

The Human-Side of Service Engineering: Advancing Technologies Impact on Service Innovation

Wojciech Cellary, Louis E. Freund, Stephen K. Kwan, Christine Leitner, Jim Spohrer
April 15, 2019

Abstract:

Purpose – As advanced technologies drive changes in digital service and service systems across industries, what are the implications for the Human-Side of Service Engineering (HSSE)? This work updates previous HSSE frameworks (Freund & Spohrer 2012, Freund & Cellary 2017), and extends Service Science, Management, Engineering, and Design (SSMED) studies (Spohrer & Kwan 2009). Newly included are HSSE areas related to determinants of trust: standards, experience, public policy, privacy & ethics. All of these are types of shared information resources that influence trust between actors and will be impacted by advances in Artificial Intelligence (AI). These updates are needed, as the impact of Information Technology (IT) on service systems continues to expand, and AI technologies successfully emulate more human capabilities, including skillful deceit. IT solutions for service systems requirements are widely employed and accepted, but they can also create new challenges and unintended consequences (Arthur 2011, 2017; Blocker et al 2019). Currently, we observe numerous instances of the mass gathering of data in real time from social media, from the Internet of Things (IoT), from AI and Augmented Reality (AR) applications. The purpose of this paper is to consider possible future directions of AI from an HSSE perspective using observations and examples. The paper explores how IT provides an essential engine for integrating the back and front stage of service provision/operation as well as a platform for enabling new innovative value propositions, business models, and service offerings. New architectures for providing digital service are discussed, along with emerging standards about digital service powered by AI/ML/DL (Artificial Intelligence/Machine Learning/Deep Learning) techniques.

Design/Methodology/Approach – Analysis of technology history, digital service transformations, as well as current achievements and trends of computer science and engineering, and deployment of modern IT solutions in different sectors are developed through observations and examples.

Findings – Challenges to society and its fundamental values coming from recent advances in data engineering including artificial intelligence are discussed. Specific determinants of trust (standards, experience, public policy, privacy and ethics) are shown to be the key elements of the future evolution of IT based service innovations.

Research limitations/implications (if applicable) – The research provides a view of the history of technology, including recent advances in IT and AI, in service and its impact on service innovation, aligned with the Service-Dominant Logic and Service Science literature, and especially HSSE.

Practical implications (if applicable) – Business and societal recommendations related to determinants of trust including standards, experience, public policy, privacy and ethics have numerous practical implications. For example, standards are emerging for [IT Service Management and IT Governance](#), including [Governance Implications of AI](#).

Originality/Value – This research addresses a gap in the literature connecting emerging standards, experience, public policy, privacy and ethics (determinants of trust) around AI to Service-Dominant Logic and Service Science literature, emphasizing HSSE. This work contributes to an understanding of the history of IT and AI in service research.

Key words (max 5) – Human-Side of Service Engineering (HSSE), Artificial Intelligence (AI), determinants of trust, service science, Service Dominant Logic.

Paper type – Conceptual/Theory Building paper

1. INTRODUCTION

This paper provides an updated introduction to the area of study known as HSSE (the Human-Side of Service Engineering). HSSE is the community within the broader service science community (see Box) that studies people as key actors within current service systems and emerging service innovations. Service innovations include inventing, adapting, and engineering technology, organizations, and information systems to better support people's needs, wants, and aspirations. In the original HSSE paper (Freund & Spohrer 2012), the service research foundations on which our efforts are built were discussed, including Service Science, Management, Engineering, and Design (SSMED) (Spohrer & Kwan 2009), Service-Dominant Logic (Vargo & Lusch 2014; 2016), and a proposed framework for Service Innovation (IfM, IBM 2008).

HSSE is concerned with the human-centric issues encountered in designing, developing, and operating better systems for our work and daily lives. It is concerned with topics ranging from ergonomics to the determinants of trust. Table 1 summarizes advancing technologies and their Human-Side impacts across human history (Harari 2014). New technologies (column 1) enable new types of systems in which people live, work, travel, as well as govern themselves and make decisions about the possible futures in which to invest their resources (column 2). Over the years (column 3), advancing technologies, organizations, and service system innovations have led to a growing population of people and a wide range of new roles in society and businesses, including new professions and disciplines interconnected with education systems (column 4). Service innovations that improve quality of life often depend on a complex co-evolving integration of systems related to efficient physical flows, fair human capital development, and trustworthy governance across multiple scales of time and space (Spohrer & Maglio 2010a; 2010b). Determinants of trust between actors is fundamental to human collaboration and allows people to interact regularly and successfully with strangers (Seabright 2010). However, recent studies indicate that trust in IT businesses and government institutions is decreasing from earlier decades (Zuboff 2019; Ortiz-Ospina & Roser 2019).

Technology	Service Systems	Years Ago	Comments
Stone Tools, Fire, Clothing, Animals, Carts	Families, Tribe Leader	~100,000 – 60,000	Hunter-Gathers; Crafts-people; Older Teaching Younger
Agriculture, Ships	Cities, Kings	~20,000 – 5,000	Farmers; Shops; Apprenticeship
Steam Engine, Trains	Factories, Nations & Legislatures	~250 - 200	Worker; Schools; General Education
Electricity, Chemistry (Oil), Automobiles	Businesses, Financiers/Banks	~150 - 120	Employees; Suburbs; Higher Education
Computers, Internet, Airplanes/Spacecraft	Startups, Venture Capitalists	~70 - 50	Globalization; Mega-cities; Graduate Education
Smart Phones, GPUs for Deep Learning, Artificial Intelligence, Drones/Avatars	Crowd & Platforms, Hedge Funds	~15 -5	Wikipedia, GitHub, Kaggle, LinkedIn, Uber, AirBnB; New Collar/Learn On-Line and On-The-Job

Table 1: Advancing technologies and their Human-Side impacts

BOX (Definitions):

The **Human-Side of Service Engineering (HSSE)** studies people as the primary variable in service systems, with service innovation as the main goal to invent, adapt, and engineer better skills, technologies, organizations, and information resources and value propositions to address the needs, wants, and aspirations of diverse people in service systems (Freund & Spohrer 2012). The disciplines of human factors, industrial and systems engineering, psychology, anthropology, and many others are relevant to HSSE studies, which align with the broader area of study known as service science. **Service science** is an emerging transdiscipline that studies the evolving ecology of nested, networked service system entities, interactions, and outcomes, their capabilities, constraints, rights, responsibilities, as well as mechanisms for value co-creation and capability co-elevation, using a wide range of disciplinary perspectives and methods from marketing, operations research, human factors and industrial engineering, design, information systems, computer science, mechanism design, management of technology, organizational development, economics, public policy, anthropology, ethics and more (Spohrer & Maglio 2010; Maglio et al 2018). **Service systems** are dynamic configurations of resources (people, technology, organizations, and shared information) connected internally and externally by value propositions forming an ecology of named entities with identities, histories and reputations based on their interactions and the outcomes as judged by stakeholders (Spohrer 2011). Examples of service system entities include people, families, businesses, universities, cities, states, and nations (Maglio et al 2009). **Shared information** includes language, processes, metrics, prices, policies, and laws as well as standards, ethical codes, specializations (professions, disciplines, skills), value

propositions, and much more (Spohrer et al 2007). **Value propositions** are a type of shared information relating to capabilities and needs of entities that help shape the interactions between entities and are used to reason about win-win value co-creation outcomes (Anderson, Narus & Rossu 2006; Wright 2001). **Front Stage/Back Stage:** The Front Stage of a service encounter refers to all interactions where any service personnel or service system elements are in direct contact with customers. Back Stage refers to all the supporting systems for a service and all employee interactions with other employees, partners, and information systems that are necessary to support a service encounter but are not in the presence of (or probably even known about) by customers (Teboul 2006). The “**discipline harmonization challenge**” relates to how best to educate and prepare future service scientists across the wide range of disciplines (IfM, IBM 2018). One approach is to educate **T-Shaped Adaptive Innovators**, who have enough depth in at least one discipline and enough breadth across the wide-range of disciplines, to work in teams to understand, improve, and sustainably innovate the smarter and wiser service systems in which they and future generations will fill roles (Spohrer et al 2017).

In Section 2, the original framework is summarized. Section 3 discusses proposed extensions. Section 4 provides concluding remarks and future research directions.

2. SUMMARY OF ORIGINAL FRAMEWORK

2.1 Background

In the original HSSE paper (Freund & Spohrer 2012), before introducing the proposed framework for the Human-Side, we began by clarifying seven related foundational concepts: Service, service systems, value propositions, modern service systems, service system entities, engineering, service engineering, and the Human-Side of service engineering. We recap the foundational concepts here:

Service: Historically, the concept of “service” is often connected with the concept of “servants.” Early specialization in agriculture and craft production meant that families/tribes were exchanging their unique access to resources and knowledge of production for other families’ resources and knowledge of production. From this perspective, the best definition of service is, and always has been, “value co-creation” between entities. Vargo and Lusch (2004) suggested the definition of service as the application of knowledge [*and skills*] for mutual benefits, also known as value co-creation. More technically, value co-creation is referred to as win-win or non-zero-sum games and provides a directional arrow for progress (Wright 2001; Spohrer et al 2013).

