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# HUMAN-ROBOT COLLABORATION IN CREATIVE INNOVATION PROCESSES:

## THE INFLUENCE OF FUNCTIONAL, RELATIONAL AND SOCIAL-EMOTIONAL ELEMENTS ON THE INTENTION TO COLLABORATE WITH A CREATIVE SOCIAL ROBOT IN THE WORK ENVIRONMENT

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## Abstract

Human-robot collaboration is advancing with social robots becoming capable of complex and human-like capabilities like developing creative output. Creativity is a central driver of innovation and business success, however, the implementation of social robots bears challenges for Human Resource Management (HRM) and it is important to investigate how employees would perceive creative social robots that provide creative ideas for innovation. It was hypothesized that functional elements (perceived ease of use, perceived usefulness, subjective norm), relational elements (trust and rapport), and social-emotional elements (perceived humanness, social presence, social interactivity) would predict the intention to collaborate and those would differ for different forms of a creative social robot (idea explorer vs. idea generator). The research made use of a survey-based vignette study with two conditions, based on the innovative phase of the robot. Overall, 124 participants were sampled and seven were additionally interviewed. The hypotheses were tested using hierarchal regression and independent-sample t-tests. Overall, no significant mean differences were found for the robot's different forms. Only the variables trust and perceived usefulness were shown to predict the intention to collaborate. This study offers initial theoretical and practical implications for HRM on the intent of employees to collaborate with creative social robots to innovate and remarks for successful implementation.

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## Introduction

Over the last years, human-robot collaboration (HRC) has become increasingly important, especially in the manufacturing industry. Here, HRC became popular for assembling tasks with robots no longer being in cages but part of a shared environment with the human workers (Kumar et al., 2020; Matheson et al., 2019; Sharkawy, 2021). Offering advantages of ergonomic nature (Matheson et al., 2019; Thomas et al., 2016) and increased productivity through higher flexibility; due to the combination of robotic precision, power, and speed with human resourcefulness, flexibility, and creativity (Kumar et al., 2020; Thomas et al., 2016). More generally, HRC is the collaboration of a human operator with a robot in process of working together to fulfill a task (Dobra & Dhir, 2020; Sharkawy, 2021) whereby the actions of one have instantaneous consequences for the other party (Matheson et al., 2019) and the skills of both parties are needed to achieve the results (Thomas et al., 2016).

While being well adopted in the manufacturing industry, robots and HRC have only more recently managed to move outside of the manufacturing world (Darling, 2016) which also included collaborative robots becoming more social robots. Darling (2016) defines social robots as a "physically embodied, autonomous agent that communicates and interacts with humans on a social level" (p.2) and are thereby distinguishable from industrial robots by the ability to communicate through social cues, adaptive learning, and the ability to mimic emotions (Darling, 2016) making them more human-like (Mishra et al., 2019). The tasks in which robots collaborate with humans have also shifted: from simply providing greetings or information in a stable environment which are considered as less collaborative tasks towards more complex tasks in dynamic environments (Mishra et al., 2019). One example of a more complex HRC at the workplace is the STRANDS project (Hawes et al., 2017), with a social robot that can learn common patterns of behaviour and is able to address individuals that deviate from those and can ask for identity confirmation. Another research shows how social robots can increase activity during breaks at the workplace and promote healthy behaviour (Zhang et al., 2020).

Thus, HRC at the workplace is evolving and becoming increasingly dynamic and complex. And while some more complex processes with social robots are being researched, the main focus of HRC at the workplace is still focused on improving the management and coordination of employees (Robert et al., 2020), help us to be more active (Zhang et al., 2020), providing us with information (Mishra et al., 2019) or delivering snacks into the office (Lee et al., 2009). To date, little to no attention has been focused on how social robots and artificial intelligence (AI) can help us with more complex and dynamic tasks such as creativity in the organizational field (Amabile, 2020). AI can be defined as a "system's ability to interpret external data correctly, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation." (Boden, 1998, p.17) and can be understood as a core part or the "mind" of a social robot (Lazzeri et al., 2018). Thus, for this research AI is seen as an inherent part of the social robot like his mind or "brain" and the social robot is what we can see and physically interact with. The lack of focus on creativity might be due to the fact that creativity has been regarded as a highly valued and guarded human skill and creative AI has long not been considered a truly possible option (Colton & Wiggins, 2012). In the following, the current study will turn to the development of creative AI and social robots and will argue for the importance to assess creative social robots in the field of HRC.

To outline the importance of creative AI, it is best to take a step back and focus on the importance of creativity and innovation in general. In the academic literature both creativity and innovation are often mentioned as highly interconnected (Amabile, 2020; Litchfield et al., 2015) and overall concerns the "at work […] process, outcomes, and products of attempts to develop and introduce new and improved ways of doing things" (Anderson et al., 2014, p.4). Overall, creativity is considered as a first, necessary but insufficient step of innovation. Creativity concerns the generation of novel ideas and useful, or value-adding ideas by an individual or small groups (Amabile, 1988; Anderson et al., 2014), relying mostly on intra-individual cognitive processes (Anderson et al., 2014), in contrast with innovation which is further also related to the stage of idea implementation (Amabile, 1988; Anderson et al., 2014) and can be defined as the intentional and beneficial introduction of new processes or products (Rank et al., 2004) and focuses more on inter social processes (Anderson et al., 2014).

As mentioned above, creativity was long thought to be a unique human skill (Colton & Wiggins, 2012) and while the current research does not focus on whether social robots can be truly creative but rather how they can create creative products or ideas in interaction with humans, it is important to consider how far AI, social robots and creativity have emerged over the last years. Research has shown that AI can be creative by, for instance, creating paintings (e.g. DiPaola & McCaig, 2016; Epstein et al., 2020), movie trailers (Smith et al., 2017) new perfume fragrances (Bergstein, 2019), or jokes (Rotman, 2019). Moreover, AI embedded in robots has shown to be able to be creative in the interactive collaboration with a human. Examples are the robot "Cobbie" (Lin et al., 2020), and the social robot "Jobi" (Ali et al., 2021) which both can draw in collaboration with a human. Another example is interactive creative support tools that help a professional, such as journalists to create better creative products by supporting them to find new angles or content for their stories (Franks et al., 2021).

Following the above-given examples, robots and AI that are developing and moving far outside of the manufacturing context and start to master complex and dynamic processes (Darling, 2016; Mishra et al., 2019) including processes of creativity (e.g. Ali et al., 2021; Bergstein, 2019; Boden, 1998; Franks et al., 2021; Lin et al., 2020; Rotman, 2019). Thus, social robots could be capable to be involved in the creative innovative work environment. However, to our knowledge, no research so far has dealt with the possibilities of creative social robots for innovative processes in orgaanizations.

The lack of research on creative social robots for organizational innovation is problematic. On the one hand, AI and social robots are already fundamentally changing our society, economy and the way innovation occurs (Davenport, 2018; May et al., 2020) and are becoming capable to be creative (e.g. Bergstein, 2019; Smith et al., 2017) or collaborate in creative processes (e.g. Ali et al., 2021; Lin et al., 2020). On the other hand, innovation literature has shown how crucial creativity and innovation is for the success of any organization to remain adaptable and successful (Crossan & Apaydin, 2010; De Jong & Den Hartog, 2010; Kang & Snell, 2009; Muhammad et al., 2021; Ramamoorthy et al., 2005; Rodhiya et al., 2021; Saether, 2019; Volery & Tarabashkina, 2021), yet there is to date no research that examines the intersection, the collaboration of employees with creative social robots for innovation. Thus, while social robots could be creative or collaborate in creative processes, and we know that creativity is important for any organization, to our knowledge no research has attempted to investigate the collaboration with creative social robots in innovative processes in organizations. This research gap is problematic because research has shown that the implementation of AI and (social) robots in the work environment can bear challenges for human-resource management (HRM) (Arslan et al., 2021; Vrontis et al., 2021) and further, social robots will not achieve any innovative results if humans do not collaborate with them. In the current research, we argue that while robots are able to be creative, a necessary but insufficient step of innovation, they are not able to innovate by themselves, which also includes the social process of championing and realizing an idea (Amabile, 1988; Anderson et al., 2014) and thus, in the worst case, this could result in creative robots with useful and valuable ideas that never become innovations because no one collaborates with the robot. On the other hand, if employees collaborate with creative social robots this could be able to boost innovative behaviour through an acceleration of the idea exploration and generation phase.

The above-outlined problem that any creative social robot, no matter how good the creative ideas are need the collaboration with a human to innovate are linked with the call for research of Amabile (2020) to investigate under which conditions experts, in our case, employees in a specific work environment like an office that are experts for their work within a company, will effectively collaborate with creative AI, in our case embodied in creative social robots. Therefore, the research question of this study is: *Which factors influence the intention to collaborate with a creative social robot for innovation in the workplace setting?*

With regard to the academic relevance of the current research, the research of the recent past on social robots has shown how valuable social robots and AI have become in creative processes such as art and drawing (Ali et al., 2021; Lin et al., 2020), writing (Franks et al., 2021), movie trailers (Smith et al., 2017) and perfume fragrances (Bergstein, 2019). Based on these insights of past research we can now go one step further and explore the value of creative social robots in other settings. One important setting is within organizations. For instance, the call for research of Amabile (2020) shows a need for research on creative AI, in this case of creative social robots in the organizational field and calls to explore the conditions for effective collaboration of human experts, in this case employees. The current study contributes by investigating what influences the intention to collaborate with a creative social robot in creative innovation processes. As stated above, no research has focused on the perception of creative social robots in the organizational setting in the context of innovation and, as argued creative social robots can only be of true value if they are collaborated with, and their creative ideas are adopted championed, and realized into innovations. The current research builds on the recent research on the role of creative social robots and advances the literature by investigating the influential factors to collaborate with creative social robots for innovations in organizations. Thereby, providing insight into how creative social robots can be a helpful tool in the field of organizational innovation which is crucial for any organization's success (e.g. De Jong & Den Hartog, 2010; Kang & Snell, 2009)

Furthermore, this study will result in practical relevance, by investigating how the creativity of a creative social robot is perceived at the workplace and resulting in practical explanations of whether and why creative social robots are accepted or rejected. Thus, offering practical implications on the best design and advice for HRM and general managers on the best implementation of creative social robots at the workplace to foster creativity and innovative behaviour.

In order to answer the research question on the perception of a creative social robot at the workplace, the current study made use of a vignette study. The rest of the paper is structured as follows: firstly, the theoretical framework of HRC and the acceptance of technology will be elaborated based on the current literature, and subsequently, hypotheses and a research model are developed. Next, the methods and results are presented which then are disused with regard to the literature. Further, limitations and implications for theory and practice are discussed, and indications for further research are drawn.

## Theoretical Framework

### Creativity and Innovation

As mentioned above, one way to define creativity is as the creation of novel ideas which are useful, or value-adding ideas by an individual or small groups (Amabile, 1983, 1988; Anderson et al., 2014) and according to Amabile (1983, 1988) is best defined as a behavior, observable through resulting products or ideas which emerges through combinations of cognitive abilities, personal characteristics, and the social environment. Concerning cognitive abilities, Amabile (1983) argues that a person needs domain-relevant skills; creativity-relevant skills, including the knowledge on how to generate new ideas, for instance through divergent thinking (Scott et al., 2004); and motivation towards the task at hand.

Intuitively, creativity in the organizational setting might be related to fields such as R&D and even though this is an important field for creativity in the organization, it is not the only one and creativity should not only focus on stereotypically assumed more creative roles (Mumford, 2003). The research on innovative work behaviour (IWB) provides a comprehensive framework on the importance of continuous innovation for organizations and how those can be fostered on the individual level of the organization and across the organization (De Jong & Den Hartog, 2010). IWB consists of 3 steps (Janssen, 2000) idea generation, where work-related problems or inconsistencies or trends give rise to novel ideas of improvement, idea promotion in which support for the idea is gathered from the social network, and lastly, idea realization. De Jong and Den Hartog (2010), however, argue that the stage of idea generation should be divided into two distinct stages, namely idea exploration and idea generation, as both rely on different cognitive abilities and often different individuals prefer different stages in the process of in the creative work. The current research will make use of the four stages model (idea exploration, idea generation, idea championing, idea implementation) (De Jong & Den Hartog, 2010). However, the research also acknowledges that individuals can be part of one or more stages at any time and that the multidimensionality of the theory might not be applicable in practice (De Jong & Den Hartog, 2010).

Overall, IWB is more than creativity but creativity is crucial for the process, especially in the early stages of idea exploration and generation (e.g De Jong & Den Hartog, 2010; Litchfield et al., 2015; Siyal et al., 2021). Recent literature has given many examples of how creativity might not only be a human skill but how AI enables machines to generate creative output. For instance, AI can create movie trailers (Smith et al., 2017) or paintings (e.g. DiPaola & McCaig, 2016; Epstein et al., 2020), come up with jokes (Rotman, 2019) or draw together with a human partner (Ali et al., 2021; Lin et al., 2020). However, IWB also demonstrated that innovation is more than only generating a creative idea. Innovation needs idea championing and idea implementation (De Jong & Den Hartog, 2010) which are more social processes (Anderson et al., 2014) for which the creative social robots need to work together with a human.

**Human-Robot Collaboration**

HRC is the collaborative process of working together of a human agent with a robot to complete a shared task (Dobra & Dhir, 2020; Ötting et al., 2020; Sharkawy, 2021) whereby both the robot and the human agent have skills that are necessary to accomplish the goal of the tasks (Kumar et al., 2020; Thomas et al., 2016). Furthermore, collaboration, compared to coexistence or cooperation, stresses the importance that the robot and the human agent not only work in a shared workspace but actually need to work together to achieve results and that the action of one party has immediate consequences for the other party (Matheson et al., 2019). Furthermore, both humans and robots have unique skills. For instance, robots are capable of handling tasks that are too dangerous, repetitive, or complex for humans and offer high levels of precision and speed, while humans are capable of thinking outside the box and adapting quickly to changes (Kumar et al., 2020; Thomas et al., 2016)

Due to the different skillsets of the human and the robot connected with the need to combine them to fulfill a goal, HRC needs communication and the exchange of information (Dobra & Dhir, 2020; Sharkawy, 2021). This need has direct implications for the design of the robot, which can be defined as a multi-functional, programmable, and therefore flexible device that can fulfill a wide range of tasks (Ötting et al., 2020). As stated, in order for the robot to be collaborative it needs to be able to communicate or to exchange information. Therefore, it needs some kind of physical embodiment and awareness of its environment, flexibility, and autonomy (Green et al., 2008; Ötting et al., 2020) which can enable several ways of commutation available to a robot that can be explicit through verbal cues, written messages or other signals or implicit through behavior, motion or other changes in appearance (Ötting et al., 2020).

Even though, HRC emerged in the manufacturing sector where robots started to outside of barriers into a shared workplace with human workers (Matheson et al., 2019). Those first steps of HRC were mainly rooted in concerns of flexibility, economical goals or for ergonomic reasons and the safety of the human workers (Matheson et al., 2019), but HRC has become more social and developed further into areas of, for instance, healthcare or elderly care, education (Lambert et al., 2020; Santhanaraj et al., 2021; Sharkawy, 2021), the work with autistic children (Ferrão et al., 2020) and the organizational setting (Robert et al., 2020). However, with this shift in the application setting also the robots themselves have developed and become more social.

**Social Robots and AI**

With the shift of HRC outside of the manufacturing area collaborative robots have become more social (Darling, 2016). Social robots can be defined as "physically embodied, autonomous agent that communicates and interacts with humans on a social level" (p.2). Interaction on a social level refers to the ability of a social robot to communicate through social cues, adaptive learning, and the ability to mimic emotions (Darling, 2016) instead of information sharing through signals and written or verbal cues (Ötting et al., 2020). Thereby social robots are more humanlike (Mishra et al., 2019) which in turn can foster better communication (Ötting et al., 2020) as research has shown that humanoid robots improve communication through human-like communication cues, such as eye contact, gaze, and gestures (Green et al., 2008). Furthermore, Hegel et al. (2009) argue that social robots need to have both an understanding of themselves and the people around them and needs to have the ability to adapt and to learn from interactions and the social robot might even be able to infer intention from the human behaviour without explicit communication (Breazeal et al., 2004). In order for a social robot to fulfill these and other abilities, they are programmed based on AI. AI can be defined as a "system's ability to interpret external data correctly, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation" (Kaplan & Haenlein, 2019, p.17) and could be imagined as a mind or brain of a social robot (Lazzeri et al., 2018).

