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# A Review of the Empirical Literature on Service Robots in Information Systems Literature

*Completed Research Paper*

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## Abstract

*Research on Artificial Intelligence (AI) robots has surged as an important topic in Information Systems (IS) domain. Although much research is empirically conducted, the available literature is fragmented and there is a lack of comprehensive understanding of current literature on service robots. Based on a review of 55 selected articles published in the top 10 IS journals and the four leading international conferences in IS field, this study identified the main research themes on robot research in IS field from the views of individuals, organizations, and design. Some suggestions for future research are also raised based on the findings in the review.*

**Keywords:** Service robots, human-robot interaction, information systems, literature review

## Introduction

Robots have been gradually applied in services, including physically embodied Artificial Intelligence (AI) robots as well as virtual robots such as chatbots. Integrating AI as a key feature in robots has enabled functional improvement, such as speech recognition, face recognition and computer vision with the help of machine learning (Rzepka and Berger 2018). Further, service robots can act autonomously, react to the operating environment, learn user behaviors, and can embrace the role of human to make social interaction with human, while even exceeding human capabilities (Čaić et al. 2019). The popular service robots include conversational agents (CA), socially assistive robots, voice assistants, and personal assistants (Schuetz and Venkatesh 2020), and have been applied in various service contexts such as entertainment, healthcare, social service, education, self-driving, etc.

AI based service robots have also attracted the attention of academics. Scholars have researched on service robots from different perspectives. Some research has investigated the value of service robots for organizations, and other research streams have attempted to understand individuals' acceptance of service robot and service robot design for human-robot interaction (HRI). However, the research findings on service robots are fragmented. There is a need for research to integrate the research findings from prior literature to provide comprehensive understanding about service robots. Also, a detailed review covering major topics related to service robots' stakeholders, such as individuals, organizations, and developers, is currently unavailable.

To address the research gap, a literature review on service robots is conducted based on the articles published at the leading journals and international conferences in IS field. The objectives of this study are to synthesize the existing research findings on service robots, to provide an overview of the

knowledge about service robots in IS domain, and to provide suggestions for future research directions for IS scholars.

This paper proceeds as follows. The background of the research field is described in section two. Then the research approach is presented with details about the article selection procedure followed by the discussion on the findings from the selected articles. Finally, potential future research areas on service robots are suggested for IS researchers based on the identified research gaps.

## Research Background

There is no fixed definition that explains and covers all types and technologies of robots. Such as in IS literature, the definitions of robots are given regarding the integrated technology, size, shape, and application of robots. As stated by Kaplan (2005), the notion that the robots are deviating from any object that humans interact created paths for multiple definitions. Robots such as virtual agents, conversation agents and chatbots that are highly integrated with AI and are mostly present in the context of social robotics deviate from the classical definitions. However, in general, a robot can be identified as an electromechanically developed device which can carry out complex series of actions, acting autonomously and sometimes mimicking humans (Madakam et al. 2019).

In IS domain, prior research has studied service robots in the service sector from different dimensions, such as the design and technology advancement of robots from the technology view as well as the value of robots, human-robot interaction, trust, affordance and applications from the robot adoption view. Some scholars examined the values and applications of service robots in organizational setting. The values are identified based on the team formation and success of the robot-human teams. The underlying technical concepts of human-robot interactions and trust appear in such scenario. Wirtz et al. (2018) have identified the differences between service robots and service employees in macro, meso and micro levels. The comparison shows values of service robots in business such as cost saving and gaining competitive advantages when employing service robots in organizational context. Thus, service robots have impacts on business in organizations.

Some studies have investigated individuals' beliefs, attitude, and behavior regarding service robots. Such as anthropomorphic design, the rapport (social bond between user and service robots) are found to be related to the likeability of service robots, user involvement or engagement with service robots and perceived closeness of service robots (Zierau et al. 2020). Social presence is closely associated with the perceived humanness of service robots. Further, trust in service robots appears to be the key factor towards the adoption of service robots among individuals (Bolton et al. 2018). Ease of use, usefulness, quality of interaction, satisfaction and helpfulness have been identified as factors related to the utility of service robots (Zierau et al. 2020). Trust, HRI and functions of service robots have been applied to explain individuals' intention of use, willingness to interact and behavior regarding service robots. These fragmented topics are categorized as individual view, organizational view, and developer view, and explained further in this study.

