On Conversational Agents in Information Systems Research: Analyzing the Past to Guide Future Work

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Abstract. Conversational agents (CA), i.e. software that interacts with its users through natural language, are becoming increasingly prevalent in everyday life as technological advances continue to significantly drive their capabilities. CA exhibit the potential to support and collaborate with humans in a multitude of tasks and can be used for innovation and automation across a variety of business functions, such as customer service or marketing and sales. Parallel to the increasing popularity in practice, IS researchers have engaged in studying a variety of aspects related to CA in the last few years, applying different research methods and producing different types of theories. In this paper, we review 36 studies to assess the status quo of CA research in IS, identify gaps regarding both the studied aspects as well as applied methods and theoretical approaches, and propose directions for future work in this research area.

Keywords: Conversational agent, virtual assistant, machine collaboration, literature review

1 Introduction

Conversational agents (CA), i.e. software that interacts with users via written or spoken natural language, increasingly permeate our lives. Nowadays, mobile devices are equipped with powerful agents by default, such as Siri or Google Assistant, offering support for a variety of tasks such as researching information, scheduling meetings, or sending messages. At its 2018 developer conference, Google demonstrated the potential of CA in the (near) future by showing their assistant autonomously making an appointment with a hairdresser in a live phone conversation [1]. For organizations, capable CA offer a variety of applications ranging from team collaboration, such as in the form of cognitive assistants in workshops [2], to service provision at the customer interface [3–5], and have attracted increasing interest in practical implementation in recent years [6]. CA have been around for several decades, starting with the agent ELIZA developed by Joseph Weizenbaum in 1966 which simulated a psychotherapist [7], yet several agents did not fulfill expectations in the past [4]. As most of these agents were primarily rule-based, their potential and capabilities were rather limited. However,

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driven by advances in natural language processing and machine learning, modern CA emerge into seemingly intelligent software that can be used to support various tasks and enhance human cognitive capabilities [8], hereby changing the allocation of task between humans and machines [9]. As CA become an integral part of our lives and application grows increasingly versatile, we believe there are multiple aspects to study ranging from the design of such artifacts, understanding emerging, collaborative work practices to the introduction of CA in organizations for automation and innovation.

While CA have been researched extensively in human-computer interaction (HCI) and computer science (CS) with the different foci prevalent in these disciplines, such as user trust in CA in HCI or optimizing natural language understanding in CS [4], they attracted the interest of the IS community recently [10] because of their profound impact on both organizational as well as individual level. As of now, a variety of IS studies address different aspects, such as design principles [4], information disclosure by the user [11, 12] or the impact of the CA on user's cognitive abilities [13]. Against this background, we aim to structure and analyze what is already known in IS research regarding CA and derive directions for future studies with the following research question:

RQ: What is the status quo and what are future directions for IS research on CA?

In order to address this question, we conduct a systematic review of IS literature with a focus on highly-regarded journals and conferences. We analyze 36 publications in terms of studied CA characteristics as well as the produced IS theory types and applied research methods. This allows us to better understand and structure existing work as well as to derive future research directions. We continue by providing the theoretical background of CA and outlining our research approach, a systematic, concept-centric review of IS literature [14]. We then present the insights from our analysis, discuss the results and close this paper by formulating research directions for future studies on CA.

2 Research Background

CA are systems that interact with people using natural language, thus simulating behavior of a human being [4, 15, 16]. Terms, such as virtual assistants, chatbots or dialogue systems are often used synonymously [4, 10]. As natural language can be written or spoken, CA communicate with their users via written language, speech, or both [17]. CA that communicate with users via written language, often referred to as chatbots, include agents such as Rose (a bot with the personality of a security analyst and hacker from San Francisco) or Mitsuku who can play games or reason with specific objects while simulating a 18-year old woman from Leeds. Examples in a company context are the CA of KLM, called BlueBot [18], that allows to find and book flights, the chatbot by H&M that provides personal shopping recommendations [10] or Amtrak's customer service bot that handles more than one million customer requests per year [19]. The most popular CA with speech-based input can be found on mobile devices that are used in our daily lives, such as Alexa, Siri, Microsoft's Cortana, or Google's Assistant.

Nowadays, more than 100.000 bots engage with users on a global scale on Facebook, and companies are showing great interest as more than 80% have already implemented bots for customer service or plan to do so by 2020 [6]. With several enterprise platforms in the market, such as IBM's Watson Conversation Service, the Microsoft Bot Platform or DialogFlow by Google, companies can now easily procure and customize off-the-shelf solutions to introduce CA in their organizations.

