The Need for Computational Thinking of Service Systems

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Service is broadly considered as an application of specialized knowledge, skill, and experience, performed for the good of its provider while being beneficial to its consumer (Lusch and Vargo 2006, Spohrer *et al* 2007, Qiu *et al* 2007). Because of the fast advancement of technologies and the accelerated globalization, today's service is performed substantially different from one before. Service has evolved from a traditional labor-based business to one manifested with innovations, collaboration and co-produced value.

As the world is now all connected economically, technically, and socially, enterprises must aggregate products and services into customer solutions by implementing integrated global value chains (i.e., globally integrated enterprises). Service indeed dominates the developed economy, resulting in today's business wave highlighted by customization, integration, intelligence, and globalization. This new wave seems to get more complicated and challenging, but it for sure entails end users better satisfaction and quality of life – the ultimate goal of human being, as the world is becoming better instrumented and interconnected, and more intelligent (Palmisano 2008).

No matter what service (including any associated physical goods) is engineered and delivered, whether the need is fully met and the customer completely satisfied currently relies on the efficient, effective and smart operations of its service-value delivery network, i.e. an integrated heterogeneous *service system*. A service system essentially has the same constituents as an integrated global value chain that makes physical goods. However, a service system puts *people* (customers and employees) rather than physical goods in the center of the globally integrated organizational structure and operations (Qiu *et al* 2007).

A service system essentially is a *social-technical* system, focusing on engineering and delivering services using all available means to realize respective values for both the provider and the consumer. It can simply be a software application, or a business unit within an organization, from a project team, business department, to a global division; it can be a firm, institution, governmental agency, town, city or nation; it can also be a composition of numerous collaboratively connected service systems within and/or across firms. No matter what a service system is, small or large, individual or composed, and intra- or interconnected, it must radically consist of *people*, technologies, infrastructures, and processes of service management and engineering (Spohrer *et al* 2007). A service system must be *people-centric*, information-driven, e-oriented, and satisfaction-focused; it should encourage and cultivate *people* to collaborate and innovate.

"Indeed, almost anything from people, object, to process, for any organization, large or small – can become digitally aware and networked." (Palmisano 2008) On one hand, the world becomes smaller, flatter, and smarter, which creates more opportunities and enormous promise; on the other hand, more challenges and issues appear in many aspects from business strategy, marketing, modeling, innovations, design, engineering, to operations and management in order for businesses to stay competitive in a globally integrated economy. Consequently, an enterprise has to rethink its operational and organizational structure by focusing on *people* (e.g., implementing a novel approach to overcoming social and cultural barriers to cultivate and enhance the cultures of co-production, collaboration, and innovations), so as to ensure the prompt and cost-effective production and delivery of competitive and satisfactory service for customers throughout its geographically dispersed while digitally integrated service systems.

No matter where, when, who, what, why and how, it is well understood that, by end of the day the real value of delivered service lies in its ability to satisfy customer's need, which is not simply and strictly shown in the technical characteristics of the service (and the physical attributes of the products included in the service). According to Dietrich and Harrison (2006), there lacks sufficient modeling of services when service is in general compared to manufacturing due to the fact that service research is confronting more challenging issues. Compared to physical goods in manufacturing and supply chain systems, resources, largely *people* - the main focus of a service system, cannot be held and are more complex to model as *people* participating in service production and consumption have physiological and psychological issues, cognitive capability, and sociological constraints, etc.

Our planet, different from one not so long ago, is becoming digitalized, data overwhelming and information rich, more capable and intelligent; in the meantime it faces more challenges and issues from globalization, integration, natural resources constraints, to humanity concerns. Clearly, our planet is progressing to the stage that needs configurable, adaptable, scalable, and smart service systems to be capable of confronting the challenges and navigating throughout a variety of uncertain circumstances. To meet the needs of steering throughout different settings regionally or internationally in a competitive manner, service systems have to enable *people* to consciously and cooperatively infuse intelligence into all levels and aspects of decision-making.

As the world becomes more complex and uncertain socially and economically, computational thinking that fully leverages today's ubiquitous digitalized information, computing capability and computational power has evolved as an optimal way of solving problems, designing systems, and understanding human behavior. Computational thinking is qualitative and quantitative thinking in terms of abstractions, modeling, algorithms, and understanding the consequences of scale and adaptation, not only for reasons of efficiency and effectiveness but also for economic and social reasons (CMU 2008).

Presumably, competitive businesses could be executed with smarter solutions, operations, and management by taking advantage of the advancement of computing and communication technologies and through significantly leveraging computational power. However, the competence of a service system largely depends on right principles and methods, and appropriate tools employed for conducting *quantitative*, *predictive*, and *social-technical* analytics at the point of need. In other words, if there was a right science, a service system would be implemented as an adaptable, configurable, scalable, and optimized solution.

From above discussions, it becomes obvious that we should develop a novel science capable of helping enterprises invest effectively to capitalize on a competitive and adaptable configuration of service systems under uncertain circumstances, resulting in the realization of more predicable outcomes in a smart, efficient, and cost-effective way. Evidently, as the world is getting better instrumented and interconnected, and more intelligent, it is of a great need for service systems to be studied using ***computational thinking***, focusing on the creation and development of service science with the potential of much broader applicability.

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