## Research Approach

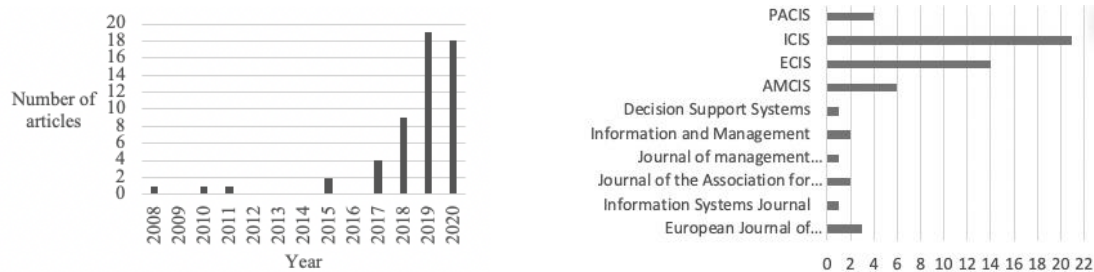
A literature review was conducted to synthesize the current knowledge on service robots and to identify the knowledge gaps to guide future research directions in IS field. The defined search scope of this literature review is in line with the dimensions mentioned by Rowe (2014) as process, sources, coverage and techniques. A sequential research process is carried out in top 10 IS journals and the leading four international conference proceeding in IS filed. Finally, as the technique, keyword search is implemented to retrieve the relevant articles. Reproducibility and transparency of a literature review are considered key quality criteria of an adequately conducted literature review (Engel and Ebel 2019). Therefore, to match those criteria, a three-step selection process was applied to obtain the finalized papers of this review.

*Step 1-Search formulation:* Based on the goal and scope of the research, the key words were selected as “robot”, “bot”, “chatbot”, “chat bot”, “intelligent agent”, “cognitive computer system” and “conversation agent”. Identifying the relevant keywords was given a major concern since most of them

were inter-related. All variations of the selected words were searched, and apart from using a search string each keyword was searched separately. These keywords were matched with the title and abstract of articles. There was no time frame selected. However, the results appeared from a time frame of 12 years ranging from 2008 to 2020.

*Step 2-Database selection:* the IS basket journals (European Journal of Information Systems, Information Systems Journal, Information Systems Research, Journal of AIS, Journal of Information Technology, Journal of MIS, Journal of Strategic Information Systems, MIS Quarterly) and two other leading IS journals (Information and Management and Decision Support Systems) were chosen for this study. The four leading IS international conferences (AMCIS, ECIS, ICIS and PACIS) were also selected to enrich the study.

*Step 3-Sorting and finalizing:* In the first phase of sorting, there were 297 articles (94 journal articles and 203 conference articles). After reading the title and abstract to confirm whether these articles are about service robots, 163 articles (33 journal articles and 130 conference papers) were sorted, and further based on full paper reading 55 articles were finalized (10 journal articles and 45 conference papers) and included in this literature review. The excluded articles had focused on other fields of robots such as data mining, neural networks, big data, and machine learning along with AI innovations.



**Figure 1. Sources and the yearly distribution of the selected papers (n=55)**

The reviewed articles were first categorized according to the source and year. Figure 1 shows the sources of the selected papers and the yearly distribution. The articles have mainly been published from 2008 to 2020. The research on service robots has raised increasing research interest in the past a couple of years.

## Findings

The selected papers were read further to get deep understanding of research on service robots. Table 1 lists the details of the selected articles, including the research context, research method, research focus, research theories and research findings. Table 2 contains a summary of these articles from the view of stakeholders involved in service robots, including the individual users, organizations, and developers.

### *Individual user level*

Based on the findings in the literature, the main research streams at the individual level focus on the benefits, adoption, trust, user experience and dark side. The **benefits** individual received in their use of service robots including the functional value (Adam et al. 2020; Allen and Wu 2010; Goeken et al. 2020; Ostern et al. 2020), the hedonic value (Mesbah and Pumplun 2020; Meske et al. 2020; Naim Zierau, Elshan, et al. 2020), and the social value (Pfeuffer et al. 2019), such as in the service contexts of e-commerce, finance, healthcare, and education. Conversational agents like *Alexa* has been found to improve customer experience while delivering enjoyment (Goernemann and Spiekermann-Hoff 2020). Humanoid or pet robots have been applied in children homes to improve the social response of children with autism (Khosla et al. 2015), and service robot tutors have been applied in education to replace teachers in the classrooms to help students with learning social interactions (Gupta et al. 2019). The study has shown that chatbots could serves as intelligent tutors for students by increasing the social interactions, answering questions and creating an environment for advanced learning (Gupta et al. 2019).