Due to the significant improvements of CA, the widespread diffusion of powerful mobile devices, and continuing trends toward digitization, a variety of CA has emerged in the past few years both in private as well as professional life. While general-purpose CA, such as Siri or Google Assistant cover a wide range of functions, domain-specific agents focus on specific tasks or domains. For example, CA can be used for automation in customer service [3, 4, 20], as digital sales assistants [21, 22] or in human resources to provide support for new employees [23]. Thus, in addition to the communication mode, CA can also be differentiated by the context in which they are used [4].

Furthermore, CA can be represented in different forms, such as with static virtual avatars [8, 24], interactive virtual avatars [25, 26], physical embodiment [27, 28] or be disembodied, i.e. lack any form of representation and only provide a natural language interface [29]. These different forms offer a variety of design options and provide non-verbal cues that influence how a CA is perceived by a user [30, 31]. For example, the experiments of Qiu and Benbasat [32] on the virtual static representation of a CA indicate that matching the ethnicity leads users to perceiving the CA as more enjoyable, sociable and useful. Additionally, Al-Natour et al. [33] investigated online shopping assistants with a focus on personality and behavioral similarity and found that customers evaluate CA that are similar to themselves more positively and show higher intentions to reuse them.

3 Research Approach

To review existing work on CA in IS research, we follow a literature review process based on the approaches of Webster and Watson [14], Brocke et al. [34], and Bandara et al. [35]. Our review consists of three phases. First, we gather studies regarding CA from established and relevant IS journals and conferences. Second, we code the identified literature along five dimensions: CA mode of communication, CA context, CA embodiment, IS theory type, and IS research method. Finally, we analyze the literature by using a concept matrix to assess the status quo of CA research and derive directions for future studies.

Table 1. Research approach phases

	Phase 1: Gather literature	**Phase 2: Code literature**	**Phase 3: Analyze literature**
Inputs	Publication databases and outlets	Literature database	Coded literature database
Methods	Literature search	Coding	Literature analysis
Steps	Conduct search and filter literature	Define coding dimensions and code literature	Create and interpret concept matrix
Results	Literature database	Coded literature database	Overview of CA research and implications

For the literature search process, the relevant literature outlets had to be identified. We decided to focus on highly-ranked publication outlets [36] and extend them by current studies from IS conferences. Hence, we focused on articles published in the basket of eight [37] and complemented these with selected conferences (ICIS, ECIS, WI, MKWI, HICSS, AMCIS, PACIS) to incorporate recent research because CA have just recently started to attract the attention of the IS community [10]. To gather publications, we used the Web of Science and AIS Electronic Library databases. Furthermore, we also included the website of the respective journal or conference if the outlet was not already included in the databases. The following search query was used:

Conversational Agent OR Virtual Assistant OR Dialogue System OR Chatbot

The full-text search was conducted in November 2018 by two of the authors. We omitted identical results and briefly scanned titles as well as abstracts to remove irrelevant articles. For example, studies with a focus on agents could research autonomous software agents that are used to fulfill specific tasks, e.g. in e-commerce, yet lack the conversational nature of the agents analyzed in this study. Similarly, the term agent included studies on human service agents, such as in customer service, which are not the focus of our review and thus were excluded. After this search and filtering process, 36 articles remained (see Table 2, outlets without relevant results are omitted).

Table 2. Literature search results

Journals	Total Found	Filtered
Journal of Management Information Systems	90	3
Journal of the Association for Information Systems	75	2
International Conference on Information Systems	383	13
European Conference on Information Systems	287	2
Pacific Asia Conference on Information Systems	198	4
Hawaii Int. Conference on System Sciences	100	5
Americas Conference on Information Systems	518	7
	Total	36

In phase two of our work we coded the literature along different dimensions. To assess the status quo, we chose a combination of dimensions related to the content of the studies (communication mode, context, embodiment) as well as regarding the methodological approach (research method) and type of produced knowledge (theory type). Thus, we were able to identify research gaps both related to the content as well as from a methodological and theoretical perspective. Difficult decisions during the coding process, such as assigning a research method in a study that uses a combination of methods, were discussed by both authors. For example, the study by Seeger et al. [38] develops a design framework and evaluates it based on an online experiment. In this case, we assigned the method "framework/conceptual model" as this can be considered the main contribution of the study. Furthermore, we differentiated the theory types "explanation" and "design and action" by the explicit formulation of design principles and patterns [39] whereas studies that explain user interaction with a CA often also provide valuable implications for the design (e.g. [40]).

