

# Chatbot in Customer Service and Its Efficiency or Accuracy

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## Abstract

The aim of this review was to critically evaluate the current status of chatbot research and applications and factors related to it. A Google search using search terms yielded 30 usable full text papers published between 2015 and 2019.

A tabulated analysis was done on the highlights of these 30 papers. Some points of interest have been discussed in the paper. A categorised table of types of studies and their relative numbers has been given. Research works and model proposals were maximum. There was a significant dearth of papers on system description and implementation.

Many points emanating from the review are discussed. The deficiencies and limitations of certain papers have been pointed out. Based on the highlighted remarks, some gaps in the current understanding of chatbots and scope for further research have been identified.

**Keywords:** Chatbot, customer service, efficiency, accuracy, review

## Introduction

Basic details about chatbots available in Expert System (2018) are described below.

Chatbots are tools for simplifying interactions between humans and computers. They are essentially artificial intelligence (AI) software that can be used for simulation of a conversation (chat) with a user in natural language using messaging applications, websites, mobile apps or telephone. Technically, chatbots leverage natural language processing to a question-answer system for many end-use applications. It is very useful in businesses for FAQs, help chats etc.

The mechanism of chatbot has two parts: analysis of user requests to identify patterns and a system for responding to queries. The user request analysis is done to identify user intent and extract relevant entities. In the next step, the user request analysis results are used for response in any of the following forms of-

- a) a predefined generic text
- b) a text retrieved from a knowledge base containing different answers
- c) a contextualized information based on data the user has provided
- d) data stored in enterprise systems
- e) the chatbot performs an action by interacting with one or more backend application and its result is used for responding to the question.
- f) a question to ensure that helps the chatbot has correctly understood the user's request

A diagrammatic representation of a chatbot system is given in Fig 1.

In business, chatbots help to enhance customer experience. Customer engagement is facilitated and operational efficiency is increased by reduction of cost of customer service. The chatbot application suitable for each purpose may differ.

In this paper, selected papers on chatbots are systematically reviewed. The purpose of this review was to evaluate how efficiently and accurately chatbots facilitate customer service in various business sectors.



Figure 1. Chatbot system

## Methodology

Google scholar was used for searching literature on chatbots in relation to customer service and efficiency. First, using ‘Anytime’ option, first five pages of Google Scholar was searched to yield 24 full text papers published during 2015-2019. Next, setting the search period as 2015-2019, further search was done using the same terms to yield 11 more papers published during the period of choice. Papers without full text or published earlier than 2015 were excluded. Using these criteria and methods, 30 usable papers were obtained. The list of 30 papers including what was discussed above, is given in the references. A summary of their highlights is tabulated and given as APPENDIX. The results of this review are discussed below.

## Results

### The general trends of papers

Topic categorisation	Number of papers	References
Theoretical or conceptual discussions	7	Ivanov & Webster (2017), Zsarnoczky (2017), Brandtzaeg & Følstad (2018), Fadhil, A. (2018), Di Gaetano & Diliberto (2018), Delamater (2018), Zumstein & Hundertmark (2018).
Model proposal and validation	9	Cui et al (2017), Qiu et al (2017), Feine, Morana & Gnewuch (2019), Atiyah, Jusoh, & Almajali (2018), Boyanov et al (2017), Colace et al (2017), Kamphaug et al (2017), Vu et al (2019), Hu et al (2018),
Reviews	5	Radziwill & Benton (2017), Deshpande et al (2017), Ahmad et al (2018), Eling & Lehmann (2018), Anagnoste, S. (2018),
Researches	8	Følstad et al (2018), Brandtzaeg, Petter Bae, & Følstad, Asbjørn (2017), Zsarnoczky (2017), Nuruzzaman & Hussain (2018), Chandel et al (2018), Luo et al (2019), Gnewuch, Morana, & Maedche (2017), Anagnoste, S. (2018),

Topic categorisation	Number of papers	References
Chatbot systems description and implementation	3	Jacobs, Powers, Seguin & Lynch (2017), Heo & Lee (2018), Memon et al (2018),
Total	32	Total is not 30 as two papers fell into two categories of papers.