**Table 1. Summary of the reviewed articles**

No	Article	Research context	Research method	Theoretical base	Focused topic/s	Research findings
1	Hinz and Frischmann (2008)	E-commerce	Log data	Concealment strategies of retailers	Business models and values	<ul style="list-style-type: none"> <li>• A positive relationship is observed between number of bundles and active retailers. This shows that bundling is a strategy to evade market pressure.</li> <li>• Methods of incorporating shopbots in bundling techniques (sophisticated search algorithms).</li> </ul>
2	Allen and Wu (2010)	E-commerce	Case study	Shopbot dilemma	Market presentation	<ul style="list-style-type: none"> <li>• The market size drives the market representation of a shopbot positively and affiliation affects it negatively.</li> </ul>
3	Nunamaker et al. (2011)	Conversational Intelligence Agents	Interview	-	Psychophysiological signals	<ul style="list-style-type: none"> <li>• Male conversational agents are considered more powerful and female embodied agents are considered more likable.</li> <li>• Smiling agents are sensed more likable than the neutral demeanor agents.</li> <li>• Conversational agents with environmental vocal sensors are capable of detecting human stress and deception using the voice pitch.</li> </ul>
4	Khosla et al. (2015)	Home-based care	Interview	-	Benefits	<ul style="list-style-type: none"> <li>• Engagement, productivity, usefulness, and reciprocity can be achieved from bonding people with autism with human-like service robots.</li> <li>• Socially assistive robots are required to be developed social context, and trust to human-robot interface can break technology barrier and induce an indirect relationship between assistive robot and young people with autism in long run.</li> </ul>
5	Lankton et al. (2015)	Educational sector	Survey	Social presence affordance theories	Trust	<ul style="list-style-type: none"> <li>• Social presence, social affordances determine the human-like or technology like of AI robots.</li> <li>• Users recognize differences in humanness between technologies. The influence of trust in the specific technology type on outcomes depends on the humanness nature of the technology.</li> </ul>
6	Talaei-Khoei et al. (2017)	Healthcare	Phenomenological interview	Media richness theory	Lean communication	<ul style="list-style-type: none"> <li>• Children with autism can improve responses according to the instructions given by AI robots.</li> <li>• A robot without facial expression is able to improve communication and uplift the performance of the receiver when focusing on the social response of children with autism.</li> </ul>
7	Mettler et al. (2017)	Hospitals	Interview	Affordance theory	Values	<ul style="list-style-type: none"> <li>• Service robots; 1) help to reduce workload of hospital professionals, 2) are strategic assets for problem solving related to spending, 3) are viewed as special tools for supporting skilled hospital professionals, 4) are gadgets with unknown practical value embedded into them, 5) are used as means of boosting the quality of services and information.</li> </ul>
8	Ben Mimoun et al. (2017)	E-commerce	Experiment	-	e-consumer productivity	<ul style="list-style-type: none"> <li>• Interactions with animated conversational agents affect the objective productivity, but not the perceived productivity.</li> <li>• Perceived productivity of users is affected by individual characteristics, but not the use of animated conversational agents (involvement) or interactions with conversational agents (internet skills and urge for interaction).</li> </ul>
9	You and Robert (2018)	Educational sector	Experiment	Emotional attachment	Team performance	<ul style="list-style-type: none"> <li>• Teams perform outstandingly when they are emotionally attached to robots. Emotional attachment to robots is increased by both robot and team identification</li> </ul>
10	Gnewuch et al. (2018)	Customer services	Online experiment	Social response theory	Response delays	<ul style="list-style-type: none"> <li>• Dynamic response delays in chatbots affect perception of customer service chatbots. Human-like responses from chatbots have higher social presence than a chatbot sending instant responses.</li> </ul>
11	Ross et al. (2018)	Music platforms	Case study	Automated communication	Values	<ul style="list-style-type: none"> <li>• Socialbots could be used in commercial context to promote goods, irrespective of the social network or the type of product.</li> </ul>
12	Darmon et al. (2018)	Finance	Case study	Crowdlending	Business model and value	<ul style="list-style-type: none"> <li>• Implementation of automated auction mechanism using an AI robot affect auction duration and determinants of interest rates.</li> </ul>
13	Seeger et al. (2018)	Health	Survey	Theory of anthropomorphism	Design features	<ul style="list-style-type: none"> <li>• There three anthropomorphic features: human identity, non-verbal and verbal.</li> <li>• Communication related cues of human-likeness are just as important as the design of anthropomorphic conversational agents.</li> </ul>
14	Blut et al. (2018)	Branding	Survey	Social robots in brand perception	Robot characteristics	<ul style="list-style-type: none"> <li>• AI robot characteristics such as anthropomorphism, likability, and perceived intelligence show strong affiliation on brand trust and brand experience.</li> </ul>
15	Stock and Merkle (2018)	Hospitality	Survey	Cognitive dissonance theory	Adoption	<ul style="list-style-type: none"> <li>• Customers accept frontline service robots with innovative service behaviors. Innovative behavioral cues generate positive customer responses.</li> </ul>
16	Stock (2018)	Hospitality	Survey	Affective events theory	Customer responses	<ul style="list-style-type: none"> <li>• Customers respond emotionally to a service robot after a service failure and consequences needs to be addressed just as interactions by human employees.</li> </ul>