Service Systems: Dynamic configurations of resources (people, technology, organizations, and information) connected internally and externally by value propositions forming an ecology of named entities with identities, histories and reputations based on their interactions and the outcomes as judged by stakeholders (Spohrer 2011). For example, people, families (households), towns, cities, counties, states, provinces, nations, universities, businesses, government agencies, non-profits, professional associations, and all named entities with legal rights and responsibilities

– in short, named legal entities such as those found in Wikipedia. Holistic service systems can exist for some period of time, even if disconnected from other external service systems.

Value Propositions: Value co-creation mechanisms; entities communicate and agree to value propositions, which they reason about and refine through trial-and-error and other processes (Spohrer, Maglio 2010a). For example, informal promises between people, contracts between businesses, and treaties or trade agreements between nations are all examples of value proposition-based interactions. Value determination is entity-dependent, history-dependent, and context-dependent. A good value proposition connects the key performance indicators (KPIs) measures of two service system entities in a mutually reinforcing manner, creating measurable value-cocreation as interactions occur over time. Borrowing and repaying with interest, installment payment plans, compound interest on deposits, and leasing are all examples of value proposition-based interactions, and one type of value-cocreation phenomena. Service can be defined as a value co-creation phenomenon between entities seeking mutually beneficial outcomes.

Modern Service Systems: As the industrial revolution took hold, economists noted that outsourcing early family activities to businesses and government was leading to a “modern service economy,” employing techniques of mass production and higher quality as human populations exploded to billions from earlier periods (Clark 1940, Levitt 1972). Clark noted that the more advanced economies had larger “service economies” as some indication of social progress. Our present age of technology-enabled abundance and prosperity presents new challenges (Auerswald 2012), including, unemployment, climate change, pandemics, terrorism, which are all challenges made worse by large, interconnected, technologically-sophisticated populations of people. Modern service systems provide easy, speedy access to local and remote, technological and human capabilities that allow capacity to scale up or down with demand via a digital connections scaling model (Hsu & Spohrer 2009).

Service System Entities: Service system entities interact to co-create outcomes. Service system entities are legal entities and have rights and responsibilities. For example, providers, customers, as well as other stakeholder roles in business and society, span a wide-range of entities including, “people, corporations, foundations, non-governmental organizations, nonprofits, government agencies, departments in an organization, cities, nations, and even families” (Spohrer et al 2008a). Service system entities are the most fundamental abstraction of service science (Spohrer et al 2008b). The concept of system entities has been criticized as overly abstract, recursive, and inclusive of too many disparate kinds of entities (Glushko 2010).

Engineering: Engineering is both an academic discipline and a highly skilled professional activity. It combines an understanding of science, mathematics, available technology and environmental conditions. Furthermore, it includes a wide range of human factors, including economic, social and political factors. Engineers make things that improve the quality-of-life of people. Scientists work to understand the world as it is, while engineers work to build new worlds that have never been.

Service Engineering: Service engineering spans multiple scales of engineered systems from direct, person-to-person customer-provider interactions to service interactions that nations provide their citizens and that nations provide other nations. Service engineering seeks to improve all value co-creation interactions between entities and move steadily towards optimal outcomes.

Human-Side of Service Engineering (HSSE): The Human-Side of service engineering is a type of service engineering with a focus on modern service systems. Modern service systems are digitally-connected-for-scaling. The people in service systems (e.g., customers, employees, citizens, entrepreneurs, etc.) are the focus. How best to increase the capabilities of people, and thereby increase societal opportunities for them is an important question. The goal is to apply the principles and science of human factors and ergonomics engineering methods to make and scale diverse types of service systems.

2.1.1 Types of Service Systems

The types of service systems have been summarized in the service science disciplines and systems framework (Spohrer & Maglio 2010). Systems – industry sectors – deal with flows, development, and governance. Flow-related service systems include transportation, water, materials, energy, and information. Physical infrastructure including technology and environmental factors are important considerations in all these service systems. Development-related service systems include buildings, retail, finance, health, and education. While flow-related service systems would be needed in a world of robots, development-related service systems have a unique relationship to people and their developmental stages as well as personal tastes and preferences. Buildings evolve to uniquely integrate flows and development of people. Governance-related service systems include city, state, national-level and sub-national (e.g., Spain) and supranational-level (e.g., European Union) systems that provide defense, security, rule-of-law, penalties for non-compliance, taxation and funding of public works, such as to essential infrastructure and regional development opportunities. While these types of service systems have existed arguably for many hundreds of years, only in the age of modern service systems have sensors and the digitization of customer-provider interactions enabled accurate record keeping.

2.1.2 Service System Entities: Roles and Measures

Service system entities are also known as actors, agents, and resource integrators (Vargo & Lusch 2011). Entities take on a range of stakeholder *roles* such as customer, provider, authority, competitor. They can be individual people, families or households, businesses, non-profits, hospitals, hotels, universities, cities, states, nations and supranational organizations (such as the EU). All of these types of entities are identifiable by name and have rights and responsibilities. A holistic product-service-system entity provides “whole service” to the people inside them. Whole service includes flows, development, and governance – for example a university provides whole service to its resident students, a luxury hotel to its guests, a hospital to its patients, a household to its family members, etc. Entities interact via value-propositions, and normatively try to produce win-win or value co-creation outcomes of mutual benefit. Often value propositions

provide one entity with access rights to the resources of another entity for temporary use (e.g., hotel stay) or permanent use (e.g., eating in a restaurant). Each entity, which is also a system stakeholder has measures of primary concern: customers' own qualification and assessment of provided service, providers' qualification, quality of service provision and productivity, authorities' compliance assessment, and competitors' innovation. Sustainability and resiliency are measures of concern to holistic entities.

2.1.3 Cultural Variants in Service Systems

Anthropologists study cultural variations and diversity. What makes sense in one culture, may make no sense at all in another culture. The Human-Side of service engineering must consider cultural variations and diversity in the design of airports, transportation hubs, hotels and restaurants, government service centers, hospitals, universities and more. Shared cultural information about language, laws, values and norms, religion, mental models, measures, standards, dress and clothing, food preferences are a major source of human factors in service systems.

2.2 AFFECTING PERFORMANCE

2.2.1 Systems Requirements

The science of ergonomics and human factors informs all aspects of service engineering and service design. Human factors range from the physical, cognitive (information processing, multitasking, mental workload, memory, etc.), perceptual, and communications (person-to-person, displays, controls, and other technological interfaces) interaction capabilities to the performance impacts of environmental factors (such as temperature, noise, and lighting) and social factors. For example, transportation service systems include aircraft and buses which require comfortable seating, storage for personal items, and properly designed ingress and egress passages and procedures, for normal operations and emergency modes. Attention to human capabilities and limitations is at the core of the Human-Side of service engineering, and rigorous systems requirements analysis.

2.2.2 Special Populations

Special populations such as children, elderly, disabled, pet-owners, pregnant women, people with allergies, gender identity, and many other types of individuals affected by rules and regulations give rise to human factors design challenges for service engineers. For example, amusement parks and entertainment centers are especially challenging because of the range of customers as well as theme park employees who may be wearing costumes that limit visibility and hearing. Accommodation means respecting the dignity of individuals while providing a real and non-demeaning approach for access and engagement. The homeless population often includes many of those suffering from mental illness who may not be accommodated very well by service systems in major urban areas. In civil society, people exercising their rights to assemble and to protest government policies are requested to behave responsibly, as are government

entities, to ensure safety of all actors, but challenges on the Human-Side of service engineering may arise. As examples, transportation, security and safety, distribution of information to special populations may be disrupted when performed in the presence of non-routine events, such as protests. The capabilities, constraints, rights, and responsibilities of members of special populations are contextual and dynamic. This is a Human-Side challenge.

2.2.3 Protecting People and Ensuring Safety

Protecting people and ensuring their safety means avoiding errors, accidents, and injury. For example, self-service ATMs near banks or other facilities may be accessed any time, night or day, and so proper lighting, cameras, and visibility are essential to protect customers and ensure their safety. Service systems such as airports and government building now require security screening on ingress – requiring the design of special procedures that includes specialized equipment and trained personnel to operate. Gun violence in schools, places of worship, movie theatres and other public places has increased awareness of the real threat of violence in service systems. New technologies such as smartphones and body-worn cameras are documenting incidences of violence as they unfold, leading to rethinking approaches to safety in service systems.

2.2.4 Exceeding Individual and Organizational Goals

Any survey of the human aspects of service engineering must include the social and behavioral aspects of people as goal-driven individuals filling roles within a wide-range of organizations on a daily basis. For example, human resource professionals seek to measure and enhance the levels of employee engagement at work. Employees and students seek to improve, exceed, be praised, be recognized, and advance according to measures of success. Gamification of a range of behaviors seeks to motivate improved performance, and recognize the hierarchy of needs, wants, and aspirations of individuals in many social contexts. The Human-Side of service engineering includes diet, exercise, enhanced healthy choices, minimizing unhealthy options, on topics from vending machines at school and work to arrangement and shelving of items in grocery stores and on shopping websites. Even the household and family can be viewed through the lens of the Human-Side of service engineering, and encouraging healthy, smart, and wise choices that achieve diverse goals.