Regarding the content-related dimensions, we determined the communication mode of the CA (text-based, speech-based, or both) to account for the fact that natural language can be written or spoken [17]. Furthermore, we assessed whether the study deals with a general-purpose CA or an agent that is domain-specific, i.e. used for a specific task or function [4]. Finally, we considered the embodiment of the CA [41], i.e. whether it has a static virtual representation, an interactive virtual representation, a physical representation or no form of representation at all. We extended these dimensions by the research methods and produced IS theory types. Palvia et al. [42, 43] assessed the research methods specifically in IS, thus we selected their methods to code our studies. With regard to the IS theory types, Gregor [44] distinguishes five types, which we used in our coding: Analysis (theory that describes and analyzes reality without the identification and structuring of cause-effect relations), explanation (theory that provides explanations for cause-effect relations but does not formulate propositions), prediction (theory that contains testable propositions but does not provide justification or explanation), explanation and prediction (theory that provides both causal explanation and testable propositions), as well as design and action (theory that informs the development of artifacts). In total, we coded the studies along five dimensions (Table 3) and all studies were assigned one characteristic per dimension.

In the third and final phase, we analyzed the coded literature by means of a concept matrix [14]. A concept matrix helps to view literature from a concept-centric [45] position and thus fosters an understanding of research beyond descriptive content summarization [14]. Furthermore, it helps to study the distribution of characteristics within the dimensions and paves the way for answering our research questions.

Table 3. Coding dimensions

Dimension	**Characteristics**				
CA communication mode	Text-based	Speech-based	Both		
CA context	General-purpose	Domain-specific			
CA embodiment	None	Virtual static	Virtual interactive	Physical	
IS theory type	Analysis	Explanation	Prediction	Explanation & prediction	Design & action
IS research method	Speculation/ comment	Frameworks /conc. model	Library research	Literature analysis	Case study
	Survey	Field study	Field experiment	Laboratory experiment	Mathematical model
	Qualitative research	Interview	Secondary data	Content analysis	

4 Results

To summarize the insights gained from the literature review, we created a concept matrix (Table 4, characteristics not present in the literature database were omitted). In the following, we present the results of this structured literature analysis in detail.

Concerning the primary mode of communication, all three interaction types (text-based, speech-based, and combined) are addressed. Text-based CA (16 of 36) were for example explored in the context of user information disclosure behavior for sensitive topics [26], user perception of customer service agents with a focus on different agent- and communication-related cues [8], and the design of a natural search agent for legal research [29]. Research on CA that interact with users via speech (8 of 36) addressed for example lie detection by the CA [41] or service satisfaction with and continued use voice assistants [46]. Studies that focus on combined modes of interaction (12 of 36) include, for example, a study by Schroeder and Schroeder [11] comparing differences between interaction modes regarding users' willingness to share personal information and the development of overarching design principles for CA [4].

Table 4. Concept matrix

Article	CA mode			CA context		CA embodiment				IS theory type			IS research method							
	Text-based	*Speech-based*	*Both*	*General-purpose*	*Domain-specific*	*None*	*Virtual (static)*	*Virtual (interactive)*	*Physical*	*Analysis*	*Explanation*	*Design and Action*	*Case study*	*Interview*	*Laboratory experiment*	*Field experiment*	*Literature analysis*	*Secondary data*	*Speculation/commentary*	*Framework/conc. model*
[13]			X	X		X					X			X						
[47]	X			X		X					X				X					
[4]			X		X		X					X					X			
[48]			X	X		X				X								X		
[41]		X			X				X			X			X					
[49]			X		X		X					X			X					
[50]			X	X		X				X									X	
[51]			X	X		X					X				X					
[11]			X	X		X					X				X					
[12]	X			X		X					X				X					
[26]	X			X				X			X				X					
[25]			X	X				X			X				X					
[52]		X			X	X						X	X							
[29]	X				X	X						X	X							
[8]	X				X		X				X			X						
[53]	X				X	X						X			X					
[54]	X			X			X				X				X					
[55]	X				X	X						X			X					
[38]	X			X			X					X								X
[56]		X			X				X			X								X
[57]		X			X	X					X							X		
[58]			X	X		X					X						X			
[59]	X				X	X						X			X					
[60]			X		X	X					X							X		
[61]			X	X			X				X						X			
[46]		X		X		X					X									X
[62]		X			X			X				X		X						
[63]		X		X		X					X							X		
[64]		X			X	X					X				X					
[65]	X				X		X					X			X					
[66]	X				X	X					X				X					
[24]	X			X			X				X				X					
[40]			X		X		X				X				X					
[67]	X				X		X				X				X					
[21]	X				X	X					X					X				
[68]	X				X	X				X									X	
∑	**16**	**8**	**12**	**16**	**20**	**21**	**10**	**3**	**2**	**3**	**21**	**12**	**2**	**3**	**18**	**1**	**3**	**4**	**2**	**3**

