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Increasing customer service efficiency through artificial intelligence chatbot

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Abstract

Purpose – This study investigated the contribution of artificial intelligence (AI) to the efficiency of customer service. This study contributes to services technological innovation in process management, a field not yet settled in the literature.

Design/methodology/approach – AI is a multidisciplinary field of research that has stood out for the technological dynamism provided to organizational products and processes. The study was carried out at an Analytical Intelligence Unit (AIU) of a Brazilian commercial bank that applies AI integrated with IBM's Watson system. The study used data content analysis, structured and supported by Atlas.ti software.

Findings – The notorious AI cognitive maturity evolution allowed 181 million interactions and 7.6 million attendances in 2020, improving services efficiency, with gains in agility, availability, accessibility, resoluteness, predictability and transshipment capacity. The chatbot service reduced the queues of call centers and relationship centers, allowing the human attendant to perform more complex attendances.

Research limitations/implications – The main limitations of this study relate to the research cutout and its borders, such as the choice of participants and their areas of activity, and the choice of the unit of analysis.

Practical implications – The results indicated that attendance through the virtual assistant increased by more than a 1,000% from 2019 to 2020, demonstrating the bank was technologically ready to face the Covid-19 pandemic effects.

Originality/value – In line with the evolutionary theory of innovation, the authors concluded that technological scaling in AI allows exponential gains in customer service efficiency and business process management. They also conclude that the strategy for creating AIUs is successful, once it allows centralizing, structuring and coordinating AI projects in R&D cooperation, cognitive computing and analytics.

Keywords Artificial intelligence, Chatbot, Digital transformation, IBM Watson, Service efficiency, Technological innovation, Virtual assistant

Paper type Research paper

1. Introduction

Digital transformation and the revolution in process efficiency started in the 2010s, with the consolidation of the Fourth Industrial Revolution, whose main objective is the improvement and competitiveness of the so-called Industry 4.0 (Kagermann, Wahlster, & Helbig, 2013). Industry 4.0 is a new era, a change, centralized in the use of information and communication technology (ICT) resources, to improve service, production and business processes (Azevedo, 2017).

The so-called digital transformation affects all sectors and companies. The expansion of digital media makes the attributes that define the software economy – concentrated on technological innovations for managing customer service processes, production and commercialization of high technology products and services – spread to the economy in

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general. This conversion challenges even traditional activities that use the Internet of Things (IoT) of workforce and little automation. The concepts of the Industry 4.0and digital transformation are based on cutting-edge technologies, linked to automation processes, such as the loT, big data and analytics and machine learning (Mendonça, Andrade, & Sousa, 2018; Azevedo, 2017; Brito, 2017; Schwab, 2016; Zackiewicz, 2015).

In particular, technological innovation in AI has fostered business transactions and services, driving companies to develop new business models. The successful applications of AI technology have multiplied, arousing great interest from users and scholars, affecting them positively, speeding up and generating benefits for management, by improving efficiency in business processes (Koehler, 2018) and customer satisfaction (Brill, Munoz, & Miller, 2019). Regarding the efficiency in business processes, Santos, Santana and Alves (2011) emphasize companies' concern with the frantic chase of their strategic targets, seeking to improve customer service. The authors highlight the need to enhance methods for business process management, in order to align the perspectives between strategic, operational and functional areas. Therefore, AI can support companies that require technological renewal and high degrees of competitiveness and operational efficiency.

Koehler (2018) observed that modern business process management, centered on ICT use and AI innovation, has sought to change customer service and commercial transactions by adding value to customers, with higher efficiency and flexibility, and providing specific answers to the needs of corporate users, for achieving their goals. Paschek, Luminosu and Draghici (2017) highlight the opportunity for AI innovation to improve, automate and support the management of business processes, such as customer service.

AI science is one of technological strands with the highest potential among ICTs. It is an area of interdisciplinary and cutting-edge research, which studies the computational replication of mind abilities, at an increasingly significant level, arousing economic and strategic interest due to its numerous practices and applications (Tigre, 2019). For Schwab (2016), AI and robotics will reach a prominent place and change activities, services and processes of companies that invest heavily in this technological innovation. The author estimates that, by 2025, 30% of the validations and monitoring of managers and auditors will be done through ICTs and process automation. In addition, AI, cognitive computing, big data and analytics are at the forefront of technologies with higher investments (Febraban, 2019), which suggests the need to investigate the evolution of this phenomenon.