2.2.5 Assuring Information Security and Privacy

Assuring security requires both protecting the privacy of information in systems and protecting the systems themselves. For example, smartphones and apps provide customers and providers opportunities to interact much more frequently, from banking to health monitoring, to social media sharing of personal information, location, and preferences. Platforms for ride-sharing have made transportation easier and more convenient but have also opened the door for bad actors. Bad actors are eager to use personal information and convenient access for mischief and crimes, from manipulating online behavior to stealing, or even identify theft. The Human-Side of service engineering benefits from advanced capabilities such as smartphones, apps, social media, but new challenges arise as well. The General Data Protection Regulation in the European Union

(GDPR) is an example that represents an important step towards protecting and securing personal information and curtailing unintended usage of such data.

2.2.6 Capability and Opportunity Enhancement

Modern service systems enhance the capabilities and opportunities of customer, employees, and other stakeholders for value co-creation and capability co-elevation. For example, loyalty programs allow customers to earn higher levels of service, as they consume more of an offering. Gamification and recommendation engines, as well as augmenting human performance through access to advanced AI systems driven by “big data,” are intended to help customers make better choices that co-create more mutual benefit for all stakeholders interacting in multi-sided, online, platform-based markets.

3. ADVANCED TECHNOLOGIES IMPACT ON SERVICE INNOVATION

3.1 Standards

As economic sectors grow, industries recognize the need and develop product and service standards to facilitate interoperability, manufacturing, supply chain operations, common control, partners and contractor’s coordination and, enabling of consumer choices. The development of associated standards has been usually industry-driven and follows, albeit slightly lagging, the maturity curve of a product or service. This is particularly true in the service sector. While the service economy has grown tremendously in the past decade and a half (e.g., in the U.S. the service sector is estimated to be 80% of the GDP in 2017¹), the development and publishing of service standards has not followed at the same pace. A recent study by Weissinger & Kwan (2018) found that service standards published by the International Standards Organization (ISO) were mostly related to the back stage (see Figure 1) of service provider’s operations such as Information Technology and enabling processes related to production (as defined by Teboul (2006)). The authors indicated that: “This was not surprising since standards have historically been developed for the technical specification and interoperability of products and this orientation favors the tendency to develop more standards in the more familiar territory of the enabling side of services” (Weissinger & Kwan 2018).

¹ <https://www.cia.gov/library/publications/the-world-factbook/geos/us.html>

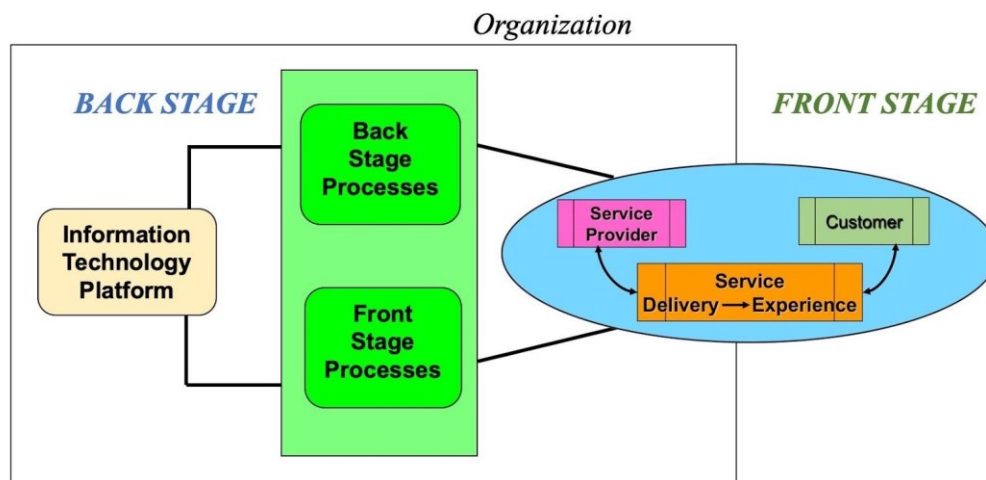


Figure 1 – Front and Back Stage of a Service Organization

On the front stage, however, the intangibility of service and the frequent involvement of human behavior in service delivery and customer interaction and experience increase the challenges of standards development for services. The study did find some recent increases in ISO's on-going service standards development that are oriented to the front stage.

The authors also reported that ISO and many national standards development organizations (e.g., those from the US, Germany, EU, etc.²) have published strategies and are actively promoting standards for the service sector. As part of this strategy, ISO/IEC had updated its Guide for Service Standards Development to be published in 2019 (ISO/IEC Guide 76 (2008)). The Committee on Consumer Policy (COPOLCO) of ISO has also been active in promoting consumer-related standards projects (some with service elements). In parallel with product specification/performance standards and service standards, many management system, governance, and quality standards that relate to the operations of organizations have also been developed and adopted. Some of these standards (sometimes called horizontal standards) are closely related to elements of service operations.

Weissinger & Kwan (2018) also studied whether there was any synergy between service science research and service standards development. They note that the number of researchers in the community who study service science has grown along with the relative size of the service sector in national economies, rapidly increasing publications in the literature and the influence of the community on industry standards and public policy. The authors found that one of the fundamental concepts of service science: "service as value co-creation" had not yet entered the world of service standards. As a matter of fact, there was very little, if any, reference to the concept of a customer's customer value proposition. The authors surmised that: "In this world,

² American National Standards Institute (ANSI), German Institute for Standardization (DIN), European Committee for Standardization (CEN), respectively.

service is often understood as the unidirectional delivery of something intangible to a customer usually as part of a product. This process is similar to the delivery of a physical good, and in the lexicon of Service Dominant Logic, reflects the prevalence of goods-dominant logic in the concepts applied in service standardization” (Weissinger & Kwan 2018).

More exchanges and closer cooperation between service science researchers (academic) and service standardization professionals (industry) will prove to be beneficial for both groups and for the overall goals of establishing service standards (see Fig. 2). For standardization, a closer cooperation with service science could be of benefit with the availability of a relatively consistent common theoretical framework that could provide a bridge and common language between different sectors and areas of service standardization. The adoption of service science concepts and models could also provide a Human-Side framework for more customer-driven orientation and alignment with customer value expectations and needs fulfillment. This would potentially lead to a gradual, timely and needed move from goods-dominant logic to Service-Dominant Logic in service standards development.

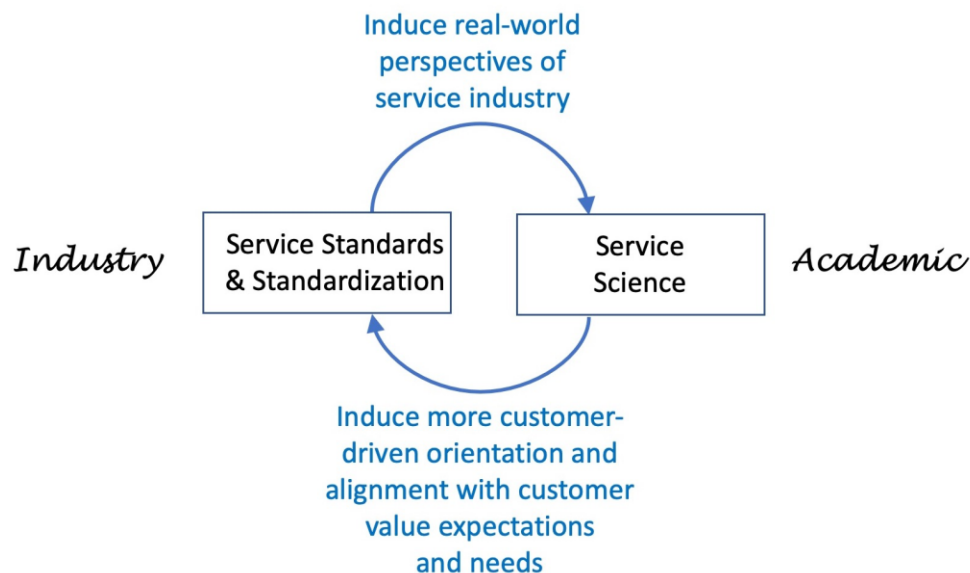


Figure 2. Exchange and Closer cooperation

For service science, closer collaboration with standardization would provide a “real world test” into the applicability of some of its concepts through their use in standards for the service industry. Standards as an instrument of knowledge dissemination and innovation, could contribute to increase the spread and influence of ideas, concepts and methods that have originated in service science.

The observations and recommendations discussed above are becoming even more relevant as AI applications are proliferating in both market-based and non-market-based (such as public) services (see Section 3.3.3 below). As the technology matures, industry is driving the

development of pertinent standards. The ISO/IEC JTC1 SC 42 Artificial Intelligence³ was formed in 2017 and there are now twenty-two member nations working on nine standards related to concepts and terminology, bias, trustworthiness, framework, use cases, governance and other matters.

3.2 Experience

Much has been written about the need for new skills in the digital economy (Markow et al 2017; Bakhshi et al 2018), but less is known about whether increasing the user's skills, alone, will satisfy the immense and growing potentials of AI in service system designs. Today, we easily can envision a future where aspects of each human's work, educational, and personal experiences (including all skills) are continuously entwined with multiple service systems simultaneously, providing information to these systems and tailored guidance to the user for each activity that he/she undertakes. Point-of-sale transaction terminals connected to cloud-based processing ensure that myriads of retail and professional services can be widely deployed with confidence in the security and validity of each transaction. Web-based communication services, such as Skype, WhatsApp, Webex, Zoom, and others have enabled new constructs for collaborations within and between organizations globally in real time. Services aimed at transporting, enriching, or caring for individuals such as car-on-demand, financial planning, medical diagnosis and treatment, education, and travel planning and many others are now broadly tied to and dependent on computing and data storage technologies. As systems and users evolve together, AI will strive to be best configured for providing any service when requested, finely attuned to the user's own experience (skills included).