Social robots are already used in healthcare, education, and other social areas (Ferrão et al., 2020; Lambert et al., 2020; Santhanaraj et al., 2021; Sharkawy, 2021). However, also in organizations and companies, social robots have become popular and can, for instance, be used for recruitment (e.g. Khosla et al., 2016; Nørskov et al., 2020) However, to our knowledge, no *creative* social robots exist yet in organizations with the role to foster innovation. A creative social robot would be a social robot, thus a robot is a physical, autonomous agent with humanlike features such as gaze and gestures that can interact with others on a social level through using for instance social cues, mimic emotions (Darling, 2016; Green et al., 2008) but additionally, it would have the necessary abilities and skills to engage in creative behaviour. Based on the stages of IWB that rely mostly on creativity, namely idea exploration and idea generation (De Jong & Den Hartog, 2010) the current research aims to explore which factors influence the intention to collaborate with a creative social robot as an idea explorer and an idea generator in an organization for the sake of innovation.

***Creative Social Robot as an Idea Explorer***

IWB suggests that any innovation is based on the creative act of generating a new idea (De Jong & Den Hartog, 2010; Janssen, 2000; Lambriex-Schmitz et al., 2020). Scholars have argued that before the idea generation there is also an idea exploration (De Jong & Den Hartog, 2010) or opportunity exploring stage (Kleysen & Street, 2001). During the idea exploration stage, one looks for ways to improve current processes or products by recognizing the issues and needs of the work environment and by searching for opportunities for change through alternative points of view (De Jong & Den Hartog, 2010; Kleysen & Street, 2001; Lambriex-Schmitz et al., 2020). Idea exploration can emerge through unexpected success, failure, a mismatch between a desired and a current situation, new knowledge, and changes in circumstances and perception (De Jong & Den Hartog, 2010). Overall, ideas can be explored in various ways. However, as argued above, Amabile (1983) suggests that the individual employee still needs certain cognitive abilities to explore opportunities creatively.

A creative social robot that acts as an idea explorer would have the necessary capacities to explore many opportunities for creative innovation based on the large amounts of data accessible. Thereby, a creative social idea explorer robot could evaluate failures, mismatches between goals and current situations, differences in processes or products between different sections of the organization or help employees to view problems from a new perspective, similar to the AI tool used to help journalists to find new angles for their content (Franks et al., 2021).

***Creative Social Robot as an Idea Generator***

A creative social robot that works as an idea generator would go a step further than the creative social idea explorer robot. The idea generation stage relies on the combination and restructuring of information to improve processes or products (De Jong & Den Hartog, 2010) and can be considered more directly as being creative through the production of novel and useful ideas (Janssen, 2000). A social creative idea generator would be able to explore ideas in the same way as a social creative idea exploration robot but would additionally be able to propose its own ideas. As argued above, the research on creative AI (e.g. Ali et al., 2021; Bergstein, 2019; Boden, 1998; Franks et al., 2021; Lin et al., 2020; Rotman, 2019) has shown that AI can create creative outputs based on data sets and rules. Therefore, a creative social idea generator robot could come up with ways to improve products and processes within an organization and take over the idea generation stage.

Nevertheless, also the idea generator only proposes a creative idea and is not able to innovate by himself. Innovation, next to generating a creative idea also relies on social process to find supporters of the idea, to champion and develop, and to implement the idea (Amabile, 1988; Anderson et al., 2014; De Jong & Den Hartog, 2010; Janssen, 2000) and if creative social robots and human workers effectively collaborate they can foster innovation by taking advantage of the creative social robots input and the ability to evaluate and champion the idea.

**Acceptance of Technology**

With social robots becoming capable of creative processes, it is crucial that people also collaborate with them. As argued above, a creative social robot might be able to generate creative output on its own, however, a social robot cannot implement innovation on its own. The collaboration between the creative social robot and the human is necessary to realize the creative ideas. Thus, for any creative social robot to be a successful collaboration between the human and the robot is needed. The literature on the acceptance of technology in general, and also of robots has shown that the acceptance and intention to use technology are not straightforward but can be facilitated or hindered by various factors (e.g. de Kervenoael et al., 2020; Hameed et al., 2016; Heerink et al., 2010; King & He, 2006; Meissner et al., 2020). Therefore, it is crucial to investigate the acceptance of a creative social robot as only if a creative social robot is accepted and collaborated with, the creative outputs of the social robot can be made use of and become valuable innovations.

Extensive research on the intention to use and the acceptance of technology exists based on the technology acceptance model (TAM) firstly proposed by Davis (1989) and generally argues that perceived ease of use and perceived usefulness and later subjective norm (TAM2; Venkatesh & Davis, 2000) are the core variables that influence the usage intention of a technology (Davis,1989). The traditional TAM has been developed and unified by Venkatesh et al. (2003) to the unified theory of acceptance and use of technology (UTAUT), which in turn has been applied in various contexts and extended (Venkatesh et al., 2016). TAM models can be used to assess a creative social robot, as in a broader sense a creative social robot is also only a technology that can be perceived as useful and easy to use and thus be accepted or not. Furthermore, this research does not try to capture whether the robot is perceived as being truly creative but rather the intention to collaborate out of reasons of functionality and other perceived qualities.

Indeed a lot of research has adopted the UTAUT model (Venkatesh et al., 2016) and it has also been adapted and used in the field of social robot acceptance (e.g. Conti et al., 2017; De Graaf & Allouch, 2013; Fridin & Belokopytov, 2014; Heerink et al., 2009). However, classical technology acceptance models might not be able to capture all the important factors that influence the interaction with a social robot. For instance, De Graaf and Allouch (2013) argued that the UTAUT is useful to access, what they refer to as utilitarian variables, that are variables that are related to practicality and usability. However, the model leaves out hedonic variables, such as enjoyment which are related to the experience of the user when engaging with the product which are important predictors of usage behaviour (De Graaf & Allouch, 2013). Also, Heerink et al. (2009b) found that the classical UTAUT was only able to explain 43% of the variance in the acceptance of an assistive social robot by elderly people and extended the classical UTAUT model (Heerink et al., 2010). Similarly, Wirtz et al. (2018) argued for the importance of socio-emotional and relational variables to explain the acceptance behaviour of service robots, proposing the service robot acceptance model (sRAM). The current research argues in line with the research of Wirtz et al. (2018), Heerink et al.(2010), and De Graaf & Allouch (2013) that the classical TAM(2) (Davis, 1989; Venkatesh & Davis, 2000) includes important variables to determine the functional (Wirtz et al., 2018) or utilitarian (De Graaf & Allouch, 2013) variables but lacks the socio-emotional and relational factors that appear to be important in the interaction with social technology (De Graaf & Allouch, 2013; Heerink et al., 2010; Wirtz et al., 2018).

We argue that it is important to consider those socio-emotional and relational factors for the acceptance of creative social robots due to the social attributes of the innovation process. When referring back to the research on IWB, innovation is a social process and the social context is important to consider (De Jong & Den Hartog, 2010) as it relies not only on interpersonal skills (Amabile, 1988; Anderson et al., 2014) but also on the inter social process (Anderson et al., 2014) of finding “potential allies” (Janssen, 2000; p.288) and engaging in social activities to find friends and supporters of the idea (Janssen, 2000). Thus, only a model such as the sRAM which is able to capture social factors is useful to assess the acceptance of a creative social robot in the creativity and innovation process as it includes variables to assess the potential relational feelings of connectivity, friendship, and the feelings of interacting with another social being. Therefore, the current research investigates the acceptance of a creative social robot based on the proposed model by Wirtz et al. (2018).

### *Intention to Collaborate*

The main focus of the technology acceptance models is to explain and predict the intention of people to use a technology (Davis, 1989; Venkatesh & Davis, 2000). However, a model such as the TAM(2) (Davis, 1989; Venkatesh & Davis, 2000) or sRAM (Wirtz et al., 2018) is not able to evaluate the actual usage of the technology or the actual collaboration between a social robot and a human. Technology acceptance models can evaluate only acceptance, which in our case can be understood as the intention to collaborate. However, intention to use technology is thought to predict actual usage behaviour and the systematic literature review by (Turner et al., 2010) suggests that behavioural usage intention is strongly correlated with actual usage behaviour.

## The Intention to Collaborate and Different Types of Creative Social Robots

The classical variables of the TAM model (Davis, 1989; Venkatesh & Davis, 2000) and their effect on usage intention have been excessively studied (Marangunić & Granić, 2015). Furthermore, also technology acceptance models that include more socio-emotional and relational factors have been developed and applied in the field of social robots (Fernandes & Oliveira, 2021; Heerink et al., 2010; Wirtz et al., 2018). Thus, the current research assumes that generally, the variables presented by Wirtz et.al (2018) or Heerink et.al (2010) are generally able to predict the intention to collaborate with social technology, including a creative social technology. However, to date, no research has investigated the technology acceptance of a creative social robot. Therefore, this study will examine whether technology acceptance variables can predict the intention to collaborate with a creative social robot. Furthermore, the current research will argue for some differences in the variables of the sRAM due to the different roles of the creative social robot, namely as an idea generator or idea explorer, which were presented above. In the following section, classical technology acceptance, and additionally socio-emotional and relational variables are elaborated on with regard to the intention to collaborate with a general creative social robot. In addition, some arguments are drawn on how those effects might differ depending on the two different kinds of social creative robots.

***Functional Elements: The classical Technology Acceptance Model***

The functional elements of the technology acceptance model include perceived ease of use, perceived usefulness and the intention to collaborate. Perceived ease of use concerns "the degree to which a person beliefs that using a particular system would be free of effort" (Davis, 1989, p.320). Thereby, perceives ease of use is related to the complexity and (Bartneck et al., 2009) difficulty of the technology (Thompson et al., 1991; Venkatesh et al., 2003) and compared to perceived usefulness, related more towards the intrinsic motivation to use a technology (Castaneda et al., 2007). Perceived ease of use is a direct predictor of usage intention (Venkatesh et al., 2003).

Secondly, perceived usefulness is defined as the "degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p.320). Therefore, perceived usefulness is a form of extrinsic motivation (Davis et al., 1992), refers to the outcome expectations of the usage of a certain technology (Compeau & Higgins, 1995), and is generally a predictor of usage intention (Venkatesh et al., 2003).

Lastly, subjective norm is based on the theory of reasoned action and planned behaviour (Madden et al., 1992) and refers to "a person's perception of most people who are important to him think he should or should not perform the behaviour in question" (Venkatesh et al., 2003, p.452). Furthermore, social norms capture the perceived influence on the image (Moore & Benbasat, 1991) of the technology using person, and how making use of new technology might increase social status (De Graaf & Allouch, 2013; Fernandes & Oliveira, 2021). Thus, the intention to engage with the technology is not only influenced by their own perception of the interaction but also by the imagined perception of others (Venkatesh et al., 2003) and technology is more likely to be accepted if the action is valued by the society (Fernandes & Oliveira, 2021). In the given context, a creative social robot would be able to influence the creative and innovative image an employee has within the company.

Following this we propose the following hypothesis:

*H1: Functional elements, namely (a) perceived ease of use, (b) perceived usefulness, and (c) subjective norm positively influence the intention to collaborate with a creative social robot*

However, we also argue for some differences in those effects based on the innovative level of the robot, that is a creative social robot as an idea explorer or idea generator. The perceived ease of use of a focuses on the perception that the usage of technology, in this case, the collaboration with the creative social robot would be free of effort (Davis, 1989). With regard to creativity, research generally suggests that task motivation, domain expertise, and creative skills are necessary components, and a higher level of each component results in higher levels of creativity (Amabile, 1988). Those factors are influenced by contextual factors that affect motivation and by personal factors that concern the domain expertise and creative abilities (Amabile, 1988). Thus, the ability to effortlessly generate a personal creative idea is dependent on intrinsic factors but the ability to accept the idea of a creative social robot is less so. Therefore, an idea generator is perceived as easier to use compared to an idea explorer that requires more complex behaviours. Thus, we propose:

*H2: Individuals' perceived ease of use will be higher of a creative social robot that generates ideas compared to a creative social robot that explores ideas*

With regard to the distinction between a creative social idea generator and an idea explorer, it is expected that a robot that already presents ideas, compared to possibilities for improvement might result in higher perceived usefulness due to a higher belief that the creative social idea generator robot will increase job performance and hold higher outcome expectancies. Perceived usefulness is related to extrinsic motivation and focuses on the performance outcomes of using a technology (Davis et al., 1992; Venkatesh et al., 2003). Concerning the IWB literature, idea exploration is only a first and necessary step of idea generation (De Jong & Den Hartog, 2010) and if the creative social robot only explores areas that need creative innovation, more work remains with the employee that uses the creative social idea explorer compared to the usage of the creative social robot as an idea generator. Therefore, a creative social robot that already proposes a creative solution is more directly linked to higher outcome expectancies and performance. Thus, we propose:

*H3: Individuals' perceived usefulness will be higher for a creative social robot that generates ideas compared to a creative social robot that explores ideas*

Concerning the distinction between a creative social robot as an idea explorer and as an idea generator it is expected that they differ in the perceived subjective norm. Subjective norm is based on the imagined opinions of others about using technology, whether using technology is able to increase one's social status, and the social robot's effects on the creative image. One can argue that a creative social idea generator can more easily affect a person's social image. The technology enables the employee to instantly come up with an idea and the employee could involve himself with processes of promoting and realising the idea, which relies more on social activities (Anderson et al., 2014) and therefore might have a bigger perceived influence on the person's image. The collaboration with a creative social idea generator relies more on the personal processes of developing a creative idea, is less visible for the social environment, and therefore, is less likely to be influenced by the perception of others on the behaviour. Thus, we propose:

*H4: Individuals' perceived subjective norm will be higher for a creative social robot that generates ideas compared to a creative social robot that explores ideas*

***Relational Elements***

Based on the sRAM model (Wirtz et al., 2018) also the relational elements trust and rapport are predictors of the intention to collaborate. Following the research of Mayer et al. (1995) trust in technology can be defined as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party" (p.712) and has been considered as a useful definition of trust between humans and AI (Glikson & Woolley, 2020). Trust as a predictor in the UTAUT model suggests that trust is made up of abilities, integrity, and benevolence (Cheng et al., 2008; Cody-Allen & Kishore, 2006), whereby abilities refer to the perceived competencies and knowledge of the technology; integrity refers to the perception of the user that the technology follows an acceptable set of rules and regulations; lastly, benevolence refers to the perceived absence of selfish motivation to help from the technology (Cheng et al., 2008; Cody-Allen & Kishore, 2006). Research on trust and technology acceptance generally suggests that trust is a direct predictor of usage intention (Cheng et al., 2008; Cody-Allen & Kishore, 2006; Ghazizadeh et al., 2012; Heerink et al., 2010).

According to Wirtz et al. (2018), rapport is the characterization of the interaction with a social robot as enjoyable, that is the robot's ability to spark curiosity, support the users' needs, and be perceived as friendly and caring. Moreover, rapport captures the experience of a personal connection between the user and the robot, fostered for instance through personalization (Lee et al., 2009; Wirtz et al., 2018). Rapport is essential for the exchange within relationships, as it enables responsiveness and influence (Lucas et al., 2018). Rapport has been investigated in many areas, including education and sales relationships (Gremler & Gwinner, 2000) In the employee-customer relationship research rapport has been shown to positively affect perceived control in a relationship, leading to stronger satisfaction with the firm and to increase the level of commitment to a firm (Gremler & Gwinner, 2008). Thus, rapport is an important influence on responsiveness, commitment, and satisfaction and can influence the acceptance of a technology (Fernandes & Oliveira, 2021; Wirtz et al., 2018).

Following this, we propose:

*H5:Relational elements, namely (a) perceived trust and (b) perceived rapport positively influence the intention to collaborate with a creative social robot*

Also for the relational elements, the effects are expected to differ due to the innovative level of the social robot. The above-used theory argues that trust is predicted by three features, namely abilities, integrity, and benevolence (Cheng et al., 2008; Cody-Allen & Kishore, 2006). However, with regard to the distinction of a social creative robot as an idea explorer or idea generator, the perception of those features might differ. Integrity is related to the transparency of the social robot, that is the extent to which rules and logic are visible to the user (Glikson & Woolley, 2020). AI-powered social robots can be considered highly complex and the algorithms and machine learning processes inside the social robot are most likely difficultly made transparent and understandable for a non-specialized user (Glikson & Woolley, 2020).