According to the above, AI has become one of the main mechanisms of technological innovation for the change and improvement of organizational products and processes. However, the influence of AI on the efficiency of customer service routines is still little investigated (Koehler, 2018; Paschek, Luminosu, & Draghici, 2017). Given this theoretical gap, we identified the opportunity to answer the following research question: *How does AI chatbot contribute to customer service efficiency in a commercial bank?*

This study strengthens the importance of AI as a remarkable cutting-edge technology for leveraging customer service efficiency. The AI chatbot application contributes to service efficiency by being assertive, effective and fast, working with agility, availability and accessibility, without interruption. The adoption of AI chatbot brings facility, simplicity and significant gains due to automation, standardization and optimization of processes and services, like customer service, by reducing expenses and improving operational efficiency. The following sections present the literature review, methodology, results and conclusions.

2. Literature review

2.1 Technological evolution and artificial intelligence

Nelson and Winter (2005) related biology to economics for supporting the evolutionary theory of innovation. They "examined the main ideas of biology that could be used to investigate

economic challenges" (p. 28), and observed that companies need to operate based on a group of norms called routines, instead of incremental practices. In the evolutionary theory, routines describe the fundamental elements of companies, similar to genes in biology (Nelson & Winter, 2005; Lopes, 2016; Tigre, 2019). A competitive differential for an organization's evolution is knowledge acquisition and transfer, and the increase of capabilities, based on the path chosen, and the creation and development of its own assets and unique skills, through a significant and continuous change of routines and processes. Abilities change due to technological perspectives and the integration of new components, programs and information systems.

For Henderson and Clark (1990), success in managing innovation relates to the organization's skills in fostering and integrating its knowledge and routines in all departments, in addition to connecting its main characteristics, described as the innovation's architecture. Likewise, professionals' competencies are necessary for linking knowledge with technological innovation and its management (Klement & Yu, 2008; Tidd, Bessant, & Pavitt, 2008).

Chesbrough (2003) states that the creation and management of innovation must be part of the organizations' essence, especially for companies where technology plays a fundamental role in activities, services, products and business processes, such as customer service. Structures, teams and professionals linked to research and development (R&D), with appropriate expertise, foster technological innovation and the development of new products, solutions and services. The more integrated and comprehensive the functions of the R&D area within the company, the better the results from its activities and practices (Santos, Fazion, & Meroe, 2011). Companies should increase their efforts in developing technological capabilities in order to improve performance (Salisu & Bakar, 2020), such as the use of AI to enhance routines' efficiency and increase competitive capacity, ensuring their influence in the market (Nascimento & Entriel, 2014).

AI provides opportunities for secondary innovations, such as Manufacturing 4.0 or Industrial Internet, and the so-called Internet of Services, which originate from the combination of various technological systems like the *cyber-physical system (*CPS). This innovation, aligned with the development of organizational skills and knowledge, can improve systems management with more intelligent, efficient and highly customized production processes, allowing different models of sales, production, logistics and service, based on technological applications (Tigre, 2019). AI is an emerging field of study, especially suitable for providing innovations for managing and restructuring business processes, such as customer service. AI has supported users with intelligent systems, eliminating, replacing or empowering people by employing fully automated tools (Koehler, 2018). Over the past few decades, science has sought to imitate the brilliant habits and attitudes of human beings with machines, which has become simpler each day, given ICTs' dissemination and evolution. AI is the science that studies such human habits and attitudes, and is a term coined by John McCarthy in 1956 (Igarashi, Rautenberg, Medeiros, Pacheco, Santos, & Fialho, 2008).

