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A system and learning perspective on human–robot collaboration

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Abstract

Purpose – The process of introducing a new robotic technology into a service system is complex, and its impacts on work practices can be challenging. By adopting a system perspective, this study investigates how human–robot collaboration (HRC) transforms work practices (i.e. customer care).

Design/methodology/approach – We conducted a two-year longitudinal analysis of an international company specializing in natural health products, examining changes in customer care practices following the introduction of chatbots. The study leverages expansive learning theory, which emphasizes activity systems and the transformations that occur within them, to trace the integration of robots and their effects on work practices.

Findings – The findings reveal that HRC enhances customer care practices by creating a human–robot activity system organized around shared goals. This system, mediated by tools, rules and the community, evolves through expansive learning dynamics. The process begins by identifying and addressing the contradictions and tensions between current human work practices and robotic capabilities, often revealing challenges and opportunities to improve HRC.

Originality/value – This research offers a novel conceptualization of the systemic and dynamic nature of HRC by placing it within broader frames of activity systems and expansive learning. Collaborations between humans and robots entail an expansive performativity that extends beyond the traditional roles or tasks of either actor or actant. It spans a diverse range of objects, tools, procedures and institutional setups, culminating in transformations of customer care practices.

Keywords Expansive learning, Chatbots, Conversational agents, Activity system, Human–robot collaboration

Paper type Research paper

1. Introduction

Quickly developing artificial intelligence (AI)–based devices and digital agents (e.g. chatbots, virtual agents) offer the potential to automate a wide range of processes and operations and thereby alter how people perform their jobs (Brookings, 2023). The robot sector is predicted to expand rapidly in the next few years, including projections that it might reach a value of $260 billion by 2030. Its main applications thus far involve customer care (Statzon, 2023), because robots can offer round-the-clock help, individualized aid, effective problem-solving and tailored recommendations (Hsu and Lin, 2023; Ranieri *et al.*, 2024), all while gathering detailed client input in a variety of industries, such as hotel, retail and healthcare (Lu *et al.*, 2020).

Service research already offers extensive findings regarding the interaction between humans and robots. Most of these studies adopt a dyadic perspective, addressing the superiority of one or the other (e.g. Leiño Calleja *et al.*, 2023) or stressing the implications of automation and substitution by robots (Belanche *et al.*, 2020). Arguably though, we are at the point that we should move beyond a focus on interaction to address collaboration (Li and Zhang, 2023; Paluch *et al.*, 2022). In cooperative, collaborative efforts, human actors and robots enhance each other's complementary strengths, namely, the leadership, teamwork,

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creativity and social skills of the former and the speed, scalability and quantitative dynamic capabilities of the latter (Mele and Russo Spena, 2024). Thus, they might accomplish advanced, shared tasks that entail greater complexity and personalization, as are commonly required for effective service delivery.

Some studies of frontline employees accordingly have adopted a collaborative view, though without in-depth analyses of the impacts of such collaborations on companies and work practices. In response, one school of thought proposes the notion of a constitutive entanglement of human actors and robot actants, according to a system perspective (Mele *et al.*, 2021; Mele and Russo Spena, 2024). An actant refers to a nonhuman entity that participates in shaping and influencing the system. From this perspective, a critical question pertains to how collaboration affects system development and dynamics (Williams, 2020). Taking a system lens also requires acknowledging multiple elements and the performative features of the (service) system. We postulate that such a view can enrich understanding of robot adoption.

The process of introducing a new robotic technology into a service system is complex, so providing continuous maintenance and support for this process, and its impacts on work practices, can be challenging (Liu *et al.*, 2022). When robots enable service provision, human workers may become concerned about job displacement or role shifts. Furthermore, it can be difficult to scale up robot deployment across multiple service practices or extend its capabilities to include various jobs (Belanche *et al.*, 2020). Therefore, studying human–robot collaboration (HRC) from the perspective of service employees is vital for understanding and adapting work practices. Employees' insights can provide a fuller understanding of how roles, responsibilities and service delivery processes evolve as robotic technologies get integrated into service systems. With such understanding, researchers can develop more nuanced and practical insights for managing transitions toward HRC in service systems. A systemic perspective depicts the process of robot adoption as a series of attempts to alter the status quo to fit new schemas, processes and institutions, which result in new work practices. Therefore, in our attempt to extend scant knowledge of the robot adoption process and collaborations of robot actants with human actors in work practices, we adopt such a perspective and pose the following research question:

RQ. How does HRC transform work practices within service systems?

To address this question, we carried out a two-year longitudinal analysis of changing work practices (i.e. customer care) after the introduction of digital agents (i.e. chatbots) in an international company specializing in developing and producing natural health products. To understand and elaborate on the findings, we leverage expansive learning theory (Engeström, 2001), which emphasizes activity systems, defined as intricate networks of interconnected factors (e.g. people, tools, regulations, the division of labor). By examining how HRC evolves over time using Engeström's model, we can trace the progressive integration of robots into employee teams and the consequent transformation of work practices.

This study in turn makes two main contributions to extant understanding of HRC within systemic activity frameworks and expansive learning. First, we conceptualize the human–robot activity system as a foundational element for enhancing customer care practices. In such a system, collaboration between humans and robots is integral and organized around shared goals; it is mediated by tools, rules and the community. Second, we explore the evolution of this activity system according to an expansive learning process, which involves a critical examination of existing work practices and an analysis of how HRC transforms such practices. This process begins by identifying and addressing the contradictions and tensions between current human work practices and robotic capabilities, which often reveal challenges and opportunities to improve HRC.

These results emphasize the systemic and dynamic nature of HRC by placing it within broader contexts of activity systems and expansive learning. As this study shows, collaborations between humans and robots entail an expansive performativity that extends beyond the traditional roles or tasks of either actor or actant. It thus spans a diverse range of objects, tools, procedures and institutional setups, culminating in transformations of working activities and innovative customer care practices.

2. Literature review

2.1 Human (employee)–robot collaboration in service research

In service research, discussions of HRC have largely replaced traditional considerations of human–robot interactions (HRI), emphasizing their cooperative and synergistic relationships. These discussions involve two main lines of research (see Table 1): (1) the dynamic roles and tasks performed by human actors and robot actants, which reflect efforts to leverage their respective strengths for enhanced performance and efficiency and (2) questions about how collaborative efforts affect work practices.

An early debate centered on analyzing robots' roles and tasks. Technology can assist both customers and employees in performing activities more effectively, which leads to enhanced capabilities and richer interactions (De Keyser *et al.*, 2019; Leiño Calleja *et al.*, 2023). Thus, (service) robots and chatbots are increasingly deployed to enhance customer service, often substituting for human agents (e.g. Le *et al.*, 2024; Lu *et al.*, 2020). These studies highlight robots' abilities to provide personalized assistance, handle routine inquiries and manage complaints, in ways that enhance the customer experience (Chung *et al.*, 2020; Ranieri *et al*., 2024).

When they explore the interactions of robots and employees in specialized service tasks, scholars also emphasize demands for more collaborative efforts (Paluch *et al.*, 2022). In this context, collaboration involves more than task execution; it includes crucial aspects of training and supervising the technologies, as performed by humans (Mozafari *et al.*, 2022; Xiao and Kumar, 2021). The dynamic interplay of service robots and frontline employees requires humans to engage in demanding roles to augment robotic services, which in turn likely require reskilling initiatives and efforts to encourage proactive attitudes among the employees (Odekerken-Schröder *et al.*, 2021). In retail settings, technology embedding likely involves a collaborative process of co-evolution and effective knowledge transfer to support employees' adaptation to the new technologies. Engaging employees early in the AI integration process is crucial for limiting resistance and ensuring smoother transitions (Bonetti *et al.*, 2023). For example, the frontline employee–robot interdependence (FLERI) framework (Le *et al.*, 2023) identifies three structural components that encourage employee adoption: shared goals, common workflows for coordination and collaborative decision-making authority. This framework supports effective integration for service-oriented tasks and identifies collaboration between frontline employees and robots as vital for enhancing the customer experience and improving service delivery. It also recognizes the challenges involved in balancing efficiency with customer-oriented service and managing employee attitudes toward robot collaborations.

Recent research highlights the complexity of integrating AI into workplace practices and emphasizes the importance of addressing human aspects to maintain a healthy and productive work environment, underscoring that when algorithms are used alongside human managers, employees' prosocial motivation, such as the desire to help others, is reduced (Granulo *et al.*, 2024). Employees' willingness and customers' readiness to collaborate with robots both are critical for successful adoption (Xiao and Kumar, 2021). Some research demonstrates that customers prefer services in which digital employees support rather than replace human employees, suggesting the need for human involvement, especially in decision-making processes (Le *et al.*, 2024). This preference stems from increased transparency and cohesiveness provided by collaborative efforts by human and digital employees. Coordination cues that emphasize the orchestration of their tasks, team goals and joint commitments to customer service also strengthen perceptions of process fluency and seamless service experiences (Chong *et al.*, 2021).