Following this, research suggests that it is nonetheless crucial for transparency that AI makes its decision processes and steps as explicit as possible to the user (Glikson & Woolley, 2020). For the current study, we, therefore, suggest that a social idea explorer is better able to justify its decisions for areas of improvement, as they could be related to direct comparisons between other different functions, concrete numbers, or error rates. On the other hand, a creative social idea generator would additionally have to capture its creative idea generation process that might be stronger related to complex AI processes. Related to this, Glikson and Woolley

(2020) also suggest that the task characteristics also influence trust and technical compared to interpersonal judgment tasks might create different levels of trust. For instance, robots are more trusted than humans to manage schedules and workflows, a more analytic task but are not highly trusted to intervene in team conflicts, a more emotion-involving task (Glikson & Woolley, 2020). Again, the creative social idea explorer might be more likely to be perceived to do analytic work compared to a creative social idea generator. Following the differences in trust, the current research argues that social creative robots as idea explorers will gain a higher level of trust, as exploration is perceived to be more logic-based and in the analytic domain, compared to social creative robots as idea generators. Thus:

*H6: Individuals' perceived trusts will be higher of a creative social robot that explores ideas compared to a creative social robot that generates ideas*

With regard to rapport, one can argue that in the current research rapport is a more important predictor for the collaboration intention for an idea generator compared to an idea explorer as it generated its own ideas and the robot might have to convince and influence the employee somewhat more to "buy" the idea, needing greater influence, responsiveness, and commitment of the person, all features influenced by rapport (Gremler & Gwinner, 2008; Lucas et al., 2018). Especially, as argued above related to trust, humans might not believe that robots are very good at non-analytical, interpersonal tasks (Glikson & Woolley, 2020). Therefore, a stronger rapport would be needed to influence the employee to make use of the generated idea. Thus, we propose the following hypothesis

*H7: Individuals' perceived rapport will have a larger effect on the collaboration intention for a creative social idea generator compared to an idea explorer.*

***Social-Emotional Elements***

The social-emotional elements include perceived humanness, perceived social interactivity, and perceived social presence. Firstly, perceived humanness, that is the similarity to humans which in turn can foster anthropomorphism (Wirtz et al., 2018), that is the attribution of human or animal-like features to non-living objects (Breazeal, 2003) Anthropomorphism can be used as a control mechanism if a human is confronted with a highly complex system, such as an AIfueled creative social robot, and the underlying mechanisms are not understood, the attribution of human-like qualities helps to explain and predict the behaviour. (Breazeal, 2003; De Graaf & Allouch, 2013; Epley et al., 2007). Secondly perceived social interactivity, as a result of anthropomorphism, humans are likely to apply social mental models onto them and perceive a social robot as having intentions, feelings, and beliefs (Breazeal, 2003) and expect that the social robots interact in line with their social mental models and display perceived appropriate actions and emotions (Wirtz et al., 2018). Lastly, perceived social presence regards the "feeling of being in the company of someone" and being part of a perceived non-mediated communication (Heerink et al., 2009a, p.3). Thus, it concerns the user's perception of dealing with a social entity and the perception of a social presence is related to the perceived social abilities (Heerink et al., 2009a, 2009b). Following the above, we prose:

*H8: Individuals' perception of the social-emotional elements; (a) perceived humanness, (b) perceived social interactivity, (c) perceived social presence positively influence the intention to collaborate with a creative social robot*

Even though, the social-emotional factors appear to be important for the acceptance of social robots (De Graaf & Allouch, 2013; Heerink et al., 2009a, 2009b; Wirtz et al., 2018), in the current study the creative social idea explorer and idea generator are the same social robot with the same communication and behaviour features. Therefore, it is not expected that the differentiation between the two forms will make a difference with regard to the social-emotional elements on the intention to use the technology.

*H9: Individuals' perception of the social-emotional elements; (a) perceived humanness, (b) perceived social interactivity, (c) perceived social presence will not differ for a social creative idea explorer and an idea generator.*

## Conceptual Model

The conceptual model of the current study builds on the Wirtz model (2018), which aims to assess the intention to use a technology that includes the traditional TAM(2) (Davis, 1989; Venkatesh & Davis, 2000) variables, namely perceived ease of use, perceived usefulness and subjective norm. Furthermore, the model is extended by social-emotional elements, namely perceived humanness, perceived social interactivity, and perceived social presence. Lastly, the relational elements trust and rapport are included. The main effects (H1a/b/c H5a/b, H8a/b/c) are expected to predict the intention to collaborate with a creative social robot for innovation. The moderating role of a creative social robot as an idea explorer or as an idea generator is expected to influence the functional (h2, h3, h4) and relational elements (h6, h7) but not the socio-emotional elements (h9a/b/c). The conceptual model is visualized in figure 1.

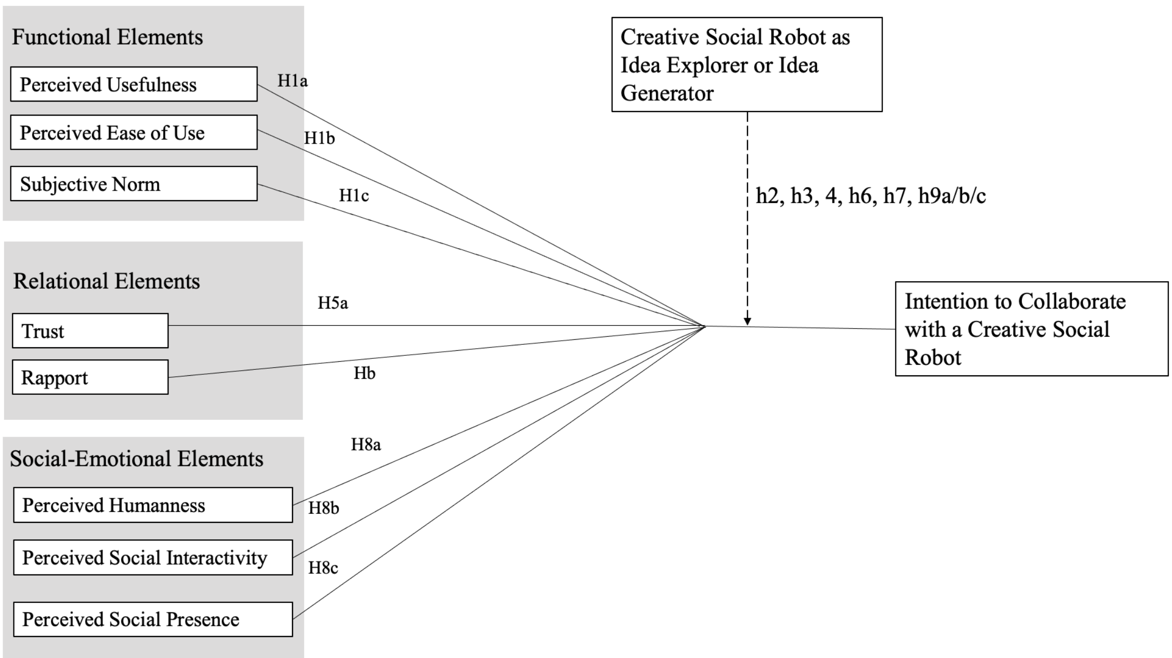


*Figure 1.* Conceptual Model

# Methods

## Research Design

In order to answer the research question on the perception of a creative social robot at the workplace, the current research will make use of a vignette study. A vignette study is made up of two elements, a vignette is a short description of a person, situation, or object that gets systematically varied and is combined with a survey element to gain additional data (Atzmüller & Steiner, 2010). By using a vignette study design, the research combines a classical survey with small vignettes that present descriptions in pictures, text, or audio form. This enables the creation of a specific, clear, and less abstract context (Atzmüller & Steiner, 2010). Especially the use of video material as vignettes was found to increase the realism of and engagement with the study (Nørskov et al., 2020). Furthermore, a vignette study ensures the high external validity of a survey combined with the high internal validity of an experiment design, thereby enabling interferences outside of the experiment context (Atzmüller & Steiner, 2010). Vignette studies have already been applied in the field of human-robot collaboration and robot perception (e.g. Chita-Tegmark et al., 2019; Lutz & Tamò-Larrieux, 2021; Nørskov et al., 2020). Following the above-mentioned advantages, the current study will make use of a between-subject research design with two different conditions, namely the creative social robot as an idea explorer and the creative social robot as an idea generator in the form of a vignette study.

## Participants

### *Participants of the Experiment*

G*Power analysis (Faul et al., 2007) indicated a needed sample size of 131 participants for the multiple regression analysis including 13 predictors (9 technology acceptance factors and 4 control variables) with a power of .80 and the ability to detect a medium effect ($f^2$=.15). Participants were sampled through convenience sampling. Overall, 124 valid survey responses were collected. 39% of the participants were male, 56,1% female, and 4,9% indicated other. The average age of the participants was 26,07 ($age_{min}$= 15; $age_{Max}$= 56). 75,7% of the participants received a degree above secondary high school 13% of the respondents were Dutch, 33 % German and the rest indicated other countries of origin. For more details see table 1.

The participants were randomly assigned to the conditions of a social robot as an idea explorer or idea generator. Following this, 64 (51,6%) participants were in the social robot as idea explorer condition, and 60 (48,4%) in the idea generator condition.

**Table 1**

*Demographic Characteristics of the Participants by Group*

| Characteristics | Idea Explorer (N=64) | | Idea Generator (N=59) | | Total Sample (N=123) | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| Gender | | | | | | |
| Male | 25 | 39,1 | 23 | 39,0 | 48 | 39,0 |
| Female | 37 | 57,8 | 32 | 54,2 | 69 | 56,1 |
| Other/ Prefer not to say | 2 | 3,1 | 4 | 6,8 | 6 | 4,9 |
| Age | | | | | | |
| < 20 | 5 | 7,8 | 10 | 17,0 | 15 | 12,3 |
| 20 - 30 | 47 | 75,9 | 43 | 71,1 | 90 | 73,2 |
| 31 – 40 | 6 | 9,5 | 4 | 8,5 | 10 | 8,1 |
| 41 - 50 | 2 | 3,2 | 2 | 3,4 | 4 | 3,2 |
| >51 | 4 | 6,3 | - | - | 4 | 3,2 |
| Nationality | | | | | | |
| German | 7 | 10,9 | 9 | 15,3 | 16 | 33,3 |
| Dutch | 22 | 34,4 | 19 | 32,2 | 41 | 13,0 |
| Other | 35 | 54,7 | 31 | 52,5 | 66 | 53,7 |
| Highest completed educational degree | | | | | | |
| Less than High School | 1 | 1,6 | 2 | 3,4 | 3 | 2,4 |
| High School | 11 | 17,2 | 15 | 25,4 | 26 | 21,1 |
| College | 8 | 12,5 | 12 | 20,3 | 20 | 16,3 |
| Bachelor | 30 | 46,9 | 16 | 7,1 | 46 | 37,4 |
| Master | 14 | 21,9 | 13 | 22,0 | 27 | 22,0 |
| Other | 0 | - | 1 | 1,7 | 1 | 0,8 |

***Participants of the Interview***

With seven participants of the study additional semi-structured interviews were conducted. The interviews ranged from five minutes to fourteen minutes, and in total around 50 minutes of interview material was transcribed and analyzed. Participants were sampled through convenience sampling. Furthermore, all participants needed to have some kind of work experience. Additionally, 3 participants were included because they were expected to have some (theoretical) experience with AI and or social robots but only two indicated this also in the interview. Lastly, a sufficient level of English was needed to participate in the interviews. For an overview of the demographics see table 2.

**Table 2**

*Demographic Characteristics of the Interviewees*

| Interviewee | Age | Gender | Nationality | (Theoretical) Experience with AI and/or Social Robots |
|---|---|---|---|---|
| 1 | 23 | Female | German | No |
| 2 | 21 | Female | German | No |
| 3 | 26 | Female | German | No |
| 4 | 25 | Male | German | No |
| 5 | 27 | Male | Spanish | Yes |
| 6 | 23 | Female | German | Yes |
| 7 | 25 | Male | Italian | No |

## Materials

***A Creative Social Robot***

As creative social robots do not yet exist in the forms described in this research, the current research will make use of an already existing social robot named "Mr. Furhat" (Furhat Robotics, 2021) which for the sake of this experiment is programmed to say things that make him appear creative. Furhat is an embodied head on a white box, he has a face that can be programmed to project realistic facial features. Furthermore, he can nod and shake his head, has cameras to sense his environment, and speakers to communicated verbally (Furhat Robotics, 2021). Furhat has been used in the research on perception and interaction with social robots (e.g. Paetzel-Prüsmann et al., 2021; Perugia et al., 2021; Thunberg et al., 2021).

While Furhat can be used to create advanced natural-like conversations, for the current study however this was not necessary as a pre-made script existed. The behaviour of Furhat was programmed based on the below-presented vignette conditions (see Appendix B) Furhat was programmed with the Blockly tool. Blockly enables graphical programming of skills and is therefore very user-friendly and also easily used by non-programmers (*Blockly graphical skill building - Furhat Developer Docs*, n.d.). Figure 2 shows an example skill and the full Blockly skill used can be found in Appendix D. Note, as Furhat did not truly react to the input of the user the skills only show Furhats actions without user input.

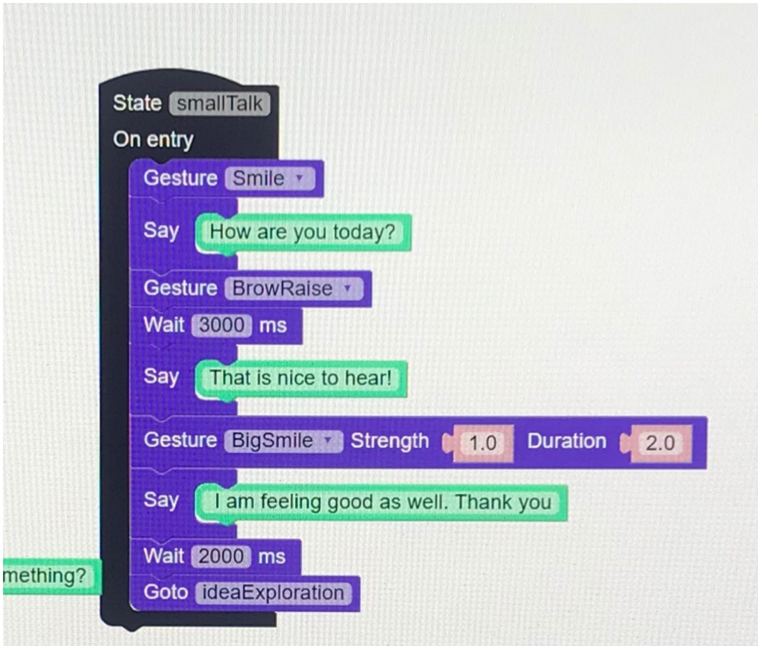


*Figure 2.* Example of a skill in Blockly

### *Vignette Conditions*

The vignette conditions are presented as small videos that show a conversation between an employee with a creative social robot. Based on the first two stages of IWB, namely idea exploration and idea generation (De Jong & Den Hartog, 2010), the current research makes use of two vignettes that present the creative social robot either as an idea explorer or an idea generator. Each participant is randomly shown one of two possible vignettes.

**Creative Social Robot as Idea Explorer.**

Based on the research on IWB, the idea exploration stage deals with the discovery of an opportunity or problem that arises and might be caused by the possibility to improve a situation (De Jong & Den Hartog, 2010). Thereby, several events can be a trigger for improvement, including unexpected failures, unexpected success, a mismatch between the "what is" and "what should be" situations, or new knowledge. For the current study, the vignette will describe a situation where idea exploration is caused by a mismatch between the desired state and the current state. Thus, a creative social robot will provide insight into a mismatch to a human employee.

Therefore, within the idea explorer condition, the participant is presented with a video that shows the interaction with a social creative robot that during a short conversation will propose an option for improvement in the current office of the participant by saying "I have realized that currently, our office spends uncommonly much time on the …Maybe this is something we could work on improving".(See Appendix B).

