembly, and digital fabrication. Or the HRP-5P humanoid bot (Cisneros et al., 2018), a 182cm tall and 105kg robot construction worker intended to fill the gap in Japan's skills shortage. Nevertheless, acceptance research on robots in the AEC sector is rare.

2.5 Behavior of Virtual Agents

According to Krämer and Bente (2021), behavior and appearance are the most influential independent variables affecting the acceptance of artificial entities. However, behavior has proven to be more influential than appearance. Like real people: *"*it depends on what the character does, what it says, and how it presents itself" (Rickenberg & Reeves, 2000, p. 55). That becomes further relevant in human-agent cooperation since humans need to perceive VAs as cooperative partners instead of tools (Groom & Nass, 2007). In that manner, verbal and non-verbal behavior have been shown to influence users' acceptance (Krämer & Bente, 2021).

In terms of verbal behavior, the quantity of an agent's utterances is influential. For instance, the talkativeness of the VA has been identified to lead to a more favorable evaluation by a human (von der Pütten et al., 2011). However, based on the finding of Shamekhi et al. (2016), users prefer an agent's conversational style that matches their own, and thus, talkativeness may not be favored by everyone. Bearing in mind that a conversational style is not entirely determined for individuals and can adapt according to their circumstances (Chaika & Tannen, 2005), a user may prefer a different conversational style at work than he would for leisure activities. Thus, when a VA is deployed in a different context, a finding like the one of von der Pütten et al. (2011) must be reviewed accordingly.

Nonetheless, most studies on an agent's behavior appear to focus on the non-verbal part. Krämer and Bente (2021) explain this by the number of possibilities that are opened by human-like embodiment on the one hand and by the unique machine-like embodiment (e.g., eyes blinking in different colors) on the other hand. Especially a human-like embodiment allows using the full multimodal spectrum of non-verbal communication (NVC) (Cassell, 2001). Since appearance does not qualify as NVC but enables it, it is discussed separately. In a human-like agent's case, possible non-verbal communication acts are gesture, gaze, facial expression, proxemics, posture, and behavioral mirroring (Wang & Ruiz, 2021).

Wang and Ruiz (2021) summarized the possible effects of non-verbal communication: managing conversation, expressing a unique personality, achieving a sense of copresence, increasing rapport, trust and empathy, and enhancing the efficacy of collaboration and learning. Overall, they find positive effects of NVC in the literature for each of these categories. NVC can further be classified into 1. Emotional feedback (conveying affect), and 2. Envelope (conversational functions) (Cassel & Thorisson, 1999).

Some relevant effects for the workplace are, for instance, that gaze and head movement of the agent have been shown to lead to a heightened attentiveness of users (Bailenson et al.,

2002). Also, verbal, and non-verbal behavior can affect the perceived personality of an agent (Cafaro et al., 2012). Moreover, Biancardi et al. (2017a) link the presence of gestures in an agent with higher levels of perceived competence. Also, participants were more willing to hire a virtual person who used hand and arm gestures, while also conveying more leadership skills and competence. On the contrary, Krämer et al. (2003) find that agents with gestures are, even though users positively connotate them in terms of their perceived sense of entertainment, found to be less helpful. In addition, Moreno (2003) argues that voice is decisive and that one cannot find distinctive effects for the presence of an agent's embodiment.

Krämer and Bente (2021) comment on these contradictions and argue that the studies that found negative effects for non-verbal behavior in agents have mostly not worked with very sophisticated agents, whose capabilities for NVC were heavily limited. They further conclude that, even though non-verbal behavior seems to have an impact, it must still be clarified how strong it is. Since most reviewed findings relate to a pedagogical or healthcare context (Bente & Krämer, 2021), they must be reviewed again at the workplace.

Moreover, it remains unclear what role the VA should have in that social environment of the workplace and what role would be preferred by the users. For instance, could the VA be seen as a teammate (Groom & Nass, 2007; Klein et al., 2004) and colleague (Nyholm & Smids, 2019), which would have implications on its desired behavior. As a colleague refers to a teammate in a professional work setting, one can review both in the same manner. Subsequently, one can define the optimal role and correspondingly the desired behavior of the VA by comparing it with and differentiating it from human teammates and colleagues. On that occasion, a couple of studies can be found that discuss ideal robot/agent teammates and colleagues by comparing them with their human counterparts. For instance, Klein et al. (2004) have stressed *"*Ten challenges for making automation a 'team player' in joint human-agent activity" (p. 91). The challenges are mainly brought up by reviewing the literature on human-human teaming behavior. Moreover, Groom and Nass (2007) investigated the appropriateness of robots as teammates by analyzing how the ideal human teammate behaves. In addition, Nyholm and Smids (2019) came up with their suggestions for robot colleagues, focusing on the properties that a human colleague should have. However, the latter have not conducted an extensive literature analysis and drew upon their interpretation from an ethical lens and the informal feedback of two organizational psychologists. All three papers have a fair bit of overlap but do not match entirely.

On the one hand, the authors all find common ground on the aspects of humans and agents sharing common goals, mental models, and values while being able to trust each other.

However, Klein et al. (2004) further stress communicative aspects, such as “Agents must be able to engage in goal negotiation” (p. 93), that the others miss out on. Additionally, Nyholm and Smids (2020) extend the utilitarian aspects of the former two by bringing in social behavior, such as “Being able to engage in pleasant, informal conversations, to help to keep work pleasant” (p. 2177) or “Potentially also doing some socializing (in a collegial, respectful, and friendly way)” (p. 2177). However, whether human employees even look for social abilities in VAs remains an open question.

As shown by Nass and Reeves’ (2007) media equation theory, people at least react to social robots and computers, as they would to fellow humans, by applying rules for social behavior in their interactions. Thus, they are most likely reacting to VAs in the same manner. Since affective communication and empathy play a pivotal role in human bonding (Julmi, 2018), they could also play out positively in a human-agent relationship (Collins, Prescott, & Mitchinson, 2015). In addition, copresence, a dimension of social presence, faith, and personal attachment, and affective dimensions of trust all elicited a comfortable feeling from participants towards Siri as a coworker and friend (Lee, Kayva, & Lasser, 2021).

Nevertheless, the current state of VA technology is sobering. Currently, human-agent communication lacks important qualities, such as the agent’s ability to understand and imagine the mental state of the human (Kopp & Krämer, 2021). Hence, Kopp and Krämer (2021) conclude that “no [current] system is able to lead a half-decent coherent and engaging conversation with a human user. Even voice assistants merely enable only task specific ‘dialogs’” (p.1). However, especially due to the lack of these capabilities, one should clarify whether pursuing of such accomplishments would serve the implementation of VAs at workplaces.

2.6 Appearance of Virtual Agents

Even though an agent’s appearance has a less profound impact on acceptance than its behavior (Krämer & Bente, 2021), recent studies have stressed that agents with visual representations are still preferred over purely speech-based agents (Kim et al., 2018; Reinhardt, Hillen, & Wolf, 2020; Wang, Smith, & Ruiz, 2019). For instance, an embodied VA was found to positively affect confidence, trust, and social presence (Kim et al., 2018). Thus, research into a VA’s appearance remains relevant. Especially, because the embodiment of agents can change the social-psychological dynamics of interaction (Corti & Gillespie, 2015).

However, it is unclear what specific features, or traits, of appearance, are decisive

(Krämer & Bente, 2021). Especially looking at the specific context of the AEC workplace, clarification is needed. Based on the lack of systematic research about the appearance of VAs, Straßmann and Krämer (2017) have attempted to categorize the field. Firstly, they address the dichotomy of embodiment vs. no embodiment. Even though research shows positive findings for agents with an embodiment (e.g., Kim et al., 2018; Reinhardt, Hillen, & Wolf, 2020; Wang, Smith, & Ruiz, 2019), the context of its application may dictate different preferences. Thus, it must be clear whether an embodiment is needed or not in the context of the workplace in the AEC industry.

Secondly, they address the species of the agent, which they define "as different classes of individuals that have common attributes and are identified by a common name" (Krämer & Straßmann, 2017; p. 414). They identify five different types of species, namely humans, animals, robots, objects, and mystical creatures. Other authors also speak of humanness (Gulz, & Haake, 2006), zoomorphic and anthropomorphic (Sträfling et al., 2010), or machine-like agents (Bergmann, 2010) instead of species. However, the identified categories by Krämer and Straßmann (2017) are central. In the context of self-driving cars, a machine-human, displaying features of a machine as well as a human, was found to be preferred over a human-like agent, which was preferred over an abstract representation. Whereby animal and machine-animal, the latter displaying features of a machine and a human, scored last and should therefore be avoided. This might be explained by the uncanny valley theory (Mori, 2012), which describes an optimal balance between human-like and machine-like features to receive positive reactions from people. If that balance is distorted, users react with feelings of eeriness towards the entity.

Thirdly, Krämer and Straßmann (2017) find the realism of agents to be a major category. By reviewing relevant literature, they conclude that there is no universal definition of realism. However, a loose definition is provided by James et al. (2015, p. 109 - 110), that describe realism "in a simple binary manner; things are more real, the more they look exactly like a real object." Furthermore, Krämer and Straßmann (2017) identify the relevant sub-categories of stylization, resolution, and detailedness. According to James et al. (2015), the realism of human faces leads to a more positive valuation, whereby it did not matter for animals. Thus, through improvement in realism and, therefore, the possibility for heightened human likeness, the uncanny valley can be overcome, as the entity appears completely real (Koschate, 2016).

Fourthly, the dimensionality, namely two-dimensional (2D) versus three-dimensional (3D) is as another relevant category of an agent's appearance (Krämer & Straßmann, 2017). Therefore, it is important to have the type of simulation in mind since the agent may be

presented within a 2D computer screen but may be 3D itself. Whereby it would also be possible to present a 2D agent in a 3D environment, for instance, provided through VR glasses (e.g., Oculus Rift). Based on the realism section, it can be argued that 3D human-like agents might be preferred over 2D agents, as long the quality of the appearance is good enough to contribute to its realism.

Fifthly, the category of feature specification is addressed. Krämer and Straßmann (2017) refer to two sub-categories: socio demographics and styling. For instance, in terms of socio-demographic features some studies include a VAs gender (e.g., Kim, Baylor & Shen, 2007) or ethnicity (e.g., Gulz, Haake & Tärning, 2007). For both categories, studies have found positive effects for matching characteristics between VAs and users (e.g., Kim et al., 2007; Gulz et al., 2007). In addition, the sub-category of styling could include features such as hair, clothing, accessories, or makeup (Gulz & Haake, 2006; Ring, Utami, & Bickmore, 2014). Gulz and Haake (2006) suggest, based on the theory of physical personality, that these features invoke the impression of personality.

Overall, it is unclear what preferences employees in the AEC industry have for a VA's appearance. However, it must be clarified whether it needs an embodiment, how human-like, and how real and in which dimension it appears. Lastly, specific features of appearance may be identified. In that manner, it seems that the task-based context may influence preferences for the VAs embodiment, whereby the uncanny valley theory dictates preferences for human likeness, realness, and dimensionality.

2.7 Contextual Factors in Human-Agent Interaction

Technology acceptance research has mostly left out social, group, and cultural factors (Bagozzi, 2007; Harth & Hofmann, 2021). This circumstance is problematic since much of human behavior cannot be described by isolating the individual because people act as agents of groups and organizations (Bagozzi, 2007). Additionally, Schäfer and Keppler (2013) postulate that acceptance subject, object, and context should be studied together.

In terms of social and group aspects, Kelman (1974) differentiates into (a) social normative behavior, which is characterized by compliance that is based on approval, acceptance, or fear of reprisal, and into (b) group norms, which is characterized by internalization, i.e., acting out of congruence in groups. Transferring this to the present approach, it is of interest in what ways AEC employees might be influenced by social normative behavior and group norms. Therefore, looking into the potential influence of their

social environment, speaking of management and colleagues, appears to be a fruitful approach.

This argument is strengthened by the work of Lines and Vardireddy (2017), that are shedding light on the nature of change adoption within the AEC industry by stressing the importance of change management practices. They identified that the most vital driver of successful change adoption was the participation of effective change agents, closely followed by the communication of benefits each employee would gain in his or her specific position. Surprisingly, the provision of sufficient training resources for technical skills is the least effective, while it was still moderately statistically related to change adoption. Moreover, the commitment of senior leaders to the change was most strongly related to sustaining organizational change adoption in long-term but among the least important on all other constructs.

To sum up, to further understand the role of contextual factors, such as social and group aspects of human-agent acceptance in the AEC industry, gathering data on how management and colleagues may influence technology-acceptance decisions of employees is a fruitful approach.

3. Method

3.1 Design

The literature on ICT acceptance often replicates known factors through the frequent use of the TAM model. Additionally, the general lack of qualitative research on ICT acceptance carries the risk of leading to a lesser understanding of the relationship between man and technology (Vogelsang, 2012). Therefore, the present research questions were investigated using an exploratory approach. In detail, the aim was to gather information on the outlined social-psychological and contextual concepts relevant to the employees' acceptance of VAs in the AEC sector. The research was accepted by the ethics committee of the faculty for behavioral, management, and social science (BMS) of the University of Twente.

Hence, semi-structured interviews with employees from the AEC sector were performed, that were asked to share thoughts, preferences, and ideas on the researched concepts. The semi-structured interview method often includes a blend of closed- and open-ended questions paired with why or how questions (Newcomer, Hatry, & Wholey, 2015). It is advantageous, if researchers: "need to ask probing, open-ended questions and want to know independent thoughts of each individual in a group." (Newcomer et al., 2015, p. 494).