AI is a field of the cognitive sciences responsible for representing skills in man's reasoning, from the connection between "things," human-machine interaction, robotics, voice analysis and consumer behavior (Tigre, 2019). Among ICTs, AI is one of the areas that showed great impulse, fostering innovations in customer service, with a good number of software programs that show a high degree of efficiency in business process management. It is a subject that raised strategic interest on the part of organizations, due to its wide application (Koehler, 2018; Tigre, 2019), and new AI technologies emerged with great strength. Some of them (Mendonça, Andrade, & Sousa, 2018; Dresner & Stone, 2008; Pan, 2016) are:

(1) The conversion of *big data* into knowledge;

(2) *Internet crowd intelligence* (used for task targeting, highly complex service flows and adversity solution);

(3) *Cross-media intelligence* (an essential attribute of the intellect, linked to the unrestricted use of information captured by different forms of discernment, like vision, vocabulary and sense of hearing, which allow the identification, induction, design, invention and anticipation);

(4) *Human-machine hybrid-augmented intelligence* (complex intelligence based on the collaboration and assistance between computer and human beings, expanding intelligence); and

(5) *Autonomous-intelligent systems* (regarding the improvement of robots and autonomous vehicles).

AI is the computer system capable of doing the required functions in devices, equipment or data processing centers. It enables support to business process management that seeks automation and higher efficiency of processes, services and customer service through new applications, operations and solutions, based on free learning and continuous information search (Paschek, Luminosu, & Draghici, 2017). Ciechanowski, Przegalinska, Magnuski and Gloor (2019) observe that the chatbot communicates with the user through natural language, through an application, a software or a computer interface, which relies on technical AI applications.

The chatbot is a conversation platform, a computer application for exchanging messages through the network or channels, with an online structure where people connect and can talk freely, either by voice, by text or both (Gartner, 2020). For Reddy (2017), chatbots will contribute to reduce expenses and customer service costs by about 30%. The use of AI, through the chatbot, provides support to business process management by means of automation and higher efficiency of processes, services and customer service, enabling new applications, transactions, operations and solutions based on free learning and continuous information research (Maedche, Legner, Benlian, Berger, Gimpel, Hess, & Söllner, 2019; Paschek, Luminosu, & Draghici, 2017).

2.2 Process efficiency

Business process management (BPM) is the third wave of management. Smith and Fingar (2007) characterize BPM as a standard that allows organizations and employees to create, improve and enhance business processes simultaneously and constantly. Through fast and efficient processes, the set of activities developed by the organization is controlled and improved in a permanent cycle of optimization and efficiency. It connects systems and technologies, workflow management, customer service and process review (Smith & Fingar, 2007; Tessari, 2008). According to Capote (2012), BPM is a change of the culture and the intellect. For the Association of Business Process Management Professionals (ABPMP, 2013), BPM adds principles, standards, concepts, influences, hegemony and culture, which lead to the success or failure of corporate projects.

BPM models guide companies' plans through the formalization of actions, procedures, norms, tactics and strategies for growth, and optimization of the organization's performance and activities, such as process efficiency in customer service. At the same time, process management is dynamic, that is, a group of active data and information, capable of change, learning and improvement, adaptable to any type of company, but still they are individual data and can be customized (Pradella, 2013; Pereira & Regattieri, 2018). A process is the organization of activities divided into actions, such as the division of procedures, operational

functions, customer service and other practices (Baldam, Valle, & Rozenfeld, 2014). Among the challenges of digital transformation, companies increasingly face significant changes in market and business structures. Consumers' new demands and expectations of faster service, product delivery and a better quality of goods and services lead organizations to new levels of efficiency in their business processes (Paschek, Luminosu, & Draghici, 2017).

BPM comprises business operations at levels beyond the functions and standards of operational organization, as well as hierarchical structures of command, designation and subordination. It still includes activities such as workflow, customer service and operations and processes until the final product/service (ABPMP, 2013; Pereira & Regattieri, 2018).

Service efficiency is the highest performance in meeting human needs or the productivity of equipment, methods, actions or processes to achieve maximum gain with minimum inaccuracy, resource waste, strength or procedures. An organization can be economically efficient if it increases profit, decreases expenses and maximizes customer service and satisfaction at the same time (Mariano, 2007; Houaiss, 2001; Tauile & Debaco, 2002). All productivity and efficiency actions that seek an organization's financial and market evolution are part of business innovation activities.

The new edition of the Oslo Manual (OECD, 2018) classifies innovation in two main categories: product and business processes. In particular, business process innovation is a new or improved process for one or more business functions, which differs significantly from the company's previous ones. A business process innovation can take place at different stages and relates to six distinct business functions of a firm where all activities, isolated or combined, aim for innovation. Business processes are linked to customer service and to services that the organization develops or uses, which can be done within the company or by external providers.