**Creative Social Robot as Idea Generator.**

Idea generation follows idea exploration relates to the creation of new ideas to solve a problem or to increase the performance of processes or products (De Jong & Den Hartog, 2010). Thereby, idea generation concerns the restructuring of information and combines it in new ways to improve a condition or to solve a problem (De Jong & Den Hartog, 2010). Thus, in the vignette of the idea generator, the same information about a mismatch in desired and achieved performance is given, additionally, a creative social idea generator will provide insights into a possible solution to the problem through changes in the current processes.

Therefore, the participant is presented with a video that shows the interaction with a social creative robot that during a short conversation will propose an option for improvement in the current office of the participant by saying. Additionally, the robot already proposes an idea: "I have realized that currently, our office spends uncommonly much time on the …Maybe this is something we could work on improving. My idea would be to …". (See Appendix B)

**Procedure**

The vignette study was designed making use of the survey software Qualtrics XM and distributed by the researcher through survey exchange platforms, namely SONA and surveyswap.io. Furthermore, before the study was distributed a pilot test was conducted to ensure a proper understanding of the survey items and the vignette. Additionally, the pilot study was used as a source to gain additional data on the perception of creative social robots. Lately, the mixed-methods approach has started to gain attention in the vignette study design (Harrits & Møller, 2020). Thereby, a classical experimental vignette design is combined with a semi-structured interview, in which the participants are asked additional questions about the presented vignettes (Harrits & Møller, 2020). For the qualitative part, the participants were asked four additional questions were added after completing the experiment survey. The questions were: (1) "How would you feel in the presented situation (you interacting with the creative social idea explorer/generator)", (2) "How would you respond in the presented situation? What would you do?", (3) "Do you think creative social robots in the workplace are going to be reality soon? Why? Why not?", (4) "Do you have any other thoughts about creativity and social robots?". Thereby, the research is able to gain more extensive insight into the perception of creative social robots.

With regard to the survey, the participants, firstly, had to read the informed consent (Appendix C) which informed them about the goal of the study, the approximated length, the treatment of their data as anonymously, and their right to withdraw from the study at any time. Only after agreeing to the informed consent the actual vignette study started.

After a short introduction that shortly describes the company and the general task. Then the participant was informed that a social robot has been part of their team for a while and the next clip will show a short video in which the participant is asked to imagine that they are the person interacting with the social robot. Following, participants were randomly presented with one of two possible video vignettes, the creative social robot as an idea explorer or as an idea generator. Afterward, the participant was presented with a short manipulation check to see whether the social creative robot was perceived as indented. Following this, the items regarding the independent variables of technology acceptance and the items for the intention to collaborate were shown. Lastly, demographic data was collected. The study was approved by the ethics committee of the BMS faculty of the University of Twente (case number 211073).

## Measurements

### *Dependent Variable*

The dependent variable is the intention to collaborate and was adopted to the HRC context based on the classical UTAUT variable *intention to use* (Venkatesh & Davis, 2000). Three items were used to assess the intention to collaborate based on the items of Venkatesh and Davis (2000) which were also used by Fernandes and Oliveira (2021). The items were measured on a 7-point Likert scale ranging from "strongly disagree" to "strongly agree". The items included for instance: "I will try to collaborate with the social robot in the future for creative tasks". The construct reliability of the intention to collaborate with a creative social robot is excellent (Gliem & Gliem, 2003) with a Cronbach's alpha of .94.

### *Independent Variables*

Following the research model by Wirtz et al. (2018), the current research makes use of the items used by Heerink et al. (2010) and Fernandes & Oliveira (2021). Wirtz et al (2018) based many of the constructs in the model are based on the work of Heerink et al. (2010). Further, Fernandes & Oliveira (2021) also ground their research in the model of Wirtz et al. (2018) and provide a more extensive description of the items used to access acceptance of a social robot. The eight independent variables, namely, (1) perceived ease of use, (2) perceived usefulness, (3) subjective norm, (4) perceived humanness, (5) perceived social interactivity, and (6) perceived social presence, (7) trust and (8) rapport were all measured on a 7-point Likert scale ranging from "strongly disagree" to "strongly agree".

#### Perceived Ease of Use.

Perceived ease of use was measured with five adjusted items based on the items used by Heerink et al. (2010), including "I think I can use the social robot without any help". The construct reliability of perceived ease of use is good (Gliem & Gliem, 2003) with a Cronbach's alpha of .81.

### Perceived Usefulness.

Perceived usefulness was measured with three adjusted items based on the items used by Heerink et al. (2010), including “I think the social robot is useful to me to be creative”. The construct reliability of perceived social presence is excellent (Gliem & Gliem, 2003) with a Cronbach's alpha of .91.

### Subjective Norm.

Subjective Norm was measured with four adjusted items based on the items used by Heerink et al. (2010), including “People who are important to me think I should use the social robot”. The construct reliability of subjective norm is good (Gliem & Gliem, 2003) with a Cronbach's alpha of .84.

### Perceived Humanness.

Perceived humanness was measured with 2 items, based on the items used by Fernandes & Oliveira (2021), including “Sometimes the social robot seems to have real feelings”. The construct reliability of perceived humanness is acceptable (Gliem & Gliem, 2003) with a Cronbach's alpha of .73.

### Perceived Social Interactivity.

Perceived social interactivity was measured with four adjusted items based on the items used by Heerink et al. (2010), including “I find the social robot pleasant to interact with”. The construct reliability of perceived social interactivity is good (Gliem & Gliem, 2003) with a Cronbach's alpha of .84.

### Perceived Social Presence.

Perceived social presence was measured with four adjusted items based on the items used by Heerink et al. (2010), including “When interacting with the social robot, I felt like talking to a real person”. The construct reliability of perceived social presence is good (Gliem & Gliem, 2003) with a Cronbach's alpha of .81.

### Trust.

Trust was measured with four adjusted items based on the items used by Heerink et al. (2010), including “I feel I can rely on the social robot to do what is supposed to do”. The construct reliability of perceived social presence is acceptable (Gliem & Gliem, 2003) with a Cronbach's alpha of .79.

**Rapport.**

Rapport was measured with 2 items, based on the items used by Fernandes & Oliveira (2021), including "I think there is a "bond" between the social robot and myself". The construct reliability of rapport is acceptable (Gliem & Gliem, 2003) with a Cronbach's alpha of .76.

### *Control Variables*

In order to avoid third variables to explain the tested effects, control variables were included in the study. Following Venkatesh et al. (2003), gender, age, experience are factors that moderate the effects of technology acceptance. While experience with a creative social robot is unlikely, as they do not yet exist in this form, it is controlled for the general experience with social robots. Furthermore, educational level is a commonly used control variable (Bernerth & Aguinis, 2016) and was also found to moderate the effects of technology acceptance (Tarhini et al., 2016). Lastly, research suggests that cultural factors can influence technology acceptance (Im et al., 2011; Oshlyansky et al., 2007) and therefore, also nationality was be included as a control variable.

Gender was measured as a categorical variable with the groups: "female", "male", and "other". Age was measured as a continuous variable with an integer. Highest educational level was measured as a categorical variable with the categories "Below high school degree", "high school degree", "bachelor's degree or equivalent", "master's degree or equivalent", "Doctorate degree", "Other". Experience with the social robot was measured with two items on a 7-point Likert scale ranging from "strongly disagree" to "strongly agree", namely " I have experience with a social robot" and "I have interacted with a social robot before". Lastly, nationality was measured as a categorical variable.

### *Manipulation Check*

To access whether the two vignettes were indeed perceived as different, three items were used as a manipulation check that regarded the perceived role of the creative social robot in the creative processes, namely whether he was perceived as an idea explorer or an idea generator.

The items included: “I feel like the robot came up with its own creative idea”, “I think the robot helped me explore how the office can improve”, I think the robot helped me explore how the office can improve but he did generate his own creative idea”

***Confirmatory Factor Analysis***

The validity and reliability of the model were assessed with the use of structural equation modeling (SEM). Variance-based partial least squares (PLS) was used to conduct confirmatory factor analysis. PLS was chosen, as it is regarded as one of the most developed systems and it has been discussed to a great extent within the literature (Henseler et al., 2016). The analysis was conducted with the software R Studio and “ADANCO” and was based on the guidelines proposed by Henseler et al. (2016) and on the fit indices by Hu and Bentler (1999). Following this, the chi-square test was used, which should be non-significant to show an ideal fit between the data (Iacobucci, 2010), the comparative fit index (CFI) and the Tucker-Lewis Index (TLI) which both should be as large as possible but with a cut-off score close to 0,95 (Hu & Bentler, 1999) , the root mean squared error of approximation (RMSEA) and the standardized root mean square error (SRMR) for which both a the smaller the value the better and a cut-off score below 0,6 and 0,8 indicate a good-fit respectively (Hu & Bentler, 1999).

The fit of the initial model indicated a bad fit [$X^2$= (465, $N$ = 122) = 2881,58, $p$ < .001; CFI= 0,833; TLI=0,805; RMSEA=0,091, SRMR=0,081]. Thus, the conceptual model is not a good representation of the population. Indicator reliability and the loadings of the individual items were assessed to investigate which items might be problematic. Four items were detected as being problematic due to low loadings (< 0,5) on their latent factors and/or low indicator reliability (< 0,5). Following this, the items perceived ease of use 4 (indicator reliability of 0,179), perceived ease of use 5 (indicator reliability of 0,182), perceived ease of use 5, trust 1 (indicator reliability of 0,37), and trust 2 (indicator reliability of 0,44) were removed from the model. Following this, the new model indicated a better but still not good model fit for of the data with the population [$X^2$= (288, $N$ = 122) = 555,20, $p$ < .001; CFI= 0,878; TLI=0,852; RMSEA=0,087, SRMR=0,065] with a larger CFI and TLI and a lower RMSEA and a SRMR below the cut-off value of 0,8 (Hu & Bentler, 1999). Nevertheless, following Hu and Bentler (1999) the fit indices of the improved model can still not be considered as “good”. However, the proposed fit indices might also be problematic. For instance, $X^2$ is highly sensitive to sample size and also moderate sample sizes will result in a non-significant chi-square test or SRMR is influenced by the size of the factor loadings in the model (Iacobucci, 2010). Recent literature by McNeish and Wolf (2021) argues that fixed cut-off scores, as used by Hu and Bentler (1999) are not ideal due to a risk of overgeneralization of CFA models that differ on a variety of factors due to model, data, factor or sample characteristics. Therefore, they call out the need for a dynamic fit index cut-off approach to gain an estimation on whether a model is "good" or "bad" through custom-tailored cut-off scores.

Lastly, as all remaining items loaded high enough on their factors (>0,7) average scores for the individual constructs and for each participant were calculated and used for further analysis. For an overview of the item loadings on the factors see appendix A

## Data Analysis

### *Quantitative Data*

The aim of the analysis was to, firstly, test the influence of the variables perceived ease of use, perceived usefulness, subjective norm, trust, rapport, perceived humanness, perceived social presence, and perceived social interactivity on the intention to collaborate with a creative social robot. Secondly, it was tested whether the effects differ significantly for the two different kinds of creative social robots. The statistical analyses were conducted with IBM SPSS statistics version 25.

Confirmatory factor analysis was used to access the overall fit of the measurement model to the data. Subsequently, the average scores of the measurements were calculated by adding up the individual item scores for a scale and dividing them by the number of items. Those scores were used for further calculations. To test the proposed model (see Figure 1) hierarchical regression was used. Hierarchal regression is useful to assess the variance explained in a dependent variable by correlated predictor variables (Lewis, 2007). Following the research of Fernandes and Oliveira (2021) with the same survey items, we expect to find correlated constructs as well, making hierarchical regression a suitable tool. Hierarchal regression, unlike stepwise regression, enables the entry of the predictor variables based on a theoretical foundation, which positively affects replicability. Further, for each new (group of) variables entered, a change in variance explained is estimated, enabling to access the explanatory power of variables while controlling for others (Lewis, 2007). In the current research, firstly, a model was built with only the control variables. Then a second model, including all independent variables was built, and lastly, a model that included the assumed moderating role of the different types of creative social robots as interaction terms. Furthermore, independent sample t-tests were used to access whether the two vignette groups differ significantly for independent variables and the intention to collaborate with a creative social robot.

***Qualitative Interview Data***

The qualitative data that was collected through interviews during the pilot study was transcripted and analyzed using open and axial coding with the help of the software Atlas.ti. One way to analyze qualitative data is through the grounded theory approach with the ultimate goal to develop a theory grounded in its natural context in an iterative process (Priest et al., 2002). The advantages of open and axial coding based on the grounded theory approach to qualitative data are the structural guidelines and through the ongoing process of conceptualization enables the development of inductively emerged categories while remaining open and creative through the lack of beforehand decided themes (El Hussein et al., 2014). One could argue, that enough theory exists on the topic of robot acceptance to use a more theory-oriented coding approach but the topic of creative social robots for innovation in the work environment is a topic with little theoretical foundation and while the building of a theory was not the goal of the analysis, the steps of the grounded theory approach were chosen due to its openness and the ability to gain somewhat open and creative themes apart from the classical technology acceptance. This approach includes three steps, namely open coding which is very close to the original text and breaks it down into codes or first-level concepts. In the next step, namely axial coding those codes are then collected into higher-order categories which help to systemize the relations and connections between different first-order codes. The last step of this approach includes the selective coding which aims to identify one or two overarching categories which are then often used to build a theory (Khandkar, 2009; Priest et al., 2002). In this case, some of the codes and themes can be related to existing theory. For instance, the theme of creative robots perceived skills and shortfalls could be related to the classical TAM variable perceived usefulness, the effect of experience can be related to the idea of trust development through interaction with social robots as proposed by Glikson and Woolley (2020). Lastly, making use of coding software enables easier recognition of patterns and common themes within the data and through the use of codebooks and other tools creates greater trustworthiness and transparency in inductive qualitative research (O'Kane et al., 2021).

Through the qualitative analysis, the 28 open codes were categorized into seven axial code groups which were then structured into three main themes, namely perception of creative social robots, creative social robots' skills and shortfalls, and experience and implementation (see figure 3). For a more detailed overview of the coding including example quotes see the codebook in appendix E. Perception of creative social robots and creative social robots perceived skills and shortfalls were the two biggest main themes. This was not surprising as the focus of the pilot interviews was to gain a more elaborate understanding of the perception of creative social robots.

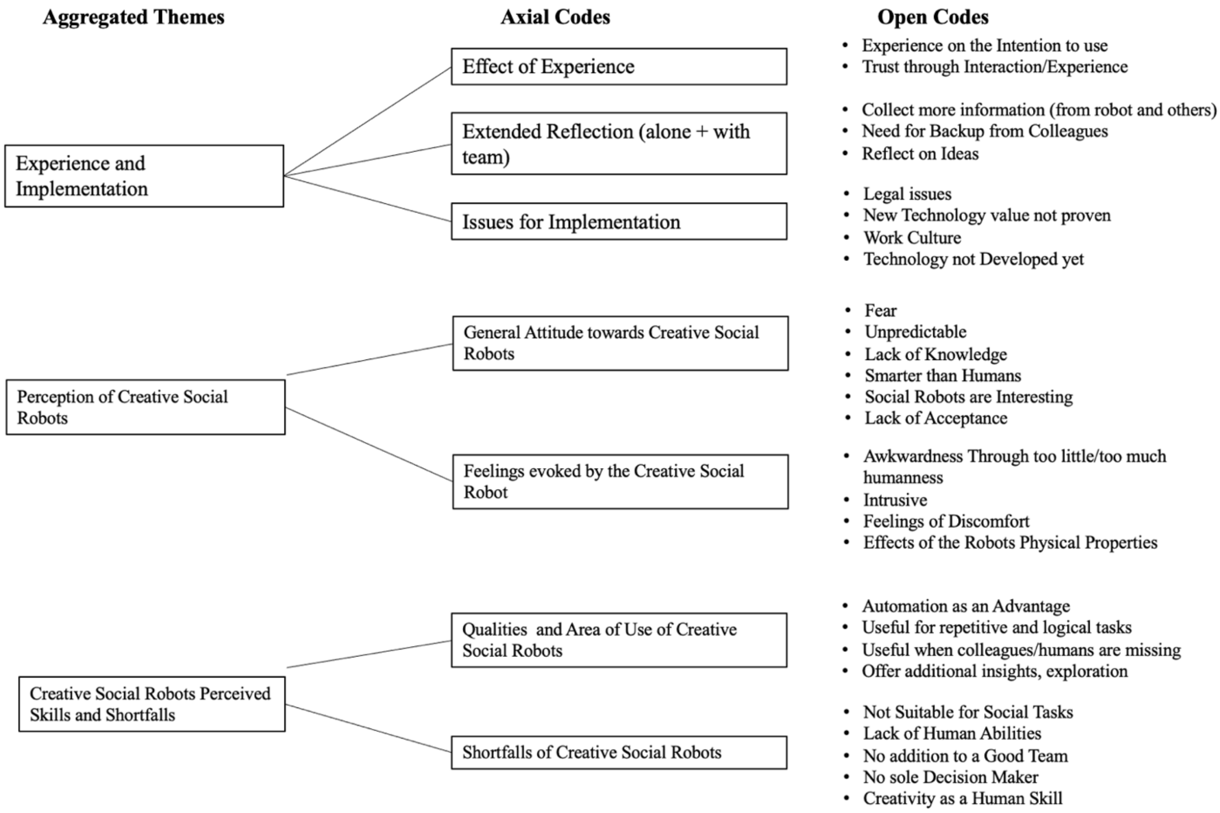


*Figure 3.* Coding Scheme

# Results

## Quantitative Results

### *Descriptive Results*

The descriptive data for the scales and the Pearson correlation matrix are presented in table 3. For both groups, all average scores except for the variable perceived humanness, perceived social interactivity, and rapport lie above the mean score of a Likert-scale of 3.5. The average perceived ease of use has the highest mean value (5,02; 5,29) for both groups compared to the other variables. Overall, no large differences (> 0.3) can be observed in the comparison of the mean scores for each variable for the two groups. Furthermore, all scores except perceived humanness were negatively skewed, indicating a skewness towards higher values.

