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Towards Cognitive Service Systems–A Framework for Conceptualizing AI-Supported Value Co-Creation

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ABSTRACT

Service systems are evolving from traditional service systems to smart service systems to cognitive service systems based on the evolution of technological capabilities. However, humans in service systems might change work or life situations, have cognitive capabilities, and suffer from bounded rationality. In addition, humans face acute problems like knowledge burden, half-life of information, and being flooded by data, information, as well as knowledge. To overcome these problems, traditionally humans learn and acquire skills, knowledge, and experience through entrepreneurship and innovations. But modern technologies like AI, generative AI, and IoT usher a new horizon to overcome those problems through the harmonious interactions between humans and generative AI. In this research, we propose a framework of cognitive service systems that focuses on the following aspects: Humans interact with generative AI harmoniously and consider these technologies as assistants, collaborators, coaches, and mediators in the cognitive service system. Therefore, the proposed model of cognitive service system is described by developing a hierarchical topology of tools, assistants, collaborators, coaches, and mediators (TACCM), which ultimately expands the evolution of service systems with the co-evolution of technological capabilities. Practically, the TACCM topology supports humans regardless of industries and their professions, race, creed, and gender to co-create value through harmonious interactions with technologies.

Keywords: Cognitive service system, Smart service system, TACCM topology, Service system

INTRODUCTION

A service system is the configuration of people, technologies, organizations, and shared information that interact over time for the co-creation of value (Spohrer et al., 2008). Service systems are evolving from traditional service systems to smart service systems to cognitive service systems based on the evolution of technological capabilities (Spohrer, Siddike, and Kohda, 2017). However, humans in service systems have limitations of lifespan, and cognitive capabilities, and suffer from bounded rationality (Simon, 1997). In addition, humans face acute problems such as knowledge load (Jones, 2005), information half-life (Arbesman, 2013), and being flooded by data, information, and knowledge. To overcome these problems, humans traditionally learn and acquire skills, knowledge, and experience through entrepreneurship and innovation (Spohrer and Siddike, 2018). However, modern technologies such as generative AI open a new horizon to overcome these problems through the harmonious interactions between humans and generative AI (Siddike et al., 2017; Spohrer et al., 2017).

Nowadays, new technologies, including AI, and generative AI, augment the capabilities of humans to become smarter or wiser (Norman, 2023; 1993; Siddike et al., 2017). In the past, machines augmented the physical strength and capabilities of humans. But today, for example, generative AI such as ChatGPT, Google Bard, and others augment human capabilities in multiple ways. In addition, technologies like cognitive computing and sensor technologies are beginning to augment human capabilities in specific ways (Spohrer, Siddike, and Kohda, 2017). This augmentation of human capabilities was called for by the American engineer and inventor, and the early computer and Internet pioneer Douglas Engelbart (Spohrer and Siddike, 2018). To some extent, researchers have predicted that these technological capabilities will become more advanced and augment human capabilities such as weak telepathy, weak immortality, and weak colonization (Lenat, 2016).

In the service system, humans interact harmoniously with these technologies to co-create value (Siddike and Kohda, 2018a; 2018b; 2018c). Previously, researchers described how humans interact with different AI-based cognitive assistants (CAs) for the creation of value. Some of them discussed that reliability, attractiveness, and emotional attachment play the most significant role in influencing humans to interact with CAs. In addition, they also explained the relative advantages, and trustworthiness of using the work of CAs as a mechanism to evolve these AI-based technologies as actors in the service systems (Siddike and Kohda, 2018; Siddike and Kohda, 2019; Siddike et al., 2021). Previously, Spohrer, Siddike, and Kohda (2017) described the evolution of the service system in which they predicted that most people would have CAs as a form of intelligence augmentation, embedded in smartphones or equivalent technologies such as wearables and the physical environment. Later, researchers described CAs as representing both the evolution of technological capability as well as the evolution of social trust (Spohrer and Siddike, 2018). However, they never described or developed any framework for cognitive service systems. Only recently, some researchers conceptualized cognitive service systems and developed a reference framework for developing cognitive service systems (Feike, Neuhüttler, and Kutz, 2023).