Table 1. Human–robot collaboration

Source	Paper type	Theory	Technology/Robot type	Findings
Odekerken-Schröder *et al.* (2021)	Empirical	Anthropomorphism, social presence, utilitarian and hedonic value	Service robots are autonomous, adaptable, system-based interfaces that interact with, communicate with and deliver services to an organization's customers	The interplay of different actors in the customer–employee–technology service triad results in customer repatronage. Utilitarian value of service robots drives customer repatronage in fast casual dining restaurants
Xiao and Kumar (2021)	Conceptual	Employee acceptance of robots (EAR), customer acceptance of robots (CAR)	Robots as mechanical machines or intangible computer programs that perform rule-based work	DRA (degree of robotics adoption) measures the extent of robotics adoption that a firm employs to automate tasks previously performed by human employees
Mele *et al.* (2022)	Empirical	Boundary objects	Cognitive assistants (e.g. assistive/assistant robot, virtual assistant) identify cognition-as-a-service	Cognitive assistants act as boundary objects by bridging actors, resources and activities. They enact the boundary work of actors through four main actions: automated dialoguing, augmented sharing, connected learning and multilayered trusting
Paluch *et al.* (2022)	Empirical	Cognitive appraisal theory	Collaborative service robots (CRSs) are embodied machines equipped with some degree of AI and functional autonomy	The interaction of employees and service robots is a multistage appraisal process based on adoption-related perceptions. Three categories (employee, robot and job attributes) provide a foundation to understand appraisals of CSRs. Four employee personas (supporter, embracer, resister and saboteur) provide differentiated perspectives on how service employee–robot collaborations may differ
Le *et al.* (2023)	Conceptual	Human–robot collaboration (HRC), human–human collaboration (HHC)	Frontline robots are autonomous systems that can coordinate, communicate and interact with both customers and	Frontline employee–frontline robot interdependence (FLERI) concept based on three structural components of an

(*continued*)

Table 1. Continued

Source	Paper type	Theory	Technology/Robot type	Findings
			employees to deliver services	interdependent relationship: joint goals, workflows and decision-making authority
Le *et al.* (2024)	Empirical	Interdependence theory	Chatbots powered by AI	HRC is a process. Human and digital employees' collaboration (vs augmentation or substitution) appeals to customers, due to their perception of a transparent process, induced by collaborative cues
Current study	Empirical	Activity systems and expansive learning	Chatbots as capable of emulating human conversation and providing activities in customer care	The collaboration between employees and robots drives systems. A human–robot activity system changes by resolving tensions. The integration of robots and HRC foster expansive learning processes that result in new customer care practices

Source(s): The above table was created by the authors

In healthcare contexts, substantial research has considered how HRC affects work practices by analyzing the integration of cognitive assistants (Mele *et al.*, 2022). Employees must adapt their workflows to use the technologies effectively and allow the cognitive assistants to complement their tasks. Thus, the employees need training in using cognitive assistants, understanding their functionalities and leveraging them for improved patient care. Cognitive assistants, as boundary objects, can facilitate collaboration among various actors (patients, caregivers, healthcare professionals), resources and activities, fostering learning and knowledge sharing to increase value co-creation and patient care (Mele *et al.*, 2022; Mele and Russo Spena, 2024).

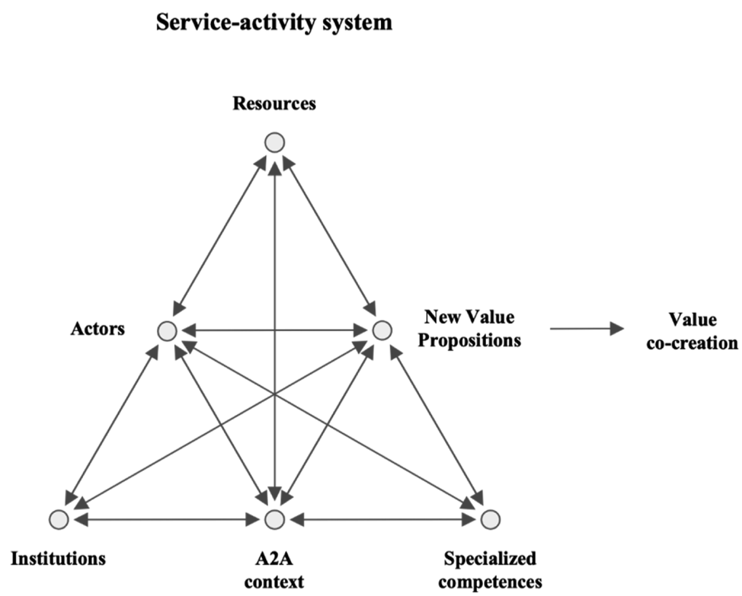
Notwithstanding these important contributions, some shortcomings persist. First, we note insufficient consideration of the system within which activities occur. Although research investigates how robots collaborate with employees and customers to execute tasks efficiently, it frequently neglects the surrounding organizational context. Second, we lack sufficient understanding of the impact of robot adoption on work practices. The process of robot adoption is rarely investigated as a progression, aimed at adapting to new frameworks, procedures and institutional setups and then ultimately leading to novel work practices. Such an understanding requires a significant shift, to include transformative and dynamic service systems. Therefore, we adopt Engeström's (2001) activity-system framework to ground our systemic perspective on how to leverage the capabilities of robotic technologies and optimize their integration into the workplace.

2.2 Activity systems and expansive learning: a service perspective

Scholars in the field of work research theorize that learning, as a transformative (cf. adaptive) process, can change and create new activities (Blackler and Regan, 2009; Engeström, 2004).

Engeström's general model of activity systems reflects collaborative efforts by a group of people to achieve shared goals. Activity is systemic by nature and comprises individual and short-term action, as well as collective interaction (Engeström, 2004). In service research, some researchers adapt this model to understand the service–activity system (SAS) (Mele and Russo Spena, 2018). As depicted in Figure 1, the SAS involves different actors (subjects) who apply specialized competencies (division of labor) to perform a set of actions involving resource integration (instrument/tool) in an actor-to-actor context (community). Collective participation is governed by institutions (rules) and enables actors to offer new value propositions (objects), representing trajectories of value in contexts of use by another activity system (beneficiary). In this sense, the outcome (i.e. element produced by the activity system, as a transformation of the object to be used by other activity systems; Engeström, 2004) reflects the essence of service provision, in that it offers potential value co-creation. Considering SAS requires understanding how elements in a system work together toward a common goal and transform themselves according to expansive learning processes. In an HRC context, an SAS implies that humans work with robots to reach goals. The division of labor is particularly crucial, because both humans and robots apply their specialized competencies (Odekerken-Schröder *et al.*, 2021; Xiao and Kumar, 2021). Embedding AI successfully involves a collaborative process of co-evolution and effective knowledge transfer, to address challenges and support employees' adaptation to the new technologies (Bonetti *et al.*, 2023). However, we know of no studies that address how system-level collaborations might be mediated by elements such as tools (technological interfaces), rules (protocols and guidelines) or the community (organizational or social context).

The concept of expansive learning offers some ideas for how activity systems work (Engeström, 2001) and deeper insights into collaboration processes (Kallio and Lappalainen, 2015). It encapsulates the notion that profound qualitative renewals in activity—development, expansive shifts and transformation—are achievable through processes of learning focused on the expansion of the object. Rather than merely describing interactions between different

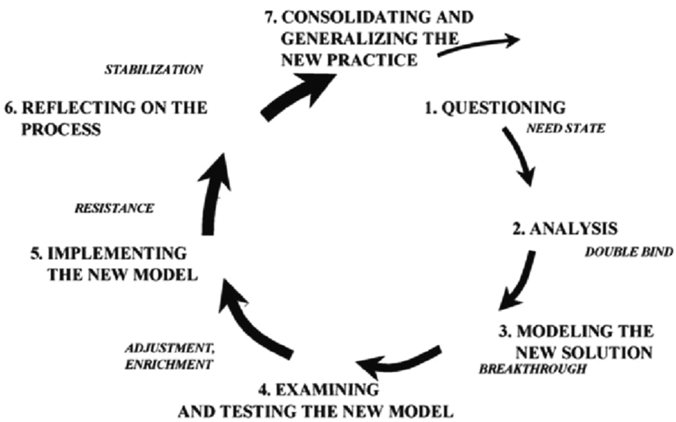


Source(s): Figure courtesy of Mele and Russo Spena, 2018 p. 549

Figure 1. From human activity systems to SAS

entities, the theory highlights the transformations that take place within an activity system. Expansive learning also addresses the challenges and disruptions to existing schemas, processes and institutions, enabling the creation of new ways of working. It suggests that the renewal of everyday activities is possible through collective learning, where cycles of expansion and transformation occur both within individual systems and across broader horizons of opportunity (Engeström, 2001). This framework illustrates a qualitative transformation in activity systems, highlighting dynamic relations among object-oriented activities, subjects and their community (Engeström, 2001, 2016; Engeström, 1999). The key stages in the cycle are depicted in Figure 2. It starts by *questioning* existing work practices and *analyzing* the situation. According to Engeström, the continuous development of an activity system gets propelled by its intrinsic tensions and contradictions. The division of labor, including specialized competencies, creates a community with diverse viewpoints, traditions and interests that constantly generates challenges and inconsistencies. These tensions, extending beyond mere problems or conflicts, manifest as historically accumulated structural contradictions within and between activity systems. They lead to disturbances, prompting translation and negotiation actions. As a result, the further phases of the cycle, including *modeling* and then *examining and testing* new models, are evident in innovative attempts to reshape systems. In these phases, to address contradictions, participants start to collectively reevaluate and reconceptualize the object, which necessitates the construction and implementation of a new way of doing. As the process evolves, the transformation initiated by individual subjects evolves into a collective movement involving the *implementation*, *reflection* and *generalization* of new work practices. In Engeström's view, expansive learning unfolds as a mix of emergent and conscious processes that cannot be known beforehand and that focus on not only specific problems at hand but also wider contexts that generate them (Engeström, 2001). The result is a qualitative transformation of all components of the system; a broadened object of activity arises, and new tools are produced to mediate intellectual and practical operations, as are novel rules and labor distributions (Engeström *et al.*, 1999; Engeström, 2004).