3.2.1 Experience, Narrow AI, and Broad AI

How can AI attain such a level of an individual's experiential background to be able to optimally impact the Human-Side of service in the manner described above? This question can be addressed by considering the two major directions of AI development. "Narrow AI" refers to systems designed to perform one task very well – with speed and accuracy (DeAngelis 2015, Jajal 2018). A Narrow AI system may be able to help you pick movies and order tickets, but it probably is not designed to also order shoes for you. Similarly, another Narrow AI system may be able to compete with you in a chess match, but it probably would not also be designed to order movie tickets. Narrow AI systems work with big data to fulfil their tasks and process much information much faster than a human can. Narrow AI systems can be arranged to run in series or in parallel to expand the perceived power of the system. Narrow AI mimics the expertise and experience a human has in a specific field or domain, assisting with speed and the depth of its resources.

Examples of such systems are very familiar. Amazon's Narrow AI mines the shopping cart, page visits, and other data associated with our activity on its site to "magically" and suddenly suggest

³ ISO/IEC Joint Technical Committee 1 Sub Committee 42 Artificial Intelligence:
<https://www.iso.org/committee/6794475.html>

other items we may be interested in, videos like those we have already watched, and prompts for reordering supplies that we may be running low on. Its AI functions assist us, on the Human-Side of their service system, to enjoy the benefits and experience of Prime membership more. Yet, this Narrow AI system does not yet know that we recently attended a workshop and may be interested in books on the topic that we have never searched for on their site. Nor does the Amazon system know that an individual has just completed a certification and may want to purchase additional supplies in the field.

Another example of how Narrow AI has impacted the human side of service systems is in the area of customer service. Many organizations now use AI natural language processing systems and have transformed their customer service (Alzahrani 2016). The systems can prompt, direct, answer, and recall information relative to our requirements as we provide it with necessary information. They have created new opportunities for customers to obtain quick resolutions of support requirements. In the customer service sector, AI systems already provide virtual assistants which ultimately aim to transcend human language capabilities (Shabbir & Anwer 2015).

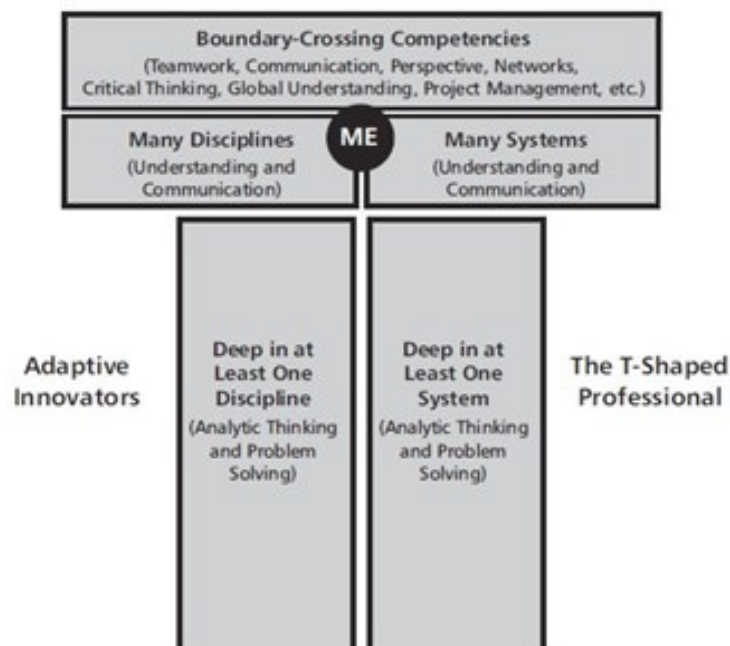


Figure 3 – The T-Shaped representation of experience, (Moghaddam et al 2016)

The second type of AI is Broad or “Strong AI”, which “refers to machines that exhibit human intelligence, and beyond. These machines will perform any intellectual task that a human being can” (Jajal 2018). They do not exist yet, and scientists are in general agreement that they have no idea as to when Strong AI systems will come. In concept however, Strong AI adds elements such as experience, judgement, understanding, learning, and creativity to the capability of the AI system. These elements suggest that Strong AI will enable AI systems to broadly interpret

problems and situations in the context of many relevant dimensions simultaneously, just as humans do, and very likely, much better than humans do.

3.2.2 AI Maps with the T-Shape Representation of Experience

Thinking positively, AI designed and operated with good intentions will be better able to support us, as individuals, if we allow it to learn more about us as we go about our daily professional lives, and additionally share aspects of our personal lives that may in turn result in better service. We may be able to establish a framework for this communication pathway by using the dimensions of a T-shaped person, a universal paradigm reflecting an individual's personal and professional achievement and experience (Spohrer, Maglio, Bailey & Gruhl 2007, Gardner & Gruhl 2007). The stem (or vertical part) of the T is meant to reflect the depth of expertise a person has gained in a discipline or a system, while the top (or cross bar) of the T reflects a person's breadth of experience in disciplines, responsibilities, cultures, organizations and other professional and personal broadening experiences (Figure 3).

Thus, in the T-Shape representation of experience there is a human parallel to Narrow AI, which is the expertise in a field that a person builds and evidences in a wide range of ways. MyT-Me, a metric for T-shaped professional (Freund 2018), defines the T-stem in terms of a person's (1) Memberships, authorships, and recognitions, (2) Education, degrees and certifications, (3) Operations responsibilities and expertise, (4) Software/Device Proficiencies, and (5) Methods/Skills and Proficiencies. Conceivably, based on a person's documented MyT stem history to date, Narrow AI could detect, configure and supplement the expertise of that person for purposes of assuring that the system and the person are optimally integrated.

The Strong AI human parallel, of course, is the human mind, learning, evaluating, deciding, and guiding a person's life by accumulating and prioritizing experiences every moment from birth. The My-T metric T-Top paradigm represents an individual's "breadth" of experience by the following categories: 1) Project management, 2) Organizational design, 3) Communications, 4) Critical thinking, 5) Teamwork, 6) Networking, 7) Empathy, 8) Perspective, and 9) Global understanding.

3.2.3 Enhancing the Human-Side with AI and the T-Shape Representation of Experience

People develop experience through both specialized and broad life experiences. Today some of these experiences and outcomes are documented in platforms such as LinkedIn. It seems likely that AI and the Human-Side of Service Systems could meet and exchange information using the MyT metric framework as a platform. As individuals advance their MyT metrics records, by completing degrees, taking on new organizational roles, traveling to a different culture, or learning a new software, the information could be passed to an AI module supporting a service system that they are interacting with. The information would be used by the AI to configure the interface for that person appropriately based on the record of accomplishments and experiences registered in his or her MyT. In other words, AI could conceivably modify the user's system interface in real time for each different person based on his or her MyT metric record.

Additionally, by “knowing” the MyT metric records of a person, AI could be a much more powerful support for systems interaction. Instead of knowing only the person’s past interactions with the system to propose guidance and support (as Amazon now guides us based only on our past interactions with Amazon), AI access to something akin to the MyT metric would be able to assist and suggest to us in much more broader contexts, based on what we do, where we have been, where we are planning to go, and myriads of other ways. As we build out our MyT profiles, the contributing elements of expertise and experience would enable interfaced AI to configure our interactions with service systems accordingly.

As these concepts evolve, the Human-Side of service systems works together with the AI supporting the systems to produce an enhanced service experience. It’s as though the human, as reflected by his/her MyT constructs is enhanced by the MyT enhanced system design.

3.3 Public Sector

IT-based platforms have enabled huge progress over the last few decades, both in the private and in the public sector. It is important to recognise, however, that the public sector operates with its own specific requirements and constraints. It does not only offer services to individual customers but delivers ‘public goods’ for the benefit of the general public. Much of public administration activity is actually about managing information, i.e., building up and maintaining public databases such as civic and land registers, geographic information systems, or official statistics on economic activities. These activities are conducted in the public interest, for the benefit of a multitude of impersonal addressees based on appropriate regulatory frameworks and infrastructures. The core relationship between government and citizens, known as the ‘social contract’, is more complex than a mere ‘customer’ relationship. It includes the delivery of public goods such as security, public order and basic infrastructures, and values such as political and economic stability, legal certainty, the rule of law and the protection of citizens’ rights and civil liberties. While disruptive innovation often causes discontinuity, the social contract is based on continuity. This tension needs to be recognised and managed whenever new technology is applied to the public sphere, always putting the citizen at the center.