With regard to the agent context, multiple studies research general-purpose CA (16 of 36) with a focus on aspects such as CA influence on decision-making [47] or the relation between CA capabilities and user experience [48]. Domain-specific CA (20 of 36) are studied in different contexts. Half of the studies on CA in specific domains focus on marketing and sales [21, 40, 49, 57, 59, 60, 64, 66–68], e.g. as product recommendation agents [40, 49] or in-store shopping assistants [21]. Furthermore, four

studies investigate the use of CA in customer service [4, 8, 55, 56]. The six remaining domain-specific CA studies focus on a variety of specific contexts: Automated interviewing [41], gamified environments [52], workshop moderation [62], idea platforms [65], contracting [53], and legal research [29].

Concerning the embodiment of CA, most studies examine CA that do not have a virtual or physical representation (21 of 36), such as simple natural language systems [12, 29] or disembodied voice assistants [57, 64]. Further studies (10 of 36) explore CA with a virtual and static embodiment. For example, Wünderlich and Paluch [8] argue that the image of a CA represents an agent-related cue and describe its (potential) helpfulness for the user for perceiving a CA in a service encounter as authentic. Few studies address CA with a virtual interactive embodiment (3 of 36) or a physical embodiment (2 of 36). The three studies with a focus on CA with a virtual interactive representation indicate that interactive avatars can contribute to user affinity towards the CA through matching common human non-verbal cues [25], use facial expressions and gestures to increase perceived human-likeness [62], and might lead to more socially desirable responding for sensitive topics by users [26]. In addition, Nunamaker et al. [41] present a physically embodied CA with multiple sensors for interviewing and study different aspects of user interaction, such as perception of different CA genders or smiling. Finally, Stock and Merkle [56] study the use of a physically embodied, humanoid CA in a service encounter and find in their laboratory experiment that customer responded rather positively to innovative service behavior.

Regarding the produced IS theory types in the studies, most of the reviewed articles provide theories that intend to explain (21 of 36) different aspects of human-CA interaction, such as trust [44, 66], self-disclosure of information [66], or perceived authenticity [8]. Studies with a theoretical orientation towards design and action (12 of 36) for example provide design principles for CA in customer service [4] or for assistance in creative workshops [62], study the effect of dynamic response times on perceived social presence, perceived human-likeness and social presence [55] or evaluate anthropomorphic product recommendation agents [49]. Studies that focus on analysis (3 of 36) study capabilities of CA and user experience through the analysis of app reviews [48], consider the use of CA in e-commerce [68] or for information resource management [50].

The research methods used in the reviewed studies revealed a focus on laboratory experiments (18 of 36) which is one of most common methods in IS research [42, 43] and seems to be suitable to CA research as these experiments can provide useful insights into human-computer interaction. In addition, secondary data (4 of 36), such as data on consumption behavior for digital content through CA [57] or app reviews for virtual assistants [48] is used in the reviewed studies. Further research methods applied in the reviewed studies include the development of frameworks or conceptual models, interviews, literature analyses (each 3 of 36), case studies and speculation/commentary (each 2 of 36) as well as a field experiment by Al-Natour et al. [21].

5 Discussion

The goal of this literature review was to examine the status quo of CA within the field of IS research and provide directions for future work. In the following, we discuss our results and propose directions for prospective studies on CA.

5.1 State of CA Research in IS

Overall, our literature review shows a strongly increasing interest in CA in IS research, confirming similar statements by other scholars [4, 8, 55]. More than half of the identified studies were published in the last two years. The reviewed studies explore different communication modes, various application domains for CA and use different research methods to primarily produce theories for explanation and prediction as well as design and action.

Concerning the context in which the CA are studied, our results indicate a variety of different application domains of CA ranging from product recommendations [40, 49] over workshop moderation [62] to the use of CA for legal research [29]. In particular, marketing and sales (10 of 20 domain-specific studies) as well as customer service (4 of 20 domain-specific studies) were explored frequently, which are the two most popular application domains in an enterprise context for text-based CA [69, 70]. However, studies on CA as collaborators in team settings, i.e. machines as teammates [2], are limited to a single study on virtual workshop assistance [62].