Recent HRC studies also acknowledge that the role of robots extends beyond technological adoption and can accommodate new forms of work (e.g. Le *et al.*, 2023, 2024; Mele *et al.*, 2022). However, this research domain lacks of systemic vision. No studies address the complex tensions and challenges associated with integrating robots into work activities.



Source(s): Figure courtesy of Engestrom, 1999, p. 384

Figure 2. Expansive learning cycle

3. Research method

Our research design is based on a longitudinal study, to support a thorough investigation of the case while also accounting for the broader context (Stake, 2005). Moreover, it allows us to collect rich, detailed data and provides the flexibility to explore various perspectives (Mele *et al.*, 2023). In detail, we investigated an international healthcare company, founded in 1978, specializing in the development of natural, effective and safe products. In its more than 40 years of experience, the company has established itself as a global leader in natural health and wellness products. The company has a fully vertical production chain, from the cultivation of high-quality organic raw materials to the verification of the pharmacological and clinical efficacy of its products. Its rigorous development process is deeply rooted in scientific evidence and designed in accordance with the principles of systems medicine—a comprehensive approach that considers the interconnectedness of biological systems.

Over time, this company has cultivated a work culture that places a profound emphasis on health and well-being as fundamental pillars. Central to the company's practices is a dedication to producing products of exceptional quality while fostering pleasant services for its customers. In turn, the organization places paramount importance on its people, recognizing them as invaluable assets pivotal to its success. This relentless focus serves as a bedrock for its innovation. The company's goals also extend beyond immediate objectives, aiming to create groundbreaking solutions that address present needs and also pave the way for a meaningful future in the healthcare industry. This dedication to excellence and foresight underscores the company's vision to make enduring contributions that enhance healthcare and well-being on a global scale.

In pursuit of these goals, the company has embraced recent AI-based technologies (chatbots), integrating them into operational workflows to enhance both internal employee interactions and customer relationships. Specifically, it has introduced seven chatbots (Table 2), according to system-based approaches (Kunz *et al.*, 2022), to deliver tailored solutions efficiently and maintain a consistent level of quality and performance across a wide scale.

3.1 Data collection

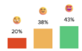
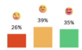
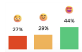
Multiple one-to-one in-depth interviews were conducted online between August 2021 and October 2023 with 14 company employees involved in the implementation of the chatbots (Table 3). Each interview lasted around 60 min, for a total of 56 h of interview data.

To ensure reliability, the authors who conducted the interviews used a consistent protocol (Denzin and Lincoln, 1998) that specified five key interview objectives: (1) to analyze existing routines, (2) to examine the objectives and processes for introducing chatbots, (3) to understand the problems and challenges experienced by employees, (4) to identify positive versus negatives outcomes and (5) to identify new activity systems and work practices. Furthermore, we transcribed each interview verbatim and meticulously crafted individual documents and notes about each discussion. Beyond conducting interviews, the researchers systematically amassed key performance indicators (KPIs) and pertinent quantitative metrics, provided by the technology provider (see Table 2). We then used these metrics to compare with statements by employees. By contextualizing the interview data to specific scenarios or settings, we sought to extract comprehensive, detailed descriptions, drawing inspiration from Geertz's (2008) thick description concept. This comprehensive approach facilitated a deeper understanding of the nuances, subtleties and broader implications embedded in these data.

3.2 Data analysis

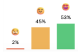
The juxtaposition of qualitative interview insights with quantitative performance metrics provides a holistic perspective that can enrich our interpretation of the study findings. We integrated "systematic data collection, coding, and analysis with theoretical sampling to formulate an integrated theory that is closely aligned with the data and expressed in a clear format for subsequent verification" (Conrad *et al.*, 1993, p. 280). This method entails scrutinizing each interpretation emerging from the data analysis against existing findings

Table 2. Chatbot types and implementation dates

		Employee Workflow by Department	Usage Data									Outcomes Achieved
			Year	Number of new users	Number of messages exchanged	Number of conversations held	Average messages per user	Messages resolved independently	Messages resolved with suggestions	Messages unresolved	Net Promoter Score	
Melanie from August 2021	Virtual assistant on a dedicated page designed to advocate for informed decisions regarding preventive medicine, a cornerstone of the company's culture; it has been trained to present how to develop a specific dietary strategy.	• Customer Care: provides timely and accurate responses to customers' inquiries about preventive medicine. • Marketing Department: advocates for informed decisions and supports efforts to promote the importance of preventive medicine among customers.	2021	511	8,801	1,497	2	85.10%	14.89%	0.01%	Not yet available	• Improved customer service through timely and accurate responses to inquiries • Enhanced access to information
			2022	1,012	15,577	2,272	5	82.15%	9.86%	7.99%	Not yet available	
			2023*	992	6,387	1,032	6	79.08%	6.30%	14.62%	Not yet available	
Peter from February 2022	Virtual assistant designed to providing detailed information (e.g., dosage and usage instructions) on a specific product page	• Customer Care: provides accurate responses to customers' inquiries about dosage and usage products instructions.	2022	5,602	31,962	5,981	2	85.36%	4.55%	10.09%	Not yet available	• Improved customer service through quick, accurate responses about a specific, frequently asked about product
			2023*	7,819	40,763	8,122	5	88.03%	4.69%	7.28%		
Erika from May 2022	Virtual assistant on a dedicated page offers comprehensive details about the company's rewards program and points accumulation.	• Marketing Department: provides comprehensive details about the company's rewards program and points accumulation.	2022	10,998	51,073	11,391	2	86.75%	2.98%	10.27%	Not yet available	• Easy access to practical information about the company's loyalty programs • Improved marketing communication
			2023*	20,060	121,287	21,064	6	87.46%	5.54%	7%		
Jemma from May 2022	Virtual assistant presented on the homepage as the initial point of contact with the customer, has been trained to respond to the most common/general questions (e.g. product advice, sales points, internships and job vacancies).	• Customer Care: seamlessly assists employees by handling routine inquiries, reducing their workload and enabling them to focus on more complex tasks. • Marketing Department: acts as a valuable tool to inform customers about sales points, thereby enhancing their communication and ultimately facilitating product purchases • Human Resource Department: helps find and connect with suitable candidates, streamlining the recruitment process and enhancing departmental efficiency.	2022	14,767	97,899	15,549	3	81.73%	5.83%	12.44%	Not yet available	• Improved customer service in managing routine inquiries effectively • Enhanced customer experience through personalized responses • Improved communication of sales points and product offerings • Improved customer service efficiency, 24/7 assistance that ensures continuous availability, and immediate response to customers
			2023*	12,915	89,785	13,545	7	87.47%	5.55%	6.98%		

(*continued*)

Table 2. Continued

Lionel from September 2022	Virtual assistant dedicated to providing detailed information (e.g., what it does, how to use, duration of treatment) about specific products	• Customer care: streamlines processes by handling complex inquiries related to a specific product, reducing the need for employees to address common questions and avoiding mistakes.	2022	236	1,416	246	1	81.23%	7.53%	11,24%	Not yet available	• Improved customer service efficiency, 24/7 assistance that ensures continuous availability, and immediate response to customers • Reduced errors in customer responses
			2023*	4,593	26,781	4,792	6	90.10%	4.17%	5.73%		
Camille from May 2023	Virtual assistant designed to providing detailed information (e.g., what it does, how to use, duration of treatment) about specific products	• Customer care: streamlines processes by handling complex inquiries related to a specific product, reducing the need for employees to address common questions and avoiding mistakes.	2023*	1,995	11,471	2,071	6	90.46%	4.32%	5.22%	Not yet available	• Improved customer service efficiency, 24/7 assistance that ensures continuous availability, and immediate responses to customers • Reduced errors in customer responses
Star from May 2023	Virtual assistant on a dedicated page for a customer care and wellness project, trained to provide specific information on health-related topics, including critical issues (e.g., celiac disease, acidity, reflux).	• Customer Care: enables access to specialized health-related information, facilitates quick and accurate responses to customer inquiries, and enhances the ability to provide tailored support and guidance to customers. • Marketing Department: advocates for informed decisions and supports efforts to provide valuable insights into customer health concerns and interests.	2023*	2,803	16,143	2,948	6	97.13%	0.78%	2.09%	Not yet available	• Improved customer service through timely and accurate responses to inquiries • Enhanced access to information on critical health issues • Enhanced support and guidance for customers