### Some notable features from certain selected papers

A historical treatment of how it all started and developed into the current status was discussed by Deshpande et al (2017) and by Delamater (2018). There are as many number of techniques as there are chatbots and the review of this aspect by Ahmad et al (2018) helps to appreciate these issues. Related to this is the Forrester report (Jacobs, Powers, Seguin & Lynch, 2017) on the top 10 chatbots inputting the parameters of determining their ranks. Are these the only parameters, none is certain.

Chandel et al (2018) analysed the technology of five chatbots using multiple non-mathematical and mathematical methods. High customer efficiency and popularity of some chatbots over the others was attributed to their specific design features, specifications and technology to match target user needs. However, challenges and problems of chatbots were not discussed. But we know, these are also important in determining usability by customers.

Chatbots for general customer services is more common both in research and in practical use. However, certain specifically attractive applications were discussed on application in tourism by Zsarnoczky (2017). Another application as a virtual coach for advice on dietetics was discussed by Fadhil, A. (2018). An extension of this may be use of chatbot as a self-management tool for patients with chronic diseases. Scope for using chatbots in public administration, health and home automation was discussed by Di Gaetano & Diliberto (2018). User sensitivity was a specific issue related to application of chatbots in healthcare. However, there are ways to deal with it by controlling access related to a particular patient on a particularly sensitive problem. This may be related to self-management of chronic diseases mentioned above. Insurance sector was chosen to study the impact of digital transformation (chatbots) in the studies of Eling & Lehmann (2018). Reviews of research and industry data were used to identify four tasks to enhance customer experience. But discussions of risks were confined to chatbots. An application, Petri Net, was used by Colace et al (2017) for purchase of tires. Surprisingly, works on use of chatbots for purchase of vehicles was not seen. This may be a limitation of the search and inclusion/exclusion methods used in this review. One generally required application is the FAQ questions and answers provided in most web systems. Chatbots may be very useful here, as was found out by Vu et al (2019) using a designed chatbot for the purpose. Use of chatbots in public transport was explored by Zumstein & Hundertmark (2018). This can be very useful application for passengers of public transport. But such chatbots need to be available for any mode of transport.

A proposal for method of measuring customer satisfaction of chatbots using objective sentiment analysis as proxies was a novel approach of Feine, Morana & Gnewuch (2019). Customer satisfaction was defined by Nuruzzaman & Hussain (2018) in terms of differences, similarities and limitations among chatbots. A good taxonomy of chatbots presented by the authors may be

useful in many ways. How this taxonomy is useful in customer satisfaction was not clear. Chatbots search information available to it from various platforms to provide precise answers to the query. Logically, if the efficiency of searching for information using the current BST algorithm can be improved, the chatbot should perform better. .Atiyah, Jusoh, & Almajali (2018) proposed BPoint Tree for exactly this purpose of improving information search replacing BST algorithm and found BPoint Tree to be superior to BST algorithm. It may be possible to use the questions and answers in web forums to enrich the information available to chatbots to provide a chance for better answers. However, the work done in this respect by Boyanov et al (2017) showed that such chatbots after training to use the enriched data could answer only about 50% of queries, not good enough for implementation. At multiple levels of gated recurrent units, chatbots can interact. The usefulness of such multi-level chatbot interactions was studied and confirmed by Kamphaug et al (2017). There is no real use to the user, if the chatbots themselves chat for a long time keeping the user waiting, an aspect studied by Memon et al (2018). So, chatbots chatting among themselves may not be very attractive. In the study of Gnewuch, Morana, & Maedche (2017), delayed response by chatbots was beneficial, as customers perceived it to be similar to human interactions and the answers are well-thought out. But, delay cannot be indefinite as in the case of chats between chatbots discussed above. There should be an optimum delay, as it's beneficial and excess delay may be counter-productive. A minimum delay to produce the beneficial effect also might exist. However, the authors did not study these aspects.

Similarly, the cost-benefit aspect was merely discussed at conceptual level by Ivanov & Webster (2017). This all-important aspect should have been discussed at least using case studies of different types involving quantitative data.