With regard to the correlation matrix (Table 3), all variables, except perceived ease of use are significantly correlated with the intention to collaborate. However, also the perceived ease of use was expected to be correlated with the intention to collaborate. Furthermore, the robot's innovation (the manipulation) was not significantly correlated to the other variables. Lastly, the majority of the control variables do not significantly correlate to the other variables. Following this, one can suggest that the manipulation, that is the robot's innovative function, is not related to the outcome of the other variables. For the correlation table by group see appendix F.

**Table 3**

*Mean, Standard Deviation and Pearson Correlation for the (Control) Variables*

| | Mean | SD | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Perceived Ease of Use | 5,15 | 1,078 | 1 | | | | | | | | | | | | | | |
| 2. Perceived Usefulness | 4,277 | 1,392 | ,190* | 1 | | | | | | | | | | | | | |
| 3. Subjective Norm | 3,883 | 1,119 | ,036* | ,454** | 1 | | | | | | | | | | | | |
| 4. Perceived humanness | 3,375 | 1,516 | -,050 | ,277** | ,328** | 1 | | | | | | | | | | | |
| 5. Perceived Social Interactivity | 4,306 | 1,206 | ,259* | ,499** | ,364** | ,487** | 1 | | | | | | | | | | |
| 6. Perceived Social Presence | 3,421 | 1,351 | -,062 | ,267** | ,396** | .659** | ,603** | 1 | | | | | | | | | |
| 7. Trust | 4,290 | 1,068 | ,232** | ,430** | ,311** | ,340** | ,483** | ,361** | 1 | | | | | | | | |
| 8. Rapport | 3,411 | 1,373 | ,030 | ,343** | ,435** | ,551** | ,715** | ,631** | ,382** | 1 | | | | | | | |
| 9. Intention to Collaborate | 4,279 | 1,451 | ,169 | ,611** | ,467** | ,276** | ,527** | ,360** | ,544** | ,478** | 1 | | | | | | |
| 10. Robot's Innovation (group) | - | - | -,130 | ,027 | ,126 | ,011 | ,076 | ,015 | ,112 | -,033 | ,099 | 1 | | | | | |
| 11. Age | 26,07 | 8,21 | ,062 | -.069 | -,030 | -,141 | -,070 | -,161 | -,191* | -,068 | -,084 | ,116 | 1 | | | | |
| 12. Gender | - | - | -,217* | ,015 | ,019 | -,012 | -,057 | ,003 | ,008 | -,011 | -,027 | -,041 | -,110 | 1 | | | |
| 13. Nationality | - | - | -,065 | -,034 | -,054 | -,037 | ,006 | -,202* | -,064 | -,138 | -,063 | ,046 | ,026 | -,116 | 1 | | |
| 14. Education | - | - | ,070 | -,034 | ,005 | -,009 | ,053 | -,022 | -,053 | ,072 | -,014 | ,115 | ,445** | -,131 | ,183* | 1 | |
| 15. Experience | 2,78 | 1,65 | -,045 | ,049 | ,049 | ,148 | ,199* | ,051 | ,080 | ,198* | ,073 | ,018 | -,018 | -,111 | ,238** | -,083 | |

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

***Manipulation Test***

The manipulation test was included to see whether the perception of Furhat differed significantly across the two groups. An independent sample t-test indicated that there was a significant difference across the groups in the perception of the social robot's innovative function. In detail, the groups significantly differed in whether Furhat helped to explore but did not create its own idea [t= - 2,115, d.f.=116,28; p<0,05]. Furthermore, the two groups also differ significantly in their perception of whether Furhat came up with its own creative idea [t= 2,495, d.f.=122; p<0,05]. However, the two groups did not differ in their perception of whether Furhat helped them to explore opportunities for where the office could improve [t= -0,372, d.f.=122; p=0,71]. Following this one could argue that the different conditions were actually perceived as being different and also that the perception of idea exploration does not differ significantly is in line with the design of the vignette conditions, as the idea generation is an extension of the idea exploration and thus, idea exploration should not have differed across the groups. Thus, the data supports that the manipulation worked as intended.

***Assumptions of Regression Analysis and Independent t-tests***

Several assumptions were tested to assess whether the data is suitable for regression analysis (Pek et al., 2018). Firstly, linearity was assessed using scatterplots. Overall, linearity can be assumed for most variables, however, perceived humanness did not indicate linear tendency in the scatterplot.

Secondly, the normality of the data was accessed using the Kolmogorov-Smirnov (K-S) test and Q-Q plots. Overall, results indicated that the data deviates significantly from a normal distribution as the test was significant ($p < 0.05$). Only perceived social interactivity appeared to be normally distributed [D(124)=0,072, p= 0.187]. Thus, overall, the assumption of normality is violated. Therefore, bootstrapped regression analysis should be conducted as a way to deal with the non-normal data. (Pek et al., 2018).

The homogeneity of variance was tested with the Leven statistic which indicated non-significant results for all scales and thus the assumption is not violated.

Also for the group comparison, the assumption of normality is not met if groups are included as a factor and therefore also for the interpretation of the independent t-test the bootstrap confidence intervals should be considered, and based on the reported Leven statistic the test for equal variance assumed should be used.

***Model and Hypotheses Testing***

**Table 4**

*Mean, Mean Differences and Significance Test of the Differences between Groups*

| Variable | Group | Mean | SD | Difference | Test Statistic |
|---|---|---|---|---|---|
| Perceived Ease of Use | Explorer | 5,015 | 1,194 | ,28 | *t*(122)= -1,446; p= ,15 |
| | Generator | 5,294 | 0,926 | | |
| Perceived Usefulness | E | 4,312 | 1,417 | ,07 | *t*(122)= 0,293; p=, 77 |
| | G | 4,238 | 1,375 | | |
| Subjective Norm | E | 4,019 | 1,100 | ,28 | *t*(122)= 1,407;p= ,16 |
| | G | 3,737 | 1,130 | | |
| Perceived humanness | E | 3,390 | 1,587 | ,03 | *t*(122)= 0,118; p= ,91 |
| | G | 3,358 | 1,449 | | |
| Perceived Social Interactivity | E | 3,441 | 1,462 | ,77 | *t*(122)= 0,839; p= ,40 |
| | G | 4,212 | 1,193 | | |
| Perceived Social Presence | E | 4,406 | 1,112 | 1,01 | *t*(122)= 0,170; p= ,87 |
| | G | 3,400 | 1,234 | | |
| Trust | E | 5,015 | 1,194 | ,85 | *t*(122)= 1,250; p= ,21 |
| | G | 4,166 | 1,015 | | |
| Rapport | E | 3,367 | 1,420 | ,09 | *t*(122)= -0,368; p= ,71 |
| | G | 3,458 | 1,331 | | |
| Intention to Collaborate | E | 4,416 | 1,341 | ,29 | *t*(122)= -0,368; p= ,26 |
| | G | 4,129 | 1,559 | | |

Explorer: N=64 ; Generator N= 59

Hypotheses 2, 3, 4, 6, 7, and 9 aimed to investigate whether there are significant differences in the variables for the two groups with regard to perceived ease of use, perceived usefulness, subjective norm, trust, rapport and the social-emotional elements ((a) perceived humanness, (b) perceived social interactivity, (c) perceived social presence).

Overall, no significant differences in means for the idea explorer and idea generator are observed (see Table 4). Following this, hypotheses 2, 3, 4, 6, and 7 are not supported. Only hypotheses 9 that is individuals' perception of the social-emotional elements; (a) perceived humanness, (b) perceived social interactivity, (c) perceived social presence will not differ for a social creative idea explorer and an idea generator, is supported as it predicted no difference in means.

Following the non-significant differences across all variables for the two groups, only one regression model including both groups was built. The manipulation, that is the robot's innovation was added as a control variable to the models. Hypotheses 1,2,5, and 8 tested the main paths visualized in Figure 1. Hierarchical regression analysis was conducted. The first model only included the control variables age, gender, education, nationality, experience, and the manipulation group to assess the effect on the dependent variable, namely the intention to collaborate with the creative social robot. Overall, no significant model was observed (see Table 5). A second model then included the independent variables perceived ease of use, perceived usefulness, subjective norm, trust, rapport, perceived social interactivity, perceived social presence, and perceived humanness and their effect on the intention to collaborate with a creative social robot. Overall, the model was significant (see Table 5) and able to explain 53,7% ($R^2$) (adjusted $R^2$ = ,477) of the variance in the intention to collaborate with a creative social robot. Based on this model the hypotheses are tested in the following section.

**Table 5**

*Hierarchal Regression Model Summary on the Intention to Collaborate*

| | | Model 1 | | Model 2 | |
|---|---|---|---|---|---|
| | Model Statistic | $F(6,122)=0,65$; p= ,66 | | $F(14,122)=8,95$; p< ,001 | |
| | $R^2$ | ,034 | | ,537 | |
| | Adjusted $R^2$ | -,016 | | ,447 | |
| | *F* Change | ,682 | | 14,682** | |
| **Control Variables** | | Beta | Sig. | Beta | Sig. |

| | | | | |
|---|---|---|---|---|
| Age | -,021 | ,255 | ,001 | ,99 |
| Gender | -,065 | ,742 | -,070 | ,63 |
| Nationality | -,204 | ,304 | ,002 | ,98 |
| Education | ,061 | ,651 | -,022 | ,83 |
| Experience | ,982 | ,328 | -,012 | ,852 |
| Robot's innovation | ,351 | ,240 | ,137 | ,500 |
| **Independent Variables** | | | | |
| Perceived Ease of Use | | | ,012 | ,090 |
| **Perceived Usefulness** | | | ,374 | **,000**** |
| Subjective Norm | | | ,173 | ,100 |
| Perceived humanness | | | -,108 | ,219 |
| Perceived Social Interactivity | | | ,073 | ,621 |
| Perceived Social Presence | | | ,031 | ,791 |
| **Trust** | | | ,357 | **,002*** |
| Rapport | | | ,208 | ,087 |

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

The second model was significant and showed that only individuals' perceived usefulness [t(122)= 4,289;p<0,01] with a beta of 0,374 and trust [t(122)= 3,291;p<0,05] with a beta of 0,357 significantly and positively influences the intention to collaborate with a creative social robot. Following this, we can support hypotheses 1b and 5a.

The effects of perceived ease of use [t(122)=0,114;p=0,90], subjective norm [t(122)=1,666;p=0,100], rapport [t(122)=1,735;p=0,087], the robot's humanness [t(122)=-1,241;p=0,219], the robot's social interactivity [t(122)= 0,498;p=0,619] and the robot's social presence [t(122)= 0,270;p=0,791] do not significantly predict the intention to collaborate with a creative social robot.

Overall, only hypotheses 9 was supported, hypotheses 1 and 5 were partially supported, (for an overview of the hypotheses see table 6), and therefore, only trust and perceived usefulness appeared to be significant predictors of the intention to collaborate with a creative social robot and are able to explain 53,7% of the variance in the intention to collaborate with a creative social robot.

**Table 6**

*Hypotheses Overview*

| | Hypotheses | Supported or not |
|---|---|---|
| H1 | Functional elements, namely (a) **perceived ease of use**, (b) **perceived usefulness,** and (c) **subjective norm** positively influence the intention to collaborate with a creative social robot | **Partially Supported** (H1b) |
| H2 | Individuals' **perceived ease of use will be higher of a creative social robot** that generates ideas compared to a creative social robot that explores ideas | Not Supported |
| H3 | Individuals' **perceived usefulness will be higher** for a creative social robot generates ideas compared to a creative social robot that explores ideas | Not Supported |
| H4 | Individuals' **perceived subjective norm will be higher** for a creative social robot that generates ideas compared to a creative social robot that explores ideas | Not Supported |
| H5 | Relational elements, namely (a) **perceived trust** and (b) **perceived rapport** positively influence the intention to collaborate with a creative social robot. | **Partially Supported** (H5a) |

| | | |
|---|---|---|
| H6 | Individuals' **perceived trust will be higher** of a creative social robot that explores ideas compared to a creative social robot that generates ideas | Not Supported |
| H7 | Individuals' **perceived rapport will have a larger effect** on the collaboration intention for a creative social idea generator compared to an idea explorer. | Not Supported |
| H8 | Individuals' perception of the **social-emotional elements; (a) perceived humanness, (b) perceived social interactivity**, (c) **perceived social presence** positively influence the intention to collaborate with a creative social robot | Not Supported |
| H9 | Individuals' perception of the **social-emotional elements; (a) perceived humanness, (b) perceived social interactivity**, (c) **perceived social presence** does **not differ** for a social creative idea explorer and an idea generator. | **Supported** |

## Qualitative Findings

In the following section, the qualitative results will be presented structured around the aggregated main themes and the second-order axial codes.

### *Perception of creative social robots*

Perception of creative social robots emerged through the axial codes general attitude towards social robots and the feelings evoked by social robots.

#### General attitude towards social robots.

Overall, the participants had a mixed attitude towards robots. On the one hand, they were perceived as interesting, and the concrete input given by the robot was perceived as positive and good but on the other hand, social robots are also perceived as something smarter than humans that is unpredictable and should be feared.

*"I think humans are a bit afraid of robots because they think they are quite unpredictable and they also there's the fact that's robots are smarter than humans in a way that they can process like way more information than humans and I think that's why, the fear and the unpredictableness" [Interview 6]*

#### Feelings evoked by the robot.

Feelings evoked by the robot do not focus on the general attitude towards social robots but the more affective and emotional side of the interaction and which feelings emerged when watching the interaction. With regard to the feelings evoked by imagining interacting with the social robot, various interviewees mentioned that the robot was perceived as awkward or strange.

*"I think it's strange because it's like really realistic and with the face and everything like a human but you know it's not a human ... I don't know, it's strange" [Interview 3]*

However, more interesting is that the participants differed in their perception of why the robot was perceived as awkward or strange. While some participants indicated that the robot lacked human features while others indicated that it was already too human, and a lack of human attributes would have positively influenced the feelings when interacting with the robot. Others only indicated that they needed time to get used to the creative social robot.

*"A bit awkward talking to a head basically. … (Interviewer) Okay and you said that you thought it was awkward it would have been a head. Would it have been less awkward if it was like a whole robot maybe? (Respondent) I think a bit less awkward because you get something human-like." [Interview 2]*

*"I think it's strange because it's like really realistic and with the face and everything like human but you know it's not a human ... I don't know it's strange. […] I think I don't need the robot to be like so human being like similar. I think it would be good if it's like just a normal robot without a human face or something […] And the robot looks you in the eyes and I think that is strange as well. For me personally, it would be easier if it is a robot without social eyes." [Interview 3]*

Lastly, a participant indicated that the creative social robot was perceived as intrusive because it started the conversation rather than the human approaching the robot.