Source(s): The above table was created by the authors-Data collected until October 2023

Table 3. Interview summary

No.	Company position	Years of employment in the company	Direct involvement in chatbot implementation	Number of interviews
1	Marketing manager	10 years	7 chatbots (Melanie, Peter, Erika, Jemma, Lionel, Camille, Star)	2 in 2021 2 in 2022 2 in 2023 (Total: 3 h and 55 min)
2	Marketing employee	10 years	7 chatbots (Melanie, Peter, Erika, Jemma, Lionel, Camille, Star)	2 in 2021 3 in 2022 3 in 2023 (Total: 5 h and 40 min)
3	Marketing employee	9 years	7 chatbots (Melanie, Peter, Erika, Jemma, Lionel, Camille, Star)	2 in 2021 3 in 2022 3 in 2023 (Total: 4 h and 15 min)
4	Marketing employee	8 years	7 chatbots (Melanie, Peter, Erika, Jemma, Lionel, Camille, Star)	2 in 2021 2 in 2022 3 in 2023 (Total: 4 h and 30 min
5	Human resources	10 years	7 chatbots (Melanie, Peter, Erika, Jemma, Lionel, Camille, Star)	2 in 2021 2 in 2022 2 in 2023 (Total: 4 h)
6	Head of customer care	10 years	7 chatbots (Melanie, Peter, Erika, Jemma, Lionel, Camille, Star)	2 in 2021 2 in 2022 2 in 2023 (Total: 3 h and 45 min)
7	Customer care employee	6 years	7 chatbots (Melanie, Peter, Erika, Jemma, Lionel, Camille, Star)	2 in 2021 1 in 2022 2 in 2023 (Total: 3 h and 55 min)
8	Customer care employee	7 years	7 chatbots (Melanie, Peter, Erika, Jemma, Lionel, Camille, Star)	2 in 2021 1 in 2022 2 in 2023 (Total: 4 h and 15 min)
9	Customer care employee	3 years	4 chatbots (Melanie, Peter, Erika, Jemma)	2 in 2021 1 in 2022 (Total: 1 h and 55 min)
10	Customer care employee	3 years	7 chatbots (Melanie, Peter, Erika, Jemma, Lionel, Camille, Star)	2 in 2021 1 in 2022 2 in 2023 (Total: 4 h and 45 min)
11	Customer care employee	4 years	7 chatbots (Melanie, Peter, Erika, Jemma, Lionel, Camille, Star)	2 in 2021 1 in 2022 2 in 2023 (Total: 4 h and 35 min)
12	Customer care employee	3 years	7 chatbots (Melanie, Peter, Erika, Jemma, Lionel, Camille, Star)	2 in 2021 1 in 2022 2 in 2023 (Total: 3 h)
13	Customer care employee	2 years	4 chatbots (Jemma, Lionel, Camille, Star)	2 in 2022 2 in 2023 (Total: 2 h and 35 min)
14	Customer care employee	3 years	7 chatbots (Melanie, Peter, Erika, Jemma, Lionel, Camille, Star)	2 in 2021 1 in 2022 2 in 2023 (Total: 3 h and 55 min)

Source(s): The above table was created by the authors

(Glaser and Strauss, 2017) to discern various facets of the studied routines and their transformations since the introduction of chatbots.

During the research period, our analysis encompassed four distinct phases associated with the introduction of the different chatbots into daily routines. We delved into the diverse perspectives of employees interacting with the chatbot to understand its impact on the SAS. We prioritized resultant effects—namely, the emergence of new work practices—by evaluating alterations in behavioral patterns and available resources among the involved participants, their strategies for integrating resources and the outcomes regarding collaborative value creation.

The coding process, aimed at achieving a clearer comprehension of the core phenomena, encompassed a structured three-tier analysis, outlined in Table 4: open, axial and selective coding (Corbin and Strauss, 2008). In the initial phase of open coding, we sought to discern patterns in the responses and continually refine these patterns through ongoing analyses of newly acquired data (Boeije, 2002). This iterative process persisted until the incoming data corroborated and solidified existing codes, leading to theoretical saturation. Subsequently, the axial coding phase involved an ongoing process of comparisons and synthesis (Kolb, 2012). Finally, in the selective coding stage, we pinpointed core categories, guided by our theoretical frameworks of activity systems and expansive learning. This methodological approach supports systematic, comprehensive analyses and enables a deeper understanding of the underlying dynamics and interrelations across the data. After completion of the coding process, we convened meetings with key stakeholders, including the technology partner, customer care and marketing managers, to elicit and compare their perspectives.

4. Findings

Our results offer a detailed account of how the adoption of multiple chatbots and generative AI can foster continuous adjustments to the work practices within an SAS. The expansive learning phases—the five distinct yet interconnected stages of (1) questioning and analysis the current practice, (2) modeling, (3) examining and testing, (4) implementing and reflecting a new solution and (5) consolidating the new practice—serve as crucial milestones in the evolution of approaches to work practices. The transitions between the phases mark pivotal moments that also mirror corresponding tensions encountered while striving to meet and exceed the evolving expectations of the company's customers. These tensions are more than mere obstacles; they constitute intrinsic elements of emerging human–robot activity systems, in which interactions take meaning from the activities they perform. Opportunities for learning, growth and transformative development shape new work practices for customer care.

4.1 Questioning and analysis of current activity systems and customer care practices

An initial analysis of the company's SAS reveals substantial hurdles related to the structure of customer care. The company's expansion to various online platforms, such as its corporate website, online communities and social networks, had escalated the volume of customer inquiries transmitted through digital channels. The company was inundated with a wave of unfavorable reviews, pointing to the inefficacies plaguing its customer care. Contradictions emerged between the service promised and its effective care practices (tension 1), as customers expressed frustration over prolonged response times, detailed experiences of waiting extensively on the phone, and then encountered the additional inconvenience of being transferred to human operators. A collective understanding of the need for change arose, motivating and directing a process of questioning traditional customer care activities:

> Managing the multitude of customer inquiries became an insurmountable task. The customer care of a company of this scale requires the backing of additional personnel. Single-handedly, it is an unattainable feat, impeding our ability to proactively address customer problems. We even have to work beyond regular hours to avoid complaints and negative reviews about customer care. (Employee 3)

Table 4. Coding process

	Phase 1: Questioning and analysis of current activity systems and customer care practices	Phase 2: Modeling new chatbot-based solution	Phase 3: Examining and testing multiple chatbot-based solutions	Phase 4: Implementing and reflecting on AI-augmented, chatbot-based solutions	Phase 5: Consolidating new human–robot activity system and new customer care practices
Selective coding	Service activity tensions lead to the use of new resources in customer care activities	Resources are applied and integrated to model a new solution, but additional tensions emerge	Improvements are performed while implementing the new model, resulting in the emergence of further tensions	Refinements are executed through testing and implementing multiple chatbot-based systems	Results and performance allow for enacting new work practices
Axial coding	Tensions in considering additional resources (personnel or automation) to manage workloads efficiently and handle customer inquiries appropriately	Tensions in improving chatbot training and performance to meet the diverse nature of all customer inquiries	Tensions in performing interconnected actions among all involved actors (i.e. chatbots, employees, customers and third parties)	Tensions in collecting and automatically analyzing huge volume of customer data insights to improve company's strategies	Use of chatbots as collaborators with employees to foster improved customer care service
Open coding	Managing customer needs Repetitive inquiries Time wastage Regulatory challenges in health products	Chatbot inefficiency Training challenges Customer frustration Complexity	Distinct scenarios Autonomy of chatbots Outdated information Limited employee involvement Third-party connection	Generative AI enhancement Workflow improvement	Enhancement of work practices Collaborative work context
Raw data (employee interviews and observations)	Employee 3: "Managing the multitude of customer inquiries becomes an insurmountable task" Employee 12: "Customers always ask the same thing, and we have to sit there wasting time to answer" Employee 4: "The institutions are not on our	Employee 9: "The newly implemented chatbot promptly addresses inquiries around the clock with a set of answers that we have specially prepared. This is a small step forward!" Employee 2": The chatbot is still in its early	Employee 11: "We manage entirely distinct scenarios due to the existence of seven different chatbots." Employee 6: "Their training is not interconnected. When information changes, it needs to be updated everywhere." Employee 3: "Chatbots are not	Employee 1: "I don't believe there was any concern about it replacing work. On the contrary, from our perspective, it helped us to reorganize and enhance it." Employee 10: "Generative AI has revolutionized our approach to customer	Employee 14: "Nowadays, the chatbot is utilized to identify potential areas for enhancement". Employee 13: "Through our new systems Customer data can be used not merely as a tool for analysis and response improvement but as a strategic

(*continued*)

Table 4. Continued

	Phase 1: Questioning and analysis of current activity systems and customer care practices	Phase 2: Modeling new chatbot-based solution	Phase 3: Examining and testing multiple chatbot-based solutions	Phase 4: Implementing and reflecting on AI-augmented, chatbot-based solutions	Phase 5: Consolidating new human–robot activity system and new customer care practices
	side. Since these are health products, you need to pay attention to every word that is said"	stages . . .. Its training is not complete." Employee 5: "Customers were often annoyed because they had not received a response from the chatbot."	always comprehensive; a lot depends on their history." Employee 8: "Only a limited number of employees are directly involved in chatbot training."	interactions, liberating us from the challenges of data overload. It has streamlined our workflows."	asset that can be seamlessly integrated into our marketing strategies."