For the European Association of Business Process Management (EABPM), BPM is a method or system that acquires, adapts, standardizes, executes, stores, measures, controls, guides and conducts processes of any nature, manually or automatically – for example, from AI – to achieve the organization's goals in a structured and sustainable way. BPM's role is to organize business processes, gradually, by controlling, recognizing, executing and classifying. Thus, the BPM system identifies potential occurrences and deviations in business processes, enabling a proper management and problem correction. In addition, the purpose of BPM is to maximize performance and improve customer service, production, and results, with higher organizational efficiency (Paschek, Luminosu, & Draghici, 2017).

The digitalization movement has changed market conditions and structure in several business segments. All activities, processes, products, business models and even customer service have become digital; therefore, the revolution regards processes. This opens space for a process management with a higher level of efficiency, from the digitalization and application of automated processes supported by AI, based on this standardized, oriented and intelligent tool that is essential for organizations to succeed and increase their information and resources. AI, as the chatbot application, also seeks to create fast and innovative solutions for customer service, by reducing process failures and problems and decreasing and limiting the decision cycle and work accumulation. Thus, it increases the availability of resources and technological channels, optimizing solutions in order to achieve expressive and convincing sustainable operational and economic results (Paschek, Luminosu, & Draghici, 2017).

3. Methodology

The nature of this study is mostly descriptive, with some exploratory aspects. We used the single case study as the research method, which "is an empirical investigation of a contemporary phenomenon within its real life context, especially when the boundaries between the phenomenon and the context are not clearly defined" (Yin, 2005, p. 32).

In addition, "the choice of a single case study is justifiable if the case consists of a rare or exclusive event, or if it serves a revealing purpose" (p. 67). The chosen case fits this definition, and we investigated the relationship between AI and the efficiency of customer service at a commercial bank.

The unit of analysis was the Analytical Intelligence Unit (AIU) of the bank. The main criteria for defining it as a unique case were:

(1) Notorious technological learning, acquired from 17 million interactions in 2019, 181 million in 2020 and around 400 million in 2021;

(2) Increase in chatbot AI customers' use: one million in 2019, seven million in 2020 and 15.9 million in 2021, with a resolution rate of 92.10%;

(3) Integration with IBM's Watson system;

(4) Prevalence among the Brazilian technologies of virtual assistants with machine intelligence (chatbot AI);

(5) Popularity of virtual assistants, which has aroused great interest from companies and generated higher efficiency and quality in customer service;

(6) A growing formal functional structure, with the centralization of employees who work with analytics and/or AI; and

(7) The fact that this commercial bank, among the largest financial institutions in Brazil and Latin America, makes considerable investments in technological innovation in banking systems.

We collected data through semi-structured interviews, based on a script of two blocks of questions extracted and adapted from the literature: AI chatbot (Carvalho, 2019; Pauli, 2019; Garcia, 2015) and AI chatbot efficiency (Bernardo, 2018; Pauli, 2019; Garcia, 2015). In the "AI chatbot" block, we investigated the following analytical subcategories: types of technology, technology adoption, technological development, technological objectives, customer interaction, systems integration and use of leverage strategy. In the "AI chatbot efficiency" block, these were the subcategories investigated: efficiency gains, assertiveness of interactions, result analysis, quality indicators, AI versus human service, incremental innovation, learning and system evolution. The questions were submitted to four levels of validation: (1) analysis by members of a research group on innovation and entrepreneurship, (2) analysis by researchers from external groups, (3) analysis by three financial market specialists and (4) application of pretests.

After validating the research script through pretests (Malhotra, 2001), we carried out 18 interviews with employees that hold positions in several units, totaling 433 minutes of conversations. After the tenth interview, most of the new answers began to repeat, showing saturation of the collected data. Even so, we conducted eight more interviews in order to capture new perceptions from interviewees and confirm data saturation. We collected data in two rounds: in March and April of 2020, and in March and December of 2021, during the Covid-19 pandemic.