3.2 Analysis

Additionally, several different methodologies are available to apply in qualitative data analysis. The most prominent two are the Grounded Theory (GT) (Glaser & Strauss, 1967) approach and Qualitative Content Analysis (QCA) (Berelson, 1952). While GT tries to develop a social theory through an inductive approach to the data, QCA is more suitable for analyzing and summarizing the relevant categories. Since the present research questions were about identifying preferences, the latter approach is more suitable for the present study.

The process of data analysis consisted of the following steps: a) selecting units of analysis – which can also incorporate all the collected data; b) creating categories/codes; and c) establishing themes (Cho & Lee, 2014). Moreover, QCA allows for inductive and deductive analysis and a hybrid approach (Cho & Lee, 2014). Since some categories have been identified in theory, a mixed approach suited the present paper. After the data coding, the categories and codes were revised and compared across cases (Cho & Lee, 2014).

To analyze the data, it was transcribed via the auto-transcription feature of Microsoft Word. Afterward, the transcript was corrected and adjusted according to the interview audio files, followed by coding the data with the software atlas.ti. To test the code book's reliability,

a 2nd independent coder was asked to perform coding on 3 interview transcripts. By random principle, 3 documents were chosen (Transcripts 4, 19, 20). The 2nd coder was provided with a thorough explanation of the researched concepts and the code book. Also, the transcripts were separated into fragments of meaning.

After coding, Cohen's Kappa was calculated, which resulted in a value of 0.68. According to Cicchetti (1994), values between 0.60 and 0.74 are a good result and can therefore be called reliable. Subsequently, the results have been discussed with both coders. Even though the code book was not adjusted according to the reliability, it was still decided to adjust the code in 4 cases. This change was done because multiple codes have been found to relate to the same concepts and have, therefore, been merged. The results of the reliability test can be found in Appendix B.

3.3 Participants

Since the study was conducted in collaboration with the organizations REHUB digitale Planer GmbH and their subsidiary REHUB FORGE GmbH (both referred to as "REHUB"), all the participants worked for either one of the firms. Since the researcher was an employee at the latter and both companies were in close contact, the study was announced in a group call with most of the colleagues attending. On that occasion, it was asked for participants. Since the employees were involved in time-consuming projects, participation was voluntary.

Because interviewees must be able to interpret the use of a VA in an AEC-related scenario to take part, a background in architecture or similar was mandatory. 21 interviews were conducted, of which half the participants were recruited through the announcement, and the rest were asked personally at the office or via Microsoft Teams chat. Also, the first 6 interviews served as a pre-test, leading to adjustments to the questionnaire. Only then questions about the contextual factors have been included. Still, they have been added to the analysis. Since there was not much new information coming in after two-thirds of the interviews, the saturation point was reached, and 21 interviews covered enough data to proceed. Except for three English interviews, the interviews were held in German. The researcher kept it in the hands of the participants, which language of the two they preferred.

Due to promised anonymity, the participants' socio-demographic data is mostly reported in averages and majorities, as exact spans and particulars make interviewees identifiable. The participants' age was 30 years on average. Moreover, 12 interviewees were male and, 9 were female. While 14 of them acquired a master's degree in architecture, there is

no further information given on the education of the other participants, due to owning particular degrees. Nevertheless, all of them related to architecture or construction. Their occupations ranged from general architects to specialists in computational design and AI.

Moreover, they were asked how long they have worked for either of the companies. Since REHUB digitale Planer GmbH was one year old, and REHUB FORGE GmbH was founded three months before the interviews were conducted, all the participants worked at the two companies for twelve months to one. In addition, they were asked how long they had been working in architecture, before joining REHUB. On average, they have spent 3 years and one month in the field.

3.4 Scenario and Interview Settings

To provide participants with sufficient context, they were given a definition of VAs based on the literature (Cassel et al., 2000; Huang, 2018; Pelachaud, 2009) and real-world examples, such as Siri, Alexa, and Cleverbot. Then, they were read a hypothetical scenario to provide context and to stimulate their imagination. Within the scenario, the software SOCRATES (Sophisticated Creation of Architectural Templates) was merged with a VA. The software was developed by REHUB FORGE GmbH and enables users, such as architects, to automate property feasibility studies. All the participants knew at least the fundamentals of the program. They were told that in the scenario, REHUB would employ SOCRATES and that they could interact with the agent whenever they needed a feasibility study or an analysis.

3.5 Procedure

The interviews were held in person at the office in a private meeting room, or via Microsoft Teams videocall. In the beginning, there was some small talk to reach rapport (Boeije, 2010). Since the participants were the researcher's colleagues, no further personal introduction was needed. The interviewees were asked whether they were okay with being recorded, done by smartphone or the built-in recording feature of Microsoft Teams. Then, the informed consent was read aloud, including a short introduction to the study's topic. The content of the informed consent was retrieved from the recommendation of the University of Twente.

After participants verbally agreed to the conditions, the questions were asked. They were structured as follows: 1. Attitude toward VAs (experiences, risks, benefits), 2. Contextual

factors (management, colleagues), 3. Behavior (verbal, non-verbal), 4. Appearance (embodiment, realism, humanness, attractiveness, dimensionality). The first part should fuel the participants' imagination and understanding of VAs in the AEC sector. The second part about the influence of management and colleagues follows as the participants were asked to think about the VAs implementation in their field of work already. Then, the third and fourth parts ask the participants to go into detail when thinking about the design of an acceptable VA. On average, the interviews took 20 to 35 minutes to complete.

Nonetheless, not every participant answered every question to the same extent. Their impression often caused that they cannot come up with anything substantial for a certain question. In some cases, that rules out follow-up questions. For example, if a participant is very sure that he does not want the VA to have an embodiment, follow-up questions, such as about a realistic appearance, were not always adequately answered. As most of the interviews were held in German, the citations are mostly translated into English, trying to be as close to their initial meaning as possible.

4. Results

The participants shared their thoughts on VAs in the AEC sector, their desired traits of behavior and appearance, as well as the influence that management and colleagues might have on their acceptance of the technology. The reported number of mentions (e.g., 7 mentions) refers to overall mentions of a particular concept, while a single participant can name a concept multiple time. The participants' answers also entail preferences for technological possibilities, requirements, and feelings toward them. In some cases, they further explained their choices.

4.1 Attitude toward VAs

To get an overview of the participants' general openness to the use of new technology, they were asked to assess themselves in that regard. While 7 participants were moderately open using new technology but mentioned exceptions like: "Yes, I am open, but sometimes I find it difficult (Participant 15), 8 people were found to be very open with lesser constraints like: "Yes, I mean it doesn't mean you have continue using it, but generally I like to try". (Participant 11), and lastly, 5 participants stressed that they were very open and did not mention any constraints like: "that's a very strong yes." (Participant 6). Thus, participants are generally open to new technologies, even though the intensity differs.

In addition, the interviewees were asked about their previous experiences with VAs and subsequently about their impressions of the technologies: 3 people had no experiences, 5 had a few, 7 had some, 3 had used it several times, and 1 used it frequently. While of those experiences, only 5 were positively connotated, for instance by participant 14, that said: "I was always positively surprised; I found all the ones that I have used of high quality.", 12 statements about negative experiences have been made. Of those, 7 find fault with the technology's sophistication, as exemplified by participant 11 that referred to the chatbot of a transportation company when saying that: "technology lacks behind in any case." In addition, 5 comments deal with frustration, which was, amongst others, caused by: "being stuck in a phone hotline for about 10 minutes" (Participant 10). Overall, participants do not frequently use VAs. This circumstance can be explained by their negative experiences, pointing toward a lack of technology sophistication.

In that regard, they were asked to think about potential benefits and risks in their jobs, using VAs that are coupled with AI technology. Overall, risks were mentioned 38 times and therefore dominated the respondents' answers, whereby benefits were mentioned only 26 times. The most often named risks were the fear of bad output through a lack of competence,

creativity, and a variety of results provided by the technology (13 mentions). This point is exemplified by participant 1, who referred to the taught importance of individual aesthetics in architecture when stating: “serial and automatic processes could disturb that.” In addition, the interviewees mentioned data security risks 7 times, such as participant 5, who said: “If it’d be activated all the time, I would be afraid we will be controlled.” Moreover, they have pinpointed the risk of job loss (6 mentions) because if you: “automate things and enforce them through an algorithm, this will cost jobs” (Participant 11).

In terms of potential benefits, interviewees often mention speed when handling tasks with the agent (12 mentions). An explanation is put forward by participant 4, who anticipates that: “seeing the results immediately” would: “raise the borders between the different professions and especially in urban planning and urban development, like when a lot of stakeholders are involved, it would be really crucial.” Based on the benefit of speed, interviewees stress that they might save time that can be particularly spent on more creative or important tasks (6 mentions). In that manner, the technology may take over tasks of: “researching themes and tasks” whereby the architect can “concentrate on the essentials, such as designing and construction.” (Participant 14). Also, they hope for the technology to be a work relief (4 mentions): “If the agent works as supporter […] maybe via web or so” (Participant 17), while they appreciate the amount of data the technology can consider (4 mentions), such as for “legal questions” because architects “have to know all kinds of [legal] paragraphs and so on.” (Participant 16).

Concerning risks, participants seem to fear both unsophisticated and sophisticated VAs. As the former lacks the necessary competence to support their work, the latter might even replace them in their roles. However, in terms of data security and job loss, the decisions of a firm’s management might play as much of a role as the technology’s capabilities. Concerning benefits, participants stress a VA that is sophisticated enough to support them in their role - not more nor less competent.

4.2 Behavior of the Virtual Agent

4.2.1 Requirements for Behavior

Some traits cannot be classified as verbal or non-verbal behavior but are settings that influence the agent’s behavior. Such as the requirement for customizability (5 mentions), which participant 14 refers to by stating: “Some personalization would be great. Because the preferences of people are just so different”. Participant 9 annotates that in the: “optimal case,

you could choose from certain pre-sets." Hence, participants desire to customize the VA, whereby the customizable traits, as well as the allowed degree of customization must be defined.

Moreover, the VA should allow for automatization (4 mentions), as elaborated by participant 10: "So it would be super nice if you'd be able to automate certain things. For instance, I use these shortcuts for my iPhone […]." As automizing shall save time, the time of interaction between the user and the VA should be reduced through it.

4.2.2 Verbal Behavior.

4.2.2.1 Modes of Communication. The interviewees frequently mentioned voice and text as modes of communication. The former was mentioned 24 times and mostly received positive remarks. For instance, participant 13 referred to another speech-based software that she liked: "As I said, I was already quite impressed by the sort of oral input that the model can perceive. […] Like, let's say you have an agent and just say your order, which kind of project you want." However, the participants regarded voice as a subject of the future, not applying to today's technological standard: "I do believe, that those models will include voice at some point." (Participant 19) or "Communication via speech is very difficult, I think. I believe that's a bit futuristic" (Participant 5). In contrast, there were also a few negative connotations like: "The feeling of speaking to a program is weird." (Participant 21). Nevertheless, most comments show a positive leaning toward voice as a mode of verbal communication.

In addition, human likeness plays a role in voice because: "it is just more pleasant to listen to a non-robotic voice" (Participant 9). This is further explained by participant 10, who voted for a human-like voice by stating: "Language is just something you cannot abstract any further." However, participant 1 annotates that a human-like voice might frighten him since he would ask himself, "is that a machine or a person?". Even though participant 8 thinks that a human-like voice could be scary too, she put it into perspective by stating: "I think with time passing you just get used to it. With Alexa, and Siri and others, it gets accepted as well." Thus, one can assume that a human-like voice is preferred over a non-human voice.

Also, the participants stressed technical requirements for the use of voice. Firstly, some comments are made about the VA's need for sufficient intelligence: "I think [the VA] can be useful, also when it has voice control - if its intelligent enough." (Participant 15) or "the machine must be smart enough to know and understand what was said." (Participant 19). Moreover, participant 8 emphasizes the need for efficiency: "So that you do not have to type

in the text first, but that could just say it, and it does it automatically." As a result, interaction through the mode of voice must allow for a flawless experience to be accepted by users. Since interacting with a VA by voice might cause anxiety in some users, a coping strategy is required.

On the contrary, some participants see more potential in text over speech: "I don't know why […] I find voice very difficult; I would prefer to type in all my things and parameters." (Participant 21). In that manner, text was mentioned 10 times as a mode of communication. Amongst others, participant 9 has a clear idea of how he would interact through text, so: "that you have an interface, where you can type in your message, like in a [Microsoft] Teams chat, and you get an answer." However, neither voice nor text seems to be mutually exclusive, as participant 17 elaborated: "I would probably prefer text over speech, so I don't have to talk to [the VA], but I could give a first input via speech, that comes back as a text protocol, that I can adjust later on.".

Participant 17 underlined his preference for text with its usability. He thinks: "that it would just work better." Overall, the utility of the mode of communication, whether its text or voice, is important because: "In the end, it matters whether it functions or not." (Participant 10). Participant 5 suggests a way to make communication via text more reliable and therefore marks it as a requirement: "I wouldn't make [the input options] too open; I think that, therefore, the potential for errors is reduced.". Hence, allowing for text in addition to voice is a fruitful approach for verbal communication between the participants and a VA.