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The pronounced volume of customer inquiries grew increasingly demanding, due to the customer care department's dependence on conventional communication methods such as emails, phone calls and online forms. This reliance exacerbated their workload, because employees struggled to address inquiries promptly across the multiple channels for which they were responsible. An emerging tension 2 related to inefficient coordination of human and technical elements across the organization's existing resources. These first two tensions created a cause-and-effect loop: Inadequacies in the customer service system (tension 1) exacerbated operational challenges (tension 2), and then frustrations expressed by customers and employees related to response times and handling capacity highlighted the inefficiency of the current system and its outdated methods. This scenario further stressed the system, amplifying the need to alter the management of customer inquiries. This discernible need for a thorough reassessment and substantial adaptation of the company's operational structure, to integrate and harness modern technologies effectively, enhanced the conversion management.

> How annoying, customers always ask the same things and we have to sit there wasting time to answer as many customers as possible without being able to deal with complicated requests. We always have a backlog of work. It would be nice if the company hired someone more or at least introduced something that could automatically respond to them. (Employee 12)

The contradictions in managing employee activities for customer care and the imperative to introduce changes became evident in this step. Despite the clear patterns of repetitive, similar customer inquiries, efforts to explore solutions to these tensions that maintained the firm's current status introduced a broader, complex layer related to compliance and regulatory standards, reflecting the stringent rules surrounding national healthcare institutions. Any failure to adhere to their rigorous guidelines could lead to additional and substantial tensions involving the company's broader network (tension 3), as well as the risk of substantial damage to multiple actors (companies, customers, regulatory institutions). The implications of possible noncompliance (tension 3) put additional pressure on customer service (tension 1) and human–technical resource coordination (tension 2) efforts that informed both the prospect and necessity of making changes:

> The norms and rules are not on our side. Since these are health products, you need to pay attention to every word that is said. A dedicated ministerial office must verify our activities and sometimes it becomes very difficult to improve our overall performance. (Employee 4)

Figure 3 depicts the focal SAS and some tensions arising from the analysis conducted during this phase. In response, the company was driven to find new solutions to improve the HRC.

4.2 Modeling new chatbot-based solutions

The challenges that emerged from the initial phase, focused on questioning and analyzing the existing SAS and customer care, prompted the company to seek more efficient solutions. The introduction of the first chatbot marked a significant turning point, shifting the company's work practices from traditional call centers and email-based approaches to a more technologically advanced design that relied on HRC. The implementation of the chatbot introduced some immediate advantages, including resolving service inefficiencies and reducing both delays for customers and cumbersome customer interactions for employees:

> Customers, coming from diverse locations, inquire about a wide range of topics . . . The newly implemented chatbot promptly addresses inquiries around the clock with a set of answers that we have specially prepared. This is a small step forward! (Employee 9)

Once overwhelmed by their excessive workload, employees experienced at least modest alleviation and could rely on collaboration with chatbots. The KPIs, including the total number of customer conversations with the chatbot and the number in which it autonomously resolved problems, substantiate this initial positive trend. However, these improvements also introduced new tensions that affected both customers and employees.

Customers interacting with the chatbot received prompt responses to basic queries but encountered limitations when seeking more detailed exchanges; the chatbot seemed unable to respond effectively—a limitation linked to the constraints of its training (tension 1). This issue led to inefficiencies in customer care and negative experiences in interactions with the chatbot:

> The chatbot is still in its early stages, so it is normal that it is not always able to respond. Its training is not complete, as its introduction was a test and now we need to work hard to understand how to continue improving it. (Employee 2)

Thus, new challenges arose for organizing work activities, putting extra burdens on employees (tension 2). Although the chatbot reduced the volume of emails and requests directed to employees through the call center switchboard, its limited performance subsequently

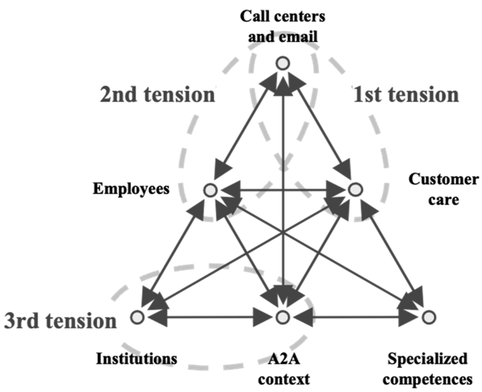

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Figure 3. Phase 1: questioning and analyzing the SAS

increased the workload and stress levels of those who had to manage interactions with frustrated customers. That is, the integration of robots into employee workflows inadvertently increased pressures rather than alleviating them:

> When customers called us, they were often annoyed because they had not received a response from the chatbot and as a consequence they had to wait on the phone for a long time to obtain assistance. I face a challenging task in responding to customers, and I am forced to effectively resolve the inefficiencies caused by the chatbot. (Employee 5)

As a result, a new need emerged for additional training procedures for the chatbot. New tensions also emerged, related to establishing new rules and work routines (tension 3). Initially, human operators had to invest significant energy and time to ensure the chatbot was prepared to address customer queries and handle diverse situations autonomously. They also needed to acquire new knowledge and competencies, because the training process was complex and multifaceted. The challenge of preventing the chatbot from confusing different training programs increased the workload of the human staff:

> I can’t be sure that users perceive how much work goes into a response they get via the chatbot . . .. Chatbot training is a long process. It is not enough to decide which topics to address through it; you must follow a strict procedure to be able to do so. And, if you want to perform something personalized for each customer, I wouldn’t even know where to put my hands. (Employee 7)

In addition, tensions resulted as direct consequences of inadequate collaboration across broader organizational settings (tension 4). Their root cause might be traced to different skills and competences across departments, which became particularly evident during the training process. Strict coordination among employees from various departments was necessary to provide timely and accurate information; furthermore, to keep chatbots up to date with novel product and service introductions, they required frequent, time-consuming updates. Any lack of collaboration between human tasks and robot tasks led to information imbalances, which grew over time and intensified existing tensions. To employees, the chatbot seemed to operate disconnected from the organization, functioning merely as an additional tool available to customers. Consequently, employees experienced diminished trust in the technology and expressed less commitment to exploiting its potential:

> We thought the chatbot would be a helpful assistant, but in reality, we found ourselves overwhelmed by the workload involved in reflecting on work practices. The chatbot ran the risk of irritating them and placed an incredible burden on us to train it. (Employee 13)

Figure 4 illustrates the modifications thus implemented in the SAS, delineating the emerging tensions associated with modeling a new solution based on a chatbot. Recognizing these challenges, the company pursued another transformative change in work practices.

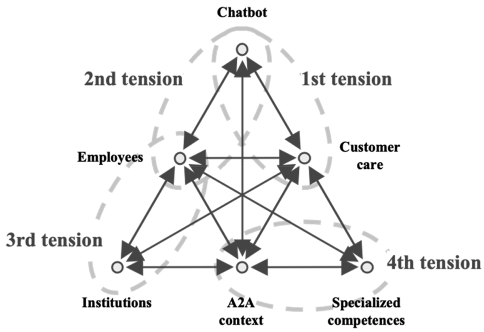

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Figure 4. Phase 2: SAS in modeling a new solution

4.3 Examining and testing multiple chatbot-based solutions

The introduction of the first chatbot solution illuminated some unforeseen organizational challenges. As the product range expanded and more tasks were assigned to the chatbot, communication effectiveness declined; it confused product details, often giving inaccurate or incorrect answers. To address this issue, the company overhauled its customer care process, shifting from reliance on a single chatbot to deploying a network of seven specialized chatbots, focused on different activities: the main website, events and marketing, or specific product lines. The chatbots were deployed only for particular instances and locations upon request, whereas employees handled more complex inquiries. Although the chatbots could efficiently answer straightforward queries, specific to their tasks, their limitations were evident, leading to significant new issues in customer care practices (tension 1). Handling vast amounts of information across multiple chatbots again sometimes resulted in outdated data:

> Currently, we manage even different chatbots, each designated for specific tasks . . .. These specialized chatbots have well-defined boundaries, ensuring that customer queries align with predefined topics regardless of the inquiry's scope, and are perfectly integrated into customer care activities. However, when the chatbot is unable to handle user requests, it autonomously attempts a maximum of only two suggestions; beyond that, it redirects customers to the appropriate departments, which intervene immediately. (Employee 11)

Overlapping information across the different chatbots also led to employee errors, due to the inconsistencies and challenges in keeping the chatbots updated. The training effort required to manage them demanded increasing attention, and updating the same information across multiple chatbots was exceedingly time-consuming. These operational limitations of specialized chatbots (tension 1) directly contributed to complexities in managing them, leading to a new set of tensions (tension 2).