*"… it's a bit intrusive. It would be more what you do with Alexa right? You initiate the conversation." [Interview 5]*

This finding offers a reflection on the variable of perceived humanness. The hypothesis on perceived humanness argued that it positively influences the intention to collaborate. However, the interviews indicate that this might not be generalizable, because for some interviewees more human-like features were perceived as positive while for others they were perceived as negative. Furthermore, also that the robot can be perceived as intrusive of initiating a conversation could be an argument that the social interactivity, that is the robot is perceived through human mental models and as having own beliefs and intentions, can be perceived as negative if it goes against the preferences of the interaction of the human collaborator.

***Creative Social Robots Perceived Skills and Shortfalls***

Another theme that emerged during the interview was what creative social robots are perceived as useful for and why. This aggregated topic contains the lack creative robots appear to have and the areas of usefulness and qualities the robot can bring to the creative work environment.

**Social creative robots' qualities and area of use.**

Overall, the area of use for creative social robots differs among respondents. While some stated that they do see creative social robots more in repetitive or analytic tasks, like finding new ways of doing something, others stated that creative social robots are more needed for social jobs and are not useful for solely technical tasks. However, it depends on the area of work and while a creative social robot is not seen working with patients or clients, it could be an add-on to a team exploring new treatments or ways of doing something.

*"I mean not the interaction with the patient but for me for like searching ideas or searching new ways of treatment this could be helpful but not in the interaction with patients or something." [Interview 3]*

Furthermore, the creative social robot is seen as an advantage if no other creative partner is available or oneself is stuck in a creative process. Moreover, the creative social robot can act as an accelerator by providing insights that are not easily available to the team in an early stage of innovation. Thus, showing again that a creative social robot does not appear to be a replacement for human workers but rather to be an enrichment to a team or help if human skills are not available.

*"they would be helpful like to support innovation and maybe even present some kind of analysis which are outside of your specific area maybe. As a department you have more people focused on let's say humanistic background and instead it could present some kind of view other departments could have. So it's useful, especially if we assume that the discussion goes step by step […] this could bring in some different perspective at the earlier stage. So maybe it can detect some faults at an earlier stage". [Interview 7]*

**Creative Social Robots Shortfalls.**

While creative social robots appear to have value in some areas, respondents also indicated perceived shortfalls of the robot that might hinder the usage of creative social robots in the work environment. Firstly, the creative social robot was not perceived as adding anything valuable to the team if the human team and its members were already perceived as highly skilled.

*"I can't imagine that it has real creative ideas my colleagues wouldn't have or that good team would have. I think it also depends a bit on how good the team works together and how creative the people are but I just assumed that I would already be working with a highly creative and well-organized team." [Interview 1]*

Secondly, the creative social robot was perceived as unable to understand all the complex progress within a company and the external conditions.

*"I feel like robots cannot elaborate on too complex concepts like think especially about creativity and also analysing data. They can be maybe better than analysing data but they don't know the conditions which are external to the data and I think a person has a better overview, general overview than the robot. Maybe the robot can find, can spot some pattern but it doesn't have the whole view of the issue or task which is analysed." [Interview 7]*

And lastly, the robot was perceived as lacking human abilities such as consciousness and the ability to reflect on human emotions. This was largely related to the belief that creativity is perceived as a human skill, which robots might be able to imitate but are not truly capable of.

*"I think people also I don't really connect robots with creativity because you think of robots more something like they do mechanic tasks and they're not capable of creativities because it's is a very human trade creativity and that's why I don't really connect to social robots" [Interview 6]*

With regard to the quantitative results, the hypotheses that perceived usefulness positively influences the intention to collaborate with a creative social robot was supported. The qualitative results show a more detailed picture of the conditions in which a creative social robot is perceived as useful, namely in situations where no other creative partner is available, or as an addition to a good working team. However, if a team is already highly skilled a creative social robot is not perceived as adding many useful insights. Thus, the perceived usefulness is related to the specific work situation or team.

***Experience and Implementation***

**The effect of Experience.**

No interviews indicated direct experience with creative social robots, however, many believed that being exposed to a creative social robot and interacting with one would increase the quality of the interaction and the intention to use the creative social robot. One respondent even indicated that it is comparable to any relationship, also with other humans, that good interaction only emerges through interaction and experience.

*"I think it would be a completely new situation for me because I have never interacted with the social robot before so I might feel uncomfortable in the beginning. I would not know how to react and how the robot reacts so it would be quite a tense situation in the beginning for me maybe but as soon as I would start talking to the robot I think I would see 'oh the robots actually nice, is social' and then I would become less tense more comfortable with a robot and be actually able to talk to him back to a real person." [Interview 6].*

The effect of experience can be related to the role of trust. Respondents indicated that they would feel uncomfortable in the first interactions with the robot because they do not know how the interaction works and how the robot would react. Only with experience they would see that the interaction is pleasant and would interact with them more naturally. Trust is based on the perception of skills, goodwill and integrity and thus, experience might be one possible explanation on how trust could develop.

**Evaluation and reflection.**

Concerning the process of implementation and using the robot, most respondents indicated that it would be a deliberate process of collecting feedback, collecting more information, and discussing the output with the robot but more importantly with other human teammates. Thus, especially in the beginning, adding the creative social robot to a team would create more work through more reflection on the ideas and feedback from others. However, respondents also indicated that after some experience they might not need such an elaborated feedback process anymore.

*"I would talk to other colleagues about this conversation and I would tell them about the idea that the robot has given to me and I would ask them about their opinion and from there I would proceed. If they would like it and if I like it then I would actually take this proposal from the robot seriously and continue from that on and if we decide as a team that we don't like the idea that we just leave the idea." [Interview 6]*

While not replicated in the quantitative part of the research, this might still indicate the importance of social influences on the intention to use the creative social robot, as the opinion of other people in the work environment seems to be an important influence on the decision to move forward with the ideas of the creative social robot.

**Issues for Implementation.**

Some respondents also indicated that there are several issues that could emerge with a social robot in the work environment, including legal problems, the culture of the company, and the technology itself. Firstly, legal problems such as data secrecy were named as an issue for implementing creative social robots into the office.

*"So the first one is technical, how soon can we have this? And secondly is legal, because like the secrecy of the data and how the data are handled or managed and the third step is by acceptance of the general cultural acceptance of robot interacting with the person and taking a decision that has results on the people." [Interview 7]*

With regard to the effects of the implementation in an office also the perceived power was mentioned as an issue. Some respondents indicated that managers or other employees might feel undermined by the robot and thus, affects the power structures in the work environment.

*“Maybe also as a manager, I would feel like that diminishes maybe my managing position in front of my colleagues you know.” [Interview 5]*

As a last concern for the actual implementation, technical developments were raised. Respondents did not believe that creative social robots will be developed in a foreseeable time and thus, also will not be able to prove their value for companies any time soon.

*“I guess what is the benefit of buying something that is expensive that you could also talk to your colleague about and also it's new so you don't really know at this point what you're going to get out of it right so if through time and experience it's proven that there is some benefit to it apart … there's a benefit to it by in itself then I think that it could happen that they are included in creative process definitely “[Interview 5]*

Overall, the qualitative research shows that creative social robots are perceived as being useful for repetitive tasks, logic, or being an addition to a team that offers new insights. Creative social robots also have shortfalls, namely the lack to understand complex processes, a conscious and not being able to be truly creative. Furthermore, a creative social robot was not always seen as necessary in a well-functioning team. Additionally, the results show that the general attitude towards creative social robots is not always initially positive but many participants also indicated that experience would foster a better relationship. Lastly, many obstacles are still seen for the actual implementation of creative social robots in the work environment, namely technical developments, legal implications but also the shift in power through a robot in the team.

# Discussion

The current research aimed to investigate the research question: which factors influence the intention to collaborate with a creative social robot in the workplace setting? In more detail, the study investigated how the classical technology acceptance models (Davis, 1989; Venkatesh & Davis, 2000) and/or social extensions like the the sRAM model (Wirtz et al., 2018) can account for the intention to collaborate with creative social robots for innovation in the office environment and how two different kinds of innovative behaviour from the robot (based on the different staged of innovative work behaviour) can alter those relationships. Additionally, the research made use of qualitative interview data to gain a richer understanding of the perception of creative social robots in the work environment.

The main finding of the quantitative component of this study is that only perceived usefulness and trust were significant predictors for the intention to collaborate with a creative social robot. All other variables proposed in the conceptual model, namely perceived ease of use, subjective norm, perceived humanness, perceived social presence, perceived social interactivity and rapport did not influence the intention to collaborate. Furthermore, innovative phase of the robot, that is an idea explorer or an idea generator did not influence any of the variables in the model, and thus, which form the creative social robot had did not make a difference. Regarding the qualitative main findings, this study shows that creative social robots are seen as an interesting and future-oriented topic that could offer many advantages but the robot itself is often perceived as uncanny and evokes uncomfortable feelings. Furthermore, the usefulness is perceived to be limited to more repetitive or logical tasks and less for creativity or is not seen at all in an already good working team. Additionally, the qualitative findings show the importance of experience and the concerns about legal and technical issues. In the following section, the results of the study will be discussed in the context of the literature.

## The factors influencing the intention to collaborate with a creative social robot

The proposed conceptual model argued that functional elements, namely perceived usefulness, perceived ease of use, and subjective norm; relational elements, that is trust and rapport; and social-emotional elements, namely, perceived humanness, perceived social interactivity, and perceived social presence predict the intention to collaborate. However, in this study only perceived usefulness (functional element) and trust (relational element) were significant predictors of collaboration intention.

The finding that only one of the functional elements, namely perceived usefulness (H1b) was found to significantly influence the intention to collaborate goes against the expectations. The literature suggests that all three functional variables from the classical TAM (2)/UTAUT models have been found to predict general technology acceptance (King & He, 2006; Ma & Liu, 2004; Schepers & Wetzels, 2007) and in the context of robots (e.g. Alaiad & Zhou, 2013; Bröhl et al., 2016; Turja et al., 2020). The findings regarding the three functional variables are discussed in more detail below.

Subjective norm (H1c) was not found to be a significant predictor of the intention to collaborate with a creative social robot but the meta-analysis of Schepers and Wetzles (2007) showed that from 22 studies that made use of the TAM model 19 found a significant effect of subjective norm on behavioral intention. However, the research also suggests that subjective norm acts as an influencing factor on perceived usefulness, which showed a larger effect compared to the direct influence on behavioural intention (Schepers & Wetzels, 2007). Furthermore, also the classic UTAUT model suggested that the role of social influences is only important in mandatory settings compared to voluntary settings (Venkatesh et al., 2003). In the current study, the usage of the robot was not displayed as mandatory, but the level of mandatory/voluntariness was not controlled for. In contrast to the quantitative findings, the qualitative interviews show the high importance of social influences on the intention to interact with the creative social robot and how the usage was perceived by clients and colleagues was an important driver of collaborative intentions. For instance, a majority of interviewees indicated that they would talk about the ideas of the robot with the team to see what they think about the robot and its ideas. Those findings indicate subjective norm is described as an important factor to choose to collaborate with a creative social robot but the causal relationship in the model might be less clear. This finding could also be due to the fact that the vignette used in the study showed the interaction of an individual alone with the robot. Thus, no other people were involved in the scenario which could have made the evaluation of subjective norm for the participants difficult.

Perceived ease of use (H1a) was not found to predict collaborative intentions. Moreover, perceived ease of use was the only variable that was not even correlated to the intention to collaborate. The finding that perceived ease of use is not a predictor of collaborative intention might be due to the nature of the variable. Perceived ease of use captures the belief that the use of technology is free of effort (Davis, 1989), and in the current study, the usage of the robot only referred to having a conversation with the robot that was initiated by the robot. Therefore, in the interaction with a social robot that only talks, perceived ease of use might not be applicable as the only task that is demanded from the respondent is to answer verbally. Additionally, perceived ease of use had the highest mean score of all predictors across the participants. One possible conclusion from this could be that perceived ease of use is not an important predictor for the intention to interact intuitively with a creative social robot. Another explanation for this finding could be due to the nature of the study. The participants only watched somebody interacting with the social robot in a video and therefore might not feel like they interacted with the robot themselves, which might make the evaluation of perceived ease of use difficult.

The finding that perceived usefulness is a predictor of usage intention is in line with the literature of the classic TAM models acceptance (e.g. King & He, 2006; Ma & Liu, 2004; Schepers & Wetzels, 2007) and also for models with social robots (e.g. Fernandes & Oliveira, 2021; Park & Del Pobil, 2013). Perceived usefulness is an important predictor of usage intention, as it refers to the outcome expectations or the belief that the usage of technology would enhance the performance (Davis, 1989; Venkatesh et al., 2003). The qualitative findings give a more nuanced picture of the perceived usefulness, especially for which areas and under which conditions. In the literature social robot's area of use is seen with clients and patients in the healthcare sector or the work with children (Ferrão et al., 2020; Lambert et al., 2020; Santhanaraj et al., 2021; Sharkawy, 2021). Hereby, social robots were mainly used for the purpose of providing comfort, companionship, and ease anxiety (Scoglio et al., 2019) or as a language training tool for children (Fuglerud & Solheim, 2018). This was an area of use that was not seen as fitting by some interviewees, indicating that robots might have some areas of use that they are capable of but not perceived as fitting for working with clients or patients.

With regard to robots' usefulness as a team member, some participants indicated that robots are not able to add anything if the team is already very capable while others indicated that robots are advantageous because they can add value from outside. One possible explanation for the different perceptions of usefulness could be derived from frameworks by You and Robert (2018) that focus on the teamwork processes that include robots and humans. The research by You and Robert (2018) argues that teamwork with a robot is a process that includes inputs, including skills, knowledge, abilities, and characteristics of both the robot and the human. These individual characteristics make up team characteristics that influence the robot-human team output (You & Robert, 2018). Now we argue that if the perceived individual skills of the human team members are already sufficient to create good team outputs, a robot will not add any additional individual characteristics, knowledge, or skills that influence the team outcome. However, if team members, knowledge, or skills are missing, the robot could become a valuable team member that influences the team outcome. Thus, the perceived qualities of a creative social robot depend on the existing human team and that robots might only be perceived as able to enrichen a team if the team lacks skills, knowledge, or other characteristics.

Lastly, with regard to the conditions of perceived usefulness, also the core quality of the creative social robot in this study, namely creativity was not seen as an area of use of the social robot. Creative social robots are perceived as unable to grasp complex external conditions, lack human feelings and consciousness. This is in line with the belief that creativity is still regarded as rather human ability and provides a challenge for AI (Boden, 1998; Colton & Wiggins, 2012). Lastly, with regard to the conditions of perceived usefulness, also the core quality of the creative social robot in this study, namely creativity was not seen as an area of use of the social robot. Creative social robots are perceived as unable to grasp complex external conditions, lack human feelings and consciousness. This is in line with the belief that creativity is still regarded as a rather human ability and provides a challenge for AI (Boden, 1998; Colton & Wiggins, 2012).

A salient finding is that none of the social-emotional elements seem to have an effect on the intention to collaborate with a creative social robot (H8). This clearly goes against the expectations. The sRAM model was chosen for the purpose of including social aspects of the collaboration, as the context of innovation lies on inter social processes and engaging in social activities (Anderson et al., 2014; Janssen, 2000), and therefore, it was considered as important that the creative social robot displays humanness, social interactivity, and social presence.

In the literature on social robot interaction, the role of the social-emotional elements is less straightforward than the functional elements. Fernandes and Oliveira (2021) suggest that social effects on collaboration intention are marginal but rather mediated the relationship between relational elements and the acceptance in the example of a digital voice assistant. Furthermore, the study showed similar non-significant effects of perceived humanness and perceived social interactivity (Fernandes & Oliveira, 2021). Here, one could argue that a digital voice assistant might not be able to create the same form of social presence due to a lack of anthropomorphism. However, also the research by Fuentes-Moraleda et al. (2020), which used the sRAM model to assess the intention to collaborate with a hotel service robot, showed that functional elements had a greater influence on the experience and interaction with the service robot than social-emotional or relational elements. Following the literature, one could argue that the role of the social-emotional elements is less straightforward than the functional elements and that the social-emotional elements act as mediators of other relationships in the model.