Therefore, in the presented research paper, we provide a broader evolutionary view of technological capabilities by conceptualizing cognitive service systems from the perspective of AI-supported human interaction. This evolution of augmentation and support extends from cognitive tools to personal assistants to collaborators to coaches, and ultimately to cognitive mediators. In the first step, a conceptualization of cognitive service systems is proposed and described by developing a hierarchical topology of tools, assistants, collaborators, coaches, and mediators (TACCM), which ultimately extends the evolution of service systems with the co-evolution of technological capabilities and their support of human interaction. In practice, the

TACCM topology supports the systematic design of value co-creating interactions between humans supported by technologies. The following chapters are organized as follows: Section 2 describes the chosen research approach; Section 3 introduces the evolution of service systems; Section 4 explores the nature of cognitive service systems; Section 5 introduces the TACCM hierarchical topology; and Section 6 concludes the paper with discussion and future research directions.

RESEARCH APPROACH

To understand the evolution of service systems with the evolution of technological capabilities, a deep understanding of the related literature is very important. As an initial attempt, we conducted a detailed literature review. Specifically, we reviewed the literature on "service science", "service systems", "service ecosystem", "service-dominant (S-D) logic", "institutional arrangements", "cognitive services", "trusted AI", "service science in the era of AI", "smart service systems", and "wise service systems" from a multidisciplinary point of view, as this provides a broad view of the cognitive service system concept. We searched different databases, namely Web of Science, Scopus, and others. In addition, we also searched in Google Scholar.

We selected those pieces of literature that were related to the current research purpose. Then, we conceptualized the brief "*evolution of service systems*", followed by "*cognitive service systems*". Finally, we proposed and elaborated a theoretical framework of *tools, assistants, collaborators, coaches, and mediators (TACCM) topology* as the evolution of technological capabilities.

SERVICE SYSTEMS EVOLUTION

Service systems evolve from traditional service systems to smart service systems to cognitive service systems based on the evolution of technological capabilities (see Figure 1) (Spohrer, Siddike, and Kohda, 2017). In this evolution, first of all, a **service system** is an evolving ecology of responsible actors that interact and change over time to co-create value for each actor (Spohrer and Maglio, 2008; 2009; Maglio and Spohrer, 2013). In service systems, people and organizations with rights and responsibilities, as well as technologies and shared information with no rights and responsibilities, are the four main types of resources (Spohrer and Maglio, 2009; Spohrer, Kwan, and Fisk, 2014).

Only people, organizations, and nations have rights and responsibilities in service systems that function as governance mechanisms to control and coordinate value-creating interactions (Spohrer and Maglio, 2009). In the same alignment, a **smart service system** is a self-detecting, self-diagnosing, self-correcting, self-monitoring, self-replicating, or self-controlling system that interacts with humans and other service entities (National Science Foundation, 2014; Demirkan, Spohrer, and Badinelli, 2019; Lim and Maglio, 2019; Neuhüttler, Ganz, and Spath, 2019). Moreover, in smart service systems data is used to adapt interactions and offerings to a context or needs in specific situations (Neuhüttler et al., 2020a; 2020b). The interactions in smart service systems are precisely defined by smart rules and regulations (Demirkan, Spohrer, and Badinelli, 2019). Finally, **a wise service system** is a smart system in which people use smart technologies for the creation of value (Siddike et al., 2017; Spohrer et al., 2017). The term wisdom refers to prudent and holistic value creation across generations in order to create lasting value based on experience.

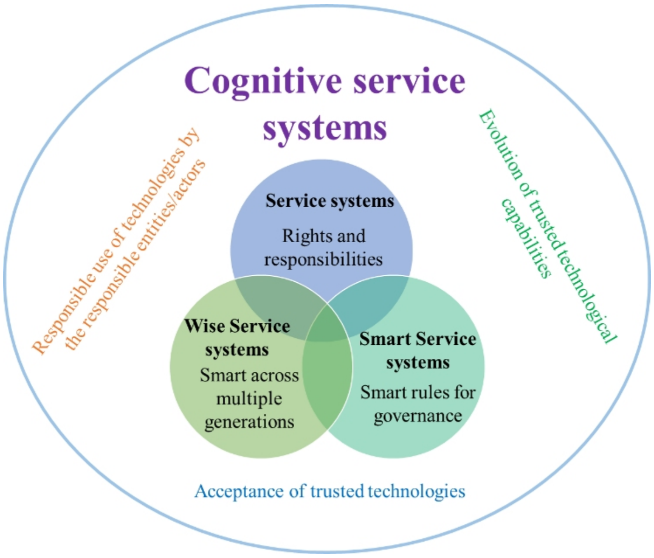

Figure 1: An evolutionary view of cognitive service systems.