> Their training is not interconnected. When information changes, it needs to be updated everywhere. Therefore, although chatbots are able to respond better, the work needed to manage them is not easy for us. (Employee 14)

Despite improvements in the efficiency and relevance of customer interactions through tailored responses, the new multi-chatbot system did not evoke positive feedback from employees. Its promising effectiveness, such that each chatbot would perfectly answer questions about its dedicated activity, never came to fruition:

> Chatbots are not always comprehensive; a lot depends on their history, considering that some were created two years ago, while others were developed just three months ago. Naturally, they evolve and change over time thus acquiring more and more autonomy. (Employee 3)

In addition, the persistent tensions affected work activities. The new system required active participation from employees from various departments during training processes, in the hope of providing chatbots with a comprehensive understanding of the organization's activities. But the lack of specialized expertise dedicated to developing and integrating the seven chatbots complicated their implementation (tension 3). The chatbots struggled to adjust their independent responses to internal changes, which reduced their ability to provide current information and also highlighted the need for improved supervision over their design and implementation.

> According to the company's decision, only a limited number of employees are directly involved in chatbot training, while each department provides their respective information that the company requires it to address or that it needs to address unanswered questions. However, it would be useful if the chatbot were to suggest what to improve and what information it is missing. It can assist customers but does not assist employees. (Employee 8)

Figure 5 presents the modifications implemented during this implementing phase. A renewed impetus arose to reevaluate and enhance the SAS, particularly to achieve a more integrated and

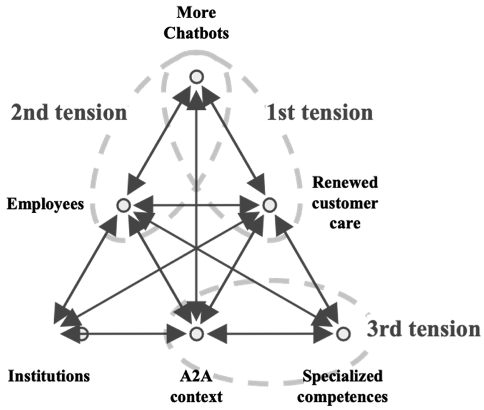

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Figure 5. Phase 3: SAS system in examining and testing multiple chatbots

streamlined system for customer care that leveraged the novel capabilities of chatbots, especially following the introduction of generative AI.

4.4 Implementing and reflecting on AI-augmented, chatbot-based solutions

Even with significant advances in technology and organizational practices, employees struggled with effective time management, primarily due to the difficulty of integrating renewed customer care activity into the multi-chatbot system. To address these issues, the company implemented generative AI to summarize chatbot–customer interactions and thereby give employees insights into these conversations, from which they might identify areas in which chatbots underperform. In seeking to realize its full potential, new challenges again arose, including the need to analyze even more extensive customer data (tension 1) and integrate the chatbot system into all working activities. Yet the potential improvements could enhance the efficiency of customer analysis and streamline workflow activities, leading to more responsive and personalized care services.

> I don't believe there was any concern about it replacing work. On the contrary, from our perspective, it helped us to reorganize and enhance it. With the chatbot on our websites, most users can receive immediate feedback, and those seeking more specific information are directed to the appropriate departments. This has significantly shortened many processes. (Employee 1)

By distilling conversations into concise summaries, the generative AI solutions empowered human operators to focus on nuanced problem-solving, rather than grappling with the sheer volume of customer data. This transformation required employees to engage in ongoing education and training (tension 2) to utilize new generative AI functionalities and improve their problem-solving skills, for which human insight remained crucial (Figure 6):

> Generative AI has revolutionized our approach to customer interactions, liberating us from the challenges of data overload. It has streamlined our workflows, allowing us to concentrate on customer problem-solving and their empathetic engagement. Concurrently, we have had to understand the data quickly and accurately to make decisions. (Employee 10)

4.5 Consolidating new human–robot activity systems and customer care practices

As the generative AI gained a refined understanding of customer queries and chatbot responses, it fostered a dynamic and evolving collaboration that improved the quality of

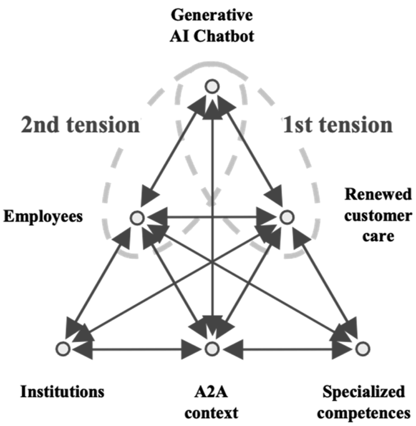

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Figure 6. Phase 4: SAS in AI-augmented, chatbot-based solutions

customer care and also highlighted employees' commitment to using technology to identify potential areas for improvement. By automatically gathering and analyzing customer data insights, the system uncovered specific areas that required enhancement or topics suitable for personalized marketing initiatives:

> The AI-based chatbot is utilized to identify potential areas for enhancement. If an excessive number of questions converge in a particular direction without finding a satisfactory answer, it reveals an area that requires improvement. For example, our chatbot data analysis revealed frequent questions about product returns, leading us to streamline and improve our returns policy and communication. This change resulted in a 15% reduction in return-related inquiries and a 10% increase in customer satisfaction regarding the return process. (Employee 14)

> Through our new systems, customer data can be used not merely as a tool for analysis and response improvement but as a strategic asset that can be seamlessly integrated into our marketing strategies. By customizing insights, we can craft highly targeted and personalized marketing initiatives. For instance, by analyzing customer queries about new product features, we launched a targeted marketing campaign that led to a 25% increase in engagement rates compared to previous campaigns. (Employee 13)

Beyond efficacy, the benefits extended to creating a work environment where humans and AI complemented each other, fostering more flexible and harmonious HRC (Figure 7). Robotic technology was recognized as a powerful tool that, when thoughtfully integrated, enhanced human abilities and enriches job roles, rather than just replacing humans for repetitive tasks.

4.6 Expansive learning through the human/robot activity systems

Because the company embraced the tensions during the initial customer care activities, the customer care practice transformed. Figure 8 provides a summary of all modifications made to the human–robot activity system throughout the expansive learning process, as also detailed in Table 6. The initial transformative phase centered on establishing a shared comprehension of the imperative for change, serving as both a motivator and guiding force. Subsequently, the second phase featured meticulous analysis and exposition of the contradictions inherent in current activities, aiming to facilitate critical examinations. In the third phase, a novel, chatbot-based activity system took shape, offering recommendations for the expansion of customer care practices. The fourth phase saw the actualization of the new activity system, executed with the implementation of multiple chatbot systems enhanced by AI, as well as continuous

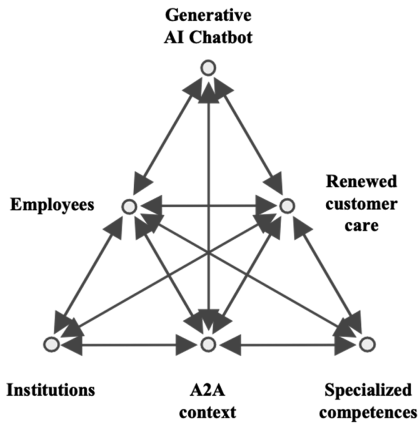

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Figure 7. Phase 5: new human–robot SAS

refinements in real-world settings. The fifth phase, dissemination and consolidation of the new human–robot activity system, reflected the outcomes of expansive learning developed through tension reflections and solutions, ensuring its widespread adoption and enduring integration.

The process was dynamic, not static, such that the introduction of various chatbots into workflows revealed complex interplays of solutions and subsequent tensions, as well as their systemic impacts on activities. After the first phase, when chatbots were identified as an immediate remedy to alleviate staffing pressures, their integration affected HRC (involving both customers and employees) and work rules. New tensions emerged from the effort to balance automated responses with human oversight. To address these issues, learning expanded, on the basis of additional questioning about how to integrate advanced chatbots programmed with sophisticated algorithms to handle diverse customer interactions. However, as chatbots became more sophisticated, needs for ongoing training and refinement of both human and robot capabilities kept increasing too, which strained resources and demanded further investments in technology and personnel training.