4.2.2.2 Verbal Behavior Traits. Next to the mode of communication, the participants shared their preferences for specific traits that the VA should integrate into its verbal behavior. In that manner, precise language has emerged, which has been mentioned 5 times. It was described by participant 7: "That would have to be a very precise language" or by participant 9: "optimally [language is] short and sharp". On top of that, the VA should be not only precise but also fluent (4 mentions): "Yes, a fluent speech flow. That is also something [if it is absent] I dislike in humans." (Participant 11) or: "In order to ensure the fluency of the communication, connected sentences […] would be nice." (Participant 1). Additionally, the VA shall be a polyglot, able to understand different languages and accents. That trait came up 5 times and was described by participant 16: "I think it is also important to be flexible with accents and different languages." As a result, precise, fluent, and multilingual language is needed to cross language barriers. All these traits ensure either the efficiency or the effectiveness of interaction. Therefore, maximizing the participants' understanding of the VA's contents.

Another category is the tone (3 mentions) of the VA's verbal behavior. It should be reasonably informal but neither drift too much in the extreme, as explained by participant 14: "I would leave it half-formal. But I would loosen it up with a few informal attributes". Following, humor (9 mentions) has a challenging standing. Nevertheless, next to 4 negatively connotated comments, for instance, placed because it: "does not serve me in any way" (Participant 7), there were also 5 positive remarks, like that of participant 5 who likes the idea of the VA being able to tell a joke: "I just find it funny, like as an extra thing." As a result, the pre-setting of a VAs tone should not drift too much to an extreme. However, users should be able to adjust it according to their preferences, which could, for example, entail humor.

Moreover, some participants prefer an agent that acts proactively, for instance by: "asking questions, that you can answer subsequently." (Participant 2) (2 mentions). A proactive VA needs to know what problems the users face. In that manner, the ability to understand technical terms has emerged, which shows to be especially relevant in an architectural studio (5 mentions) because the work is: "something very specific, where you handle a lot of technical terms" (Participant 2). Moreover, architectural work is often circumscribed with: "[ambiguous] words that describe emotion, which the AI must understand correctly" (Participant 19). Through the circumstance that: "architects always naturally have a problem expressing [themselves] correctly and to describe things" (Participant 7). Hence, to act proactively, the VA must know and understand architectural problems to a degree, where it anticipates what the user thinks, whereby its ability to express technical terms must be on point.

4.2.3 Non-Verbal Behavior Traits

Furthermore, the participants stressed how a VA should act in a non-verbal way. For instance, it should emphasize its speech with moderate gestures (9 mentions). In that manner, participant 11 thinks that, "Especially with animated things [gestures] are often exaggerated and too extreme, but I find it good if it's just a bit and continuous." However, gestures might comprise too many emotions and should appear relatively neutral, as described by participant 1: "I think the problem is that, with mimic and gesture, like between colleagues, that it discloses too much information […] Thus, it should maybe be very neutral."

The need for discretion in a VA's non-verbal behavior has been further stressed (3 mentions). For example, participant 4 thinks that: "[The VA] shouldn't be irritating. Like having too many notifications." Participant 9 annotates: "That would be a nightmare. Having pop-up messages every three minutes." While most participants missed defining specific

gestures, participant 1 would like the VA to show friendly gestures such as “always smiling and waving.” Consequently, the VA should use gestures, but it must use them discretely not to annoy the user. Also, the need for discretion counts for any other form of non-verbal interaction, such as notifications.

The interviewees further underline the visualization of verbal speech and text to be relevant for architects (16 mentions). An explanation is delivered by participant 10, who believes that: “90% of [an architect’s] communication goes via images, and thus, I would prefer if such a virtual agent would present his ideas visually.” This is further stressed by participant 18, who stated that he finds: “[...] it super interesting, if you give [the VA] certain instructions […], that you can immediately see the results on another screen.” Thus, since architects communicate visually, a VA must do as well. For instance, communication about a specific part of an architectural model might always be accompanied by presenting it to the user.

Logically, the VA’s ability to react to the users’ gestures (6 mentions) becomes important since: “Most of the people kind of don’t understand [an architectural model as a flat drawing]. Then there is this whole process of model making, just to feel and to see [the model].” (Participant 13). Hence, to make architectural models understandable, participant 13 concludes that: “some kind of physical interaction would be really good.” Additionally, participant 2 would like to use: “gestures and your hands to change something in the picture”. He hypothesized that: “it’s probably even more intuitive than speech”. Thus, subsequent to visualizing architectural communication, the users’ physical interaction with the presented model allows for more depth in their understanding.

4.2.4 Comparison to a Human Colleague

When the participants thought about the overlap between an acceptable VA and a desirable human colleague, they accentuated the need for pleasant behavior (13 mentions): “What both should comply with is being pleasant when dealing with each other” (Participant 2). Participant 3 supports this by stating: “What both should do is that they are both friendly.” Therefore, since the user is an emotional human being, the unemotional VA must comply with social rules of etiquette. It shows that software can emotionally affect people and that its design must follow the exact requirements for social interaction that a human colleague should.

In addition, a VA and a human colleague, should both be able to explain their actions (8 mentions). Firstly, users want to understand their colleagues’ behavior because: “A black box is always bad. And then, when you do not know what happens, anxiety rises” (Participant

6). Secondly, it shows that VAs and human colleagues understand their actions when highlighting: “what the background [of a decision] is.” (Participant 14). Thus, it’s a sign of intelligence.

Also, both: “must definitely be competent” (Participant 17) (4 mentions). However, 2 participants challenged a VAs competence by stating that humans are supposed to have: “more experience and more background knowledge” (Participant 5). Therefore, a VA must be at least as competent in its area of expertise as a human colleague. Because its capabilities are questioned more often, it has an even higher need to validate its appropriateness and explain its behavior.

Moreover, whether for a machine or a human: “Honesty is important.” (Participant 7) (2 mentions). Compared to a human: “that will maybe even be easier for the agent.” (Participant 7) because VAs are expected to be less emotional than them (10 mentions). Therefore, one can consider the VAs lack of: “human properties like empathy” (Participant 17) an advantage over humans. Participant 14 argues that “[emotionally neutral mimic and gesture] could get communication problems out of the way.” Participant 20 concludes that “the big benefit [of a VA] is that it has no feelings. Because, in human-to-human interaction, you must take care about that”. Hence, a VAs unemotionality is an advantage over and a difference to human colleagues. Naturally, a VA is expected to be more honest than a human.

Additionally, there is no need for social interaction between humans and VAs (14 mentions). Even though participant 9 thinks that it is: “always wonderful, that you can talk [to colleagues] in between, also about how you are”, with a VA it should: “just be short and concise, that it is just as simple as possible.” Also, participant 18 wants: “direct information clearly depicted.” and does not: “need any small talk that comes with it.” Consequently, the VA seems to be all about utility (9 mentions). It is viewed as: “a tool, but not my best friend” (Participant 14). Or as a: “source of information […] not a real colleague” (Participant 15). Following, interaction with a VA should be reduced to a functional minimum - a clear difference to an interaction between human colleagues. While the VA must comply with the social rules of etiquette as much as humans do, its’ social responsibility mostly stops there. However, as some participants favored a humorous VA, the level of social interaction might be left open to customization.

4.3 Appearance

4.3.1. Requirements for Appearance

The participants have stressed customizability as a requirement for a VA's appearance (7 mentions). Participant 1 explained his preference by referring to the video game Sim City: "where you could choose your avatar in the beginning." He finds it cool "if you could create your spirit human as your avatar." Another explanation is delivered by participant 14, who states that "the differences in [users'] preferences are too high [for a standard design]." Next to personal preferences, the VA can be adjusted to its field of application. It "should not always be the same, so that he differs according to the theme [of the interaction]" (Participant 17). Consequently, a VAs appearance must be open to customization and depends on personal preferences and its context of application.

4.3.2 Embodiment

Even though the interview questions about a VA's embodiment, realism, human-like appearance, and dimensionality were asked separately, the interviewees discussed them in strong relation to each other. For instance, they built their arguments toward an embodiment on opposing an abstract representation, toward a realistic, human-like embodiment (e.g., "simple interface" ≠ "a character" (Participant 9), "something abstract" ≠ "a beautiful realistic embodiment" (Participant 10)).

On the one hand, the participants stressed their preference for an abstract representation, such as a physical object (7 mentions) or a symbol (11 mentions). Participant 11 explains that he finds it: "charming that [Siri & Alexa] are just representational things like a glowing light ring" so he concludes, "if it's on a notebook, it would just be enough if there's an LED somewhere". In addition, participant 8 and participant 10 both argue that the VA could also be embodied by an object that is "something like a smartphone". In that manner, Participant 6 could imagine the VA being resembled by a symbol that looks like: "a small and funny house" to make it fit the architectural context. Additionally, and amongst others, participant 19 refers to the fictional VA 'J.A.R.V.I.S' from the Movie Iron Man. He concludes: "[Just as J.A.R.V.I.S] it could be a symbol […] I would like that better than standing in front of something resembling a real person."

On the other hand, some participants think a more sophisticated embodiment can be important (6 mentions), because the interaction with an abstractly or unembodied VA might be: "a bit weird" (Participant 5), and because it could be cool to: "interact with someone like a

person" (Participant 2). Interestingly, 4 of 5 people that have positively connotated a more sophisticated embodiment have also named more abstract embodiments as viable alternatives (e.g., Participant 2).

Nonetheless, participants stressed the low importance of an embodiment in 15-, and even advocated against an embodiment in 17 comments. So did participant 9 state: "For me it does not really matter whether it's a character […] or just a simple interface.", and participant 2 say: "No, it could also just be something else, like a voice." Participant 14 concludes: "Something really invisible would be the most honest and the most direct, and therefore [the most] acceptable kind of tool."

Additionally, the context of use and the type of the VA direct the need for an embodiment as in: "If the VA is an informational source, it does not need an embodiment." (Participant 18). Therefore, the interviewees stated that certain interaction types mimicking human-human communication might require a more sophisticated representation. Such as a virtual room with virtual avatars because: "It requires a higher credibility of the agent." (Participant 19) or a one-on-one conversation (Participant 12).

All in all, an embodiment of the VA is of low or no importance to the participants. Even those that have mentioned a preference for a more sophisticated embodiment see an abstract visualization as a viable option. Since a few positive connotations were made, it might be left open to customization, whether the VA has one. If so, an abstractly represented VA, as in a physical object or a symbol, might be preferred over one resembling a real person. However, the type of interaction dictates whether a more sophisticated embodiment is needed, as its absence means no gestures. For instance, an interaction that mimics human-human communication needs two actors that are close enough to an embodied human to facilitate it. Even though a symbol or any other abstract representation cannot provide human-like gestures, it might still provide visual feedback that could fulfill the role of gestures.

4.3.3 Humanness

In addition, the interviewees discussed the human-like appearance of the VA. Some have stressed that it is of low (8 mentions) or no importance (10 mentions) to them. Such as participant 8, who states: "I cannot get something out of a VA that resembles a living being.", or participant 18, who says: "I don't need an animated face or so" (Participant 18).

Nonetheless, some interviewees would still prefer a human-like embodiment (10 mentions). They defined certain basic human features that the VA should embody (10

mentions). Instead of creating a real-looking human, it should be: “just enough to make it look a bit human, but little enough to make it still look like a robot” (Participant 1). Participant 1 wants it to have: “a general expression that leads to a good mood.” On that occasion, the participants frequently mention the importance of eye contact (5 mentions), requiring the VA to have eyes. Because: “a face with eyes […] I think that’s important to create a bond with the VA.” (Participant 13). So: “it doesn’t have to look all human, but a bit, so you can hold eye contact” (Participant 9).

Moreover, the interviewees answered whether the VA could resemble another species. Their comments reveal that it is not preferred for most (13 mentions), whereby a few have specified animals that the VA could embody (3 mentions). Participant 13 speaks against the VA being resembled by another species when stating: “I cannot think of speaking to something like an alien or so.” Also, participant 7 does not want anything: “like a Tamagotchi.” On the contrary, 3 participants have expressed that they could think of the VA as looking like a specific animal, whereby 2 named a dog (e.g., Participant 12), and 1 named a seal (Participant 6). However, participant 12 shares that the species is not essential to her, because she thinks it is more important “to see human-like behavior” in the VA.

All in all, the participants’ preferences for human-like appearance are divided. Also, a preference for a human-like appearance contradicts the general preference for an abstract or symbolic embodiment. However, if a human-like appearance is implemented, there is a need to integrate basic features, such as a face with eyes, that enables a smile and eye contact. Consequently, the VA is still identifiable as a machine but is human-like enough to facilitate proper communication. Integrating another species in the VA’s appearance can be disregarded.

4.3.4 Realism

Overall, participants stress realism of low (6 mentions) or no importance (6 mentions). So did participant 17 refer to realism as: “not very important” and participant 6 annotate: “it doesn’t matter.”. They only advocate in favor of a realistic appearance (4 mentions) if it is of sufficient quality, thus, is: “made well” (Participant 11), or: “hyper-realistic” (Participant 19). Participant 12 annotates: “It’s like an [architectural] rendering, either its extremely good or I don’t like it.” On that occasion, participant 18 explains why an unreal human-like appearance can be disliked as he states: “Facial features on something that isn’t real is mostly frightening to me.” Consequently, if a VA should attempt to look real, it is all or nothing because there is no allowance for it to look less real to avoid the uncanny valley.