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17	Schuetzler et al. (2018)	Information interaction platforms	Interview and online survey	Social presence theories	Anthropomorphism	<ul style="list-style-type: none"> <li>• Conversational abilities of conversational agents influence users largely when eliciting socially desirable responses from users.</li> <li>• Embodiment is less significant in yielding truthful responses to sensitive questions. However, conversational agents with higher embodiment (with more anthropomorphic features) are considered “better” in humanlike realism.</li> </ul>
18	Tozadore et al. (2019)	Schools	Case study	Cognitive adaptive systems	Benefits	<ul style="list-style-type: none"> <li>• Speech recognition treatment is the most demanded improvement of the adaptive service robots in teaching.</li> <li>• Participants’ self-statement and their activity enjoyment are not enhanced by the robot’s personalized treatment to them.</li> </ul>
19	Rühr et al. (2019)	Digital investment	Survey	Trade-offs in decision support	User control	<ul style="list-style-type: none"> <li>• Usage intentions are indirectly affected by control over the system because of the perceived risk.</li> </ul>
20	Stock et al. (2019)	Corporate	Experiment	Script theory and media equation theory	Trust (employees trust)	<ul style="list-style-type: none"> <li>• Trust is lowest for android robots and highest for humanoid robots.</li> <li>• Self-disclosure of robots affects trust positively, and physical appearance and contingency factors (task complexity, self-disclosure requirement) influence trust too.</li> </ul>
21	Schneider et al. (2019)	Vocational education	Survey	HRI	Efficacy	<ul style="list-style-type: none"> <li>• Application of social, anthropomorphic robots in training provide both time-flexible coaching which enriches face-to-face interactions for organizations.</li> </ul>
22	Sohn et al. (2019)	Online retailing	Online experiment	User interfaces, social presence	Privacy concerns	<ul style="list-style-type: none"> <li>• Availability of Conversational User Interfaces (CUI) induce perceptions of social presence the convert to perceptions of being watched, thereby positively influencing the privacy concerns.</li> </ul>
23	Diederich et al. (2019)	Telecommunication	Online experiment	Social response theory	Anthropomorphism	<ul style="list-style-type: none"> <li>• Adaptive responses increase perceived empathy, perceived humanness, social presence, and service encounter satisfaction in comparison to static responses in relation to conversational agents in customer service.</li> <li>• Users favor anthropomorphized conversational agents in a service context.</li> </ul>
24	Bruckes et al. (2019)	Finance	Survey	Trust	Trust in adoption	<ul style="list-style-type: none"> <li>• Trust is closely linked to the intention to use.</li> <li>• Trust negatively affects perceived risk and positively induce structural assurances.</li> </ul>
25	Feine et al. (2019)	Telecommunication	Interview	Design science theory	Design features (interaction)	<ul style="list-style-type: none"> <li>• Interactive chatbot development system is crucial in increasing subjective and objective engagement.</li> <li>• Direct manipulation interfaces, contingent responses to user input and auto-generated interaction metrics are key design features to increase perceived interactivity and engagement.</li> </ul>
26	Dias et al. (2019)	Financial services	Case study	Theory of knowledge embodiment	HRI	<ul style="list-style-type: none"> <li>• There are four cognitive stages: cognitive reasoning, cognitive collaborating, cognitive scaffolding, and cognitive extending which explain how humans and service robots interact to perform knowledge work together in organizations.</li> </ul>
27	You et al. (2019)	Education	Experimental study	Group dynamics theory	Team formation	<ul style="list-style-type: none"> <li>• Better performance is observed when groups treat all group members equally as a whole including robots.</li> <li>• Robot identification and team identification are key factors in subgroup formation.</li> </ul>
28	Pfeuffer et al. (2019)	Judge-advisor systems	Online experiment	Social response theory	Stereotypes regarding gender	<ul style="list-style-type: none"> <li>• Users’ perceived competence is increased by female (vs. male) conversational agents and stereotypical female (vs. male) traits.</li> <li>• Improvement of users’ subjective knowledge results in decrease of trust in conversational agents.</li> </ul>
29	Tauchert et al. (2019)	Corporate	Experimental study	Task-technology fit	Advice-taking behavior	<ul style="list-style-type: none"> <li>• Users followed robotic advisors more than human advisors in decision making since robot-advisors deliver the outputs based on statistical and mathematical calculations.</li> </ul>
30	Feine et al. (2019)	Chatbot designing	Interview	Design science theory	Design features	<ul style="list-style-type: none"> <li>• Social cues (clothing, interaction, confidence, language) design should consider also about the design characteristics (formality, level of interaction) to investigate user reactions (positivity, negativity, or satisfaction) to the design.</li> </ul>
31	Gupta et al. (2019)	Education	Interview	-	Benefits and barriers	<ul style="list-style-type: none"> <li>• Benefits of using chatbots in classrooms are ease of accessibility, interactivity and confidentiality,</li> <li>• Issues include lack of interpersonal emotional communication.</li> <li>• Chatbots designs aims include holistic academic success, augment teacher-student interaction, enhanced IQ</li> </ul>
32	Ross et al. (2019)	Social networks	Design research	Spiral of silence theory	Public opinion formation	<ul style="list-style-type: none"> <li>• The public opinion can be determined or tipped over by the presence of a smaller number of bot percentage (2% -4%) if the conditions are polarized. The polarization might depend on the network position and network density.</li> </ul>
33	Goeken et al. (2020)	E-commerce	Survey	Normative social influence theories	Review valence	<ul style="list-style-type: none"> <li>• Social interaction between humans and chatbots shapes the generation of online review.</li> <li>• There is a direct link between use of chatbots and review valence. The valence of the provided reviews is influenced positively by the chatbot-mediated review elicitation.</li> </ul>
34	Gnewuch et al. (2020)	Conversational commerce	Survey	Social response theory and similarity-attraction theory	Dominance and self-disclosure	<ul style="list-style-type: none"> <li>• Users pertain a dominant personality to a chatbot with strong language with assertions, commands, and self-confident statements.</li> <li>• Language style is a key design feature of chatbots and corresponds to the interplay of design.</li> </ul>