Each step in the process of integrating chatbots thus initiated a cycle of problem-solving and new challenges, necessitating an expansive learning process of dynamic and systemic transformations. In each phase, by identifying and exploring emerging tensions and contradictions—such as discrepancies between customer needs and company provision or between chatbots' capabilities and employees' expectations—the organization also engaged in expansive learning. Once chatbots could handle routine inquiries, employees spent more time on tasks that required empathy, critical thinking and complex problem-solving. New employee roles emerged too, such as chatbot trainers and AI system supervisors, in which employees worked closely with AI developers to improve the chatbot algorithms and performance. This continuous process extended beyond adapting or integrating new robots; it entailed transforming employee–robot collaborations and the entire customer care practice to establish a hybrid system that could combine robot and human abilities. This system then could improve response times and operational efficiency (Table 5) while also enhancing the customer care service process by providing immediate support for simple queries and specialized attention for complex issues.

5. Discussion

In framing the notion of collaboration between human actors and robotic actants, we build on an activity systems framework and the dynamics of expansive learning (Engeström, 2001,

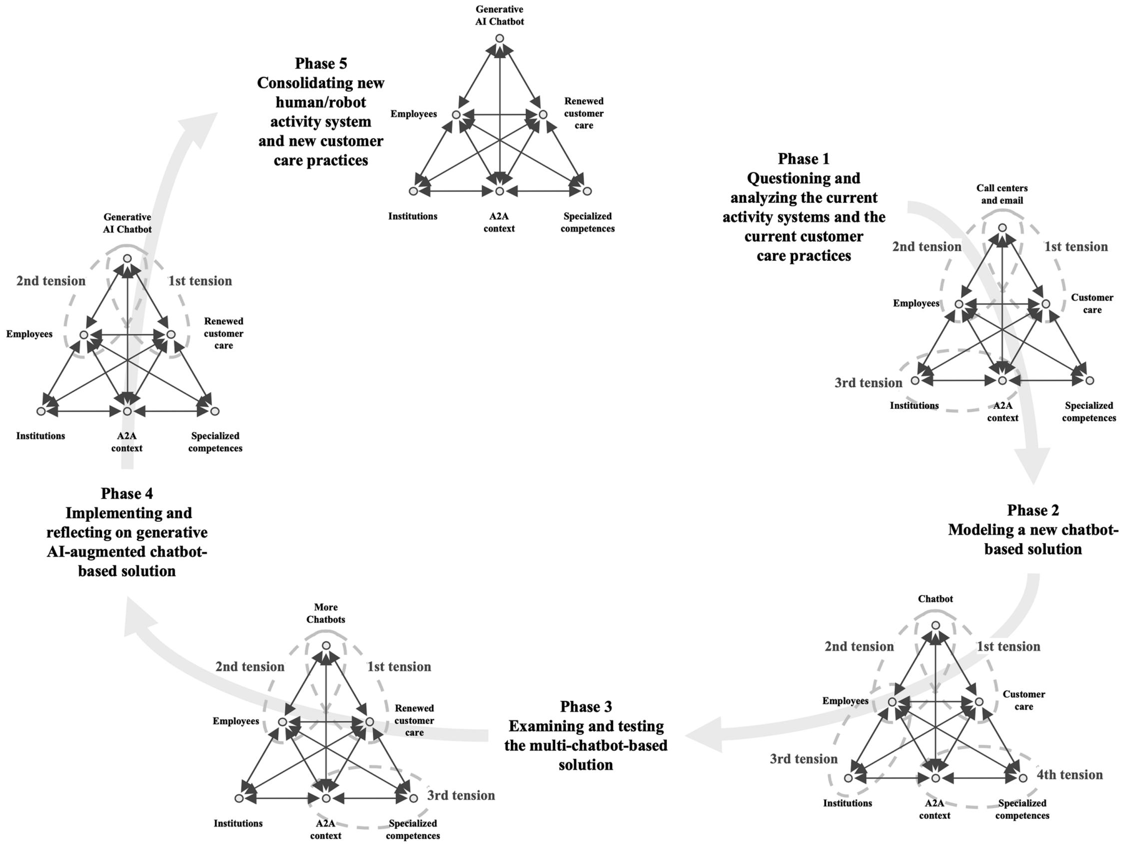

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Figure 8. Expansive learning by the human–robot activity system

Table 5. Customer care KPIs (in 2023)

Number of new users engaging with the chatbots	51,117	Weighted average rate of messages resolved independently by the chatbots	88.20%
Total messages exchanged	312,617	Weighted average rate of messages needing for customer suggestions	0.78%
Unique conversations managed	53,574	Weighted average rate of unresolved messages (%)	5.04%
Average messages per user	6.16 m	Weighted Net Promoter Score*	*positive* 40.76% *neutral* 36.59% *negative* 22.65%

Note(s): *Calculated on the basis of data available for four chatbots (Peter, Erika, Jemma, Lionel)
Source(s): The above table was created by the authors

2016; Mele and Russo Spena, 2018). The comprehensive view of HRC, we offer extends beyond typical dyadic HRI to encompass a systemic perspective that can facilitate the adoption of robotic technologies in customer care practices. We make two main contributions to HRC discussions: first, enriching extant studies on the evolving roles and tasks of humans and robots, and second, exploring how collaborative efforts reshape work practices.

First, we conceptualize the human–robot activity system as a specific case of the service-activity system (SAS) framework (Mele and Russo Spena, 2018), designed to enhance customer care practices. Within this shared system, HRC emerges as a dynamic collaboration where human actors and robotic actants operate, mediated by tools, rules and the community (Engeström, 2004). The focus of HRC—enhancing customer care—serves as the motivating objective of this system. Introducing new technology-based actants (e.g. chatbots) initiates a transformative process involving all the SAS components. Our findings highlight that the positive impacts of HRC extend beyond operational efficiency, accommodating new forms of working practices where humans and robots leverage their complementary strengths. This result adds to previous studies showcasing how collaboration drives greater efficiency and innovation in service provision (De Keyser and Kunz, 2022; Odekerken-Schröder *et al*., 2021).

Rather than perceiving robots as simple replacements, we emphasize their entanglement with human actors, where both parties leverage their respective strengths to enhance operational effectiveness and performance. This perspective enriches theoretical discussions on the dynamic roles of humans and robots in work practices, moving beyond simple task automation to highlight their interdependent collaboration within evolving work environments (Mozafari *et al*., 2022; Le *et al*., 2024). Humans and robots are interrelated, forming a system where collective development takes place through engagement in working activities. However, this process is neither smooth nor static. As our study shows, established schemas and specialized competences can either hinder or facilitate collaboration and outcomes. Our results confirm claims that human abilities and willingness are crucial to the successful integration and acceptance of robotic technologies in organizational settings (Xiao and Kumar, 2021). Involving employees early in the implementation phase can help ensure that the design of technology-based tools aligns with their practical needs, mitigates resistance and encourages a smoother transition (Bonetti *et al*., 2023).

Second, building on expansive learning theory (Engeström, 2001), we explain how the human–robot activity system evolves, addressing the concept of expansive performativity that emerges when HRC actively transforms the system in which they operate. As human actors and robotic actants collaborate, contradictions and tensions between current work practices and robotic capabilities arise. Most traditional studies on HRI do not address these contradictions, often portraying human–robot work practices as mere reproductions of

Table 6. Chatbot-related solutions to service activity tensions

Phase	Tension	Company actions	Results of expansive learning
Phase 1: Questioning and analysis of current activity systems and customer care practices	• *Tension 1* - Contradictions between the service promised and its effective care practice • *Tension 2* - Less efficient coordination of human and technical elements • *Tension 3* - Fear and implications of possible noncompliance	Find new solutions to enhance relationships with customers. A new technology is introduced: the chatbot	• Transition from traditional call center/ email-based operations to innovative communication channels • Improved service alignment • Adherence to regulatory compliance • Risk mitigation
Phase 2: Modeling new chatbot-based solutions	• *Tension 1* - Issues due to training constraints • *Tension 2* - High workload and stress levels of the employees • *Tension 3* - New rules and work routines • *Tension 4* - Inadequate collaboration across broader organizational settings	Adapt the technology to meet the needs of both employees and customers to ensure its effectiveness	• Relief from energy and time expenditure • Enhanced customer–robot interactions • Reduced human intervention in conversations • Strengthened technology collaboration
Phase 3: Examining and testing multiple chatbots-based solutions	• *Tension 1* - Issues in operational limitations of specialized chatbots • *Tension 2* - Increasing complexities in managing the solutions • *Tension 3* - Lack of specialized expertise	Improve the technology to overcome operational limitations for addressing detailed requests. A multiple chatbot-based solution is introduced to accommodate specific tasks and increase HRC	• Enhanced operational efficiency • Improved responsiveness • Shared workload with advanced technological solutions
Phase 4: Implementing and reflecting on AI-augmented, chatbot-based solutions	• *Tension 1* - Issue for a complete integration of the chatbot system across all company departments • *Tension 2* - Overburdened employees, struggling with the huge volume of data	Enhance robotic technology to become autonomous and capable of actively collaborating with employees. Generative AI has augmented chatbot capabilities	• Reduced employee burdens • Improved customers' data analysis • Contextually appropriate responses • Streamlined operations • Enhanced decision-making • Improved productivity

Source(s): The above table was created by the authors

existing activities, with the only difference being the introduction of a nonhuman actant. Instead, expansive learning emerges as a transformative process in which HRC not only adjusts to, but actively drives, a continuous and dynamic refinement of roles, tasks and institutional setups. This process of resolving contradictions and tensions triggers the co-evolution of human competencies and robotic functionalities, thereby reshaping work practices. The outcome is not only mastery of existing human skills but also the creation of new ways of working and organizational transformation (Le *et al.*, 2023; Leiño Calleja *et al.*, 2023).