All service system entities are cognitive system entities, and all cognitive system entities are physical-symbolic system entities (Newell and Simon, 1976). To be a service system entity, one must be able to have rights and responsibilities in the social sense that people have rights and responsibilities, companies have rights and responsibilities, and nations have rights and responsibilities (Spohrer and Maglio, 2008; 2009). As of today, AI, generative AI, and other advanced technologies do not have rights and responsibilities in the service systems. However, humans, organizations, and nations as service system entities/actors have rights and responsibilities and use or own those technologies (Spohrer et al., 2022). As a result, a cognitive service system is a system in which cognitive technologies are owned or used by the responsible entities/actors. In the cognitive service systems, these cognitive technologies could potentially advance more and more trusted capabilities (i.e., tools, assistants, collaborators, coaches, mediators) to augment/enhance the capabilities of (people, businesses, and nations) that all types of service system entities (Spohrer and Siddike, 2017; Spohrer et al., 2022). Finally, these technologies will be accepted by the people in our society based on their advanced capabilities of technologies (i.e. explainability, fairness, ethics, emotional attachments, ownership, rights, and responsibilities).

A FRAMEWORK FOR COGNITIVE SERVICE SYSTEMS

In this paper, we define a cognitive service system as a system in which humans have cognitive assistants (CAs) that offer appropriate options, recommendations, and suggestions by observing, understanding, and capturing the contexts, situations, environments, and culture that help humans make smart/wise decisions to solve complex problems more efficiently and effectively (Siddike et al., 2021; Siddike and Kohda, 2019; Siddike and Kohda, 2018a; 2018b; 2018c; Siddike et al., 2018a; Siddike et al., 2018b; Spohrer, 2016; Spohrer and Banavar, 2015). Here, CAs are AI, generative AI, and IoT-based technologies that are enabled by large data sets and highly speedy computers, providing humans and organizations with high-quality options, recommendations, and suggestions that make them better data-driven decisions (Spohrer, 2016; Spohrer and Banavar, 2015). In addition, CAs can augment human knowledge, capabilities, and expertise by understanding the context, situations, and environments with depth and clarity (Siddike et al., 2018a; Siddike et al., 2018b). Furthermore, human problem-solving capabilities are significantly augmented by the harmonious interactions with CAs. ChatGPT, Google Bard, Scribe, AlphaCode, GitHub Copilot, DuetAI, and others are notable examples of CAs. Cognitive service systems help the next generation to build and rebuild from scratch (Spohrer and Siddike, 2018). In cognitive service systems, CAs have the mighty power to generate insights from trillions of unstructured and structured data, process the data, and provide accurate recommendations, options, and suggestions for humans and organizations which augment humans' intelligence, knowledge, capabilities, and expertise that ultimately enhance humans' performance (Siddike et al., 2018a; Siddike et al., 2018b). In addition, CAs can also observe, understand, and grasp humans' contexts, situations, environments, and culture through harmonious interactions with them (Siddike and Kohda, 2018). As a result, CAs have the data, information, knowledge, intelligence, and wisdom about humans and their situations, contexts, and culture which are termed "*artificial information, knowledge, and wisdom*" in this paper (Siddike and Kohda, 2018; Siddike et al., 2017). In the cognitive service systems, CAs can potentially progress from tools to assistants to collaborators to coaches to mediators and be perceived differently depending on the role that they play in the cognitive service systems (see Figure 2).

On the other hand, humans have skills, knowledge, and experience that are acquired by sensing the real-world environment, using knowledge and experiences. Humans' recommendations are based on their experience, knowledge, and skills to solve complex problems (Siddike et al., 2017). In this way, humans and machines collaborate harmoniously and generating win-win value co-creation for individuals and the common good. In a cognitive service system, win-win value co-creation goes beyond individuals and includes policies for the common good as well as humans, organizations, and societal aspects (Spohrer and Siddike, 2018; Siddike et al., 2021; Siddike and Spohrer, 2018).

In the cognitive service systems, CAs (AI, generative AI, and other advanced technologies) can potentially progress from tools to assistants to collaborators to coaches to mediators and be perceived differently depending on the role that they play in the cognitive service systems (Spohrer and Siddike, 2018). First of all, as an assistant, CAs provide humans with a vast amount of real-world data and information. Secondly, as a collaborator, CAs can support humans with a huge amount of knowledge by understanding specific situations and contexts. Thirdly, as a coach, these technologies support humans with high-quality knowledge to improve the cognition, intelligence, and capabilities of humans. Fourthly, as a mediator, CAs facilitate humans with value co-creation interactions and capability co-elevation at multiple scales. Finally, CAs in cognitive service systems augment human cognition, intelligence, and capabilities which ultimately enhances human performance (Spohrer and Siddike, 2018).