The digital government (r)evolution is underway, and there is no turning back. Governments have been deploying technology for several decades to enhance service systems and delivery. Starting in the late 1990s New Public Management (NPM) reinforced these trends with a focus on efficient service provision and dealing with citizens as ‘customers.’ With the advent of the Internet and its explosive growth, and inspired by the use of e-commerce, governments embarked on their going digital journeys around the year 2000. The initial aim was to promote the use of the Internet. Singapore’s e-government strategy, for example, contributed to a rise in Internet penetration rates from 16 per cent in November 1999 to 53 per cent in March 2000. (Dunleav & Margetts, 2000). At the same time, reinforced by the NPM’s focus on efficiency, technology enabled back stage integration lead to significant savings in certain government sectors, for example tax administration and social security systems. Even though public policies promoted citizen centric, inclusive and transparent public e-services (e.g. the Dutch e-Citizens’ Charter), for a long time,

solutions from e-commerce were often ‘imported’ into the public sector, with little attention to the specific needs of citizens in a given socio-cultural context (Leitner 2003).

The advent of web 2.0, cloud computing, web services and increased network capacity, mobile devices, social media, machine learning and AI has given rise to a wave of innovation in government. Technological innovations have triggered profound changes within the public sector. Smart services and evidenced-based policy-making have become the new normal. New architectures and governance models have emerged, with a focus on ‘co-creation’, ‘co-production’ and the Human-Side of citizen participation (e.g. in participatory budgeting). The Internet of Things (IoT), in particular, is driving Smart City development, while automated systems, machine learning, AI and robots are replacing routine processes (e.g. the granting of building permits), taking over hazardous activities (e.g. the use of robots to clean up hazardous waste) or forecasting (e.g. disaster management and pandemics prevention). Public sector employers can thus focus on tasks that provide more value for citizens and that are tuned for successful citizen interactions, while generating more high-quality jobs and increasing job satisfaction among public sector employees. To this end, continuously upgrading the T-shape experiences of the public workforce in both depth and breadth, as discussed in the previous section, will be crucial.

Given these technological advances, three questions must be addressed: (1) Engaging Citizens: How best can governments engage citizens while addressing the challenges of digital government transformation? (2) Staying Safe: How to ensure security, and mitigate cybercrime, disinformation, and civil unrest? (3) Fair Distribution: How to ensure more equal distribution of benefits and costs?

(1) Engaging Citizens: Roughly two decades after the advent of ‘e-government’, public administration is now going ‘digital by default’ (e.g. Denmark and the United Kingdom were the first to implement this policy in the EU). Based on a number of recent incidents and increasing awareness about the potential negative impact of disruptive technologies on individuals and society (for example in connection with abusive practices during elections) it is not surprising that stakeholders are calling for future government to be focused on the ‘human side’ (OECD 2019). Citizens in democratic societies expect their government to ensure a number of fundamental deliverables based on the social contract, such security, the protection of their rights and the provision of public service offerings based on their needs (and wants).

(2) Staying Safe: Cyberattacks by criminals against individuals and companies, by government or state-sponsored actors in pursuit of a political agenda are a serious, and growing, concern. Cybersecurity risks to infrastructure, which is already a major concern for conventional networks, are likely to be compounded by the advent of the IoT when networks serving the government’s systems are populated with thousands, if not millions of devices, most of them relatively small, with limited on-board processing power, only basic defences, and without permanent human monitoring. In retrospect, the cyberattacks on public institutions and critical infrastructure in Estonia in April 2007 may be regarded the beginning of an era where digital technology has demonstrated its potential as a powerful and destructive geopolitical weapon.

In recognition of the potentially catastrophic consequences of a cyberattack on critical infrastructure, such as power grids, traffic systems or communication networks, governments the world over have turned their attention towards improving the resilience of these essential networks. Outright cyberattacks are, however, but the tip of the iceberg. Open and connected societies are exposed to a variety of other types of interference such large-scale online espionage, fraud, data theft and the targeted dissemination of disinformation ('fake news') via the electronic media.

Social cohesion is under threat when the use of technology triggers divisive dynamics that stir up or increase tensions between groups or segments of society. One recent example is the phenomenon of 'filter bubbles' in social media where the combination of user profiling and search algorithms applied by digital media operators may end up locking users into self-contained, self-referential and self-reinforcing networks of like-minded participants where entrenched views and positions are rehashed and reasserted (Pariser 2011). Online discourse that takes place in 'filter bubbles' becomes fragmented and is no longer effective as an integrative, inclusive medium for public deliberation and consensus-building.

(3) Fair Distribution: The social contract comes under additional strain when certain segments of society bear a disproportionate share of the costs and negative side effects of adopting a new, disruptive technology. This aspect is being discussed intensively at present in the context of AI. Forecasts of large-scale job losses due to the adoption of AI and robotics, and the experience that returns from IT-enabled productivity gains tend to accrue disproportionately to a small segment of the population, are likely to unsettle large parts of the population. All this undermines acceptance of the existing social contract and renders citizens susceptible to populist agitation (Leitner & Stiefmueller 2019).

3.4 Privacy and Ethics

In the current stage of development and deployment of IT, we observe integration of the physical world with the digital world giving birth to the cyber-physical world (Alur 2015). The blood of the cyber-physical world is the data gathered through the internet of people and things, transmitted through 5G telecommunication, stored as 'big data' in the 'cloud', and processed by means of myriads of artificial intelligence (AI) protocols for diverse purposes. After extracting new knowledge from data, AI is used to influence people either directly or indirectly through things surrounding them, again through the internet of people and things (Unemyr 2017). Stored data reflect not only a person's possessions, actions, and relationships with other people, but even their wishes, intentions, and emotions. Data collected in real-time about a person may be combined with those cumulated over a long time. Data collected for a particular reason may be re-used for a very different reason. Finally, data describing a particular person may be processed in the context of data describing different, but somehow similar persons, circumstances, and events (Alpaydin 2014).

Predicting human behavior in complex service systems is an important aspect of Human Factors and the Human-Side of Service Engineering (Freund & Cellary 2017). The availability of big data

and AI tools opens great opportunities not only to predict human behavior, but also to then attempt to influence future behavior of people (Alpaydin 2014). Such predictions are not 100% sure, because AI methods are not based on causality – a fundamental characteristic of human reasoning – but on correlation. The goal of big data analysis is to apply mathematical methods to calculate the probability that a scenario concerning a particular person being in a particular circumstance that the person has already experienced, or has been experienced by persons similar to him/her, will repeat. The predictions coming from data analysis may be just or unjust, and the consequences of unjust predictions may be insignificant or significant. For example, if an advertisement selected to be shown to a particular user of a digital service is unwanted, because he or she is not interested in it, nothing particularly bad happens. Simply, a company paying for that advertisement will not get a customer. However, if AI has determined that an innocent person is a potential terrorist or criminal, and as a result he or she is put under surveillance, the consequences of this AI finding on his/her life may be very severe. This simple hypothetical example indicates the potential for danger coming from AI based on probabilistic methods. AI forecasts future behavior of a particular person based on the collective behavior of similar persons who have been in similar situations. Such forecasts are never 100% sure. A forecast concerning future behavior of a person may be incorrect because that person may act according to his/her free will, and that may be opposite to average collective behavior of the population. Therefore, despite the potential of AI methods, a person should only be judged on the grounds of what he or she has really done in the past, and there should be no judgements based on statistical predictions of what the person might do in the future (Cukier & Mayer-Schönberger 2013). We must conclude that detecting and removing such bias in AI models is the social responsibility of vendors (Partnership on AI 2019).

An important issue concerns the intentions of persons or institutions that make predictions. The potential good uses include providing people with services that are personalized and well adapted to their needs, as well as more effectively and quickly protective against hazards. The potential evil uses include forming personalized restrictions of individual rights and the erosion of the foundations of trust inherent in a democratic society (Draft Ethics Guidelines for Trustworthy AI 2018).

In the future cyber-physical world inundated with data, the problem of people's privacy will become crucial (Schneier 2015, Pasquale 2015, Angwin 2014). It is generally agreed that private data should be kept secured for at least four different reasons: (1) To reduce the possible distress caused by the change in social relations: a person who has lost some aspect of his or her privacy can consequently be subject to judgment by other people, hardly ever favorable; (2) To reduce a person's vulnerability to business-related attacks such as aggressive marketing, refusing to enter certain contracts, or aggravating contractual provisions; (3) To minimize the probability of criminal attacks. Private data is aggressively sought by cyber criminals to target potential victims and to minimize their risk when planning a crime; (4) To minimize vulnerability to identity theft. Identity theft has serious consequences for a victim. It is very hard to prove that decisions, such as bank transfers, were made by an identity thief, instead of a true bank client, when the credentials used in the transaction appeared in all respects to be authentic.

Business, unsurprisingly, is interested in maximizing the profitable use of the personal data of its current and potential clients. Business wishes to reduce its risk of presenting unwanted offers of goods and services that, on one hand, disturb customers, while, on the other hand, generate costs but do not provide business with profit. A business may use its customer's data to detect and forecast his/her possible needs and vulnerability to arguments and suggestions to purchase its goods and services to meet those needs. This is a kind of win-win situation in the business – customer relationship. The problem, however, arises with regard to whether a business that collects private data about people uses it only for the above-mentioned purposes. Alternatively, does the business use it for other purposes that may be harmful for people or sell it to other businesses whose purposes were never agreed by the people concerned? (General Data Protection Regulation GDPR 2016)

Business behavior is still quite mild, however, when compared to the application of the same techniques to convince a person to vote for a particular candidate in democratic elections. The personalized arguments used for such campaigns addressed to individuals on mass scale must be convincing, but do not need to be true, and often are not true (Fogg 2002).