Discussion on implementation issues and solutions by Radziwill & Benton (2017) provide helpful clues to those who struggle with the system not giving the desired outcomes. Although chatbots may be readily accepted by customers due to their specific benefits, there is always an element of trust determining its ultimate success or failure, contend Følstad et al (2018). Unfortunately, it was just a qualitative treatment of this important topic. Trust is always linked to motivation to use chatbots and Brandtzaeg, Petter Bae, & Følstad, Asbjørn (2017) did well in doing a quantitative survey research to study this albeit using smaller sample size due to difficulties of identifying the proper samples. These motivations and needs of users are highly dynamic. So, a cross-sectional study may not be adequate to capture the real time trends, as was deliberated by Brandtzaeg & Følstad (2018) using textual analysis of chatbot contents. Automated card-based chatbots as an example of proper designing and implementation was discussed by Heo & Lee (2018). However, it may not mean that chatbots other than this type are not properly implemented, although the authors did compare it with normal chatbots to prove its superiority. There is definite advantage of chatbots are not disclosed to the user in terms of effectiveness of sale calls. If the chatbot identity is disclosed, the purchase rate is reduced substantially. If this result of an experimental study by Luo et al (2019) really exists, there is no real use of chatbots in commercial environments. Tone of expression when answering questions may be very important. Hu et al (2018) created a novel tone-aware chatbot that generates toned responses to user requests on social media.

### **Some aspects of chatbots which need further studies or fresh research**

In the table given in the APPENDIX, the remarks column indicates scope for more research on various aspects of chatbots. The chatbots usually appear on the lower righthand corner of the PC. Some experiments were limited by the small sample sizes and very limited scope of enquiry.

Direct commercial applications of chatbots in the case of Alibaba and Amazon provide useful examples for readers to understand what it is all about since there are millions of Alibaba and Amazon users. Such studies on other popular business sites and more public transport systems in other countries may be useful.

Where there were only textual matter, more quantitative information is required. This is especially so in the case of economic aspects. Scope of newly developed models to more extensive industries and types of applications are topics of future research. Testing of service encounters need to be broad enough to represent all typical situations. Examples of good chatbots (need not be top ranked) can be used as case studies exposing all the possible dimensions for the readers to get as full a picture as possible. In sectors like public transport, public administration and healthcare, chatbots have high potential and research must be done on priority basis. Although many models proposed have been validated by their authors, more independent evaluations will provide greater validity to them. The first step, here, may be to collect and collate all such models and select promising ones which can be subjected to independent evaluations. These models have not been tested under more challenging user environments. It is a tricky question whether chatbots should chat among themselves and thus delay the response to the user.

One important aspect is challenges and problems in designing an appropriate chatbot for a context and implementing to the desired outcomes. These aspects have not been adequately dealt in the reviewed papers. Excepting very few case studies and even fewer experiments, there had not been any real research on chatbots yet. This is a serious deficiency to be rectified at once. Some specific problems need further probe. For example, only 50% answers were possible in the information-enriched improved chatbot. Reduction in purchase rates when the chatbot identity is revealed is another aspect.

### **Conclusions**

This review revealed many exciting developments on chatbot research and their practical applications. However, there are still many gaps to address and imperfect knowledge. Future research need to address these issues and lead to better and more extensive use of chatbots in all aspects of human and business activities.

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## APPENDIX

Table 1. Highlights of reviewed papers

No & Reference	Aim	Method	Results	Remarks
1.Cui et al (2017)	Propose SuperAgent, a powerful customer service chatbot to leverages large-scale and publicly available ecommerce data.	System description and demonstration using a product page of Amazon.	PC image of Amazon and System overview and an example case are given.	Can be used as an add-on extension to mainstream web browsers such as Microsoft Edge and Google Chrome, where the conversation UI is shown at the bottom right corner.
2.Radziwill & Benton (2017).	Review of chatbot quality issues and attributes related to chatbot development and implementation.	Review of literature	A sample dialogue of ELIZA, relationship between classes of software-based dialogue systems, list of quality attributes with references as per ISO 9241, tabulation of reviewed papers, example data of hierarchical quality assessment and model, priority matrices, AHP results of an example problem are given.	Being a recent review, current status regarding the researched aspects are available.
3. Deshpande et al (2017).	Description of evolution of chatbots	A survey of literature and secondary data	A list of chatbots with details are given as a table, generic flow of	Good to know how it all began and developed into what we see