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35	Goernemad Spiekerm-Hoff (2020)	E-commerce	Interview	Moment of truth concept	User experience	<ul style="list-style-type: none"> <li>User experiences which is impacted by truth formation deliver valuable insights for developers and helps to analyze customer interactions.</li> </ul>
36	Meyer et al. (2020)	Stationary retail industry	Interview and survey	-	Adoption	<ul style="list-style-type: none"> <li>Perceived usefulness, harmonious cooperation, improvement of service interaction, clear hierarchical relationship, transparent responsibilities, professional and qualified assistance, balanced state of mind, anthropomorphism, facial expressions and gestures, height, and stature drive customer adoption of service robots.</li> </ul>
37	Mesbah and Pumplun (2020)	Healthcare	Interview	Unified theory of acceptance and use of technology	Adoption	<ul style="list-style-type: none"> <li>Medication, medical history, trust in system, trust in provider, access to health system, compatibility, technology self-efficacy, self-reported health conditions are identified as factors that influence the intention and usage behavior of healthcare robots.</li> </ul>
38	Danckwerts et al. (2020)	Media streaming services	Survey	Social presence theory Trust	Adoption	<ul style="list-style-type: none"> <li>Perceived social presence affects perceived enjoyment positively.</li> <li>Perceived personalization increases users' trust in recommendation chatbots.</li> <li>Trust, perceived usefulness, and perceived enjoyment positively influence users' intention to use recommendation chatbots.</li> </ul>
39	Bittner et al. (2020)	Idea platforms	Experiment	Idea elaboration	Values	<ul style="list-style-type: none"> <li>Conversational agents, when playing the facilitator roles have the feasibility to replace and match human facilitators without impeding creativity or openness.</li> </ul>
40	Hofeditz et al. (2020)	Social media	Case study	-	Crisis communication	<ul style="list-style-type: none"> <li>Emergency management framework possesses areas for application of robots for emergency communication. Social robots can communicate beyond automated alerts and potential responses can even be recorded.</li> </ul>
41	Diederich et al. (2020)	e-bike sharing	Survey	Theory of planned behavior, Social response theory	Persuasiveness	<ul style="list-style-type: none"> <li>Human-like design and human perception of conversational agents contribute to persuasiveness.</li> <li>Potential of anthropomorphic design to facilitate a stronger persuasiveness.</li> </ul>
42	Jiang et al. (2020)	Online retailing	Survey	Push-pull-mooring (PPM) model	User switching behavior	<ul style="list-style-type: none"> <li>Users switching intentions are determined by the drawbacks of AI chatbots, the advantages of human agents, and other environmental and personal mooring factors.</li> </ul>
43	Prakash and Das (2020)	Healthcare	Survey	Social response theory	Trust	<ul style="list-style-type: none"> <li>Social presence, perceived usefulness, safety risk, and propensity to trust are determinants of consumer's trust in health chatbots.</li> <li>Enhancing the humanness/humanlike aspects of the chatbot is a way to increase the consumer trust.</li> <li>Anthropomorphic design elements such as visual embodiment or improvement of the empathy and responsiveness of the chatbot create social presence that has significant impact upon consumer trust.</li> </ul>
44	Meske et al. (2020)	Healthcare	Interview	Affordance theory	Affordances	<ul style="list-style-type: none"> <li>Conversational agents are designed to afford the user three different action possibilities such as reading and answering questions, identifying health problems, and reflating personal mood or mental state.</li> <li>Actualizing features such as improved dashboards and interfaces build user capacity to self-help the users.</li> </ul>
45	Zierau et al. (2020)	Customer services	Interview	Trust (nascent design theory)	Trust	<ul style="list-style-type: none"> <li>Building trust-supporting design features stimulate adoption and usage.</li> <li>Identification of five design principles that include transparency, trust, social cues, mitigation of initial mistrust and guidance.</li> </ul>
46	Mozafari et al. (2020)	Energy provider	Survey	Attribution theory	Trust	<ul style="list-style-type: none"> <li>Disclosing a chatbot might have negative consequences, however, can lead to positive outcomes as well depending on the user perception.</li> <li>Disclosing may lead to lower trust levels and affect emotional involvement.</li> </ul>
47	Meske and Amoyo (2020)	Small-and medium sized enterprises	Interview	Affordance theory	Affordance	<ul style="list-style-type: none"> <li>Transferring offline socializing with incorporates robots to online networking context expands users' perceptions of the affordances in enterprise social networks, which lead to increase actualization and overall enterprise social network use.</li> <li>Identification of the Enterprise Social Bots (ESB) as a perception-benefactor of ESB affordances.</li> </ul>
48	Zierau et al. (2020)	Conversation agents	Interview	Service experience theory	User experience	<ul style="list-style-type: none"> <li>Identify functional, mechanic, humane clues as the main characteristics of conversation agents.</li> <li>Superior user experience is caused by high quality design features, which is highly important in conversation agent adoption.</li> </ul>
49	Haas et al. (2020)	Intelligent agents	Survey	Schema theory	Anthropomorphism	<ul style="list-style-type: none"> <li>Intelligent agents (IA) with more congruency with human category schema result in higher user perceptions of anthropomorphism of the agent. This helps to alter users' perception of the IA's intelligence.</li> </ul>
50	Ostern et al. (2020)	Personal wealth management	Survey and Interview	-	Security and privacy	<ul style="list-style-type: none"> <li>Functional and regulatory design in AI-driven voice assistant is capable of improving customer-advisor interactions.</li> <li>Alignment with regulatory frameworks preserves privacy in user interaction.</li> </ul>
51	Ahmad et al. (2020)	Communication satisfaction	Online experiment	Personality, language cues	Personification of CAs	<ul style="list-style-type: none"> <li>Extraverted personality adaptive conversational agents have higher perceived communication satisfaction than the introverted counterpart.</li> <li>Personified linguistic styles affect user interactions.</li> </ul>