As technologies advance, so do rules, such as standards (discussed in Section 3.1 above), policies, and laws (Romer 2010; Spohrer et al 2012). Each new technology, always, is related to opportunities and threats (Wojtowicz & Cellary 2018). To take advantage of opportunities but eliminate or at least reduce threats, legal strategies are applied which forbid some practices that are technically possible but socially unacceptable. Unfortunately, this is not so easy in case of the wanton abuse of data. On the one hand we have the internet that provides technical access to data from everywhere on the globe, while on the other hand we have 193 legal systems independently developed and used by the 193 countries that are members of the United Nations. These legal systems are not compatible, and often can be presumed to be conflicting, so all together they do not provide efficient privacy protection. An even worse situation exists when one considers the variations in the practices of law enforcement in these 193 different countries.

Service innovation is highly stimulated by new information technologies. One may expect many new kinds of service offerings following from the integration of tangible and digital aspects in the cyber-physical world. We must ultimately face the fact that the disclosure of confidential information entrusted to a person cannot be prevented by technology. Hence, with the growth of AI, we must expand our concerns with the Human-Side of services, which may ultimately provide the limiting factor to their design and usefulness. A person or system that has gotten to know confidential information may willingly or under coercion share it with unauthorized entities, be they people or systems. Only an increase of ethical practice together with new legal solutions and their coordination among countries, as well as the development of technical tools will permit people to benefit from new services emerging in the cyber-physical world without incurring excessive risks. Morals and markets co-evolve (Friedman 2008).

4. CONCLUSIONS AND FUTURE WORK

Across a range of determinants of trust, from standards to experience to public policy to privacy and ethics, AI is poised to impact the Human-Side of service engineering and service innovation, both through more automation as well as augmentation (Rouse & Spohrer 2018; Pakkala & Spohrer 2019). Along with other information technologies such as augmented reality, virtual reality, and blockchain for trust, advances in AI will fundamentally transform business and societal systems by accelerating the socio-technical system design loop, which directly impacts human extension factor which are measures across domains such as transportation, communications, and much more (Kline 1995). Furthermore, AI will surely play a major role in solving the service science *“discipline harmonization challenge.”* As defined above, this challenge relates to how best to educate and prepare future service scientists across the wide range of disciplines (IfM, IBM 2018). One approach is to educate T-Shaped Adaptive Innovators. Someday in the next two decades, the following will be achieved – the creation of a single, low cost AI that can correctly answer nearly all of the questions in most top university textbooks, in the major languages and across the disciplines that span service science. Multitask learners have already made some progress in this direction (Wu et al 2018), though hurdles remain (Lake et al 2018). What are the implications of such an AI for next generation service scientists, especially with respect to the Human-Side of service engineering? So called *“super-minds”* with harmonized disciplinary capabilities will augment our human-intellect far more than today’s ubiquitous and indispensable smartphones (Malone 2018; Engelbart 1962). Our personalized super-minds will profoundly impact the nature of research, education and work (worthy goals) that people perform in future service systems (Baumol 2002; Spohrer et al 2013; Freeman 2018; Gilbert 1978).

As our data and experience become enmeshed with our AI helpers, the future research directions of the HSSE community should include work on: (1) ethical AI, (2) protecting personal data, (3) new methodologies and tools, (4) service robots, and (5) platforms and service ecosystems.

Ethical AI: Many scholars and policy makers are calling for ensuring that algorithms governing our lives are transparent, fair, and accountable (MIT Media Lab, 2017). There is, already, a substantial body of research highlighting the limitations of IT-enabled platforms, such as algorithm-based AI. They include analytical fallacies and shortcomings caused by the limitations of available data and contextual information. There are also methodological issues to be considered when designing digital services and applying them to particular use cases. The use of statistical methods and inductive logic to infer rules from correlations within a large set of data, for example, runs the risk of conflating correlation and causality. In fact, some proponents of Big Data analysis explicitly advocate a reversal of the traditional scientific method of using empirical data to test and accept or reject hypotheses (Anderson, 2008). This is not at all compatible with the requirements of rule-making in society, which relies on proven causality as the primary justification for the application and enforcement of the law (Leitner & Stiefmueller, 2019). The deployment of digital technologies also places new demands on legality and accountability. The adoption of AI, in particular, could be interpreted as tantamount to inserting an unaccountable ‘third party’ into the relation between citizens, on the one hand, and private or public-sector providers of digital

services, on the other. In the EU, for example, the GDPR grants EU citizens the right to review decisions that were informed by machine-profiling by a human. However, citizens, policy makers, legislators, legal scholars, lawyers, and judges may not have the skills to understand computer code, algorithms, and neural networks (Hildebrant 2015). Finally, it is important to pay close attention to the use of AI – in administrative processes and commercial applications alike and to ensure that legal safeguards for citizens against discrimination, exclusion and abuse that exist in the physical world are monitored and enforced by authorities with equal effectiveness in the emerging, AI-enabled environment online (Cukier & Mayer-Schönberger 2013). So clearly, a future research direction for the HSSE community is to continue to study the challenges for both citizens and professionals in the digital age. This will require close scrutiny of studies published on the potential impact of AI on employment, such as Frey, Osborne (2013) and McKinsey Global Institute (2017) and others.

Protecting Personal Data: Due to the combined effect of advances in hardware (data storage, processors), software (virtualisation, data analytics) and infrastructure (broadband capacity), data in general, and personal data in particular, has become a storable and tradeable commodity enabling companies to devise new business models and governments to re-design public service offerings for businesses and citizens. The collection of data through smart devices connected via IoT platforms, however, also raises new questions related to the protection of privacy and ethics. Personal devices, whether they be baby monitors, fitness trackers, smart watches or medical alert sensors for seniors, are communicating sensitive personal information all the time onto the network. Smart devices that monitor public spaces may collect information about individuals without their knowledge or consent. More and more of these data, and the tools and infrastructure to process it in large quantities, is increasingly concentrated in the hands of ever fewer players. Private companies, such as digital media companies and telecom operators, have become large and powerful repositories of personal data. In some cases, meanwhile, government's appetite for gathering and processing personal data rivals, or even surpasses that of the private sector (e.g. the Chinese social credit system.⁸) Smart services based on the commercial or public use of citizens' data (e.g. based on the so-called 'once-only principle', which requires the consent of the individual) offer increased convenience for customers, while, at the same time, citizens' right to privacy increasingly come under threat. In response to that, the EU's General Data Protection Regulation (GDPR), for example, established an enforceable right to data protection for all EU citizens – by design and by default. Any collection of personal data must be adequately disclosed, formally justified and restricted to the necessary minimum. Citizens' personal data cannot be processed unless necessary for a specific, legitimate purpose. The purpose, expiration, security, etc., of the data collected must be communicated clearly to the person concerned. Personal data must be retained for as short a time as possible. To date, 'privacy by design' as a fundamental architectural feature of every IT platform that deals with citizens' personal data is still relatively vaguely applied. Models need to be further developed and evaluated to breathe life into this assurance of citizens' rights in the digital age.

New Methodologies and Tools: Especially when studying vulnerable populations, new methodologies must operate at the highest ethical standards. The study of human memory and

creativity in the age of smart machines should also be made a priority. Increasing capabilities of individuals and families in the era of AI could give rise to self-study methodologies and tools.

Service Robots: The deployment of service robots in businesses as well as in households is an important HSSE topic. The design of service environments may try to make some robots invisible, while other contexts may require robots that are increasingly human-like. The ability to transform a service robot to provide personalized service is an area for future research. How might government service robots lead to new forms of computational democracy? How will service robots in transportation and logistics, in healthcare and education, impact quality of life?

Platforms and Service Ecosystems: The growing economic impact of platforms in all walks of life, most accessible from smartphones that almost always in the position of an individual, create diverse opportunities for HSSE studies. Digital marketplaces, circular economy, multi-sided markets, government as a platform and more and more interactions that are made by our AI agents on our behalf will lead to unexpected consequences that are fertile areas of study for HSSE researchers and practitioners alike.

Finally, as future editions of the Handbook of Service Science are planned, sections should be dedicated to HSSE chapters, including standards, T-shaped representations of experience, public policy, privacy, ethics, ethical AI, protecting personal data, new methodologies and tools, service robots, platforms and service ecosystems, and more. The Human-Side and the Technology-Side co-evolve – so both are important to the HSSE community (Engelbart 1962; Spohrer & Engelbart 2004).

References

Alpaydin E. (2014), Introduction to Machine Learning (Adaptive Computation and Machine Learning series), The MIT Press, 2014, ISBN 978-0-262-02818-9

Alur R. (2015), Principles of Cyber-Physical Systems, The MIT Press, 2015, ISBN 978-0-262-02911-7

Alzahrani H (2016), Artificial Intelligence and Customer Communication, Global Journal of Computer Science and Technology: D Neural & Artificial Intelligence, Global Journals, Inc. (USA), 16, 1.

Anderson, JC, Narus JA, van Rossum, W (2006) Customer Value Propositions in Business Markets. Harvard Business Review. Spring. Pp. 90-99

Angwin J. (2014), Dragnet nation: A Quest for Privacy, Security, and Freedom in a World of Relentless Surveillance, Henry Holt and Company, LLC, 2014, ISBN 978-0-8050-9807-5

Arthur WB (2011) The Nature of Technology: What It Is and How It Evolves. Free Press.