4.3.5 Attractiveness

Although some participants state that the attractiveness of a VA is not essential (8 mentions), most participants show a positive leaning toward an attractive look of the agent (12 mentions). Participant 9, however, thinks attractiveness is irrelevant and says: “It is probably too hard to meet everyone’s taste anyway, so there’s always someone that dislikes it. So, I think it is best to just look over it”. Participant 20 also builds on his preference for an abstract visualization of the VA by stating: “if the VA is a simplified, minimalistic thing, attractivity doesn’t really matter anymore.” On the other hand, participant 10 says: “I would prefer an attractive human over an unattractive human”, so he thinks: “it’s important” for an agent too. Moreover, participant 21 comments: “aesthetically pleasing interfaces are also nice for the eye so I would like that in the VA too”.

Since the participants do not advocate either entirely in favor or against attractiveness in a VA but see it as more or less critical it might still be designed aesthetically pleasing. As a result, it has a positive influence on those who think it is important and no influence on those who think it is irrelevant.

4.3.6 Dimensionality

The preferences of the participants, in which dimension the VA should be displayed, range from having no preferences (7 mentions) to 2D (8 mentions), to 3D (10 mentions), and a hologram (4 mentions). Participant 16 shares that she has no preference because: “in the end, if it works, I don’t care.” In addition, the type of the VA influences participant 4’s opinion since: “if it’s a tool that just visualizes what’s discussed, it doesn’t matter.” Participant 7 argues against adding too many dimensions because: “more dimensions mean higher development costs.” Additionally, participant 13 anticipates that 2D: “is easier and faster” to handle.

However, participant 12 thinks that: “with gestures and eye contact, it’s probably better working in 3D”. Moreover, of those comments preferring 3D, 5 comments stress a VR environment as a requirement. In that manner, participant 9 speculates: “if you really have VR glasses and then interact with the software, it would be nice having something in 3D.” Furthermore, some comments reveal the participant’s preference for a hologram, while they are aware of the technical limitations to make it work: “The coolest thing would be a hologram, but technology-wise, we are probably a bit far away from it.” (Participant 10).

Accordingly, the dimension of how the VA is displayed is affected mainly by the technological capacities, possibilities, and dimensions of interaction. If the VA does not act within a VR environment, it should appear in 2D. Nonetheless, when the interaction is based on gestures and facial expressions, a 3D appearance allows for richer communication.

4.4 Contextual Factors

4.4.1 Management Influence

When the interviewees were asked what the management could do for them to make the VA more acceptable, they provided multiple requirements. The first requirement is the possibility of training (10 mentions), meaning: “Giving me enough time to really try it out” (Participant 21). This involves: “understanding flexibility, so that I can just try it out [without pressure for results].” Participant 21 refers to new software when adding: “In the beginning it is always a productivity disadvantage because we don’t have the time [to train with it].” Thus, to ensure that the participants can implement the advantages of the VA, the management must allow them enough time to train with it.

Moreover, the participants expect that the management will explain the benefits of the software to them (5 mentions). In other words: “Somebody has to explain the advantages to me, and the Workflow” (Participant 11), or: “There must be an incentive [...] so it makes sense to me”. Hence, the management must ensure that the participants understand the VA and its' utility before implementing it.

In addition, the interviewees require the possibility for honest communication (4 mentions). So: “If you don’t like something, you can say it openly, and you can argue.” (Participant 4). On that occasion, participant 10 compliments his current employer: “With the current management, you can just address everything openly - everything is open and direct.” However, he states that: “if you have someone that is always a bit secretive […] the threshold [to try the software] is higher.” Accordingly, the possibility for honest communication reduces mistrust of employees in their management, and therefore heightens the chance that employees try out a software that their management recommends.

Moreover, some interviewees have mentioned that the management should ensure that the VA is not replacing employees at work (2 mentions.) Participant 9 understands this as: “Ensuring me that I don’t lose my job next month because of it.” Also, if a VA is introduced to the company, participant 1 forecasts: “I would feel as if I had to distinguish myself all the time, so showing that I am not replaceable.” Therefore, the management could positively

influence the employees' acceptance of the VA, by guaranteeing that they keep their job.

In addition, likeminded management may inspire and positively affect (3 mentions) the employees' acceptance of a VA. Participant 17 sees it as unusual for the AEC sector that the management is positive toward new technology and annotates: "This is something I value, and therefore I think [REHUB's] approach kind of supports and motivates me." In that manner, participant 6 adds that it is excellent: "if the CEO shows that he's up for it as well". Hence, optimally, the management implements the VA only when it stands fully behind it and communicates that to the employees.

4.4.2 Colleague Influence

Moreover, the participants came up with requirements on how their colleagues could positively influence them to accept the VA. They share that colleagues could recommend the software to them (4 mentions). Therefore, when a colleague says: "I did this project with it, and it worked" other colleagues may think: "Now I really want to try it out as well" (Participant 6). Also, when one of participant 16's colleagues would tell her: "the program is really good; you really have to try it out" she would immediately consider following her recommendation. Consequently, to convince all their employees to accept the VA, management may focus their resources on convincing only a few of them. If they accept it, they potentially recommend it to others.

In that manner, the daily exchange between colleagues plays a role in their acceptance of the VA (3 mentions) - because: "if you discuss [the software] with each other, it gets more interesting" (Participant 21). Participant 14 explains: "Just the daily exchange about technology is a huge thing already. Maybe [it does] not [directly have an effect] on my acceptance, but on my overall perception and understanding, of possibilities and opportunities related to it." Thus, as the interviewees expect that it positively affects their acceptance of the VA, if the management explains the program's utility to them, the same might apply to the daily exchange with their colleagues, as it also leads to a better understanding of the VA's utility.

In addition, some participants shared that likeminded colleagues can positively affect their acceptance of the VA (2 mentions). Participant 17 explains by complimenting her colleagues: "We work with technology-open people in our team. They aren't conventional architects [...]; They always look for innovation. So, I think it can actually influence you too." For participant 20 that means: "We try to get the best out of it together". Hence, like-

mindedness, as in being technology-open, may be fruitful toward the participants' acceptance of the VA.

4.5 Summary

Overall, participants have shared a diverse range of preferences for how an acceptable VA shall behave and look while also naming several factors of how management and colleagues influence their acceptance of it. In that manner, they revealed that they have a slightly negative attitude toward VAs as they report more risks than benefits. Unsophisticated and highly advanced VAs cause fear, as the former may produce poor output, and the latter may replace humans at work. Instead of viewing the VA as a human colleague, the employees see it as a tool.

To effectively utilize VAs, the mode of verbal interaction must be tailored to the task at hand: Text-based communication suits precise input, and voice-based communication suits open brainstorming. In interaction, the VA shall be verbally fluent and precise while speaking and understanding multiple languages and accents. Also, to act proactively, the agent must understand the architects' problems. Next, the VA must support speech with discrete non-verbal behavior. However, it must present visually profound representations of the architectural object of discussion and allow for physical interaction with it.

Since a sophisticated embodiment of the VA is not essential, an abstract symbol is sufficient. Suppose the VA shall appear human-like; it should respect the uncanny valley effect while focusing on aspects fundamental to human communication, such as a face with eyes. Generally, the VA can look aesthetically pleasing. The dimensionality of the VA is based on the type of interaction, whereby no initial preference was stated. Overall, the behavior of the VA seems to be more important to the participants than the appearance.

Moreover, management should ensure that sufficient training resources are made available and that they explain the benefits of the VA. Additionally, honest communication must be guaranteed in both directions, from and toward employees. Also, participants wish that management ensures that the VA is not potentially replacing them at work. As in being open to new technology, management and colleagues that are likeminded serve as a motivator in VA acceptance. Lastly, recommendations from colleagues and discussions about the agent in their daily exchange are beneficial.

5. Discussion

5.1 Social Psychological Factors

The participants want the VA to be a tool, not a colleague. As such, it empowers them in their roles without threatening their employment. In line with social determination theory (Deci & Ryan, 1985), the VA as a tool allows employees to practice their autonomy, feel more competent, and control their actions. The latter might be further strengthened through the participants' wish to customize the VA's behavior and appearance since it is an act of power. However, according to Groom and Nass (2007), humans need to see VAs as cooperative partners instead of tools to cooperate with them successfully. Therefore, the question arises whether participants would decline a VA that can fulfill a colleague's role or accept it and choose successful cooperation instead. That reveals the dilemma that developing a VA capable of being equal to employees might serve cooperations and those who run them, whereby employees fear its development and losing their current job roles.

As they view the VA as a tool, participants do not seek to socialize with it either. This finding is contrary to Nyholm and Smids's (2020) perspective, who proposed that a VA colleague should be able to engage in pleasant, informal conversation and potentially do some socializing. While they may have a valid point in a scenario in which a VA matches human colleagues in social ability, they fail to consider that users want the VA to be a useful tool only, not an equal. Seeing this through the theory of mind lens, participants might not attribute a mental state to the VA as a tool, lacking goals, intentions, and beliefs (Veltman et al., 2018). This view can explain the employees' negative tendency toward social interaction with the agent.

Interestingly, even though participants do not want to socialize with the VA extensively, the VA must still abide by social rules of etiquette. For example, it must exhibit pleasant behavior and be honest to reduce user discomfort. This finding is in line with the media equation theory (Nass & Reeves, 2007), which states that participants will respond positively to pleasant behavior, regardless of whether it comes from a machine or a human colleague. It highlights that the media equation is automatic, while social behavior towards machines is natural and effortless. However, since participants do not wish to socialize with the VA extensively, the technology's social duties are limited to a few fundamental aspects of social conduct.

When discussing the desired verbal traits of the VA, the participants desired verbal proficiency, such as precise and fluent speech, as well as speaking multiple languages and

accents. This result might be explained by rational considerations of the TAM, as these traits possibly relate to the PU and PEU of the VA. Even though the present study aimed to look at the data without applying the TAM or iterations of the model, the influence of its independent variables should not be neglected.

Moreover, the participants state that the VA's voice shall be human-like, as voice is difficult to abstract. On the contrary, they feel anxious that it may be hard to tell whether they speak with a VA or a human. In the light of the uncanny valley theory (Mori, 2012), this finding challenges the balance of human likeness for traits that can hardly be robotized without sacrificing the quality of interaction.

Additionally, the participants emphasized that a VA should visualize its speech. In other words, it should present the object that it is talking about, such as the architectural model or a specific part of it. As architects use verbal speech to communicate as much as visual tools like two-dimensional drawings, three-dimensional computer-generated architectural models, renderings, simulations, and walk-throughs (Norouzi et al., 2015), a VA applied in architecture should do the same. Therefore, a VA applied in architectural work must provide sufficient media richness.

In that manner, and further in line with media richness theory (Daft & Lengel, 1986), the participants mentioned that the VA should be able to react to the user's gestures. Thus, it should allow for physical interaction with the architectural model, as they assume it strengthens the users' comprehension of it. Interfaces with the affordance to react to gestures are known as multimodal interfaces (Pustejovsky & Krishnaswamy, 2021). A multimodal interface is desirable, as speech and gesture complement each other, and using both modalities increases human working memory while it decreases cognitive load (Dumas, Lalanne & Oviatt, 2009). However, a multimodal interface might be hard to design. Especially in 3D, as adding more dimensions means adding more complexity. Also, when participants discussed the presentation and interaction with the architectural model, they did not differentiate between the VA and the connected AI technology. That shows that the employee's acceptance of the VA could positively influence the acceptance of AI technology, as they see it as one.

Even though the embodiment of a VA is thought to have multiple positive effects on users, such as on confidence, trust, and social presence (Kim et al., 2018), most of the participants mark it as being of low or no importance or voted in favor of a more abstract representation, such as in a physical object or symbol. Their opinion goes along with the suggestion of Segura et al. (2012), who state that users in task-based contexts focus more on an agent's behavior than its appearance. The absence of a sophisticated embodiment allows

users to focus more on the information and tasks at hand without being distracted. An argument against an embodiment can also be found when reviewing the theory of cognitive dissonance, as the non-verbal behavior of the VA may violate our expectations or experiences of appropriate behavior (Harmon-Jones, & Mills, 2019). However, gestures are one of the desired non-verbal traits of the participants and are ruled out if the VA's embodiment is too abstract.

Even though a substantial amount of the participant's comments stressed a human-like appearance of the VA of low or no importance, there are still many positive connotations. Nonetheless, these contradict the participants' tendency for an abstract representation, as that can be humanized to a lesser degree than a more sophisticated one. The positive comments might only be relevant if the VA must have a more sophisticated representation. In that case, instead of creating a very human-like appearance, it should embody basic human features only, to still be identifiable as a machine. This result again points toward Mori's uncanny valley theory, suggesting an optimal balance of human and nonhuman features in artificial beings (Mori, 2012).

In that manner, the participants desire the presence of a face with eyes, able to hold eye contact during conversation, as important basic human features. As faces are communication instruments in human-to-human interaction (Ekman & Friesen, 2003), they also appear important for human-to-agent interaction. Additionally, the eyes function as informers about the emotional state of a human, whereby eye gaze is used to guide and interpret social behavior (Baron-Cohen, 1994). Interestingly, even though the participants have stressed that the VA is only a tool to them, these features seem to be so deeply anchored in human interaction that they desire it in a human-like artificial being too. However, since James et al. (2015) have found that realism led to a positive evaluation of human faces, the desired features of a human-like face with eyes can only be fully utilized if they appear realistic. In line with Koschate's (2016) suggestion, hyperrealism might help to overcome the uncanny valley, as it leaves no degree to look less real than real.