No & Reference	Aim	Method	Results	Remarks
			chatbot working mechanism,	today.
4.Følstad et al (2018)	Qualitative evaluation of how and why users trust chatbots.	Interview study	Analysis of responses, tabulated with categorised frequencies for factors perceived as affecting trust by users	Benefits and challenges, opportunity of misuse etc are discussed. Limited generalisability due to small sample size is a limitation.
5. Qiu et al (2017)	Propose AlimeChat, an Alibaba application	Information Retrieval (IR) and Sequence to Sequence (Seq2Seq) based rerank model, experimental evaluation	Diagram of the hybrid approach, mainly for Chinese, experimental evaluation results, chat dialogue example	May be specific for Alibaba only. Scalable context and personification are to be worked on.
6. Brandtzaeg, Petter Bae, & Følstad, Asbjørn (2017)	People's motivation to use chatbots in USA	Questionnaire survey with 146 samples 16-55 years old	Productivity; timely and efficient help; social, entertainment and relational motivations, curiosity about what the new thing offers; user and gratification theories applied to explain the results.	Small sample size and inclusion of people of 16 years may reduce validity and generalisability.
7. Ivanov & Webster (2017)	Cost-benefit analysis of chatbot use in tourism and hospitality firms.	Textual descriptions of likely lists of costs and benefits and discussions.	Costs and benefits depend on business context and how it is applied.	Only textual comparison and no data presented.
8. Zsarnoczky (2017)	How chatbots affect tourism	Textual descriptions	Chatbot use patterns, types of	The scope of the study can be

No & Reference	Aim	Method	Results	Remarks
	industry	followed by a Hungarian resorts case study validation	questions show that the users seek practical information on the services of the host. Number of website visits are not related with chatbot uses. More use of chatbots occurred in the mornings	expanded.
9.Brandtzaeg & Følstad (2018)	Analysis of failure of some chatbots and how changing motivations and user needs affect success	Textual analytical discussions with examples	Reasons for failure of some chatbots were analysed. The effect of changing user needs and motivations in designing chatbots were discussed.	Some quantitative data would have been helpful.
10.Feine, Morana & Gnewuch (2019)	To propose a method of measuring customer service encounter satisfaction with chatbots	3-step process- Comparison of sentiment analysis methods, Correlation analysis between sentiment scores and CSES values and Exploratory analysis of sentiment scores and CSES values using dialogue corpora and different automated sentiment methods.	Objective sentiment analysis was better and can be used for deriving customer satisfaction on service encounters with chatbots.	Differences between different automated methods may produce different results. The narrow range of service encounters tested may limit generalisability.
11. Ahmad et al	Review of	Various chatbots	Many different	Only a limited

No & Reference	Aim	Method	Results	Remarks
(2018)	techniques used in designing chatbots	with figures of design, diagrams and appearance are discussed.	types and applications of chatbots exist. They use different types of designs and mechanisms of chats on different types of topics related to their location.	variety have been discussed. There are more varieties which can be discussed in a similar work later.
12. Jacobs, Powers, Seguin & Lynch (2017).	Discussions on 10 top chatbots	A Forrester report. Ten enterprise-grade chatbots selected and evaluated for various characteristics.	Differentiation, equal status, need for improvement and recommended were four grades of comparisons. Each of the 10 chatbots product overviews given. The products have been ranked.	There are many more than 10. But only the top 10 were discussed. Do the top ten change every year? This is not known, but in all probability, they do.
13. Fadhil, A. (2018).	Explore the possibilities of a chatbot to act as a virtual coach for advice on dietetics.	Theoretical discussions. Current challenges of technical, theoretical, behavioural, and social aspects discussed.	A pipeline approach for designing a chatbot for advice on dietetics proposed.	A model chatbot for advice on diet could have been designed and tested.
14. Heo & Lee (2018).	How proper designing and implementation can improve business interests	A case study of Naver TalkTalk explained	It began as a card-based non-automated chatbot and then automated to increase usefulness as a quick and easy to handle chatbot	High level of customer satisfaction may indicate the scope to increase the use of card-based chatbots
15. Nuruzzaman	Identify	A survey of	The sequential	All the chatbot