Arthur WB (2017) Where is technology taking the economy? McKinsey Quarterly. October 2017. URL: <https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/where-is-technology-taking-the-economy>

Auerswald PE (2012) The coming prosperity: How entrepreneurs are transforming the global economy. 2012 Apr 2. Oxford University Press (OUP).

Bakhshi H, Downing J, Osborne M, Schneider P (2017) The Future of Skills: Employment in 2030. London: Pearson and Nesta. URL: <https://www.nesta.org.uk/report/the-future-of-skills-employment-in-2030/>

Barile S and Saviano M (2013), Dynamic Capabilities and T-Shaped Knowledge: A Viable Systems Approach, in Barile S (Ed), Contributions to Theoretical and Practical Advances in Management. A Viable System Approach (VSA), ARACNE Editrice S.r.l., Roma, pp. 39-59.

Baumol, WJ (2002) Services as Leaders and the Leader of the Services. In Gadrey J, Gallouj F, Productivity, Innovation and Knowledge in Services: New Economic & Socio-Economic Approaches, Edward Elgar, Cheltenham, UK, pp. 147-163.

Bitner MJ, Brown SW, Meuter ML (2000) Technology infusion in service encounters. Journal of the Academy of Marketing Science. Jan 01, 2000; 28(1), pp. 138-49

Blocker C, Brennan D, Anderson L (2019) JSR Special Issue: Transformative Service Research and Unintended Consequences: Helping Without Harming. URL: <https://journals.sagepub.com/pb-assets/cmscontent/JSR/Transformative%20CFP.pdf>

Brundage, M., et al., 2018. *The Malicious Use of Artificial Intelligence: Forecasting, Prevention and Mitigation*. Oxford: Future of Humanity Institute, Oxford University.

CEBR (2015) The economic contribution of standards to the UK economy. Centre for Economics and Business Research Ltd. (CEBR). British Standards Institution, London.

Clark C (1940/1957) Conditions of Economic Progress. Third Edition, 1957. New York, NY: Macmillan.

Cukier, K. N. & Mayer-Schönberger, V., 2013. *Big Data: A Revolution That Will Transform How We Live, Work, and Think*. 1st ed. New York: Houghton Mifflin.

Davis MM, Spohrer JC, Maglio PP (2011) Guest editorial: How technology is changing the design and delivery of services. Operations Management Research. Jun 1, 2011; 4(1-2), pp. 1-5

DeAngelis S (2015), Narrow Artificial Intelligence has Broad Application, Enterra Solutions, <https://www.enterrasolutions.com/blog/narrow-artificial-intelligence-has-broad-application/>

Dunleavy, P., Margetts, H. (2000) The advent of digital government: Public bureaucracies and the state in the internet age. Annual Conference of the American Political Science Association, Washington.

https://www.researchgate.net/publication/228791061_The_advent_of_digital_government_Public_bureaucracies_and_the_state_in_the_internet_age

EC (2018) Ethics Guidelines for Trustworthy AI (2018), The European Commission's High-Level Expert Group on Artificial Intelligence, Working document for stakeholders' consultation, Brussels, 18 December 2018, <https://ec.europa.eu/digital-single-market/en/news/draft-ethics-guidelines-trustworthy-ai>

EU (2016) General Data Protection Regulation (GDPR), Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016, <https://gdpr-info.eu/>

European Commission (EC) Expert Group on Public Sector Innovation, 2013. *Powering European Public Sector Innovation: Towards A New Architecture*, Brussels: European Commission (DG Research and Innovation).

European Parliament, 2017. *New Technologies Disrupting the Public Sphere: Information, Democracy and the Media*. <http://www.ngi-summit.org/goals/new-technologies-disrupting-the-public-sphere-information-democracy-and-social-media/>

Engelbart DC (1962) Augmenting Human Intellect: A Conceptual Framework. Summary Report, Stanford Research Institute, on Contract AF 49(638)-1024, October 1962, 134 pages. Scanned Original, Unclassified AD 289 565, Reproduced by Armed Services Technical Information Agency, 1963 Jan 04. URL: <https://apps.dtic.mil/dtic/tr/fulltext/u2/289565.pdf>

Fogg BJ (2002) *Persuasive Technology: Using Computers to Change What We Think and Do*, Morgan Kaufmann, 2002, ISBN: 9781558606432

Freeman RB (2018) Ownership when AI robots do more of the work and earn more of the income. *Journal of Participation and Employee Ownership*. (2018 Jun 11). 1(1):74-95. URL: <https://www.emeraldinsight.com/doi/full/10.1108/JPEO-04-2018-0015>

Friedman D (2008) *Morals and Markets: An Evolutionary Account of the Modern World*, Palgrave Macmillan, 2008, ISBN 978-0-230-60097-3

Freund LE, Spohrer JC (2012) The human side of service engineering. *Human Factors and Ergonomics in Manufacturing & Service Industries*. 23(1) 2-10.

Freund L (2018) MyT-Me – Your personal T-Shape scoring system, in *T-Shaped Professionals; Adaptive Innovators* by Moghaddam Y, Demirkan H, and Spohrer J, Business Expert Press, New York, NY.

Freund LE, Cellary W (2017) Advances in The Human Side of Service Engineering, Proceedings of the AHFE 2017 International Conference on The Human Side of Service Engineering, July 17-21, 2017, Los Angeles, California, USA, vol. Advances in Intelligent Systems and Computing 601, Springer, ISBN 978-3-319-60485-5, DOI 10.1007/978-3-319-60486-2

Frey, C. B. & Osborne, M., 2013. The Future of Employment: How Susceptible Are Jobs to Computerisation, Oxford: Oxford University.

Government Office for Science, 2015. *Artificial Intelligence: Opportunities and Implications for the Future of Decision Making*, London: Government Office for Science.

Hildebrandt, M., 2015. *Smart Technologies and the End(s) of Law*. Cheltenham / Northampton: Edward Elgar.

Gardner P, Estray D (2017) A Primer on the T-professional, Collegiate Employment Research Institute, Michigan State University. <http://www.ceri.msu.edu/wp-content/uploads/2018/03/Primer-on-the-T-professional.pdf>

Gilbert TF (1978). Human competence—engineering worthy performance. *Performance Improvement*, 17(9), 19-27.

Glushko RJ (2010) Describing Service Systems. Presented at the 19th Frontiers in Service Conference, Karlstad, Sweden.

Hänninen M, Mitronen L, Kwan SK (2018) Retail 2.0+ : Understanding How Retail Is Moving Closer to the Customer. Presented at the 6th Nordic Retail and Wholesale Conference (NRWC), November 8-9, 2018, Reykjavík Iceland.

Harari YN (2014) *Sapiens: A brief history of humankind*. Random House.

Hsu, C., Spohrer, J.C. (2009). Improving Service Quality and Productivity: Exploring the Digital Connections Scaling Model. *Service Technology and Management*, 11(3): 272- 292.

Hutson, M., 2017. *Even Artificial Intelligence Can Acquire Biases Against Race and Gender*. <http://www.sciencemag.org/news/2017/04/even-artificial-intelligence-can-acquire-biases-against-race-and-gender>

IfM, IBM (2008) *Succeeding Through Service Innovation: A Service Perspective for Education, Research, Business, and Government*. University of Cambridge Institute for Manufacturing, Cambridge UK.

ISO/IEC Guide 76 (2008) Development of service standards – Recommendations for addressing consumer issues. <https://www.iso.org/standard/45417.html>

ISO 40 (2019) IT Service Management and IT Governance. URL: <https://www.iso.org/committee/5013818.html>

ISO 42 (2019) Artificial Intelligence. URL: <https://www.iso.org/committee/6794475.html>

Jajal TD (2018), Distinguishing between Narrow AI, General AI, and Super AI, Medium.com, <https://medium.com/@tjajal/distinguishing-between-narrow-ai-general-ai-and-super-ai-a4bc44172e22>

Kline SJ (1995) Conceptual Foundations For Multidisciplinary Thinking. Stanford University Press.

Lake BM, Ullman TD, Tenenbaum JB, Gershman SJ (2017) Building machines that learn and think like people. Behavioral and Brain Sciences. 40:1-70. URL: <https://cims.nyu.edu/~brenden/LakeEtAl2017BBS.pdf>

Kelsen, H., 1967. *Pure Theory of Law*. 2nd ed. Berkeley: University of California Press.

Leitner, C. (ed.), 2003. *eGovernment in Europe: The State of Affairs*. Maastricht: European Institute of Public Administration.

Leitner C, Stiefmueller C (2019) Disruptive Technologies and the Public Sector: The Changing Dynamics of Governance. In: Baimenov A, Liverakos P (Eds.), *Public Service Excellence in the 21st Century*, Singapore, Palgrave

Levitt T (1972) Production-line approach to service. Harvard Business Review, 50(5): 41- 52.

Maglio PP, Kieliszewski CA, Spohrer JC, Lyons K, Patricio L, Sawatani Y (2018) Handbook of Service Science, Volume II. Springer.