						<ul style="list-style-type: none"> <li>Enhancing users' communication satisfaction can be carried out, when language cues which reflect personality dimensions are considered during the designing process of personality adaptive conversational agents.</li> </ul>
52	Wagner and Schramm-Klein (2020)	E-commerce	Interview	Three-factor theory media equation theory	Anthropomorphism	<ul style="list-style-type: none"> <li>Social behavior, adaptability, similarity to the user, personality, independence, voice, appearance, and interaction contribute to the anthropomorphizing of a digital voice assistant</li> <li>Anthropomorphism is positively perceived when the voice assistants reflect socially adapted behavior, embodies a certain role, and from personality.</li> </ul>
53	Adam et al. (2020)	Financial support systems	Survey	Social response theory, anchor-adjustment theory	Anthropomorphism	<ul style="list-style-type: none"> <li>Increment of anthropomorphism in robot-advisors leads to higher perceptions of social presence, that leads to higher investment volumes and higher usage intentions.</li> </ul>
54	Benlian et al. (2020)	Smart home assistants	Online experiment	Person-technology fit, Self-regulation theory	Strain and interpersonal conflicts	<ul style="list-style-type: none"> <li>Unintentional voice activation, lower user anonymity and high presenteeism trigger user perceptions of privacy invasion, which lead to strain and interpersonal conflicts in home setting.</li> </ul>
55	Turja et al. (2020)	Healthcare	Survey	Unified theory of acceptance and use of technology (UTAUT)	Acceptance (intention to use)	<ul style="list-style-type: none"> <li>Intention to use is mainly depending on dispositional attitude and perceived enjoyment. Ease of use and trustworthiness are not the main factors concerning robot acceptance.</li> <li>Complex robot designs demand more expertise from the users while trust becomes a key feature along with the increase of autonomous nature of service robots.</li> </ul>

**Table 2. Focused research areas in AI service robots research in IS field**

Research field		Papers
Individual user view	Benefits	4, 6, 17, 18, 29, 31, 40, 44, 47
	Adoption	15, 24, 36, 37, 38, 55
	Trust	5, 14, 20, 24, 28, 43, 45, 46
	User experience	3, 8, 14, 16, 19, 22, 35, 42, 48, 55
	Dark side	31, 32, 54
Organizational view	Values	1, 2, 7, 11, 21, 39
	Business models	1, 12
	HRI	9, 10, 12, 26, 27, 33
Design view	Anthropomorphic features	13, 23, 25, 30, 34, 41, 49, 52, 53
	Personalization	51
	Security and privacy	50
	Regulatory frameworks	50