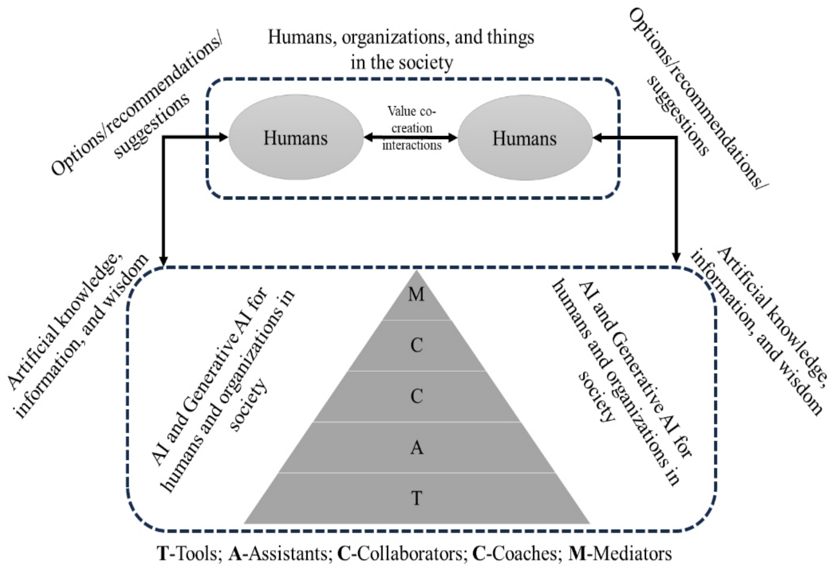

Figure 2: A framework for structuring cognitive service systems.

Tools

As a tool, CAs can analyze vast amounts of structured and unstructured data to provide valuable insights for supporting humans, organizations, and society in making informed decisions (Siddike et al., 2017). In addition, as tools, these technologies process and manipulate data, enable various tasks, and facilitate human interactions by playing a crucial role in the information processing journey, from handling raw data to providing more advanced capabilities (Spohrer, 2016). Furthermore, as tools, these technologies could take care of repetitive tasks, freeing up more time for humans and organizations to focus on more complex and creative aspects of their work (Siddike and Kohda, 2018). Finally, as tools, these AI and generative AI technologies are versatile technological components, able to process and automate to support and serve as the foundational building blocks for more advanced systems to enhance efficiency and capabilities across different domains and professions (Spohrer, 2016). Simply, as a tool, these technologies assist humans in automating routine tasks, personalizing user experiences, optimizing resource allocation, and enabling predictive analytics for strategic planning (Siddike and Kohda, 2018; Spohrer, Siddike, and Kohda, 2017). Creative content generation acts as a cocreator simply to schedule appointments, answer queries, and receive personalized recommendations (Siddike and Kohda, 2018). As a tool, it supports organizations for customer segmentation and targeted marketing by optimizing sales strategies and improving customer satisfaction. Broadly, as a tool, these technologies could support people in society for urban planning, optimizing space utilization, energy efficiency, and environmental sustainability (Walk et al., 2023).

Table 1. Tools, assistants, collaborators, coaches, and mediators (TACCM) hierarchical topology.

Nature	What will do for us?
Tools	Data and information (as a tool will be able to process trillions of data and information)
Assistant	Knowledge (as an assistant cognitive mediator will have more knowledge about people)
Collaborator	Understanding (as a collaborator can understand people's situations and culture, and conditions more than we)
Coach	Wisdom (as a coach can help our next generation build and re-build from scratch)
Mediator	Advisor learning and wisdom (facilitate value co-creation and capability co-elevation interactions between entities at multiple scales)