All in all, the participants desire the VA to be a tool whose affordances and behavior must serve their advantage at work. Therefore, it must incorporate human-like traits only when they serve the task-based context, for instance, through improving communication with a human-like voice and eventually a face with eyes. Based on the task-based context, an embodiment is of less importance to them than the VA's behavior. Regarding the specific needs of architects, the VA's media richness plays a profound role, as it enables communication on a level of human architects and beyond.

However, as the capabilities of AI technology continue to advance, the role of virtual

agents as mere tools may be challenged. Suppose a virtual agent surpasses the user's level of competence or even develops a general intelligence. In that case, it will no longer serve solely as a tool for the user. Then, it is in question who remains a desirable user. It could alter the dynamic of the relationship between the user and the technology, forcing the architects to reevaluate their value and worth as human beings in the workplace. It also raises questions about the ethical implications of creating intelligent beings that may surpass our abilities. These are important considerations as the AEC industry will rely more heavily on AI technology in the future.

5.2 Contextual Factors

When considering how the management can impact their acceptance of the VA, the participants mentioned providing sufficient training resources. The provision of training resources fits into Rogers' innovation diffusion process (Rogers, 1963) at the knowledge stage. Providing training resources for the newly introduced software can help employees learn how to use it and understand its potential benefits. It can make them more likely to move on to the next stage of the innovation diffusion process, where they will consider whether to accept the software. This argument supports Bagozzi's (2007) critique of the TAM model, which stresses the model as too static, neglecting that technology acceptance is a process. Hence, it lacks an explanation of essential preliminary stages to technology acceptance.

Moreover, the participants require honest communication, so they can speak openly as much as the management speaks openly to them. In that manner, DuFrene and Lehmann (2014) state that the employees' need for honest communication is even higher in times of change since they view it as a crisis. According to the communication accommodation model (Dragojevic et al., 2015), people alter their communication styles to fit in with those around them. In the context of organizational change, employees may adapt their communication styles and behavior in response to how the management communicates the change. Therefore, if the management communicates the change honestly and transparently, employees may be more likely to trust and accept the change. On the other hand, if management is not transparent or honest about the change, employees may be more likely to resist or reject the change, which can make the implementation process more difficult.

Furthermore, the participants assume that likeminded management, and likeminded colleagues, have a positive influence on their acceptance of the VA. A shared vision, values, and sense of identity are called organizational culture (Martin, 2013). According to Martin

(2013), this can be both a blessing and a curse to those facilitating change, as the object of acceptance must be agreeable with the organization's culture. In light of Kelman's distinction between social normative and group behavior, an organizational culture that employees widely adopt shows group behavior. That means they primarily act out of congruence instead of fear (Kelman, 1974). Moreover, as communication accommodation theory stresses that honest communication creates a shared sense of identity, honest communication contributes to the organizational culture.

Participants believe that their colleagues can positively influence their acceptance of the VA through direct recommendations or daily exchanges. To no surprise, word of mouth (WOM) has been stressed as positively influencing PU in technology acceptance (Parry, Kawakami, & Kishiya, 2012). The concept of community of practice, which suggests that employees learn most of the relevant knowledge in an organization through their interactions with colleagues, supports the idea that word of mouth can play a significant role in technology acceptance. When colleagues recommend a technology or system to each other, they effectively share their knowledge and experience with it, which can help others see its value and usefulness (Retna & Ng, 2010).

Finally, the process of technology acceptance is complex and multifaceted. It is influenced not only by individual factors, such as a person's experiences or attitudes and preferences towards technology, but also by the broader context in which the technology is being used. This context includes organizational culture, which can significantly shape people's perceptions and behaviors (Martin, 2012). In line with the concept of community of practice, colleagues will inform each other about technology and potentially foster its acceptance (Retna & Ng, 2010). Additionally, the way technology is introduced and implemented within an organization can influence its acceptance. For example, if people are given the necessary training and support, and the technology is aligned with their needs and goals, they are more likely to embrace it. Overall, the success of technology acceptance depends on a combination of individual, technology-specific and contextual factors.

5.3 Practical Implications

The present study's findings can be converted into recommendations for industry and science. Primarily due to the exploratory nature of the study, results must be further validated. In that manner, designers of VAs and AEC management should consider customization of behavior and appearance. However, research must clarify which parts of a design should be

open to customization and to which degree they are customizable. For behavior, a valuable option might be conversational style (Shamekhi et al., 2016), including humor or quantity of utterances (von der Pütten et al., 2011). For appearance, one can focus on easily visible and recognizable parts (Ducheneaut et al. (2009).

The participants expected that text-based interaction would lead to the better utilization of the VA, as it is more precise while they doubt its ability to process natural language input correctly. However, communication via natural language and, thus, voice may be appropriate when parameters are more open. Since neither text nor voice is mutually exclusive, and users like to be able to control whether they use voice or text (Weber & Ludwig, 2020), designers can use both modes in combination. Whether the former assumption holds must be further studied.

As human-like features of behavior and appearance can provoke fear in users, firms must implement a coping strategy. However, as known from cognitive behavioral therapy, exposure to the trigger can reduce anxiety over time (Hildebrand et al., 2022). Thus, if voice technologies further pervade society, the users' anxiety about using it will naturally shrink. Also, as language is difficult to abstract, and a human-like voice is more pleasant to listen to, reducing the voice's human-likeness could be a wrong reaction. Hence, a designer may make the VA articulate that it is a machine. This assumption should be researched.

Moreover, since human-like gestures are ruled out with an abstract representation, one can potentially integrate alternative non-verbal behavior to compensate for gestures, such as different lighting. Also, designers should integrate an architecture-specific VA in a multimodal interface. Since participants did not distinguish between the VA and the software it is embedded in, the VA might be seen as the face of the software. Hence, management should consider how they present the VA to employees, as they prefer viewing it as a tool. This stresses that management should know about the preferences of employees for a VA's design, as that informs them about how to effectively frame it when introducing it.

To facilitate the adoption process, the management must provide sufficient training resources and honest communication with their employees. It will allow employees to gain knowledge about the software, understand its potential benefits, and feel more confident and prepared to use it. Future research may clarify the most valuable training resources and inform management on how they best provide them.

Additionally, management should consider their behavior and organizational culture's impact on employee acceptance of the VA. A shared vision and values between management and employees can foster a positive attitude. Colleagues' impact on employee acceptance

should not be underestimated either, as word of mouth can play a significant role. Research should clarify the respective impact of management and colleagues on organizational culture and whether a focus on one of them is valuable for technology acceptance.

5.4 Future Research Directions

The present study reveals several opportunities for future research. First, the need for the study is based on the assumption that improving acceptance of a VA improves acceptance into intertwined AI technology. Even though participants not separating between the two concepts indicates that the assumption could be true, research must validate it. The lack of distinction makes it difficult to make statements about one concept without meaning the other. Nonetheless, that does not discredit the study's findings, as the combination of VA and AI technology stands in focus and delivers practical implications for both. Still, future research might better clarify which traits are valid only for the VA or the AI technology.

Moreover, the approach of researching acceptance-subject, -object, and -context together has limitations too. First, it might forbid the focus needed to gather in-depth data on each acceptance part. That could have been countered by conducting more extended interviews, which implies that participants have enough stimulation to talk about the subject. However, most importantly, the participants have never been confronted with the chosen scenario before, consisting of a VA merged with the SOCRATES software. Therefore, their imagination might have been limited, as they could not think about it for a longer period. As they were only presented with a relatively short read-out scenario, they might be introduced to the topic more extensively. Future research may also provide the scenario days before the interview to ensure participants have more time to think about the topic. However, it must be ensured that the material does not bias the participants' opinions. Additionally, future research may benefit of the recent hype of Chat GPT (OpenAI, 2023), that took place after data collection, as its popularity means that people gather more experiences with virtual agents, which might broaden their perspective on the topic.

Lastly, to gather more extensive data on acceptance subject, -object, and -context, future research might start with two separate studies that combine first acceptance-subject and -object, followed by a second study on acceptance subject and -context, while a third study takes the findings and studies their relations. In that manner, the latter study can tackle another limitation of the present paper: Even though a VA's design and AEC workplace have been investigated together, it did not extensively attempt to find relations between them. To fulfill the potential

of this approach, future investigations must attempt it.

5.5 Conclusion

This study investigated AEC employees' preferences for how a VA should behave and look and what management and colleagues could do, to positively impact their acceptance of the agent. Thus, various traits, features, and contextual ways of influence have been identified. All are influenced by the participants viewing the VA as a tool, not a colleague. Also, the finding's implications and interplay have been discussed. It was shown how the AEC workplace context influenced desired traits while challenges of balancing certain traits and features have been revealed. Future research must shed light on these challenges. Moreover, potential ways of influencing the employees' social work environment inform the industry on how to facilitate the acceptance of VAs within organizations.

References:

Abrishami, S., Goulding, J., & Rahimian, F. (2020). Generative BIM Workspace for AEC Conceptual Design Automation: Prototype Development. *Engineering, Construction and Architectural Management*, *28*(2), 482–509. https://doi.org/10.1108/ecam-04-2020-0256

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. *Action Control*, 11–39. https://doi.org/10.1007/978-3-642-69746-3_2

Ajzen, I., & Fishbein, M. (1975). A bayesian analysis of attribution processes. *Psychological Bulletin*, *82*(2), 261–277. https://doi.org/10.1037/h0076477

Anumba, C. J., & Evbuomwan, N. F. (1997). Concurrent engineering in design-build projects. *Construction Management and Economics*, *15*(3), 271–281. https://doi.org/10.1080/014461997373006

As, I., & Basu, P. (2021). *The routledge companion to artificial intelligence in architecture*. Routledge, Taylor & Francis Group.

Azhar, S. (2011). Building Information Modeling (BIM): Trends, benefits, risks, and challenges for the AEC Industry. *Leadership and Management in Engineering*, *11*(3), 241–252. https://doi.org/10.1061/(asce)lm.1943-5630.0000127

Bagozzi, R. (2007). The legacy of the technology acceptance model and a proposal for a paradigm shift. *Journal of the Association for Information Systems*, *8*(4), 244–254. https://doi.org/10.17705/1jais.00122

Bailenson, J. N., Beall, A. C., & Blascovich, J. (2002). Gaze and task performance in Shared Virtual Environments. *The Journal of Visualization and Computer Animation*, *13*(5), 313–320. https://doi.org/10.1002/vis.297

Baron-Cohen, S. (1997). *The maladapted mind: Classic Readings in evlutionary psychopathology*. Psychology Press.

Berelson, B. (1952). Content Analysis in Communication Research. *The Library Quarterly*, *22*(4), 356–357. https://doi.org/10.1086/617924

Bergmann, K., Eyssel, F., & Kopp, S. (2012). A second chance to make a first impression? how appearance and nonverbal behavior affect perceived warmth and competence of virtual agents over time. *Intelligent Virtual Agents*, 126–138. https://doi.org/10.1007/978-3-642-33197-8_13

Berriman, R., & Hawksworth, J. (2017). *Will Robots Steal our Jobs? The Potential Impact of Automation on the UK and other Major Economies. PwC UK Economic Outlook.* Retrieved December 30, 2022, from https://fsc-ccf.ca/references/will-robots-steal-our-jobs-the-potential-impact-of-automation-on-the-uk-and-other-major-economies/

Biancardi, B., Cafaro, A., & Pelachaud, C. (2017). Analyzing first impressions of warmth and competence from observable nonverbal cues in expert-novice interactions. *Proceedings of the 19th ACM International Conference on Multimodal Interaction*. https://doi.org/10.1145/3136755.3136779

Boeije, H. R. (2014). *Analysis in qualitative research*. SAGE.

Breazeal, C. (2017). Social Robots: From research to commercialization. . *Proceedings of the 2017 ACM/IEEE International Conference on Human-Robot Interaction*. https://doi.org/10.1145/2909824.3020258

Cafaro, A., Vilhjálmsson, H. H., Bickmore, T., Heylen, D., Jóhannsdóttir, K. R., & Valgarðsson, G. S. (2012). First Impressions: Users' judgments of virtual agents' personality and interpersonal attitude in first encounters. *Intelligent Virtual Agents*, 67–80. https://doi.org/10.1007/978-3-642-33197-8_7

Cassel, J. (2000). *Embodied conversational agents*. MIT press.

Cassel, J. (2001). *Nudge nudge wink wink: Elements of face-to-face conversation for embodied conversational agents.* (Ser. Embodied Conversational Agents). MIT Press.

Cassell, J., & Thorisson, K. R. (1999). The power of a nod and a glance: Envelope vs. emotional feedback in animated conversational agents. *Applied Artificial Intelligence*, *13*(4-5), 519–538. https://doi.org/10.1080/088395199117360

Chaika, E., & Tannen, D. (1985). Conversational style: Analyzing talk among friends. *Language*, *61*(4), 912. https://doi.org/10.2307/414501

Cho, J., & Lee, E.-H. (2014). Reducing confusion about grounded theory and qualitative content analysis: Similarities and differences. *The Qualitative Report*. https://doi.org/10.46743/2160-3715/2014.1028

Cho, Y. K., Jang, Y., Kim, K., Leite, F., & Ayer, S. (2019). Understanding different views on emerging technology acceptance between academia and the AEC/FM Industry. *Computing in Civil Engineering 2019*. https://doi.org/10.1061/9780784482438.077

Cicchetti, D. V. (1994). Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. *Psychological Assessment*, *6*(4), 284–290. https://doi.org/10.1037/1040-3590.6.4.284

Cisneros, R., Benallegue, M., Benallegue, A., Morisawa, M., Audren, H., Gergondet, P., Escande, A., Kheddar, A., & Kanehiro, F. (2018). Robust humanoid control using a QP solver with Integral gains. *2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. https://doi.org/10.1109/iros.2018.8593417

Collins, E. C., Prescott, T. J., & Mitchinson, B. (2015). Saying it with light: A pilot study of affective communication using the Miro Robot. *Biomimetic and Biohybrid Systems*, 243–255. https://doi.org/10.1007/978-3-319-22979-9_25

Corti, K., & Gillespie, A. (2015). A truly human interface: Interacting face-to-face with someone whose words are determined by a computer program. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.00634

Creswell, J. W., Hanson, W. E., Clark Plano, V. L., & Morales, A. (2007). Qualitative research designs. *The Counseling Psychologist*, *35*(2), 236–264. https://doi.org/10.1177/0011000006287390

Daft, R. L., & Lengel, R. H. (1986). Organizational Information Requirements, media richness and structural design. *Management Science*, *32*(5), 554–571. https://doi.org/10.1287/mnsc.32.5.554

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319. https://doi.org/10.2307/249008

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. Plenum Press.