We analyzed data by using the content analysis technique. Bardin (2011) highlights the relevance of rigidity in this type of practice, and the importance of exposing indecisions and doubts, by pointing and clarifying the questions. We carried out this analysis technique in three stages: (1) previous analysis, (2) content investigation and (3) organization of results, deductions, perspectives and understandings.

We used Atlas.ti software to support data coding and interpretation. It is a program with resources for analysis, especially qualitative studies, where a significant amount of

information is captured from texts, audios and other means of data mining. Structuring, sorting and systematizing these contents contributed to research quality. We present the results through the creation and interpretation of networks. For the description of the main codes found for the formation of networks, we considered the criteria of magnitude, related to the number of citations linked to the described code, and density, related to the number of codes and subcodes linked to the main code.

4. Results

4.1 Technological Innovation Network

Figure 1 shows the company's *technological innovation* network and the interrelated analytical categories derived from the interviews. We present the results, based on network formation, under the lens of the evolutionary theory of innovation. The second part, regarding the analysis, was carried out from the description of the research goal. The theoretical lens considers two levels of analysis: the company transformations that require change and new practices, through incremental and disruptive technological innovations, especially AI application; and the organization's survival due to technological adaptation. The theoretical lens considers that the world changes, renews itself and the company shifts, shaped by technological change; therefore, it survives.

In line with the contributions of Tigre (2019), Schwab (2016) and Nelson and Winter (2005), Figure 1 shows that the commercial bank adopts *technological innovations* to remain competitive, concentrating resources for the development of new commercial practices, from the potential of the Industry 4.0. The company has invested in new *strategies related to AI*, since the creation of the AIU, in 2019, seeking to develop *new solutions*, *AI applications* such as the *chatbot*, as well as its *integration with existing systems*. Based on *the robot school*, *the curatorship* has sought to improve processes and *interactions at the various service channels*, besides providing new services and information in order to consume part of the data that are not available for the bank's use yet. In short, with technological innovation, creativity and higher efficiency, the bank is increasing its results and, consequently, achieving greater exposure in the market.

Therefore, we can resume the research objective as *"to analyze how AI chatbot contributes to customer service efficiency in a commercial bank."* Initially, we describe the creation of the

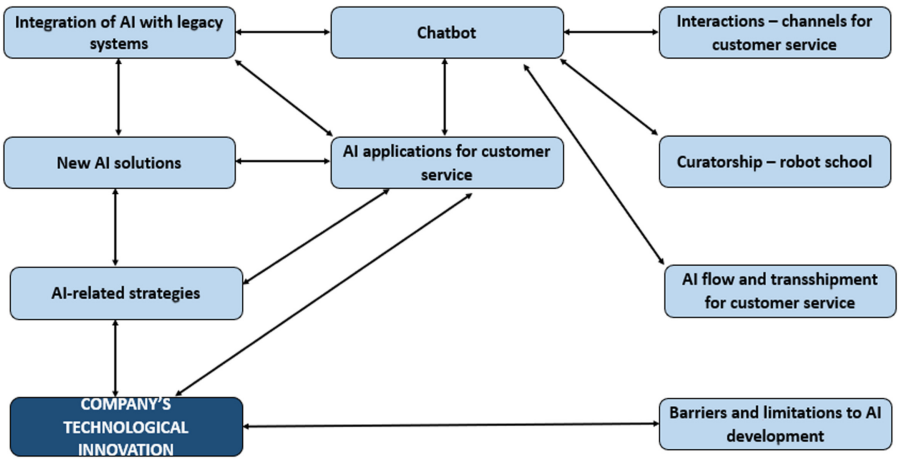

Figure 1.
Company's technological innovation network

AIU and the AI technology, the chatbot virtual assistant developed by the bank. Next, we show how AI contributes to an efficient customer service.

An effective organizational innovation at the bank was the creation of an AIU, for centralizing, structuring and coordinating projects and activities related to AI, cognitive computing and analytics. AIU is also responsible for employees' empowerment, articulation with units and teams, including the curatorship (robot school), and for the accreditation and hiring of suppliers of AI services. The main purpose of creating AIU was to provide greater assertiveness, flexibility and agility in negotiations with direct and indirect suppliers of technology products and services, according to the bank's regulatory requirements for bidding processes.