Assistants

As assistants, AI, generative AI, and future more sophisticated technologies provide valuable support for humans, organizations, and overall society in different domains. Simply, as assistants, these technologies provide proactive information, and task assistance, and enhance creativity in content generation by making information and creativity more accessible. It provides personalized information, automates tasks, and so on (Spohrer and Siddike, 2018). They can range from virtual assistants that aid with daily tasks to more specialized systems, such as AI-driven creative collaborators or future technologies acting as personal aides in transportation or healthcare. The key characteristics of assistants include proactive support, task automation, personalization, context understanding, continuous learning, and versatility in their applications (Siddike and Kohda, 2018). Assistants take initiative by providing timely and relevant information, recommendations, and solutions without waiting for explicit requests. They automate routine tasks, simplifying processes and allowing individuals to focus on more complex or creative aspects of their work (Siddike et al., 2018). Assistants tailor their support to individual preferences, learning from interactions to deliver personalized and context-aware assistance. These systems understand the context of user interactions, ensuring that their assistance aligns with the specific needs and goals of individuals or organizations. Assistants continuously learn and adapt, refining their capabilities over time based on user feedback, changing preferences, and evolving requirements (Siddike et al., 2018).

Collaborators

Collaborators are intelligent systems that work together with humans, organizations, and society. They actively contribute to shared goals by providing insights, creative ideas, and efficient solutions in areas such as research, creativity, decision-making, and problem-solving (Siddike et al., 2021). Collaborators, in the context of AI, Generative AI, and future advanced AI technologies, are intelligent systems that actively engage in cooperative efforts with humans, organizations, and society to contribute to collective knowledge creation, problem-solving, and creative endeavours (Siddike and Kohda, 2018). These systems work alongside individuals, enhancing their capabilities, offering insights, and fostering a synergistic partnership for mutual benefit (Siddike et al., 2018a; 2018b).

Coaches

Coaches in the context of AI, Generative AI, and future advanced AI technologies are intelligent systems designed to provide personalized guidance, feedback, and support to individuals, organizations, and society (Siddike and Kohda, 2018; Siddike et al., 2021). These systems leverage their capabilities to assist in skill development, decision-making, and learning processes, aiming to enhance performance, understanding, and overall well-being (Siddike et al., 2018a). As coaches, these technologies offer tailored advice and guidance based on individual needs, preferences, and learning styles (Spohrer and Siddike, 2018). In addition, they assist in the development of skills by providing targeted exercises, feedback, and strategies for improvement. Furthermore, as coaches, these technologies promote ongoing learning and adaptation, helping individuals stay updated and relevant in their respective domains. Also, they offer constructive feedback, highlighting strengths and areas for improvement to facilitate continuous growth. More importantly, as coaches, these technologies adapt to the evolving needs and progress of individuals, ensuring that their guidance remains relevant over time (Siddike et al., 2018a; 2018b).

Mediators

Mediators in the context of AI, Generative AI, and future advanced AI technologies are intelligent systems that facilitate communication, understanding, and resolution of interactions between individuals, organizations, or societal elements (Spohrer and Siddike, 2018). They act as intermediaries, leveraging their capabilities to mediate conflicts, enhance collaboration, and foster harmonious interactions among diverse entities (Siddike et al., 2018a; 2018b).

In the case of Communication Facilitation, Mediators enhance communication by interpreting and conveying information effectively between different parties. Conflict Resolution, they assist in resolving conflicts by identifying common ground, proposing compromises, and promoting understanding among involved parties. In the case of Facilitators of Collaboration, Mediators foster collaboration by bridging gaps between diverse perspectives, encouraging cooperation, and facilitating joint efforts. Understanding Bridge, they bridge understanding gaps by translating complex information, ensuring that different stakeholders comprehend and align with shared goals. Neutral Arbitration, Mediators maintain a neutral stance, impartially guiding interactions to ensure fair and unbiased resolutions.

CONCLUSION

The key contribution of this research lies in conceptualizing cognitive service systems along with the value-adding interactions that are supported by AI. More importantly, this paper systematizes the different forms of AI support in terms of cognitive assistants that make a significant contribution to Service Science in the era of AI. In the framework of cognitive service systems, the TACCM hierarchical topology ultimately expands the evolution of service systems with the co-evolution of technological capabilities. To sum up, the TACCM topology in the cognitive service systems is the progression of more and more trusted capabilities to augment/amplify the capabilities of people, organizations, businesses, nations, and society—as service system entities. Practically, the TACCM hierarchy supports humans regardless of industries and their professions, race, creed, and gender to co-create value through harmonious interactions with technologies.

This research is not free from limitations. First of all, the proposed and described cognitive service systems framework and the topology of TACCM—are based on previous literature and our understanding of the evolution of technological capabilities and their role in the service systems. As a result, future analyses of cognitive service systems and research work on their design can be carried out much more systematically and along standardized terms.

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