Dragojevic, M., Gasiorek, J., & Giles, H. (2015). Communication accommodation theory. *The International Encyclopedia of Interpersonal Communication*, 1–21. https://doi.org/10.1002/9781118540190.wbeic006

Ducheneaut, N., Wen, M.-H., Yee, N., & Wadley, G. (2009). Body and mind. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. https://doi.org/10.1145/1518701.1518877

DuFrene, D. D., & Lehman, C. M. (2014). Navigating change. *Business and Professional Communication Quarterly*, *77*(4), 443–452. https://doi.org/10.1177/2329490614544736

Dumas, B., Lalanne, D., & Oviatt, S. (2009). Multimodal interfaces: A survey of principles, models and Frameworks. *Lecture Notes in Computer Science*, 3–26. https://doi.org/10.1007/978-3-642-00437-7_1

Eiris, R., & Geihsari, M. (2017). Research trends of virtual human applications in architecture, engineering and construction. *Journal of Information Technology in Construction*, *22*, 168–184.

Ekman, P., & Friesen, W. V. (1984). *Unmasking the face: A guide to recognizing emotions from facial clues*. Consulting psychologists Press.

Emaminejad, N., & Akhavian, R. (2022). Trustworthy AI and robotics: Implications for the AEC industry. *Automation in Construction*, *139*, 104298. https://doi.org/10.1016/j.autcon.2022.104298

Everett, J. G., & Slocum, A. H. (1994). Automation and robotics opportunities: Construction versus manufacturing. *Journal of Construction Engineering and Management*, *120*(2), 443–452. https://doi.org/10.1061/(asce)0733-9364(1994)120:2(443)

Fitrianie, S., Bruijnes, M., Richards, D., Abdulrahman, A., & Brinkman, W.-P. (2019). What are we measuring anyway? *Proceedings of the 19th ACM International Conference on Intelligent Virtual Agents*. https://doi.org/10.1145/3308532.3329421

Fortunati, L., Cavallo, F., & Sarrica, M. (2018). Multiple communication roles in human–robot interactions in public space. *International Journal of Social Robotics*, *12*(4), 931–944. https://doi.org/10.1007/s12369-018-0509-0

Gambao, E., Balaguer, C., & Gebhart, F. (1999). A robotic system for automated masonry. *Proceedings of the 16th IAARC/IFAC/IEEE International Symposium on Automation and Robotics in Construction*. https://doi.org/10.22260/isarc1999/0093

García de Soto, B., Agustí-Juan, I., Joss, S., & Hunhevicz, J. (2019). Implications of construction 4.0 to the workforce and organizational structures. *International Journal of Construction Management*, *22*(2), 205–217. https://doi.org/10.1080/15623599.2019.1616414

Giftthaler, M., Sandy, T., Dörfler, K., Brooks, I., Buckingham, M., Rey, G., Kohler, M., Gramazio, F., & Buchli, J. (2017). Mobile robotic fabrication at 1:1 scale: The in situ fabricator. *Construction Robotics*, *1*(1-4), 3–14. https://doi.org/10.1007/s41693-017-0003-5

Groom, V., & Nass, C. (2007). Can robots be teammates? *Interaction Studies*, *8*(3), 483–500. https://doi.org/10.1075/is.8.3.10gro

Gulz, A., & Haake, M. (2006). Design of animated pedagogical agents—a look at their look. *International Journal of Human-Computer Studies*, *64*(4), 322–339. https://doi.org/10.1016/j.ijhcs.2005.08.006

Gulz, A., & Haake, M. (2006). Virtual pedagogical agents: Naturalism vs. stylization. *Intelligent Virtual Agents*, 455–455. https://doi.org/10.1007/11821830_44

Gulz, A., Haake, M., & Tärning, B. (2007). Visual gender and its motivational and cognitive effects—a user study. *LUCS: Lund University Cognitive Studies*, *137*, 1–22.

Görgü, L., Campbell, A., Dragone, M., & O'Hare, G. M. (2010). Exergaming. *Computers in Entertainment*, *8*(4), 1–3. https://doi.org/10.1145/1921141.1921147

Harmon-Jones, E., & Mills, J. (2019). An introduction to cognitive dissonance theory and an overview of current perspectives on the theory. *Cognitive Dissonance: Reexamining a Pivotal Theory in Psychology (2nd Ed.).*, 3–24. https://doi.org/10.1037/0000135-001

Harth, J., & Hofmann, A. (2021). Mixed Reality Methods for Analysis of Multimodal Human-Agent Interactions. https://doi.org/10.13140/RG.2.2.17235.71208

Huang, H.-H. (2017). Embodied conversational agents. *The Wiley Handbook of Human Computer Interaction*, 599–614. https://doi.org/10.1002/9781118976005.ch26

Hüsing, B., Bierhals, R., Bührlen, B., Friedewald, M., Kimpeler, S., Menrad, K., Wengel , J., Zimmer, R., & Zoche, P. (2002). Technikakzeptanz und Nachfragemuster als Standortvorteil. *Fraunhofer ISI*. https://doi.org/ 10.24406/publica-fhg-291511

ISO 29481-1:2016. (2021, October 7). Retrieved December 30, 2022, from https://www.iso.org/standard/60553.html

James, T. W., Potter, R. F., Lee, S., Kim, S., Stevenson, R. A., & Lang, A. (2015). How realistic should avatars be? *Journal of Media Psychology*, *27*(3), 109–117. https://doi.org/10.1027/1864-1105/a000156

Julmi, C. (2018). A theory of affective communication: On the phenomenological foundations of perspective taking. *Human Studies*, *41*(4), 623–641. https://doi.org/10.1007/s10746-018-09485-0

Kelman, H. C. (1974). Further thoughts on the processes of compliance, identification, and Internalization. *Social Power and Political Influence*, 125–171. https://doi.org/10.4324/9781315129693-6

Khatri, C., Venkatesh, A., Hedayatnia, B., Gabriel, R., Ram, A., & Prasad, R. (2018). Alexa prize — state of the art in conversational AI. *AI Magazine*, *39*(3), 40–55. https://doi.org/10.1609/aimag.v39i3.2810

Kim, Y., Baylor, A. L., & Shen, E. (2007). Pedagogical agents as learning companions: The impact of agent emotion and gender. *Journal of Computer Assisted Learning*, *23*(3), 220–234. https://doi.org/10.1111/j.1365-2729.2006.00210.x

Klein, G., Woods, D. D., Bradshaw, J. M., Hoffman, R. R., & Feltovich, P. J. (2004). Ten challenges for making automation a "team player" in joint human-agent activity. *IEEE Intelligent Systems*, *19*(06), 91–95. https://doi.org/10.1109/mis.2004.74

Kopp, S., & Krämer, N. (2021). Revisiting human-agent communication: The importance of joint co-construction and Understanding Mental States. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/fpsyg.2021.580955

Koschate, M., Potter, R., Bremner, P., & Levine, M. (2016). Overcoming the uncanny valley: Displays of emotions reduce the uncanniness of humanlike robots. *2016 11th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*. https://doi.org/10.1109/hri.2016.7451773

Krämer, N. C., Tietz, B., & Bente, G. (2003). Effects of embodied interface agents and their gestural activity. *Intelligent Virtual Agents*, 292–300. https://doi.org/10.1007/978-3-540-39396-2_49

Krämer, N., & Bente, G. (2021). Interactions with artificial entities reloaded: 20 years of research from a social psychological perspective. *i-Com*, *20*(3), 253–262. https://doi.org/10.1515/icom-2021-0032

Lai, P. C. (2017). The Literature Review of Technology Adoption Models and theories for the novelty technology. *Journal of Information Systems and Technology Management*, *14*(1). https://doi.org/10.4301/s1807-17752017000100002

Le, Q. T., Pedro, A., & Park, C. S. (2014). A social virtual reality based construction safety education system for experiential learning. *Journal of Intelligent & Robotic Systems*, *79*(3-4), 487–506. https://doi.org/10.1007/s10846-014-0112-z

Lee, S. K., Kavya, P., & Lasser, S. C. (2021). Social interactions and relationships with an intelligent virtual agent. *International Journal of Human-Computer Studies*, *150*, 102608. https://doi.org/10.1016/j.ijhcs.2021.102608

Lee, W., Lin, T.-H., Castronovo, F., & Lin, K.-Y. (2014). Serious games for the learning and practices of hazard recognition: Understanding the design complexity for 3D Construction Site Modeling. *Computing in Civil and Building Engineering (2014)*. https://doi.org/10.1061/9780784413616.255

Lim, S., Buswell, R. A., Le, T. T., Austin, S. A., Gibb, A. G. F., & Thorpe, T. (2012). Developments in construction-scale additive manufacturing processes. *Automation in Construction*, *21*, 262–268. https://doi.org/10.1016/j.autcon.2011.06.010

Lines, B. C., & Reddy Vardireddy, P. K. (2017). Drivers of organizational change within the AEC industry: Linking Change Management Practices with successful change adoption. *Journal of Management in Engineering*, *33*(6). https://doi.org/10.1061/(asce)me.1943-5479.0000548

Martin, J. (2013). Organizational culture and organizational change: How shared values, rituals, and sagas can facilitate change in an academic library.

Martin, J. (2013). Organizational Culture and Organizational Change: How Shared Values, Rituals, and Sagas can Facilitate Change in an Academic Library. *Workplace Culture in Academic Libraries*, 39–56. https://doi.org/10.1016/b978-1-84334-702-6.50003-4

Martínez-Miranda, J., Martínez, A., Ramos, R., Aguilar, H., Jiménez, L., Arias, H., Rosales, G., & Valencia, E. (2019). Assessment of users' acceptability of a mobile-based embodied conversational agent for the prevention and detection of suicidal behaviour. *Journal of Medical Systems*, *43*(8). https://doi.org/10.1007/s10916-019-1387-1

Meissner, A., Trübswetter, A., Conti-Kufner, A. S., & Schmidtler, J. (2021). Friend or foe? understanding assembly workers' acceptance of human-robot collaboration. *ACM Transactions on Human-Robot Interaction*, *10*(1), 1–30. https://doi.org/10.1145/3399433

Miller, G. A., Dawood, N. N., & Kassem, M. (2012). Building an emergent learning environment for construction health and safety by merging serious games and 4D planning. *Computing in Civil Engineering (2012)*. https://doi.org/10.1061/9780784412343.0017

Moreno, R. (2003). The role of software agents in multimedia learning environments: When do they help students reduce cognitive load? *[Paper Presentation]. European Association for Research on Learning and Instruction Annual Conference, Padova, Italy.*

Mori, M., MacDorman, K., & Kageki, N. (2012). The uncanny valley [from the field]. *IEEE Robotics & Automation Magazine*, *19*(2), 98–100. https://doi.org/10.1109/mra.2012.2192811

Nass, C., & Reeves, B. (1996). The media equation: How people treat computers, television, and new media like real people and places.