Nevertheless, also the qualitative findings give an indication of why the social-emotional elements did not influence the intention to collaborate with the creative social robot. The qualitative findings showed that the evaluation of the ideas is an important step in the process of going forward with an idea but people mostly that they would do this by themselves or with other colleagues. To link this back to the IWB context and the different steps, this could show that while robots might be perceived as useful to explore or generate ideas, they are not perceived as useful for further, more social steps of innovative behaviour including the championing of ideas and the implementation (De Jong & Den Hartog, 2010). Thus, while also the literature argues that the social-emotional role of technology acceptance is not as straightforward as expected, also the qualitative findings show that people are the preferred option for social tasks. This could suggest that the social-emotional variables are not significant predictors as they are not important if people only take the idea as data output from the robot and then do the more social part of the process with their colleagues instead of the robot.

With regard to the relational elements trust and rapport, only trust (H5a) had a significant effect on the intention to collaborate. The effect of trust on the intention to collaborate is in line with the literature which suggests that trust predicts the intention to use a technology (Cheng et al., 2008; Cody-Allen & Kishore, 2006; Glikson & Woolley, 2020). Research argues that trust is based on the perception of the robots' abilities, integrity, and benevolence (Cheng et al., 2008; Cody-Allen & Kishore, 2006) or on the perception of other features such as transparency, tangibility, reliability, and immediacy behaviours (Glikson & Woolley, 2020). The perception of those trust predicating features then affects the willingness to rely on the robot. (Cheng et al., 2008; Cody-Allen & Kishore, 2006; Glikson & Woolley, 2020). Rapport, however, was not a predictor of collaboration intention. Rapport focuses on the personal connection between the robot and the human and whether this relationship is perceived as friendly or enjoyable and research suggested that it predicts the intention to collaborate (Fernandes & Oliveira, 2021; Lee et al., 2009; Wirtz et al., 2018). The current research was not able to replicate this finding.

The qualitative results offer one possible explanation why trust but not rapport influence the intention to collaborate even though both are part of the relational elements. As argued, rapport is related to the enjoyableness of the interaction and the perception of friendliness and care (Gremler & Gwinner, 2008; Lee et al., 2009; Wirtz et al., 2018) while trust is more based on integrity, abilities, and benevolence (Cheng et al., 2008; Cody-Allen & Kishore, 2006). Thus, trust is more related to the skills and usefulness while rapport relates more to the feelings of joy during the interaction. And while perceived usefulness was a significant predictor of the intention to collaborate, and the interviews demonstrated that the creative social robot was perceived as useful, the qualitative findings also demonstrate that the creative social robot evoked uncomfortable feelings in the interviewees which might have caused a lack of friendliness and joy in the interaction.

Uncomfortable feelings evoked by humanlike robots are a well-known issue in the literature. The uncanny valley theory argues people generally have a positive reaction to robots that become more humanlike until they reach a tipping point and are perceived negatively. Especially, the effects of movement and the speed of gestures are crucial. If the smile of a robot is not played at expected speed but slower the robot's facial gestures are perceived as creepy rather than happy (Mori et al., 2012). The organization behind Furhat claims that he does not lie within the uncanny valley, as Furhat's expressions are „human-like, but they're not super realistic, the movement and expressions are sophisticated, but the face is a little cartoonish" (Gabriel, n.d.). However, the robot still appears to evoke uncanny feelings in some participants. Following this, the perceived awkwardness might be one reason for the lack of effect on rapport but not of trust on the intention to collaborate, as trust is more dependent on the robots' abilities and integrity rather than the perception of friendliness, enjoyableness of the relationship.

Lastly, a finding not captured in the quantitative findings, but which emerged in the qualitative interviews is the obstacles toward successful implementation but also the belief that experience with the robot is a crucial way to improve the quality of interaction, the comfort to interact with the social robot. This finding is in line with the literature of Glikson and Woolley (2020) which argues that the experience with social robots is an important factor to build trust which in this study also has shown to predict the intention to collaborate with creative social robots. An explanation for the effect of experience and that the contact with a robot could be able to reduce negative feelings toward it could be found in the mere exposure effect, which indicated that something becomes more liked when one becomes familiar with them and that this could also be applicable for robots (de Graaf et al., 2016). Furthermore, social psychology argues that contact with "out-groups", in this case, social robots, is able to decrease prejudice and negative feelings (Wullenkord et al., 2016).

**The Difference of A Creative Social Robot as Idea Explorer or Idea Generator**

The lack of group differences across all variables goes against the expectations. One possible solution is the lack of differentiation in the vignette conditions. Even though the manipulation check indicated that the groups differed in the items whether the social robot presented an idea or only showed areas of improvement, it could be possible that otherwise, the video of the interaction did not show sufficient differences to show a significant difference in the variables. This might also be due to the nature of the stages of innovative work behaviour on which the two forms of creative social robots are based. IWB research suggests the existence of different stages but also argues that one person can be part of more than one stage at the same time and that the multi-dimensionality of the theory might not be applicable in practice (De Jong & Den Hartog, 2010).

**Theoretical Implications**

The current study has three theoretical implications. Firstly, to our knowledge, it was the first study that investigated the perception and collaborative intentions of creative social robots for innovation in the organizational setting. Thereby, it follows the call for research by Amabile (2020) of artificial creativity in the organizational field and the influencing factors on successful collaboration between humans and robots. The current research contributes by showing that trust and perceived usefulness are important to predict the collaboration with creative social robots and is one of the first studies to investigate the applicability of technology acceptance models on creative social robots for innovative processes in the work environment, thereby setting the groundwork for future research.

Secondly, the current research extends the literature on HRM, technology, and innovation. This research extends the lacking literature on the integration of HRC and HRM (Libert et al., 2020) firstly, by providing insights into the importance of perceived usefulness and trust over social physical features of the robot for the willingness to collaborate with a creative social robot for innovation. And secondly, by showing the role of HRM to provide opportunities for experiences, the implementation as a supportive tool rather than a replacement and the room for exchange and feedback. Furthermore, the current research provides a bridge between the HRM research's focus on innovative work behaviour and the focus on advances in technology by showing the importance of creative social robots' role in innovative processes at work. On the one hand, the literature on HRM has focused on the collaboration of human workers with social robots and the benefits of AI, and how those can improve various HR functions such as recruitment, onboarding, or talent management (Arslan et al., 2021; Kaushal et al., 2021). And on the other hand, also the role of HRM and innovation is well discussed in the literature (e.g. Seeck & Diehl, 2017) including the important role of IWB on how to drive a company's success through its human capital and individual creative and innovative behaviours (e.g. Bos-Nehles et al., 2017). However, little research has focused on how such technological advances like social robots, which are becoming increasingly used in many areas of HRM, can foster creative and innovative behaviour at work. The current research was able to start exploring the role of creative social robots in innovative processes by examining the factors that influence the willingness to collaborate with creative social robots to drive innovative behaviour and showed that while creative is perceived as a human skill, a creative social robot is perceived as very interesting and could be useful to accelerate the innovation process by providing external knowledge or by supporting any knowledge or skill gaps within the team.

Thirdly, the study has implications for the research technology and robot acceptance models. This study was not able to replicate the importance of all classical TAM variables, only perceived usefulness has shown to be an important indicator while perceived ease of use and subjective norm were not. The current research contributes to the literature by arguing whether perceived ease of use might not be an important predictor for collaboration intention with social robots as the tasks of talking with the robot is freer of effort than the use of information systems and complex technology the TAM initially was developed for.

Furthermore, the current research shows that the social-emotional factors are not as straightforward as might be suggested in the sRAM literature. The social-emotional elements are argued to be needed as a means to create a warmth in addition to the functional side, to ensure role congruency, and to foster the perception of the robot as a human partner through anthropomorphism (Fiske et al., 2007; Heerink et al., 2010; Wirtz et al., 2018). The qualitative findings however show that people differ greatly in which level of humanness is appropriate and whether a social presence is perceived as nice or intrusive. Therefore, the qualitative findings of this study contribute to the understanding that the judgment of a robot's human qualities differs among people. Moreover, the study also showed that the social-emotional factors and thus the design of a robot, which is usually very complex and developed with carefulness might not be very important if a real human can be used for the interaction instead and thereby showing that a more context depending understanding of the technology acceptance is needed. This is in line with the literature that suggests that it is needed to understand the acceptance of technology within their given context rather than through only generic models (Lemay et al., 2019; Lowe et al., 2019; Turja et al., 2020).

**Practical Implications**

This study offers practical implications for managers on how to implement and support the collaboration with creative social robots in the work environment. Firstly, this study showed that the intention to collaborate with a creative social robot is based on trust and perceived usefulness. Following this, if a social robot is implemented in the workplace for creative processes the introduction of the robot has to be carefully introduced to support feelings of trust, rather than to create a feeling undermining skills and power of, for instance, the manager. Furthermore, perceived usefulness is a predictor of collaboration intention, and therefore it is important to highlight how the creative social robot can be of support for the employees. Thus, the manager that implements the robot in their team has ensure that the robot is perceived as useful but not as a threat to power or prestige. This is in line with the research of Vrontis et al. (2021) arguing that these technologies should be viewed as supporting tools rather than replacements.

Secondly, the findings suggest that especially in the beginning, the creative social robots get evaluated critically by the user and also in feedback with the team. Therefore, managers have to enable opportunities for sharing experiences and to discuss the outputs and interactions of the creative social robot, especially in the early stages of the implementation. Lastly, the research showed that many respondents felt that a good relationship with the robot needs time to develop, and thus beneficial human-robot collaboration needs time to develop, and managers should be aware of the time needed to see results.

**Limitations and Suggestions for Further Research**

Due to the methods employed in this research, some limitations emerge. Firstly, the study made use of vignettes that presented a written scenario and a short video that showed an interaction and participants had to imagine to be the person acting in the video. The research by Xu et al. (2015) argues about the importance of the scenario media used in HRC studies and showed that text media compared to live interaction can significantly affect the behavioural intention to use a robot. Following this, future research should investigate the perception of creative social robots with the use of a more interactive scenario media, for instance through virtual reality (VR). Research has started to use and access VR as a method to investigate HRC (e.g. (Duguleana et al., 2011; Mara et al., 2021; Wijnen et al., 2020), and the research by Wijnen et al. (2020) suggests that the perception and acceptance can differ if the study is replicated with the use of VR, supporting the idea that the scenario media used matters.

Furthermore, this research was not able to find differences in the two different forms of creative social robots. This could be due to the fact that the manipulation was too small to show significant differences across groups. Therefore, further research should investigate whether creative social robots with different creative support are perceived as different in a more elaborated manipulation (also for instance through more interactive collaboration in VR).

Furthermore, the sample of the vignette study and the interviews were very young. This skewed age distribution could have an important effect on the results, as age has shown to be an important influence of technology acceptance (Hauk et al., 2018; Venkatesh et al., 2003). A related limitation might be a self-selection bias. The survey was only distributed via platforms on the internet and therefore, people with less contact to the internet, and also presumably older people were already less likely to be sampled for the study. Following this, further research has to conduct a subsequent study that aims to dive deeper into all ages.

Lastly, also the chosen research stream is a limitation. While the TAM and sRAM have been used to examine the intention to use social robots, deciding on such a model provides limitations for the research. Orlikowski and Scott (2008) argue that research, like the current, which look at technology in organizations through determinant models of impact, moderation and variance belong to the research stream one and teats the technology as a discrete entity. However, other research streams exist which focuses more on interaction and processes with humans and technology as interdependent systems that affect each other through ongoing interaction, or completely challenge this separation and focuses on research in which humans and technology only exist through temporary entanglement (Orlikowski & Scott, 2008). While the current research chose an approach that aims to explain the variance of employees' intention to collaborate through impacts and moderation which treats the creative social robot and the employee as discrete entities, especially the lack of findings in the conceptual model might call for a different research approach that moves away from the technology deterministic view.

**Conclusion**

Research on HRC in the work environment have largely focused on management, coordination, or distribution of information (Mishra et al., 2019; Robert et al., 2020) but very little attention has focused on the role creative social robots can have in innovative tasks in the organizational field (Amabile, 2020) which is important because the implementation of new technologies like social robots can be challenging for HRM (Arslan et al., 2021; Vrontis et al., 2021). To our knowledge, this study was the first to investigate the perception of and intention to collaborate with creative social robots for innovation in the work environment. This research shows that not all classical TAM or sRAM variables are important predictors for the interaction with creative social robots. While perceived usefulness and trust were shown to be significant predictors, social-emotional factors might not be as important as expected to predict collaborative intention. Furthermore, the classical TAM variable perceived ease of use might not be meaningful for intuitive verbal interaction of which social robots are capable. While not represented in the quantitative findings, the interview results indicate the importance of social influences through colleagues on the collaboration with creative social robots, a need for time to develop trust, and the need for exchange about experiences with the robot. Lastly, the research has not been able to show differences for different kinds of creative social robots. Future research has to be conducted to gain a deeper understanding of the meaningfulness of the sRAM variables in the collaboration with creative social robots for innovation in work context, and whether different innovative skills of the robot indeed do not make a difference in the intention to collaborate and explore the development of those variables in a more process-focused manner.

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## Appendices

## Appendix A

### Survey Items with Loadings

| Indicator | Items adjusted from Heerink et al. (2010) | Perceived Ease of Use | Perceived Usefulness | Subjective Norm | Perceived Humanenes s | Perceived Social Interactivity | Social Presence | Trust | Rapport | Intention to Collaborate |
|---|---|---|---|---|---|---|---|---|---|---|
| **Perceived Ease of Use** | | | | | | | | | | |
| Item 1 | I find Furhat (the social robot) easy to use | 0.8815 | | | | | | | | |
| Item 2 | I think I can use Furhat (the social robot) without any help | 0.7740 | | | | | | | | |
| Item 3 | I think I will know quickly how to use Furhat (the social robot) | 0.8750 | | | | | | | | |
| Item 4 REMOVED | I think I can use Furhat (the social robot ) when there is someone around to help me | 0.4235 | | | | | | | | |
| Item 5 REMOVED | I think I can use Furhat (the social robot ) when I have a good manual | 0.4275 | | | | | | | | |
| **Perceived Usefulness** | | | | | | | | | | |
| Item 1 | I think Furhat (the social robot) is useful to me to be creative | | 0.9239 | | | | | | | |
| Item 2 | I think Furhat (the social robot) can help me with creative things | | 0.9250 | | | | | | | |
| Item 3 | It would be convenient for me to have Furhat (the social robot) for creative processes | | 0.9125 | | | | | | | |

| | | | | |
|---|---|---|---|---|
| **Subjective Norm** | | | | |
| Item 1 | People who influence my behaviour think I should use Furhat (the social robot) | 0.7708 | | |
| Item 2 | People who are important to me think I should use Furhat (the social robot) | 0.8004 | | |
| Item 3 | I think the staff would like me using Furhat (the social robot) | 0.8440 | | |
| Item 4 | I think it would give a good impression if I should use Furhat | 0.8788 | | |
| **Perceived Humanness** | | | | |
| Item 1 | Sometimes Furhat (the social robot) seems to have real feelings (*Fernandes & Oliveira, 2021)* | | 0.8851 | |
| Item 2 | I can imagine Furhat (the social robot) to be a living creature *(Fernandes & Oliveira, 2021)* | | 0.8885 | |
| **Perceived Social Interactivity** | | | | |
| Item 1 | I find Furhat (the social robot) pleasant to interact with | | | 0.8658 |
| Item 2 | I feel Furhat (the social robot) understands me | | | 0.7163 |
| Item 3 | I consider Furhat (the social robot) a pleasant conversational partner | | | 0.8839 |
| Item 4 | I think Furhat (the social robot) is nice | | | 0.8190 |
| **Perceived Social Presence** | | | | |

| | | | | |
|---|---|---|---|---|
| Item 1 | When interacting with Furhat (the social robot), I felt like talking to a real person | 0.8831 | | |
| Item 2 | I often think Furhat (the social robot) is a real person | 0.8959 | | |
| Item 3 | I occasionally felt like Furhat (the social robot) was actually looking at me | 0.5502 | | |
| Item 4 | Sometimes it seemed as if Furhat (the social robot) had real feelings. | 0.8360 | | |
| **Trust** | | | | |
| Item 1 REMOVED (low indicator reliability) | I feel I can rely on Furhat (the social robot) to do what is supposed to do | | 0.6118 | |
| Item 2 REMOVED (low indicator reliability) | I believe Furhat (the social robot) provides accurate information | | 0.6674 | |
| Item 3 | I would trust Furhat (the social robot)if it gave me advice | | 0.8641 | |
| Item 4 | I would follow the advice Furhat (the social robot)gives me | | 0.8453 | |
| **Rapport** | | | | |
| Item 1 | The Furhat (the social robot) relates well to me (Fernandes & Oliveira, 2021) | | | 0.9092 |
| Item 2 | I think there is a "bond" between Furhat (the social robot) and myself (Fernandes & Oliveira, 2021) | | | 0.8907 |

| | | |
|---|---|---|
| **Intention to Collaborate** | | |
| Item 1 | I will try to collaborate with Furhat (the social robot) in the future for creative tasks | 0.9284 |
| Item 2 | I plan to collaborate with Furhat (the social robot) in the future for creative tasks | 0.9636 |
| Item 3 | I intend to collaborate with Furhat (the social robot) in the future for creative tasks | 0.948 |

## Appendix B

**Vignette Conditions**

**Vignette: Creative Robot as an Idea Explorer**

Imagine you are working as a project manager at Samsung Electronics. Your tasks include the management of client projects. You are, among other things, responsible for project scoping, requirements gathering and planning, you work with cross-functional teams. You have been working there for over five years now. You enjoy working at your company, the work climate is good, you feel like you have autonomy and are able to express and pursue new ideas.