With regard to the theory types, we find that only 12 of 36 studies produce theories to inform and guide the design of CA whereas successful design represents a major challenge in practice [16, 77, 78]. Interestingly, nearly all design-oriented studies focus on domain-specific CA, such as the design principles formulated by Gnewuch et al. [4] for CA in customer service or by Al-Natour et al. [21] for CA as shopping assistants.

We further observe a research focus on disembodied CA or CA with a virtual static embodiment (31 of 36) whereas studies on CA with virtual interactive embodiment or physical embodiment remain sparse. Many of the reviewed studies examine text-based CA, or chatbots, that are typically represented by means of a static avatar or lack any form of (virtual) embodiment [4]. A notable exception is the study by Stock and Merkle [56] who explore the use of the humanoid robot Pepper in a service encounter. Finally, our review of the applied research methods shows a focus on laboratory experiments (16 of 36) while the exploration of CA in the field, for example with the help of case studies (2 of 36) or field experiments (1 of 36) is limited.

5.2 Research Directions

Based on our assessment of the status quo, we propose four directions for future CA studies in IS research (Table 5): First, we suggest to extend the investigated application domains with regard to team settings in which a CA serves as a collaboration partner. While CA have the potential to support collaborative work [2], for example through the ad-hoc provision of information, we found only one study that addresses this context by developing design guidelines for CA as assistants for workshop moderation [62].

Second, we propose to conduct more and contrast design-oriented studies due to the rather limited number of studies that inform CA design and the fact that design remains a major challenge in practice [16, 71, 72]. As the contexts in which CA design is investigated become increasingly diverse, we believe it can be useful to contrast design knowledge across different contexts to identify common design principles as well as domain-specific aspects. For example, CA design for marketing and sales could place emphasis on increasing the persuasiveness of the agent [73] while a CA in customer service could benefit from being particularly empathetic in service encounters [20].

As a third research direction, we recommend to specifically study CA with a virtual interactive or physical embodiment as only five of the reviewed studies investigate embodied CA. Compared to disembodied CA or agents with a virtual static representation, embodied CA offer an increased variety of cues, such as facial expressions or gestures, that impact user interaction and provide additional options for design [30]. As technological approaches to create virtual interactive avatars improve [25] and physically embodied CA emerge, such as SoftBank's Pepper, we argue that studying their special features becomes increasingly relevant.

Table 5: Research directions and rationale

Direction	Description	Rationale
Investigate CA in team collaboration settings	Exploration of CA as innovative collaboration partners in team settings	CA in collaboration are only addressed by a single study despite their potential
Conduct more and contrast design-oriented CA studies	Formulation of design principles and design as well as evaluation of expository instantiations	Lack of design-oriented studies and successful CA design as a practical challenge
Explore virtually or physically embodied CA	Study of interaction with and design of embodied, both virtually and physically, CA	Existing focus on disembodied or virtually static embodied CA with limited social cues
Study CA introduction and use in the field	Expansion of CA research to the field, for example through case studies or field experiments	Half of the reviewed studies apply laboratory experiments in controlled settings

Finally, we propose to investigate real-life settings, for example through case studies or field experiments as half of the identified studies used laboratory experiments for their work. From our point of view, these experiments are useful for investigating different aspects in user and CA interactions in controlled settings. Nonetheless, we believe that future research can benefit from applying additional methods in the field [42, 43] regarding actual CA introduction and usage in enterprises in real-world settings. With these methods, results from CA studies can also provide stronger practical insights and thus ensure the relevance of our work for practitioners.

6 Concluding remarks

The aim of this research essay was to assess the status quo of CA in IS research and derive directions for future work. We conducted a systematic literature review and analyzed 36 studies with regard to five dimensions: CA context, CA communication mode, CA embodiment, IS theory type, and IS research method. Based on our findings we propose to move CA research in IS forward by the investigation of CA in collaborative settings, a stronger focus on design-oriented research, the exploration of embodied CA, and the study of CA in the field. While our study contributes to the understanding of the current state of CA research, it will require future updating and re-analysis as new studies emerge. Furthermore, we deliberately included only IS research in our study without incorporating work from other disciplines, such as human-computer interaction or computer science, to capture the status quo in IS research. We suggest that future work expands the view towards these disciplines when investigating design of or interaction with CA.

Overall, we believe that studying CA is a valuable research endeavor. In particular due the increasing capabilities of these agents and the variety of applications in private and professional life, they are an interesting, dynamic phenomenon to investigate in the context of digital transformation and can provide insights into new forms of human-computer interaction.

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