Maglio PP, Vargo SL, Caswell N, Spohrer J (2009) The service system is the basic abstraction of service science. Information Systems and e-business Management. 2009 Sep 1;7(4):395-406.

Malone TW (2018) How Human-Computer 'Superminds' Are Redefining the Future of Work. MIT Sloan Management Review. 2018 Jul 1;59(4):34-41. URL: https://ilp.mit.edu/media/news_articles/smr/2018/59423.pdf

Markow W, Hughes D, Bundy A (2018) The New Foundational skills of the Digital Economy: Professionals of the Future. Burning Glass and Business Higher Education Forum Report (BHEF). URL: http://www.bhef.com/sites/default/files/BHEF_2018_New_Foundational_Skills.pdf

Meuter ML, Ostrom AL, Roundtree RI, Bitner MJ (2000) Self-service technologies: understanding customer satisfaction with technology-based service encounters. Journal of Marketing. Jul 1, 2000; 64(3), pp. 50-64

MIT Media Lab, 2017. *Society in the Loop: Programming the Algorithmic Social Contract*.
<https://www.media.mit.edu/publications/society-in-the-loop-programming-the-algorithmic-social-contract/>

Moghaddam Y, Bess C, Demirkan H, and Spohrer J (2016), T-Shaped: The New Breed of IT Professional, Agile Product Management & Software Engineering Excellence Executive Update
<https://www.cutter.com/sites/default/files/APM/apmu1608.pdf>

Ng, ICL (2018) The Market for Person-Controlled Personal Data with the Hub-of-all-Things (HAT). Working Paper. Coventry: Warwick Manufacturing Group. WMG Service Systems Research Group Working Paper Series (01/18). (Unpublished)

OECD, 2017. *Embracing Innovation in Government: Global Trends*, Paris
<http://www.oecd.org/gov/innovative-government/embracing-innovation-in-government.pdf>

OECD, 2019. Going Digital: Shaping Policies, Improving Lives.
<https://www.feani.org/sites/default/files/OECD%20Report%20Digital.pdf>

Ortiz-Ospina E, Roser M (2019) Trust. URL: <https://ourworldindata.org/trust>

Pariser, E., 2011. *The Filter Bubble: What the Internet Is Hiding from You*. New York: Penguin Press.

Pakkala D, Spohrer J (2019) Digital Service: Technological Agency in Service Systems. Proceedings of the 52nd Hawaii International Conference on System Sciences. Pp. 1886-1895, URL <https://scholarspace.manoa.hawaii.edu/bitstream/10125/59628/0188.pdf>

Partnership on AI (2019), <https://www.partnershiponai.org/>

Pasquale F (2015) *The Black Box Society*, Harvard University Press, 2015, ISBN 9780674368279
https://www.researchgate.net/publication/228791061_The_advent_of_digital_government_Public_bureaucracies_and_the_state_in_the_internet_age

Rouse W and Spohrer J (2018), Automating versus augmenting intelligence, Journal of Enterprise Transformation, Taylor & Francis Online,
<https://www.tandfonline.com/doi/abs/10.1080/19488289.2018.1424059>

Rouse WB, Spohrer JC (2018) Automating versus augmenting intelligence. Journal of Enterprise Transformation, 1-21. URL: <http://service-science.info/wp-content/uploads/2018/08/Rouse-Spohrer-Automating-Versus-Augmenting-Intelligence-12-21-17-copy.pdf>

Schneier B (2015) *Data and Goliath: The Hidden Battles to Collect Your Data and Control Your World*, WW Norton & Company, 2015, ISBN 978-0-393-24481-6

Seabright P (2010) *The Company of Strangers: A Natural History of Economic Life-Revised Edition*. Princeton University Press; 2010 Apr 12.

Shjabbir J and Anwer T (2015) Artificial Intelligence and its Role in Near Future, *Journal of LaTeX Class Files*, 14, 8, August <https://arxiv.org/pdf/1804.01396.pdf>

Solomon M (2018) AI (Artificial Intelligence) And The Customer Service Experience: 3 Key Principles (December 11), Forbes, <https://www.forbes.com/sites/micahsolomon/2018/12/11/ai-artificial-intelligence-and-the-customer-service-experience-3-key-principles/#345cace6e566>

Spohrer J, Maglio PP (2010a) Service Science: Toward a Smarter Planet. In Karwowski W, Salvendy G (eds) *Introduction to Service Engineering*. Wiley, New York, pp 3–30

Spohrer JC, Maglio PP (2010b) Toward a Science of Service Systems: Value and Symbols. In: Maglio P, Kieliszewski C, Spohrer J (eds) *Handbook of Service Science. Service Science: Research and Innovations in the Service Economy*. Springer, Boston, MA. 157-194.

Spohrer, J., Anderson, L., Pass, N., Ager, T. (2008a). Service science and service-dominant logic, *Otago Forum 2: Academic Papers*, 2, 1-18.

Spohrer, J., Vargo, S.L., Caswell, N., and Maglio, P.P. (2008b). The service system is the basic abstraction of service science, *Proceedings of the 41st HICSS*, Jan. 2008.

Spohrer, JC (2011) On looking into Vargo and Lusch's concept of generic actors in markets, or "it's all B2B... and beyond!". *Industrial Marketing Management* 40, 199–201.

Spohrer J, Bassano C, Piciocchi P, Siddike MAK (2017) What Makes a System Smart? Wise?. In: Ahram T, Karwowski W (eds) *Advances in The Human Side of Service Engineering. Advances in Intelligent Systems and Computing*, Vol. 494. Springer.

Spohrer J, Giuiusa A, Demirkan H, Ing D (2013) Service science: reframing progress with universities. *Systems Research and Behavioral Science*. 30(5):561-569.

Spohrer J, Maglio PP, Bailey J, Gruhl D (2007) Steps towards a Science of Service Systems, in *IEEE Computer*, 40(1) 61–77.

Spohrer J, Banavar G (2015) Cognition as a service: An industry perspective. *AI Magazine*. 2015 Dec 1, 2015; 36(4) 71-81.

Spohrer J, Giuiusa A, Demirkan H, Ing D (2013) Service science: Reframing progress with universities. *Systems Research and Behavioral Science*. 2013 Sep;30(5):561-569.

Spohrer J, Kwan SK (2009). Service Science, Management, Engineering, and Design (SSMED): An emerging discipline – outline and references. *International Journal of Information Systems in the Service Sector*. 3(1) 1-31.

Spohrer JC, Engelbart DC (2004) Converging technologies for enhancing human performance: Science and business perspectives. *Annals of the New York Academy of Sciences*. 2004 May 1;1013(1):50-82.

Teboul, J. (2006) *Service is Front Stage – Positioning services for value advantage*. INSEAD Business Press, Palgrave McMillian.

Tien JM (2011) Manufacturing and services: From mass production to mass customization. *Journal of Systems Science and Systems Engineering*. 2011 Jun 1; 20(2) 129-154.

Unemyr M (2017) The Internet of Things – The Next Industrial Revolution Has Begun: How IoT, big data, predictive analytics, machine learning and AI will change our lives forever.

UK Government Office for Science, 2015. *Artificial Intelligence: Opportunities and Implications for the Future of Decision Making*, London: UK Government Office for Science.

UNDP, 2016. *The Social Contract in Situations of Conflict and Fragility*, New York (N.Y.): UNDP.

United Nations, 2015. *Responsive and Accountable Public Governance: 2015 World Public Sector Report*, New York (NY): United Nations.

Vargo SL, Lusch RF (2004) Evolving to a new dominant logic for marketing. *Journal of marketing*. 68(1):1-7.

Vargo SL, Lusch RF (2011) It's all B2B...and beyond: Toward a systems perspective of the market. *Industrial marketing management*. 40(2):181-7.

Vargo SL, Lusch RF (2016) Institutions and axioms: an extension and update of service-dominant logic. *Journal of the Academy of Marketing Science*. 44(1):5-23.

Weissinger R, Kwan SK (2018) Service Science Research and Service Standards Development, in G. Satzer et al. (Eds.) *Exploring Service Science – Proceedings of 9th International Conference, IESS 2018, Karlsruhe, Germany, September 19-21, 2018*. Springer Nature Switzerland AG.

Kobie N (2019) The complicated truth about China's social credit system: China's social credit system isn't a world first but when it's complete it will be unique. The system isn't just as simple

as everyone being given a score though. Wired (online). 2019 Jan 21 URL: <https://www.wired.co.uk/article/china-social-credit-system-explained>

Wójtowicz A, Cellary W, (2018) New Challenges for User Privacy in Cyberspace, in: A. Moallem (ed). Human Computer Interaction and Cybersecurity Handbook, CRC Press - Taylor and Francis, Boca Raton, USA, 2018, pp. 77-98, ISBN 9781138739161

Wright R (2001) Nonzero: The logic of human destiny. Vintage.

Wu J, Child R, Luan D, Amodei D, Suskeve I (2018) [Language Models are Unsupervised Multitask Learners](https://d4mucfpksyww.cloudfront.net/better-language-models/language_models_are_unsupervised_multitask_learners.pdf). URL: https://d4mucfpksyww.cloudfront.net/better-language-models/language_models_are_unsupervised_multitask_learners.pdf

Zuboff S (2019) The age of surveillance capitalism: the fight for the future at the new frontier of power. Profile Books; 2019 Jan 31.