Among the categories present in the technological innovation network, AI technology stands out – the chatbot virtual assistant. The bank developed customer service through a chatbot due to the increasing number of interactions on social media. The AI chatbot, the common name used in commercial banking, was conceived initially as a solution for frequently asked questions (FAQ). Then, they added advanced features to the AI system, through integration with IBM's Watson system, which enabled speech recognition to identify which was the best answer to a customer's question. The bank's specific computational system is the main integration with Watson's programming interface. The system stores answers for interaction and customer feedback, by mirroring Watson's information, because of bank secrecy and customers' need for privacy.

For most respondents, the AI chatbot handles the simplest and frequently asked questions. Its purpose is to serve as many customers as possible, clarifying, for example, doubts regarding credit cards. According to interviewees, virtual assistants start with a smaller service scope and achieve complexity gradually, as issues are solved, by expanding databases, feeding back information and allowing later use by the client. Progressively, new functions are added for interaction with the customer. The AI chatbot is a first service layer, with easy access, an attendant that has the ability to interact through various channels and platforms, quickly and without interruption. AI applications, especially the virtual assistant, are an essential path for the bank's competitive performance in the Brazilian financial sector.

Based on the above, Figure 2 shows how AI chatbot contributes to customer service efficiency, through the main relationships among the analytical categories.

The main AI chatbot's contribution is to maximize the efficiency of technological resources, both hardware and software, which has expanded the processing capacity of the data collected from the interaction with customers. AI is evolving in cognitive computing capacity and stimulating new technological solutions, leading to agility and a high level of efficiency in business process management, such as robotic process automation (RPS), optical character recognition (OCR) and the AI chatbot to serve the client. Respondents highlight that AI application through the chatbot contributes to the efficiency in service because it is more assertive, effective, fast and functional, when compared to traditional customer service. It operates with *agility, availability and accessibility*, continuously, 24 hours a day, seven days a week. The virtual assistant can change some human calls that lasted over 20 minutes into fast and efficient interactions in fractions of seconds, which is the estimated latency time. The AI chatbot handles the most requested issues and answers simple questions, like a well-built FAQ, and its purpose is to serve the largest possible number of users, by answering with high assertiveness.

> We can change a service that would take, I suppose, 20 minutes at an agency, into seconds. Hence, the efficiency is very high; it is not possible to compare a well-done service with the chatbot, to a slower service [. . .]. (Interviewee 13).

In the case of transactions, such as payments, transfers between accounts, balances and statements, a quick authentication process checks the link between smartphone and

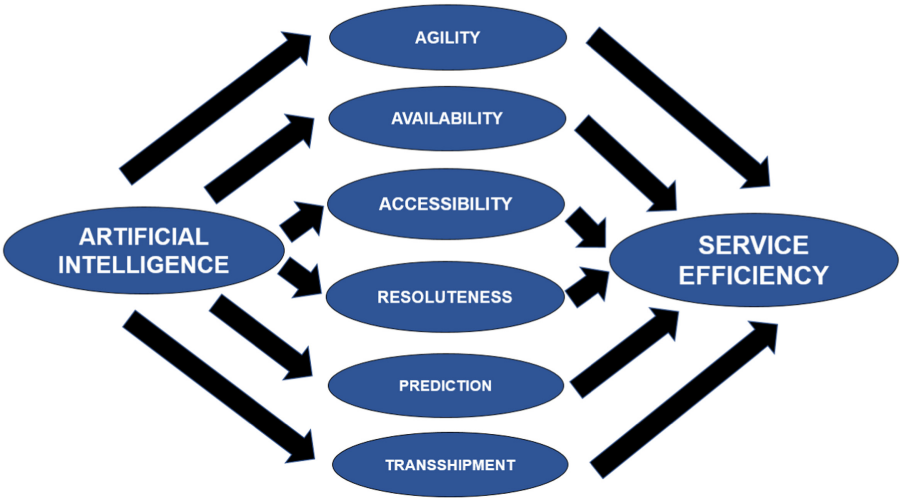

Figure 2.
AI and service efficiency

customer. Clients have shown increasing levels of demand, and they want to choose the channel – Internet, social networks, WhatsApp, APPs or bank-specific applications. Given the increase in the number of calls to the virtual assistant, especially by WhatsApp, the channel is responsible for 96.53% of AI chatbot interactions (2021). Interviewees said that the bank would no longer be able to meet all these demands without the support of a virtual assistant.