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& Hussain (2018)	similarities, differences and limitations of currently used chatbots in achieving good customer satisfaction.	currently used chatbots, taxonomy of chatbots, 11 chatbots discussed, technical details and limitations tabulated.	attention mechanism in deep recurrent neural networks, an architecture for the development of chatbot system with self-learning capabilities was derived.	examples described here are not the same as those in the Forrester report cited above. So, many of them here, are not the top ones.
16. Atiyah, Jusoh, & Almajali (2018)	Propose a new method, BPoint Tree, to increase the efficiency of searching for accurate answers by adding an additional data structure to the traditional BST algorithm.	The designed BPoint Tree was compared with traditional BST.	B-Point Tree outperforms the traditional BST. Thus, BPoint Tree can enhance the efficiency of chatbots. The structure, algorithm and examples are given. Also experimentally verified.	Appears promising. But more independent evaluations by others must take place.
17. Chandel et al (2018)	Analyse the technology of chatbots and investigate its development, which is becoming a popular trend now.	Five example chatbots analysed. Design principles, tabulated requirements of chatbots, pre-usability test procedures, flow chart, word processing algorithm and mathematical analysis given.	The popularity of chatbots is due to their increased utility and efficiency of customer service which is facilitated by design features, specifications and technology matching user needs.	No challenges or problems were discussed. Chatbots is not a completely rosy concept.
18. Di Gaetano & Diliberto (2018).	Explore new chatbot-based conversational interfaces that allow users to	Three chatbot applications in public administration, health and	In health, it helps to discuss sensitive issues without affecting user's sensitivity	May be these concepts can be extended to business chatbots also.

No & Reference	Aim	Method	Results	Remarks
	exploit the most used interaction strategies by human beings	wellbeing and in home automation have been discussed.	much with correct tone and agent personalisation. In home automation, it reduces users' effort and to increase their engagement in using assistive living tools. In public administration, it becomes the main tool to clarify doubts. It could facilitate digitalization and simplify public administration procedures. In services, increasing requests for information by citizens has a trade-off: on the one hand administrations need to speed up the process of providing information. On the other hand, citizens need to be provided with easy procedures to retrieve information. Chatbots provides solution.	
19.Boyanov et al	Proposal to train	Data on Q&A	63.5% increase	The 50% is not

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(2017).	chatbots using questions and answers in forums.	are extracted from forums. Shortened texts are used in seq2seq model to train chatbots. Further optimisation using a new modelling strategy. The automated tasks were evaluated.	for the proposed approach from the current approaches. About 50% of the questions can be answered when the proposed model is used.	good enough for a good chatbot. It needs to be improved tremendously. Many answering errors in Table 4.
20.Eling & Lehmann (2018).	Analyse the impact of digital transformation on the insurance sector	Review of papers and industry studies. Porter's value chain used.	Four major tasks enhancing the customer experience, improving business processes, offering new products and preparing for competition with other industries. Three key areas of change in insurability: the effect of new and more information on information asymmetry and risk pooling, the implications of new technologies on loss frequency and severity and the increasing dependencies of systems through connectivity.	Specific to insurance. Risks not related to chatbots not covered.
21.Luo et al (2019).	Comparison of chatbots with human	Experimental study. 6200 customers who	Undisclosed chatbots have similar	The reduction is intriguing and if not tackled,

No & Reference	Aim	Method	Results	Remarks
	interactions.	are randomized to receive highly structured outbound sales calls from chatbots or human workers. Tables and figures given.	effectiveness as proficient workers and four times more effective than inexperienced workers in engendering customer purchases. A disclosure of chatbot identity before the machine-customer conversation reduces purchase rates substantially, as the customers perceive that the chatbot is less knowledgeable or emphatic.	chatbots may not be useful.
22.Colace et al (2017).	Designing a prototype of a conversational workflow for a Chatbot in tires domain to manage communication and propose the most suitable tires for users.	Petri Net was used. A real case has been investigated developing a Chatbot, BotWheels, for a tires' seller. Experimental campaigning was done to demonstrate its utility and efficiency. Supportive data and diagrams given.	The results showed promise for using this chatbot after the prototype is developed further into fully usable form.	This is an example of a very specific application of chatbot. More similar studies on other specific applications are required.
23. Kamphaug et al (2017).	Propose a novel deep learning architecture for	The architecture is designed to capture complex	The new model provided higher accuracy	Such a learning method can provide large