Newcomer, K. E., Hatry, H. P., & Wholey, J. S. (2015). Conducting semi-structured interviews. *Handbook of Practical Program Evaluation*, 492–505. https://doi.org/10.1002/9781119171386.ch19

Norouzi, N., Shabak, M., Embi, M. R., & Khan, T. H. (2015). The architect, the client and effective communication in architectural design practice. *Procedia - Social and Behavioral Sciences*, *172*, 635–642. https://doi.org/10.1016/j.sbspro.2015.01.413

Nyholm, S., & Smids, J. (2019). Can a robot be a good colleague? *Science and Engineering Ethics*, *26*(4), 2169–2188. https://doi.org/10.1007/s11948-019-00172-6

Occhipinti, C., Carnevale, A., Briguglio, L., Iannone, A., & Bisconti, P. (2022). SAT: A methodology to assess the social acceptance of innovative AI-based technologies. *Journal of Information, Communication and Ethics in Society*. https://doi.org/10.1108/jices-09-2021-0095

Open AI. (2023). *CHATGPT: Optimizing language models for dialogue - openai.com*. ChatGPT: Optimizing Language Models for Dialogue. Retrieved January 18, 2023, from https://openai.com/blog/chatgpt/

Pan, Y., & Zhang, L. (2022). Integrating bim and AI for Smart Construction Management: Current status and future directions. *Archives of Computational Methods in Engineering*. https://doi.org/10.1007/s11831-022-09830-8

Park, E., Kwon, S. J., & Han, J. (2019). Antecedents of the adoption of building information modeling technology in Korea. *Engineering, Construction and Architectural Management*, *26*(8), 1735–1749. https://doi.org/10.1108/ecam-04-2018-0174

Parry, M. E., Kawakami, T., & Kishiya, K. (2012). The effect of personal and virtual word-of-mouth on technology acceptance. *Journal of Product Innovation Management*, *29*(6), 952–966. https://doi.org/10.1111/j.1540-5885.2012.00972.x

Pelachaud, C. (2009). Modelling multimodal expression of emotion in a virtual agent. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1535), 3539–3548. https://doi.org/10.1098/rstb.2009.0186

Pustejovsky, J., & Krishnaswamy, N. (2021). The role of embodiment and simulation in evaluating HCI: Theory and framework. *Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management. Human Body, Motion and Behavior*, 288–303. https://doi.org/10.1007/978-3-030-77817-0_21

Reinhardt, J., Hillen, L., & Wolf, K. (2020). Embedding conversational agents into Ar. *Proceedings of the Fourteenth International Conference on Tangible, Embedded, and Embodied Interaction*. https://doi.org/10.1145/3374920.3374956

Renn, O. (2005). Technikakzeptanz: Lehren und rückschlüsse der akzeptanzforschung für die Bewältigung des Technischen Wandels. *TATuP - Zeitschrift Für Technikfolgenabschätzung in Theorie Und Praxis*, *14*(3), 29–38. https://doi.org/10.14512/tatup.14.3.29

Retna, K. S. (2011). Communities of Practice: Dynamics and success factors. *Human Resource Management International Digest*, *19*(4). https://doi.org/10.1108/hrmid.2011.04419daa.008

Rickenberg, R., & Reeves, B. (2000). The effects of animated characters on anxiety, task performance, and evaluations of User Interfaces. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '00*. https://doi.org/10.1145/332040.332406

Ring, L., Utami, D., & Bickmore, T. (2014). The right agent for the job? *Intelligent Virtual Agents*, 374–384. https://doi.org/10.1007/978-3-319-09767-1_49

Rogers, E. (1963). Diffusion of innovations. *Journal of Pharmaceutical Sciences*, *52*(6), 612. https://doi.org/10.1002/jps.2600520633

Schäfer, M., & Keppler, D. (2013). Modelle der technikorientierten Akzeptanzforschung. https://doi.org/10.14279/depositonce-4461

Segura, E. M., Kriegel, M., Aylett, R., Deshmukh, A., & Cramer, H. (2012). How do you like me in this: User Embodiment preferences for companion agents. *Intelligent Virtual Agents*, 112–125. https://doi.org/10.1007/978-3-642-33197-8_12

Shehzad, H. M., Ibrahim, R. B., Yusof, A. F., & Khaidzir, K. A. (2019). Building Information Modeling: Factors Affecting the adoption in the AEC Industry. *2019 6th International Conference on Research and Innovation in Information Systems (ICRIIS)*. https://doi.org/10.1109/icriis48246.2019.9073581

Siemon, D., & Jusmann, S. (2021). Preferred Appearance of Embodied Conversational Agents in Knowledge Management. *AMCIS 2021 Proceeding*, (1). https://doi.org/ https://aisel.aisnet.org/amcis2021/adopt_diffusion/adopt_diffusion/1

Straßmann, C., & Krämer, N. C. (2017). A categorization of virtual agent appearances and a qualitative study on age-related user preferences. *Intelligent Virtual Agents*, 413–422. https://doi.org/10.1007/978-3-319-67401-8_51

Strauss, A. L. (1967). *The discovery of Grounded Theory: Strategies for qualitative research*. CA: Sociology Press.

Sträfling, N., Fleischer, I., Polzer, C., Leutner, D., & Krämer, N. C. (2010). Teaching learning strategies with a pedagogical agent. *Journal of Media Psychology*, *22*(2), 73–83. https://doi.org/10.1027/1864-1105/a000010

Sweet, R. (2018). The contractor who invented a construction robot. *Construction Research and Innovation*, *9*(1), 9–12. https://doi.org/10.1080/20450249.2018.1442702

Tajfel, H., & Turner, J. C. (2004). The social identity theory of intergroup behavior. *Political Psychology*, 276–293. https://doi.org/10.4324/9780203505984-16

Tamayo-Moreno, S., & Perez-Marin, D. (2016). Adapting the design and the use methodology of a pedagogical conversational agent of secondary education to childhood education. *2016 International Symposium on Computers in Education (SIIE)*. https://doi.org/10.1109/siie.2016.7751819

Turner, R. H., & Homans, G. C. (1961). Social behavior: Its elementary forms. *American Sociological Review*, *26*(4), 635. https://doi.org/10.2307/2090265

Veltman, K., de Weerd, H., & Verbrugge, R. (2018). Training the use of theory of mind using artificial agents. *Journal on Multimodal User Interfaces*, *13*(1), 3–18. https://doi.org/10.1007/s12193-018-0287-x

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, *46*(2), 186–204. https://doi.org/10.1287/mnsc.46.2.186.11926

Venkatesh, V., Morris, M., Davis, G., & Davis, F. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425. https://doi.org/10.2307/30036540

Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of Technology. *MIS Quarterly*, *36*(1), 157. https://doi.org/10.2307/41410412

Vogelsang, K., Steinhüser, K., & Hoppe, M. (2013). A Qualitative Approach to Examine Technology Acceptance. *International Conference on Interaction Sciences.*

von der Pütten, A. M., Hoffmann, L., Klatt, J., & Krämer, N. C. (2011). Quid pro quo? reciprocal self-disclosure and communicative accomodation towards a virtual interviewer. *Intelligent Virtual Agents*, 183–194. https://doi.org/10.1007/978-3-642-23974-8_20

Wang, I., & Ruiz, J. (2021). Examining the use of nonverbal communication in virtual agents. *International Journal of Human–Computer Interaction*, *37*(17), 1648–1673. https://doi.org/10.1080/10447318.2021.1898851

Wang, I., Smith, J., & Ruiz, J. (2019). Exploring virtual agents for augmented reality. *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. https://doi.org/10.1145/3290605.3300511

Watzlawick, P., Bavelas, J. B., & Jackson, D. D. (1967). *Menschliche Kommunikation – Formen, Störungen, Paradoxien. (Originaltitel: Pragmatics of Human Communication. A Study of Interactional Patterns, Pathologies, and Paradoxes.* (13th ed.). W.W. Norton & Company.

Weber, P., & Ludwig, T. (2020). (non-)interacting with conversational agents. *Proceedings of the Conference on Mensch Und Computer*. https://doi.org/10.1145/3404983.3405513

Yu, B. (2015). Agents and E-commerce: Beyond Automation Full Paper.

Appendices

A: Questions

Content Category	Theme	Main question	Sub-topics
Socio-demographic characteristics	Age	In which year have you been born? *In welchem Jahr wurdest du geboren?*	-
	Gender	What gender do you identify with? *Mit welchem Geschlecht identifizierst du dich?*	-
	Education	Which level of education have you obtained? *Welches Bildungsniveau hast du? (z.B. Bachelor, Master, Phd)*	-
		What study program did you follow? *Welchen Studiengang hast du belegt?*	
	Profession	What is your profession at REHUB? *Was ist dein Beruf bei REHUB?*	-
		How long have been working in your profession? *Wie lange arbeitest du bereits in deinem Beruf?*	-
User variables	Technological openness	How much do you enjoy new technology?	-

		Wie gerne probierst du neue Technologien (z.B. Software) aus?	
	Explanation ECAs/VAs: This study is about the acceptance of intelligent virtual agents. These are autonomous, partly graphically modeled and animated characters in a virtual environment that possess artificial intelligence. Chatbots and voice assistants are among the intelligent virtual agents (e.g. Siri or Cleverbot). *In dieser Studie geht es um die Akzeptanz von intelligenten virtuellen Agenten. Das sind autonome, teils grafisch modellierte und animierte Charaktere in einer virtuellen Umgebung, die eine künstliche Intelligenz besitzen. Chatbots und Sprachassistenten zählen zu den intelligenten virtuellen Agenten (z.B. Siri oder Cleverbot).*		
	Experiences with ECAs and VAs	Have you used any ECAs or VAs in the past? Please describe your experience *Hast du in der Vergangenheit irgendwelche ECAs und/oder VAs benutzt? (Voice Assistenten, Chat Bots,…)*	-
		What is your impression using those technologies? *Was ist dein Eindruck nach dem Nutzen der Technologie?*	

	Scenario: REHUB uses an intelligent virtual agent that can perform feasibility studies and all corresponding analyses (comparable to SOCRATES in terms of functionality). You can communicate with it easily via speech and gestures. So whenever you need a feasibility study or similar, you go into communication with this virtual agent. *REHUB setzt einen intelligenten virtuellen Agenten ein, der Machbarkeitsstudien und alle entsprechenden Analysen durchführen kann (vom Funktionsumfang mit SOCRATES vergleichbar). Du kannst mit ihm einfach über Sprache und Gestik kommunizieren. Wenn immer du also eine Machbarkeitsstudie oder ähnliches benötigst, gehst du mit diesem virtuellen Agenten in die Kommunikation.*		
	Feelings towards ECAs and VAs	What is your feeling towards working with AI powered ECAs/VAs in the AEC industry? *Was ist dein Gefühl bezüglich der Arbeit mit KI unterstützten ECAs/Vas in der Architektur und Baubranche?* What are risks and benefits of working with a VA that you can imagine? Was sind die Risiken und Benefits der Zusammenarbeit mit einem VA im genannten Szenario?	

Context related acceptance factors	External Factors	In what circumstances would you like to work with the technology? *Unter welchen Umständen würdest du mit der Technologie arbeiten wollen?*	
	Management Factors	Think about the implementation of such an VA at work: What could REHUB do, to make you work with it? *Denke über die Implementation so eines VAs am Arbeitsplatz nach: Was könnte REHUB tun, damit du mit dem VA arbeiten wollen würdest?*	
	Relationship Factors	In how far could the relationship you have with your supervisors, play a role in your acceptance of the VA? *Inwiefern glaubst du spielt die Beziehung mit deinen Vorgesetzten eine Rolle?*	
		In how far could the relationship you have with your colleagues, play a role in your acceptance of the VA?	

		Inwiefern glaubst du spiel die Beziehung mit deinen Kollegen eine Rolle?	
ECA acceptance factors	General factors	How do you imagine an ECA, that you would an accept to work with? *Wie stellst du dir einen ECA vor, mit dem du gerne arbeiten würdest?*	-
	Behavioral factors	Imagine the behavior of the ECA. What would make her more acceptable to you? Explain your answer. *Stelle dir das Verhalten dieses ECAs vor. Wie verhält sich ein ECA, mit dem du gerne arbeiten würdest?*	- verbal - non-verbal -comparison to human colleague - social vs utilitarian factors
		What verbal/communicative factors can you imagine? *Welche verbalen/sprachlichen Faktoren fallen dir ein?*	
		What non-verbal factors can you imagine (gesture, motion, facial expression)?	

		Welche non-verbalen Faktoren fallen dir ein? (Gesten, Bewegungen, Gesichtausdrücke)	
		In comparison to a human colleague, what are behavioral factors that you would wish for in an ECA? *Im Vergleich zu einem Menschlichen Kollegen, wie sollte sich ein ECA verhalten?*	
		How important are social (the ability to socialize) vs utilitarian factors in an ECA for you? (follow up*)* *Wie wichtig sind soziale Faktoren im Vergleich zu nützlichen?*	
	Appearance	Imagine the appearance of the ECA. What would make her more acceptable to you? Explain your answer. *Wie sieht ein ECA aus, mit dem du gerne zusammenarbeiten würdest?*	-embodiment -realism -humanness -likeability/attractive
		Would an agent be more acceptable with an embodiment to you?	

		Sollte der agent überhaupt einen Körper haben?	
		How important is realism for you? *Wie wichtig ist Realismus für dich?*	
		How important is humanness? In comparison also to other species or machine-like features? *Wie wichtig ist Menschlichkeit? Oder sollte der Agent einer Maschine, oder einer anderen Spezies gleichen?*	
		How likeable/attractive should it be? *Spielt ein attraktives Äußeres eine Rolle?*	
		Should it be 2D or 3D? *Sollte der agent 2D oder 3D sein?*	
		Feature specification (will probably specify it, if not, ask for it)	

		Gibt es bestimmte Features, die dir in den Sinn kommen?	