Data show that, in 2021, there were 400 million interactions, an increase of about 2,350% when compared to 2019 (17 million interactions). More than 15.9 million customers used the virtual assistant in 2021, an increase around 1,590%, compared to 2019 (one million customers). In addition, the problem-solving index grew about 19%, from 77% in 2019 to 92% in 2021. This considerable growth shows that the bank was technologically ready to face the challenges imposed by the social isolation against the Covid-19 pandemic.

Data analysis also highlights the existence of dashboards with indicators of the level of quality of the AI chatbot functions, such as customer satisfaction, positive and negative feedback, resoluteness and operational efficiency, which is an expected monitoring (Brill *et al.*, 2019). One specificity of the feedback indicator is to assess, each day, if the virtual assistant's answer helped the user. Secondary data indicated that the average level of AI chatbot's satisfaction in 2021 was 3.9 (on a scale from 1 to 5), with more than 70% of the ratings with the highest grades (4 or 5) in chatbot interactions through WhatsApp. Interviewees mainly highlighted the importance of *resoluteness* in customer service, for customer satisfaction and for strengthening the bank's competitiveness. Resoluteness is the term used to measure the percentage of customer service that the AI chatbot application effectively answered, excluding the transshipment to an employee for handling the problem.

> [. . .] Resoluteness, let's call it that, is the term we use internally, which is the percentage of customer service actually served by AI effectively, without overflowing to human service, but the objectives are these: efficiency and experience. (Interviewee 2)

Secondary data also indicated that the AI chatbot recognizes the interactions and transfers 7.9% of the calls to human attendants assertively. Thus, the chatbot automatically responds

to user queries (92.1%) or transfers the call (7.9%) to a human assistant at an agency, central office or team expert, making a correct choice and improving user experience.

The AI chatbot and analytics allow the company *to predict* the customer's intention and will; that is, they progressively understand users' demands, improving the experience and customer service. The AI chatbot service has reduced waiting lines at call centers, allowing human attendants to solve complex issues, contributing to a more efficient service. The AI chatbot is accessible and practical, and acts as a first layer of service, a kind of operator that is extremely fast, competent and ready to support service on different platforms and channels that consumers prefer, and has the ability to filter and transfer complex calls to specialized human assistance.

Data analysis also showed that handling data, information and patterns of programmed answers (creation, inclusion or change) to be provided by the AI chatbot is progressing due to the curatorship of the "robot school," with the addition of new services, according to customers' main needs. The curatorship has met the objectives of investigating, assessing, editing and producing answers to new intentions, expanding the content and the scope of services, improving the quality and performance of the cognitive virtual assistant, enhancing the quality of interactions and dialogue and specifying and adjusting changes to unsatisfactory responses.

The AI chatbot is always ready to assist and support various applications, programs and the most convenient channel chosen by the customer. It can filter interactions, transferring calls or transshipping contacts to an employee, a team or a specialized channel for assistance. AI and the analytics enable the chatbot to predict the client's intention and will, which means accessing its knowledge base, capturing, recognizing and developing learning skills and understanding, continuously and gradually, in order to meet clients' interests, and answer key questions and requests, in order to improve customer service and experience.

> [. . .] We usually say that, regardless of the channel, we have to complete the customer service. If I start with the chatbot and move to a human service solution, and the specialized human service is not able to solve it with his knowledge, we have to go all the way and make this customer service possible, by articulating with other areas. Because once overflowed, there is no justification for passing on this client [. . .]. (Interviewee 5)

In addition, the transshipment of the AI chatbot to call centers, relationship centers and specialized teams can occur when the customer requests human service, in interactions where the virtual assistant is unable to solve or when the level of confidence in the chatbot's answer is below expected. In these cases, the AI chatbot recognizes its limitations, suggests the option or directs the call to the permanent or outsourced employee at the most specialized service channel, such as call centers or relationship centers, agencies, customer services, managers or specialized teams.