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	content recognition that consists of multiple levels of gated recurrent units (GRUs).	sentence structure at different levels of abstraction. The model becomes an open domain chatbot with GRU architecture for data driven conversations. The model was tested and validated using the large amount of open data in youth information service.	compared to content recognition techniques like SVM, Naive Bayes, random forest and K-nearest neighbour. All of them failed on this challenge of open domain dataset.	amount of database for the chatbot to give more precise answers. The model may be tested in more challenging user environments.
24. Gnewuch, Morana, & Maedche (2017).	Compare user perceptions of dynamically delayed chatbot responses with near-instant chatbot responses.	Online experiment. Dynamic delay estimated from complexity of the response and complexity of the previous message.	Dynamic response delays increase users' perception of humanness and social presence and lead to greater satisfaction with the overall chatbot interaction. Social response theory was used to explain this result. A chatbot's response time represents a social cue that triggers social responses shaped by social expectations.	Interesting to note that delay is beneficial. But is there a minimum, optimum or excess delay?
25. Anagnoste,	Chatbots as one	A general	Different RPA	Not focused only

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S. (2018).	of the applications of robotic automation process in various business areas.	review. Case study on chatbot and other RPAs.	applications, their development and progress, several service areas and process that can be made automatic, questions on their scope, potential assessment in different business areas show high scope in the immediate future itself.	on chatbots.
26. Memon et al (2018).	Building chatbots to sustain agents in collaborative learning by interacting with one or more chat agents or multi-agent communication system.	Design and implementation of interaction between two or more chatbots interactions.	The model developed consisted of KR (Knowledge Reorganization) system, NLP (Natural Language Processing), KB (Knowledge Base) to handle its intelligent capabilities and client server socket system for integration implemented through Java.	Is it collaborative learning or multi-agent system, not well defined.
27. Vu et al (2019).	Propose a chatbot system that uses machine learning to answer Frequently Asked Questions (FAQs) from our school website.	The designed system included different types of user query and a vector similarity analysis component to handle long and complex user	The target system was build a system that is both scalable and modular, so it is easy to add or remove other modules when necessary. To	Very essential and useful in almost all websites.

No & Reference	Aim	Method	Results	Remarks
		queries. In addition, the Google's Dialog Flow framework 1 is used for intention detection. The system was evaluated experimentally.	further improve the system, the following additional modules need to be implemented: a) Collecting and analysing the user evaluation, b) Using output of Question Generation to improve the accuracy, c) Text summarization to provide the flexible and short response in conversation style and d) support SPARQL database search.	
28. Hu et al (2018).	Create a novel tone-aware chatbot that generates toned responses to user requests on social media.	First step, a formative research to understand the effects of tones in conversation. Next, a deep learning based chatbot is designed, that considers the tone information. Then trained the system using 1.5 million customer care conversations in Twitter. The designed chatbot was tested for its utility compared to human agents.	The designed tone-aware chatbot generated appropriate responses to user requests just like human agents. The chatbot was perceived to be even more empathetic than human agents.	This is a good effort. Similar efforts to design chatbots for self-care of chronic diseases can be useful.

No & Reference	Aim	Method	Results	Remarks
29. Delamater (2018).	History of artificial intelligence development and how it revolutionises customer services.	The discussion topics are: a brief history, use of technology in customer services, chatbots and compatible chatbot platforms	Artificial has entered into our lives as an absolutely critical element without which daily life has become almost impossible. Use of chatbots for customer service by leading businesses is a trending example.	It is only a general discussion. There is no specific focus on any aspect of chatbots.
30. Zumstein & Hundertmark (2018).	Examine the scope for chatbots in public transport sector.	General review type discussions on types of chatbots and designs, components, languages, applications, benefits and challenges by SWOT type analysis, some researches on chatbots in public transportation, ticket purchases and chatbot experiences, digital services and real time information for passengers, future scope of chatbot for passengers, survey of	With chatbots, passengers find out timetables, buy tickets and have a personal, digital travel advisor providing real-time and context-relevant information about trips. Chatbots collect and provide different data about users and their journey in public transportation systems. They include travel, product, service and content preferences, usage patterns, demographic and location-based data. Customers like to use	The scope of using chatbots in any mode of transportation is high. A lot of further work is required here.

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		customers	chatbots for transformation through mobile applications, but they are not available now.	