B: Codebook

Category	Group	Code	Description	Example	Frequency
User Variables	openness for technology	moderately open uo: mo	moderately open toward new technology	"So not the most open, but basically I'm curious."	7
User Variables	openness for technology	Open uo: o	open toward new technology	"Definitely, I'll try everything if it's... Yes, yes, that doesn't mean that you have to keep using it afterwards, but I always think it's good to try."	8
User Variables	openness for technology	very open uo: vo	very open toward new technology	"Yes, definitely, so I'm fully involved and sometimes read articles about new things."	5
User Variables	experience with VAs	none ue: n	no experience with Vas	"I haven't either, no. I wouldn't want to either."	3

User Variables	experience with VAs	less ue: l	very few experiences with Vas	"Hm, rather less so I'm not one who likes to use Siri."	5
User Variables	experience with VAs	some ue: s	some experiences with Vas	"Whoa, rudimentary at first so I sometimes use my Google Assistant on my cell phone mainly to query the weather and appointments from my calendar."	7
User Variables	experience with VAs	more ue: m	more experiences with Vas	"Yes, I have an Alexa myself"	3
User Variables	experience with VAs	a lot ue: al	a lot experiences with Vas	"I write programs with AI background myself."	1
User Variables	impression of experience	Positive ui: p	positive about their experiences with Vas.	"The last time I used it actually worked quite well, so he really understood my question and was then able to pass it on to me. Last interaction with it was ok."	2

User Variables	impression of experience	frustration ui: f	frustratedabout their experiences with Vas	"…or the category where you want to go isn't listed at all, so of course you get frustrated very quickly..."	5
User Variables	impression of experience	unsophisticated technology ui: ut	impression that the technology lacks sophistication	"So I actually don't like to use voice control now from Amazon or Siri, I somehow always have the feeling I don't know, because there's nothing behind it, so you just feel like you're talking to the air"	7
User Variables	benefit of VAs in AEC	speed ub: s	working with Vas is fast.	"The benefit is actually quite clear, one could act faster"	12
User Variables	benefit of VAs in AEC	more time for important tasks ub: tfit	more time left for important task due to the VA	"Yes, the best thing is of course all the free working time, i.e. everything that can be automated and that is easy to replace."	6
User Variables	benefit of VAs in AEC	work relief ub: wr	Vas can be helpful.	"Yes, that would definitely make our work easier…"	4

User Variables	benefit of VAs in AEC	quantity of data ub: qod	the quantitiy of data that a VA can consider is a benefit	"In the end he takes over, the intelligence takes over what might be 300-400 different perspectives and that not only saves time, but also the ideas of as many different people as possible."	4
User Variables	risks of VAs in AEC	fear of bad output ur: fobo	fear of bad output through a lack competence, creativity, and variety of results	"In general, I've sometimes had a bit of skepticism about architecture, because I believe that students are always taught architecture in particular, that the individual, aesthetic is very important and that it may be through, shall I say, very serial, Automated processes may interfere a bit"	13
User Variables	risks of VAs in AEC	data security ur: ds	fear of a lack of data security	"I just don't have an iPhone and I think I only switched to smartphones relatively late and when the topic came up a bit at some point, we don't use it, then at the same time all this here data tapping, scandals and co, on the cell phone, which is why I just said ok I	7

				don't need it so far, why should I stress now? So wait and see what happens next."	
User Variables	risks of VAs in AEC	job loss ur: jl	fear of losing their job through the VA	"Well actually, if you say come here try it, I wouldn't have a problem with that, so long as I get some sort of reassurance that I don't have to worry about losing my job in a month."	6

Category	**Group**	**Code**	**Description**	**Example**	**Frequency**
Contextual Factor	management	training resources cm: tr	management should provide training resources	"That means there has to be time for it, I think that's almost the most important thing"	10
Contextual Factor	management	explaining benefit	management should explain	"In any case, if that were presented and they would show what possibilities	5

		cm: eb	the benfits of the VA	there are, I wouldn't say that I'm not using it now."	
Contextual Factor	management	honest communication cm: hc	management should ensure an honest communication culture	“With the current management you can just address everything openly - everything is open and direct.”	4
Contextual Factor	management	ensuring job security cm: ejs	management should ensure that employeeswill not lose their job due to the VA	"Well, if you say come here try it out, I wouldn't have a problem with that, as long as I get some kind of assurance that I don't have to worry about losing my job in a month."	2
Contextual Factor	management	likeminded cm: l	management should be likeminded to the employees	"I think in a way yes, because I see my supervisors like my project leader and my manager as a very like minded people. "	3
Contextual Factor	colleagues	recommendation cc: r	colleagues can recommend the VA to others	"If one of my colleagues were to tell me whoa, the program is really really good, you really have to try it out, then	4

				of course I would think about it straight away."	
Contextual Factor	colleagues	daily exchange ccc: de	colleagues can talk about the VA in their daily exchange	"Just the daily exchange about all kind of new technology is already a huge thing."	3
Contextual Factor	colleagues	likeminded cc: l	colleagues should be likeminded	"Uhm, if you have colleagues or like I would say like the scenario that we have, I think like we, we work with technology-open people in our team . […] So I think that it has like it can actually influence you too."	2

Category	Group	Code	Description	Example	Frequency
Behavior	general	Customizing bg: c	the VA's behavior should be customizable	"I simply believe that there is a certain degree of personalization because the differences between the preferences of individual people are large"	5
Behavior	general	automating bg: a	the VA's behavior should be automatable	"Of course, it would be nice if certain things could be automated relatively easily"	4
Verbal Behavior	mode of communication	voice vm: v	the mode of communication with the VA is voice	"...generally a kind of voice control"	24
Verbal Behavior	mode of communication	text vm: t	the mode of communication with the VA is text	"My first impulse is to say in writing, in some way in text form."	10
Verbal Behavior	trait	precise language vt: pl	the VA's language should be precise	"That would have to be a very precise language"	5

Verbal Behavior	trait	fluent speech vt: fs	the VA's speech should be fluent	“In order to ensure the fluency of the communication, connected sentences […] would be nice.”	4
Verbal Behavior	trait	polyglot vt: p	the VA should speak and understand multiple languages and accents	"I think it is also important to be flexible with accents and different languages”	5
Verbal Behavior	trait	tone vt: t	the VA's tone should be reasonably informal, while not drifting to an extreme	“I would leave if half-formal. But I would loosen it up with a few informal attributes”	3
Verbal Behavior	trait	humor negative vt: hn	the VA should not incorporate humor in its speech	“...does not serve me in any way”	4
Verbal Behavior	trait	humor positive	the VA should incorporate	“I just find it funny, like as an extra thing.”	5

		vt: hp	humor in its speech		
Verbal Behavior	trait	pro-active vt: pa	the VA acts pro-active	"Ask questions, the technical one for me, do you want A B or C or special requests from me as free input…"	2
Verbal Behavior	trait	technical terms vt: tt	the VA knows relevan technical terms	"Of course there is always something very specific and with technical terms, depending on the situation. Then there would have to be an assistant that might also have the function of translation somehow."	5
Non-Verbal Behavior	trait	moderate use gestures nvt: mug	the VA should moderately use gestures	“Especially with animated things [gestures] are often exaggerated and too extreme, but I find it good if it’s just a bit and continuous.”	9
Non-Verbal Behavior	trait	discretion nvt: d	the VA should be discrete in ist non-verbal behavior	“[The VA] shouldn’t be irritating. Like having too many notifications.”	3
Non-Verbal Behavior	trait	visualizing verbal speech	the VA should present its	“90% of [an architect’s] communication goes via images and	16

		nvt: vvs	speech visually as well	thus, I would prefer if such a virtual agent would present his ideas visually.”	
Non-Verbal Behavior	trait	react to gestures nvt: rtg	the VA should react upon the user's gestures	“gestures and your hands to change something in the picture”	6
Comparison to Human Colleague	overlap	pleasant behavior cco: pb	the VA should behave pleasant	“What both should comply with is being pleasant when dealing with each other”	13
Comparison to Human Colleague	overlap	explain actions cco: ea	the VA should explain its actions	"So easy explanations, maybe with a little joke."	8
Comparison to Human Colleague	overlap	competent cco: c	the VA should be competent	"Equally probably in any case competence"	4
Comparison to Human Colleague	overlap	honest cco: h	the VA should be honest	"So I think honesty is important. Go into communication, it will probably be easier for virtual agents than for most people."	2

Comparison to Human Colleague	difference	no social-interaction ccd: nsi	the VA should not try to socialize	"Well, I definitely don't want to discuss my own problems with the virtual agent or about some kind of interpersonal care"	14
Comparison to Human Colleague	difference	tool ccd: t	the VA is seen as a tool, not as a colleague	"I think it should be like just a tool, just without like any human related assets "	9

Category	**Group**	**Code**	**Description**	**Example**	**Frequency**
Appearance	general	customizing ag: c	the VA's appearance should be customizable	"I think I think it's pretty cool if you could create your own spirit human as an avatar"	7
Appearance	embodiment	abstract physical ae: ap	the VA should be embodied by a physical abstract object	“if it's on a notebook, it would just be enough if there’s an LED somewhere”	7

Appearance	embodiment	abstract symbol ae: as	the VA should be embodied by an abstract symbol	"I was just a bit stuck in this point with speaking, I think the whole time about a kind of picture of this figure of the frequency from the voice, so why such a DKW graph."	11
Appearance	embodiment	person-like e: pl	the VA's embodiment should be person-like	"then you really see a real person with whom you can communicate"	6
Appearance	embodiment	not important ae: ni	an embodiment of a VA is not important	"No, so if it's really a program interface that doesn't talk to me now, I don't need a visual representation."	17
Appearance	embodiment	low importance ae: li	an embodiment of a VA is of low importance	“For me it does not really matter, whether it’s a character […] or just a simple interface.”,	15
Appearance	embodiment	important ae: i	an embodiment of a VA is important	"Because it's kind of cooler if you can actually interact with someone if the character speaks my language."	6
Appearance	humanness	not important ah: ni	a human-like appearance is not important	"No. That should be either abstract or non visual at all."	10

Appearance	humanness	low importance ah: li	a human-like appearance is of low importance	"Yes, I don't like animated people. If so, then it must be extremely good"	8
Appearance	humanness	important ah: i	a human-like appearance is important	"Uh yeah, definitely more human"	10
Appearance	humanness	basic features ah: bf	the appearance should be reduced to basic human features	“just enough to make it look a bit human, but little enough to make it still look like a robot”	10
Appearance	humanness	eye contact ah: ec	the VA should have eyes to enable eye contact	“it doesn’t have to look all human, but a bit, so you can hold eye contact”	5
Appearance	other species	not preferred aos: np	the VA's appearance should not resemble another species	“I cannot think of speaking to something like an alien or so.”	13

Appearance	other species	animal aos: a	the VA's appearance should resemble an animal	"I always have to think of a seal like that, they're always funny and they can clap their hands and stuff like that."	3
Appearance	realism	not important ar: ni	a realistic appearance of the VA is not important	"More realistic would probably be more of a deterrent"	6
Appearance	realism	low importance ar: li	a realistic appearance of the VA is of low importance	"Yes, in that sense not really that important."	6
Appearance	realism	Important ar: i	a realistic appearance of the VA is important	"Preferably a human representation, if you can do it well, then I think that distracts least from the obvious or from the content."	4
Appearance	attractivity	not important aa: ni	an attractive appearance of the VA is not important	"No, now in the context of a digital assistant, that would be completely irrelevant to me."	8

Appearance	attractivity	Preferred aa: p	an attractive appearance of the VA is preferred	"I think I would prefer the person to be attractive. As not attractive so likeable."	12
Appearance	dimensionality	no preference ad: np	the dimensionality of VA's appearance does not matter	"At the end of the day I don't think it matters."	7
Appearance	dimensionality	2D ad: 2	the VA should appear in 2D	I'm very strong at simple 2d, almost line graphics that are shown in a certain perspective at most	8
Appearance	dimensionality	3D ad: 3	the VA should appear in 3D	"I personally would prefer 3d"	10
Appearance	dimensionality	hologram ad: h	the VA should appear as a hologram	Of course, I think the coolest thing would be a hologram, but we're probably still a bit away from that	4

C: Reliability Table

C	1	2	Revised
1	cm: tr	cm: tr	
2	cm: l	cm: l	
3	cc: r	cc: r	
4	vm: v	vm: v	
5	vt: p	vt: p	
6	vt: t	vt: t	
7	I		
8	toi: cw	toi: cw	
9	ae: as	ae: as	
10	ae: as	ae: as	
11	ccd: le	ccd: le	
12	ae: as	ae: as	
13	ae: as	ae: as	
14	hla: p	hla: p	
15	hlb: pi	hlb: pi	
16	owhc: se	owhc: se	
17	ah: i	ah: i	
18	aos: a	aos: a	

C	1	2	Revised
34	ad: 3	ad: 3	
35	toi: vr		toi: vr
36	ah: ni	ah: ni	
37	nvt: mug	nvt: mug	
38	ad: 3	ad: 3	
39	toi: vr	toi: vr	
40	cco: ea	cco: ea	
41	cco: pb	cco: pb	
42		vt: t	vt: t
43	cco: pb	cco: pb	
44	cco: pb	cco: pb	
45	cco: ea	cco: ea	
46	ad: 3	ad: 3	
47	ah: bf	ah: bf	
48	ah: bf	ah: bf	
49	aos: np	aos: np	
50	ar: ni	ar: ni	
51	ar: i		

19		ae: p	ae: p
20	nvt: cg	nvt: cg	
21	nvt: rtg	nvt: rtg	
22	ar: li	ar: li	
23	ad: np	ad: np	
24	nvt: vvs	nvt: vvs	
25	vt: tt	vt: tt	
26	vm: v	vm: v	
27	vm: v	I	vm: v
28	nvt: vvs	nvt: vvs	
29	vm: v	vm: v	
30	vm: t	vm: t	
31	cc: l	cc: l	
32	toi: cw	toi: cw	
33	vm: t	vm: t	

52	aa: p	aa: p	
53	ad: 2	ad: 2	
54	ad: 3	ad: 3	
55	vm: t	vm: t	
56	ut	ut	
57	us	us	
58	hlb: ni	hlb: ni	
59	ae: ni	ae: ni	
60	ccd: nsi	ccd: nsi	
61	ccd: nsi	ccd: nsi	
62	ccd: t		ccd: t
63	hlb: ni	hlb: ni	
64	a: pa	a: pa	
65	aa: p	aa: p	
66	vt: fs	vt: fs	