Our findings enrich theoretical discussions on performativity and organizational transformation, revealing how HRC reshapes work systems, redistributes tasks and redefines institutional rules to accommodate new forms of work (Bonetti *et al.*, 2023; Xiao and Kumar, 2021). The entanglement between humans and robots entails an expansive performativity that transcends the traditional role boundaries of either actor or actant, creating new ways of working and communicating between humans (employees and customers) and robots (e.g. multi-chatbot systems). This transformation creates new opportunities, redefines institutional structures and broadens the scope of collaboration.

Finally, this study offers a system-based and learning-oriented perspective on HRC. The increasing complexity of service tasks and the demand for personalized services are likely to foster continued collaboration between service employees and robots, while also driving employees to enhance their skills for creatively engaging with and adapting to a robot-enhanced environment. This environment is marked by advanced tools, new rules and procedures to accommodate change. Their complementary strengths suggest a future in which humans and robots collaborate to reorganize service activities, upskill human abilities and innovate service provision.

5.1 Managerial implications

We offer several insights for managers regarding how to embrace a systems perspective to facilitate the transformative adoption of robotic technologies in work practices. First, HRC can produce a significant improvement in operational efficiency. Robots handle routine questions, reducing the workload on human employees and decreasing response times by improving customer service efficiency and satisfaction through timely and accurate responses to customers' inquiries. The expansive learning process we investigated illustrates how customer care tasks are increasingly being delegated to chatbots. At the examined company, by refining the training and capabilities of chatbots, customers receive more accurate and timely responses about products without the need for human intervention. As such, we recommend that managers work to leverage similar efficiencies to optimize their resource allocation and streamline service processes.

Second, the adoption of robot actants necessitates a careful redefinition of roles and responsibilities, including an appropriate division of labor. Employees must adapt to new roles as technology trainers or AI system supervisors, which means they must develop new competencies and problem-solving skills. Our investigated case illustrates how employees transition toward becoming technology collaborators. Employees have continuously enhanced their skills through customized workshops, learning how to use, train and understand the full potential of the technology. They have also adapted their activities to share their workload with the technology. We suggest that managers implement comprehensive training programs to ensure employees are proficient in using and managing the technologies, which should foster a collaborative environment where human and robotic capabilities combine synergistically.

Third, the integration of robots into service systems often leads to tensions, conflicts and contradictions, including mismatches between chatbot capabilities and customer expectations or increased workloads due to initial inefficiencies in chatbot performance. At the examined company, a feedback loop emerges where changes made in the service activity system to resolve known tensions often generate new ones. For instance, the introduction of additional chatbots provides more accurate responses to customers but creates challenges for employees who must manually manage various overarching training programs. Accordingly, we encourage managers to adopt a proactive approach to identifying and resolving such tensions through iterative problem-solving and expansive learning processes, doing so would involve continuously evaluating and improving the HRC, while also ensuring alignment with organizational goals and customer needs. In addition, Table 6, presented in the findings, can serve as a guide for the firm to identify tensions and assess potential actions, helping it navigate through the various phases.

Fourth, to mitigate resistance and ensure a smooth transition, managers should engage employees early in the design and deployment process, to help ensure the robotic technologies meet their practical needs and to foster a sense of ownership and acceptance. A participatory approach can address concerns about job displacement and build a collaborative work environment. In addition, a culture of continuous learning and adaptation can encourage employees to engage in ongoing training and development to stay abreast of technological advancements and optimize the collaborative potential of HRC systems. The investigated expansive learning process highlights the need for a feedback loop where insights from HRI are continuously integrated into system design and training. Employees continuously monitored and adapted AI training, suggesting new features and interfaces to enhance the technology's effectiveness while staying updated on its developments. These recommendations further suggest the need for a feedback loop, in which insights gained from HRI get continuously fed back into the system design and training processes.

By embracing such implications, practitioners can achieve innovation and transformation by enhancing operational efficiency, redefining roles, addressing tensions, promoting continuous learning and improving customer care. A proactive, inclusive approach to HRC paves the way for a future in which human and robotic capabilities get integrated harmoniously, creating dynamic and resilient service systems.

6. Limitations and further research

This study has some limitations that can guide further research. First, it is based on a longitudinal analysis of a single international healthcare company specializing in natural health products. The findings provide valuable insights into the integration of HRC in this specific context, but the generalizability of the results to other industries and organizational settings may be limited. Continued studies should consider diverse organizational contexts to validate and expand on these findings, as well as to address specific research questions such as: *How can the balance between automated service delivery and human touch be optimized in different customer care settings to maximize customer satisfaction and operational efficiency? What specific training programs and support mechanisms are most effective in helping employees adapt to working alongside robotic technologies? In what ways can organizations identify and resolve tensions between human work practices and robotic capabilities to achieve smoother collaboration and enhance system functionality?*

In addition, a potential avenue for future research could involve studying how expansive learning cycles unfold in different industries or settings, including how contradictions between current work practices and robotic capabilities lead to improved collaboration and work efficiency. Specific questions could be: *How do expansive learning processes vary across different sectors, and what factors influence the successful integration of HRC? What are the key triggers and facilitators of expansive learning in collaborative human–robot systems across various industries?*

Second, we examine chatbots and virtual assistants primarily within the customer care domain, so we might have overlooked other robotic and AI technologies that could have more significant roles in other service contexts. Further research could explore a broader range of technologies, including cognitive assistants, robotic process automation and physical service robots, to provide a more comprehensive understanding of HRC. Example questions include: *How do cognitive assistants and robotic process automation impact different domains of service delivery, beyond customer care? What challenges and opportunities arise when integrating physical service robots into human workflows across various service sectors ? What specific tensions emerge when integrating multiple AI technologies within a single service organization, and how do these tensions influence customer care practices?*

Third, investigating the social and psychological aspects of HRI might provide valuable insights into the acceptance, trust and collaboration dynamics between human employees and robots. Methodologies from social sciences or psychology might help reveal these aspects, offering a more holistic view of HRC. For example, *How do social and psychological factors, such as trust and perceived reliability, affect the willingness of employees to collaborate with robots in the workplace? What role do HRI design features play in shaping the social acceptance of HRC across different organizational cultures? What role do cultural differences play in shaping attitudes toward HRC, and how can these differences be addressed to minimize tensions in collaboration?*

Fourth, though we identify improvements in customer satisfaction, this finding reflects internal performance metrics and employee reports. Direct feedback from customers regarding their experiences with the integrated HRC systems is limited; comprehensive customer surveys and feedback mechanisms could reveal the end-user experience and satisfaction levels. Specific questions could include: *What are the key factors that influence customer satisfaction and acceptance when interacting with a combined human–robot service system? How does the quality of human–robot collaboration impact the perceived value of service from a customer perspective? How can customer feedback help address specific tensions, such as inadequacies in the customer service system? How can customer insights help organizations balance automation and human intervention, reducing service inefficiencies?*

Fifth, as the adoption of AI and robotics in service industries grows, rules and regulatory considerations become increasingly important. Therefore, we call for further research to address key issues such as data privacy, algorithmic bias and regulatory compliance and thereby help ensure the responsible and ethical use of robotic technologies. For example, *How do existing regulatory frameworks affect the implementation and operation of HRC systems? What measures can be taken to reduce algorithmic bias in service robots and ensure fair and ethical treatment of all customer segments?*

Sixth, we do not consider economic impacts. Assessing the economic implications of HRC, according to cost–benefit analyses, productivity gains, or impacts on employment, can provide valuable information for organizational decision-makers. Research that integrates economic evaluations could determine the financial viability and benefits of HRC investments and produce answers to the following questions: *What are the economic benefits and trade-offs associated with implementing HRC in various service sectors? How do initial investments in HRC compare to the long-term financial benefits for service organizations, particularly in terms of efficiency and cost savings? How does the adoption of HRC technologies affect workforce structures, employment patterns and overall productivity within organizations?*

By addressing these questions, continued research can provide even more comprehensive insights into the multifaceted aspects of human–robot collaboration, enhancing its implementation and effectiveness in various service contexts.

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