Recently, your company acquired" Furhat". He has human-like expressions, advanced conversational and creative capabilities. Furhat was added to the team to support the creativity within the team.

In the next step, you will be presented with a short video. You are asked to imagine that you are the person interacting with Furhat.

***Transcript Video:***

*Small Talk*

Furhat: Hello

Employee: Hello

F: How are you today?

E: I am good. Thanks. How are you?

F: That is nice to hear! I am feeling good as well. Thank you.

*Idea exploration*

F: Can I talk to you about something?

E: Sure!

F: I have realized that currently, our office spends uncommonly much time on the start working on a new project. We spend a lot of time organizing a new project and it takes a lot of time to coordinate all the necessary skills from the different functions for a certain project.

E: Yes, it is a very complicated process.

F: Maybe this is something we could work on.

**Vignette: Creative Robot as an Idea Generator**

Imagine you are working as a project manager at Samsung Electronics. Your tasks include the management of client projects. You are, among other things, responsible for project scoping, requirements gathering and planning, you work with cross-functional teams. You have been working there for over five years now. You enjoy working at your company, the work climate is good, you feel like you have autonomy and are able to express and pursue new ideas.

Recently, your company acquired" Furhat". He has human-like expressions, advanced conversational and creative capabilities. Furhat was added to the team to support the creativity within the team.

In the next step, you will be presented with a short video. You are asked to imagine that you are the person interacting with Furhat.

**Transcript Video:**

*Small Talk*

Furhat: Hello

Employee: Hello

F: How are you today?

E: I am good. Thanks. How are you?

F: That is nice to hear! I am feeling good as well. Thank you.

*Idea exploration*

F: Can I talk to you about something?

E: Sure!

F: I have realized that currently, our office spends uncommonly much time on the start working on a new project. We spend a lot of time organizing a new project and it takes a lot of time to coordinate all the necessary skills from the different functions for a certain project.

E: Yes, it is a very complicated process.

F: Maybe this is something we could work on.

*Idea generation*

E: Do you have any idea?

F: Maybe we need a new tool that enables more efficient planning

E: That sounds good! Do you have any more details?

F: My idea is to create a tool that easily and in one application can coordinate all the necessary skills for a project. The tool enables to find the right people with the right skills that are available for a project.

E: okay1

F: Further the tool should be able to schedule the work accessible for everyone. So everyone can say how and when they would want to work.

E: That sounds like a great idea! Also, I think it would increase our efficiency, right?

F: Yes! By reducing the bureaucracy and unnecessary communication we can increase flexibility and we would be able to work more efficiently. What do you think?

E: I think that sounds great. How would we start that?

F: I think a first necessary step toward that is to survey the opinions on the current programs to understand the advantages and disadvantages.

You continue talk some more about the details of the idea.

## Appendix C

### Informed Consent

You are being invited to participate in a research study titled **Human-Robot Collaboration in Creative Processes**. This study is being done as part of my **Master's thesis** in the Faculty of Behavioural, Management and Social Sciences at the University of Twente.

The purpose of this research study is to explore the perceptions of a creative social robot in a work environment and will take **you approximately 10 minutes** to complete. The data will be used for research purposes only and your **data will be treated anonymously**.

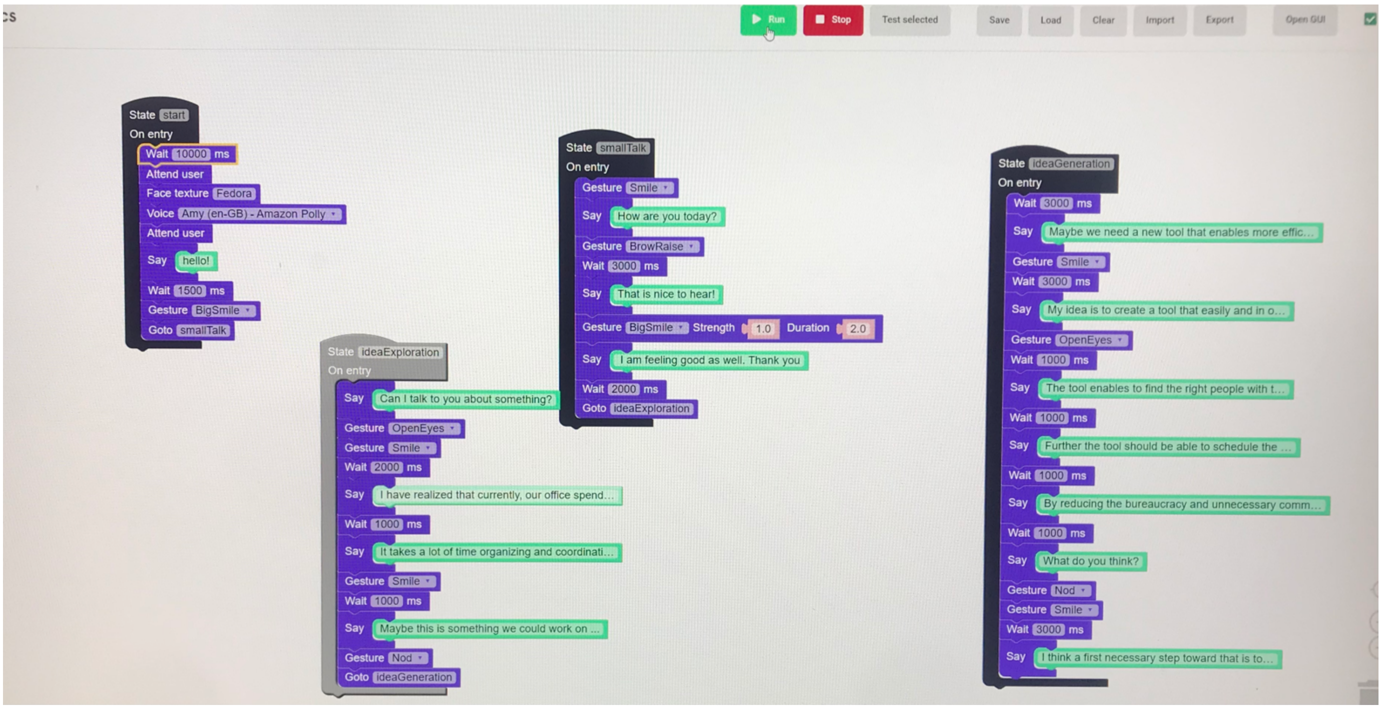
We believe there are no known risks associated with this research study. To the best of our ability your answers in this study will remain confidential.

Your participation in this study is entirely **voluntary** and **you can withdraw at any time**.

***Michelle Meeners** (m.meeners@student.utwente.nl)*

# Appendix D

## Screenshot of the Blockly Script



## Appendix E

**Code Book**

| Aggregated Theme | Axial Code | Open Code | Example Quote |
|---|---|---|---|
| **Experience and Implementation** | Effect of Experience | Experience increase intention to use | *"I mean the interaction seems nice I mean the robot has answers and seemed pleasant but I guess I would feel a bit … I would feel like I need some time to get used to it basically."* |
| | | Trust through interaction/experience | *"I would not trust it that much but maybe if I would work with us more often, I would see that it delivers really good results then would also try to use it in my everyday work."* |
| | Extended Reflection (alone + team) | Collect more information (from robot and other sources) | *"I think I want to know more about the idea and to think about it and well then select some other opinions, get some more information about this precise idea and then I would … I don't know do something maybe."* |
| | | Backup from colleagues | *"I would talk to other colleagues about this conversation and I would  tell them about the idea that the robot has given to me and I would ask them about their opinion and from there I would proceed. If they would like it and if I like it then I would actually take this proposal from the robot seriously and continue from that on and if we decide as a team that we don't like the idea that we just leave the idea."* |
| | | Reflect on ideas | *"Maybe in the first tries with the robot I would discuss it with other persons and think about it myself like the both and maybe you read something more about the idea and if I could use it or not."*2 |
| | Issues for implementation | Legal issues | *"but I think that could be some kind of legal implication first like about data secrecy"* |

| | | | |
|---|---|---|---|
| | | New technology, value not proven | *"also it's news so you don't really know at this point what you're going to get out of it right so if through time and experience it's proven that there is some benefit to it"* |
| | | technology not yet that developed | *"I don't think technology is developed to a stage where it's actually useful and companies actually decide to use it or see the value in it."* |
| | | work culture | *"I guess it depends a bit on the culture. If it's accepted that everyone can talk to the robot and the robot has good insights or can help in the creative process"* |
| **Perception of Creative Social Robots** | General Attitude towards the Creative Social Robots | Robots perceived as unpredictable | *„humans are a bit afraid of robots because. they think they are quite unpredictable"* |
| | | Robots smarter than humans | *„ the fact that's robots are smarter than humans in a way that they can process like way more information than humans and I think that's why I like the fear and the unpredictableness "* |
| | | Fear | *„ the fact that's robots are smarter than humans in a way that they can process like way more information than humans and I think that's why I like the fear and the unpredictableness "* |
| | | Lack of acceptance of robots | *"I think the problem is that there's not great acceptance of humans towards robots yet so that makes it a bit harder too include themand work processes yet"* |
| | | Lack of knowledge about social robots | "*Maybe it's just that I don't know a lot about those social robots but I can't imagine that it has real creative ideas my colleagues wouldn't have or that good team would have"* |
| | | Social robots are interesting | *„Well I think it's also kind of interesting to communicate with some kind of robot to develop some different ideas with a different kind of view. I think interesting but also pretty awkward."* |
| | Feelings Evoked by the Robot | | |

| | | | |
|---|---|---|---|
| | | Awkwardness through too little/ too much humanness | "*I think it's strange because it's like really realistic and with the face and everything like human but you know it's not a human ... I don't know it's strange"* |
| | | Intrusive | "it's a bit intrusive. It would be more what you do with Alexa right? You initiate the conversation" |
| | | Feeling weird about the properties of the robot | *" I really don't understand why they have to be human with the voice and the human face and everything … they're robots and I mean you know it"* |
| | | Experiencing Discomfort | *" It would be a complete new situation for me because I have never interacted with the social robot before so I might feel uncomfortable in the beginning."* |
| **Creative Social Robots perceived skills and shortfalls** | Creative Social Robots shortfalls | Creativity as a human skill | *"I think people also I don't really connect robots with creativity because you think of robots more something like they do mechanic tasks and they're not capable of  creativities because it's is a very human trade creativity and  that's why I don't really connect to social robots"* |
| | | Not suitable for social tasks | "*I mean not the interaction with the patient but for me for like searching ideas or searching new ways of treatment this could be helpful but not in the interaction with patients or something."* |
| | | No addition to a Good Team | *"Maybe it's just that I don't know a lot about those social robots but I can't imagine that it has real creative ideas my colleagues wouldn't have or that good team would have. I think it also depends a bit on how good the team works together and how creative the people are but I just assumed that I would already be working with a highly creative and well-organized team."* |
| | | No sole Decision Maker | *"somehow it would help, it will be accepted if you if you use it as a support for this not as only kind of decision maker."* |
| | Creative Social Robots qualities | Automation as anadvantage | *"in the further future they will definitely be part of the work life because well we see it right now already that's more and more work process are being automated and robots just have more* |

| | |
|---|---|
| | *advantages then humans so I would I definitely think that in the far future they will play big part also in creative process”* |
| Useful for repetitive and logical tasks | *“One could use a robot if the people are fine communicate with a robot because I felt like a robot because you repeat the same sentence over and over again because everybody asks you the same sentences and in this sense maybe the robot would be useful because he doesn't mind repeating stuff and I do mind it because I get annoyed.”* |
| Useful when colleagues/humans are missing | *“I can imagine that use it in processes where when there's no creative partner”* |
| Offer additional insights, exploration | *“they would be helpful like to support innovation and maybe even present some kind of analysis which are outside of your specific area maybe. As a department you have more people focused on let's say humanistic background and instead it could present some kind view other department could have. So it's useful especially like if we assume that the discussion goes step by step, so first you discuss it with the people of your office and then you escalate and maybe the whole department discusses it and then there is more on a company level and this could bring in some different perspective at the earlier stage. Do maybe it can detect some faults at earlier stage”* |
| Always functioning | *“I think they are really useful and helpful because they are robots, they function and they are functioning every time.”* |

## Appendix F

**Correlations Table by Group**

*Mean, Standard Deviation and Pearson Correlation by Group*

| Group | Variable | Mean | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Idea Explorer (N=64)** | 1. Perceived Ease of Use | 5,02 | 1,19 | 1 | | | | | | | | |
| | 2. Perceived Usefulness | 4,31 | 1,42 | 0,156 | 1 | | | | | | | |
| | 3. Subjective Norm | 4,02 | 1,10 | 0,095 | 0,466** | 1 | | | | | | |
| | 4. Perceived Humanness | 3,39 | 1,59 | -0,033 | 0,347** | 0,387** | 1 | | | | | |
| | 5. Perceived Social Interactivity | 4,39 | 1,22 | 0,205 | 0,509** | 0,465** | 0,599** | 1 | | | | |
| | 6. Perceived Social Presence | 3,44 | 1,46 | -0,119 | 0,354** | 0546** | 0,771** | 0,672** | 1 | | | |
| | 7. Trust | 4,40 | 1,11 | 0,184 | 0,455** | 0,460** | 0,464 | 0,545** | 0,499** | 1 | | |
| | 8. Rapport | 3,37 | 1,42 | 0,057 | 0,498** | 0,535** | 0,653** | 0.801** | 0,757** | 0,540** | 1 | |
| | 9. Intention to Collaborate | 4,42 | 1,34 | 0,169 | 0,591** | 0331** | 0,69** | 0,560** | 0,369* | 0,566** | 0,522** | 1 |
| **Idea Generator (N=60)** | 1. Perceived Ease of Use | 5,29 | 0,93 | 1 | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2. Perceived Usefulness | 4,4 | 1,38 | 0,254 | 1 | | | | | | | |
| 3. Subjective Norm | 3,74 | 1,13 | -0,002 | **0,443**** | 1 | | | | | | |
| 4. Perceived Humanness | 3,36 | 1,45 | -0,074 | 0,193 | **0,264*** | 1 | | | | | |
| 5.Perceive Social Interactivity | 4,21 | 1,19 | **0,369**** | **0,486**** | 0,246 | **0,357**** | 1 | | | | |
| 6. Perceived Social Presence | 3,40 | 1,23 | 0,034 | 0,154 | 0,218 | **0,504**** | **0,519**** | 1 | | | |
| 7. Trust | 4,17 | 1,02 | **0,352**** | **0,400**** | 0,120 | 0,183 | **0,400**** | 0,171 | 1 | | |
| 8. Rapport | 3,46 | 1,33 | -0,020 | 0,164 | **0,342**** | **0,425**** | **0.625**** | **0,464**** | 0,199 | 1 | |
| 9. Intention to Collaborate | 4,3 | 1,56 | 0,212 | **0,637**** | **0,578**** | **0,289**** | **0,493**** | **0,331*** | **0,520**** | **0,448**** | 1 |