Apart from these applications, some scholars have also explained the benefits of service robot to individuals from the view of affordance (Meske et al. 2020). **Adoption** of service robots is vital for the diffusion of service robots in service industry. The innovative technological features of service robots can trigger positive responses from users (R. Stock and Merkle 2018). Such as, the drivers of acceptance of service robots as identified by Meyer et al. (2020) are functional capabilities, role congruency and physical appearance whereas discouragement and mistrust based social presence are barriers. The traditional technology acceptance model has also been applied to explain service robot acceptance, such as perceived usefulness and perceived enjoyment are found to lead to acceptance of service robots (Danckwerts et al. 2020; Gnewuch et al. 2020). Mesbah and Pumplun (2020) show that performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value and habits influence seniors' behavioral intention to use health chatbots.

**Trust** has been a highlighted research topic at individual level. Humanness, social presence and social affordances have been identified as antecedents of trust to service robots (Lankton et al. 2015). The physical appearance, privacy concerns, intention of disclosing and benefits affect trust development (Shi et al. 2020). When the physical appearance is considered, the interface of a conversational agent (male/female) has an effect on trust (Pfeuffer et al. 2019), and if the user's subjective knowledge about a particular area is advance when interacting with a conversational agent, the delays or vague responses can lead to a loss in trust. Contrastingly, Bruckes et al. (2019) and Tauchert et al. (2019) reveal that humans tend to trust robot advisors than human advisors when there are critical and statistical related decision-making situations or in finance services. Trust has also been identified as an important factor determining the acceptance of service robots (Mesbah and Pumplun 2020; Prakash and Das 2020; Shi et al. 2020).

**User experience** is closely related to service robot characteristics. Likability, anthropomorphism, intelligence, disclosing truth during interactions and responses have been found to affect user experience (Blut et al. 2018; Goernemann and Spiekermann-Hoff 2020; Rühr et al. 2019). Moreover, integration of high level privacy measures (Sohn et al. 2019) and high quality design factors (interface, application of social cues, communication) (Zierau et al. 2020) have been found to help enhance user experience of service robots. When users are satisfied with the services and experiences they have achieved, users will be less likely to switch (Jiang et al. 2020). When Service robots are perceived empathetic, they often reflect likability, support and trustworthiness (Diederich et al. 2020). Notably, the research on **dark side** of service robots is very scarce in IS field. However, Gupta et al. (2019) emphasize that there is lack of emotional communication due to drawbacks in service robot designs while Benlian et al. (2020) explain about automatic and unintentional voice activations when using smart home assistants which arises confusions and concerns regarding privacy of users.

### **Organizational view**

According to the findings, the main research areas of focus are values, business models and HRI. When considering the **values** of service robots for organizations, the reviewed studies in the IS domain have mostly experimented in the contexts of education (Schneider et al. 2019), e-commerce (Allen and Wu 2010; Hinz and Frischmann 2008) and healthcare (Mettler et al. 2017). These organizations include the firms that implement robots as well as firms that develop robots. The developer view is specifically explained in the next section. According to Schneider et al. (2019), when social robots are employed in coaching, time-flexible coaching with real time interactions with analytical feedbacks is easily carried out, and the productivity and efficacy can be easily measured. In school environments, service robots help with educational activities. For example, teachers can assess the performances of with students' real-time feedbacks and interactive learning sessions (Tozadore et al. 2019). Goeken et al. (2020) describe chatbots as a rapidly emerging technology and stress on the importance of chatbot use in online platforms. Furthermore, service robots have been used in retailing to enhance the market representativeness, to promote products, and to boost sales aggressively (Allen and Wu 2010). Service robot advisors are used to take precise investment decisions in finance-based applications and personalized wealth management platforms. Utilization of the outputs of robot-advisors than the reports of human advisors have shown profitable results (Adam et al. 2020; Ostern et al. 2020; Tauchert et al. 2019). In healthcare, service robots with physical embodiment are used to deliver medications, meals

and heavy tools, facilitate communication between doctors and patients (Mettler et al. 2017), and assist in surgeries (Mettler et al. 2017).

**HRI** is a major concern at the organizational level. In firms, service robots collaborate with human employees to form teams, increase productivity, and enhance workplace safety (Stock and Merkle 2018). Harmonious human-robot teams with transparent responsibilities improve service interactions (Meyer et al. 2020). The acceptance of service robots as a team member is essential for HRI (Dias et al. 2019; Schneider et al. 2019). The study by You et al. (2019) show that teams perform better when the team members regard service robots as team members other than robotic tools. However, as explained by Gnewuch et al. (2018) response delays might hinder successful HRI in organizational environment, and Human-like responses by chatbots tend to obtain higher interaction rates and more social presence than instant replying chatbots. Additionally, You and Robert (2018) claim that emotional attachment between human-robot team members can lead to a successful human-robot collaboration.