5. Conclusions

The research question that guided this study was: *How does AI chatbot contribute to customer service efficiency in a commercial bank?*

We conclude that technological innovation in AI positively contributed to the efficiency of customer service at the chosen bank. AI innovation, through its applications, such as the chatbot, has become an essential technology for improving an organization's operational performance, by optimizing and achieving higher efficiency in business processes and by using multidisciplinary technical and management knowledge. The following AI chatbot increase occurred from 2019 to 2021: 2,350% in interactions through WhatsApp, 1,590% in new customer adoption and 19% in problem-solving. Therefore, the bank reached a successful rate of technological diffusion during the Covid-19 pandemic, showing the need for the AI chatbot technology and customers' acceptance.

The AI chatbot application contributes to service efficiency because it is assertive, effective and fast, acting with agility, availability and accessibility, without interruption. The virtual assistant can change time-consuming human calls into fast and efficient interactions in fractions of seconds, which is the estimated latency time. It answers simple and standardized doubts gradually, and aims to serve as many users as possible. It works as a first service layer, with interactions that are fast and have a high degree of objectivity and resoluteness. The AI chatbot service has reduced queues at call centers and relationship centers, allowing human attendants to solve difficult questions, which contributes to service efficiency.

This study showed that AI applied to customer service through a chatbot brought significant gains and higher levels of operational and organizational efficiency. The study also contributes to the evolutionary theory of innovation, regarding the importance of technological scaling, as it showed the considerable potential of innovations and AI applications that enabled exponential efficiency gains in customer service routines. The virtual assistant of the commercial bank revealed a significant growth in cognitive computer intelligence, which has increased the number of interactions with customers, in a short period. This allows concluding that the bank's open innovation with IBM Watson improved the AI technological capability and, consequently, the bank's performance.

The study confirms the evolutionary assumptions that a company's technological innovation is capable of revolutionizing its internal business structure, in a process defined as "creative destruction" (Schumpeter, 1950). It refers to abandoning the previous technological framework, replacing it with new emerging technologies to provide a new cycle of evolution, development, dissemination and global change, such as AI applications. The investigated bank has created and adopted new technologies, like those related to AI, to achieve higher efficiency for its organizational functions.

In addition, based on Febraban's (2019) research, this study highlighted the importance of financial sector's investments in Brazil and worldwide, in order to foster production, and commercial and service activities, especially those related to cutting-edge technological innovations. AI and cognitive computing are at the forefront of technologies, with higher resources invested by banks. The AI chatbot application has been widely used by the bank, mainly to improve bank customers' experience. These aspects confirm the bank's interest in the technological management of resources and innovations, in the search for improvement and higher levels of efficiency in business processes, to serve customers and keep its competitiveness.

The findings allow concluding that AI application, especially the virtual assistant, is an essential path for the performance and survival of the company in the financial segment, confirming the ideas of Tigre (2019) and Lopes (2016), who contributed to the evolutionary innovation approach. The commercial bank focused on the development of new products, services and the efficiency of business processes, as in AI application and the chatbot for customer service. This confirms the scenario described by Reddy (2017), that AI chatbots will be responsible for cost reduction in customer service by about 30% due to service expansion and less employees.

The study also allows concluding – from the approach by Nelson and Winter (2005) and others, like Tigre (2019) and Lopes (2016) – that routine efficiency, such as in the customer service process, is one of the main reasons for a company to exist. In the current scenario of extreme competition, the investigated bank can also distinguish itself from competitors by creating, developing and disseminating knowledge, thus improving its organizational skills and practices through the regular and significant change of routines and processes. The bank's organizational capacities will continue to change, based on new technological solutions and new applications in ICTs, especially AI.

The curatorship and robot school have contributed to the efficiency of customer service, since they play a relevant feedback function, combining and balancing routines and innovation for expanding knowledge. In addition, they can increase the scope of the chatbot service, improve the quality and performance of the cognitive virtual assistant, enhance

interactions and dialogue, and adjust and change eventual unsatisfactory answers. AI was one of the company's main technological innovations, an application with the highest potential among ICTs. On the other hand, AI applications are still developing and will reach higher levels of maturity.

The main limitations of this study relate to the research cutout, such as the choice of participants and their areas of activity, and the choice of the unit of analysis. As suggestions for future studies, we recommend additional research on organizational and financial results from AI applications, in addition to studies relating IA with labor creativity and productivity, Industry 5.0 and green AI, which may also contribute to the literature.

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