The selected articles have scarcely discussed about **business models**. Hinz and Frischmann (2008) discuss about business models with regards to shopbots. The study states that the existing business models are unlikely to fulfil the market transparency with shop bots. Darmon et al. (2018) suggest a business model about lending robots in a digital platform-based credit market, and they found that the use of the business model can affect the price (interest rates).

### *Design/developer view*

Service robot design is another research stream in the selected articles, especially the **anthropomorphic features**. The attribution of human like characteristics or traits is called anthropomorphism. For service robots, the development of human like capabilities can also be considered anthropomorphism, such as cognitive capabilities (Seeger et al. 2018). Wagner and Schramm-Klein (2020) investigates the anthropomorphic design of AI enabled digital voice assistant and found that users have positive perceptions of anthropomorphic design of robots. According to Jiang et al. (2020), user switching behavior in online platforms is directly affected by anthropomorphic features of AI chatbots. Benlian et al. (2020) and Diederich et al. (2020) argue that use of high-end anthropomorphic design features create trust, lead to acceptance of robots, and enhance the collaboration between employees and robots in human-robot teams (Schneider et al. 2019). Seeger et al. (2018) explain the psychological theory behind the application of anthropomorphic design features in the interface design, and human identity, non-verbal, verbal design dimensions, and are categorized as important features. However, the study unveils that inclusion of all available anthropomorphic design dimensions does not bring out the optimal chatbot which caters all expected functions.

Personified linguistic features in service robots affect user interactions. Extraverted personality adaptive CAs are able to gain higher communication satisfaction to users (Ahmad et al. 2020). Therefore, **personification** is closely linked to anthropomorphic features, which further lead to user satisfaction. User-centric designing (Goernemann and Spiekermann-Hoff 2020) along with high **privacy** concerns (Shi et al. 2020) is essential for service robots. Further, service robots need to meet the expectations of both users and designers in the long run (Gnewuch et al. 2020). Ostern et al. (2020) highlight the importance of adhering to **regulatory frameworks** when designing service robots. Since the regulation require to preserve security and privacy of the customers. Privacy preservation helps to strengthen trust, secure robot-user interactions and adoption of service robots (Bruckes et al. 2019). Therefore, as suggested by Zierau et al. (2020), optimum value delivery is possible in chatbots when user experience-based perspective is considered in development.

## **Possible Future Research Directions**

### *Business models*

In the reviewed literature, business models for service robots have been discussed from the organizational view. Service robots should be developed as per the requests of organizations and also to meet the needs of end users. Therefore, future research should take an integrated view to develop business models for service robot which can balance the needs from different perspectives and yield

positive outcomes, such as value-centric and user-centric business models. Developers' expectations and barriers in investments should also be considered and they must also be satisfied with the offered value propositions. Therefore, creating viable business models needs to ensure that the enormous investments are paid back in long-run while delivering the values for developers as well.

### ***Human-robot collaboration***

HRI is a classical research topic in the robotic literature. The enhancement of features of service robots such as anthropomorphism, embodiment, autonomy and assistive role (Čaić et al. 2019) can enhance HRI. As the applications of service robots penetrates in different service contexts, coexistence of humans with robot is certain (Lyytinen et al. 2020). Thus, there is a need to investigate how humans and robots coexist and collaborate in organizational environment. Future research should explore the mechanism to explain human-robot relationship (such as service robot as a companion/partner or a technical tool), the collaboration model and the value for both employees and organizations. Further research can provide guidelines to companies in the implementation of service robots successfully. In addition, future research can also explore how the anthropomorphic designs can help human-robot collaboration in organizational environment.

### ***Building organizational culture for robots***

Prior studies examine service robots in organizations mainly from the view of value, HRI, and business models. Organizational environment and culture are also important to support the application of service robots within organizations. Such as employees might tend to restrict the usage of robots in work because of their fear of being replaced by service robot in work. There is a need for investigating on methods of cultivating the organizational culture of treating service robots as collaborative partners in work. Therefore, further research could identify the exact capacity of robotic involvement ensuring the confidence in employees in the usage of robots and seeing robots as helpers rather than as threats. Moreover, barriers to establish robotic culture and how to address them could also be studied in organizational context.

## **Conclusion**

This literature review presents an overall understanding of the current research on service robots in IS domain from the individual, organizational and developer views. The research findings help to identify potential research gaps and future research directions, such as from the perspectives of business models, human-robot collaboration, and organizational culture. However, there are two specific limitations in this study. First, this study does not represent a broad view of service robots, but only focused on the IS domain. Second, the reviewed articles are only selected from the top 10 IS journals and the leading IS conferences.

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