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Agent-enabled service-oriented decision support systems

Ching-Shen James Dong, Ananth Srinivasan *

The University of Auckland Business School, OGG Building, 12 Grafton Road, Private Bag 92019, Auckland, New Zealand

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ABSTRACT

The design of Decision Support Systems have recently emphasized web enablement as the next step in design improvements for this class of applications. We argue that these approaches fail to address the key notion of adaptability in the support for decision makers. Instead of focusing exclusively on automation in decision making, we believe it is also necessary to pay attention to the interplay between decision makers and organizational processes. The service oriented view of organizations recognizes the need to accommodate the changing reality of organizational dynamics. For example, the service science approach focuses on interactions between service providers, their clients, and consumers as important interacting components of a service system. Current approaches to DSS design are constrained in terms of their ability to adapt to changes in user requirements and to provide support for the evolution of systems. This situation worsens when resources are distributed at different locations across organizations, decision making processes are required to be integrated at different points in time, and when collaboration is needed among decision makers. However, this typically characterizes the needs of collaborative decision making in networked organizations as exemplified by systems used for supply chain management. To address these problems we leverage the power of services for designing a framework that explicitly recognizes the need for design based on service delivery. We develop an agent-enabled service-oriented architecture to realize the proposed framework with service and agent paradigms. The architecture is refined and validated with an implementation in the supply chain context.

1. Introduction

Organizations, large and small, local and global increasingly define their primary purpose as 'service' rather than products [10,17]. In both global and local contexts, for firms of all sizes, the delivery of service increasingly relies upon both intra- and inter-organizational connectivity that includes social and technical connections, which are effective and efficient. Systems to support organizational decision making has been discussed in the literature for several years. Two important trends motivate us to rethink fundamental design issues pertaining to implementing such systems. First is the development of tools and methodologies that take a service oriented view of design. Business processes need to be supported by clearly acknowledging the need for a collaborative environment amongst organizational units to deliver solutions. A useful way to address this issue is to build the notion of service delivery directly into design implementations. Second is the recognition at an organizational level that service interactions are key functions of successful modern organizations — the ubiquity of supply chains in organizations being a good case in point. We discuss these issues and link them to the objectives of our work.

Current research perceives service as the foundation for all economic exchange [40,41]. Markets and corporations have shifted toward a service-oriented environment, which raises the need for new approaches towards service research. Palmisano [33], Maglio and Spohrer [29], Spohrer et al. [37] and others have called for a "science of service", aiming to provide new theories and practical advice for service firms. The role of information technology in this process has subsequently become a research priority for service science [32].

Every service system relies on the interaction and sharing of information with customers during service engagements. Customer involvement is generally seen as a prerequisite for successful service engagements and value co-creation. Driven by technological changes, service engagements have shifted into virtual realms, resulting in so called technology-enabled value co-creation. Traditional approaches to studying the services theme have differentiated tangible products from intangible services in order to clearly articulate the point of differentiation for items with economic value and their interaction with markets [27]. The emphasis of this work is on examining a particular characterization of service delivery — one that leverages the use of IT to achieve this objective. The particular issues that we attempt to look at revolve around a better understanding of business process definitions, distributed project compositions, and coordination amongst project teams.

The phenomenon of service systems as enablers of business innovation has been discussed by various researchers. Conceptually, we

* Corresponding author.
E-mail address: a.srinivasan@auckland.ac.nz (A. Srinivasan).

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can envision three components of the service framework. The first is a service provider that could be a combination of individuals, organizations, and technologies. The second is a service client that could be a combination of individuals and organizations. The third is the object or target of the service — the entity that will be transformed by the application of the service. This could be a combination of people, organizations, processes, technologies, information, etc. Fig. 1 below (adapted from the work of [29]) highlights the key aspects of thinking about service systems and the issues that arise when we want to study such entities.

Such a framework enables us to define a set of interesting research issues around the interaction between the components of the framework, including an emphasis on intra- and inter-organizational connectivity.

Organizational decision making is a dynamic and complex process. Decision making requirements are constantly changing over time and vary from person to person. They are made at different levels of an organization, and involve many people from different locations with different business orientations towards the decision making process [9]. This variation in terms of organizational level and orientation makes collaboration among the decision makers vital. The decision making process, whether it be structured, semi structured or unstructured, requires data and information from a multiplicity of sources. Decision makers need to quickly get to the essence of the underlying data/information by going through a gathering, accessing, integrating, transforming, discovering and learning cycle. The application of this cycle gradually fine tunes the decision scope either by continuous inputs over a period of time or through the decision maker's insightful inputs at specific points in the decision making process.

Systems to support decision makers in the decision making process have been formally recognized as a separate class of systems since the 1970s. Decision support systems (DSS) [6,36], have been formally defined as interactive computer based systems [1,4,38] that support decision making processes for decision makers to solve semi-structured and/or unstructured problems [19]. In the current organizational context, such systems need to be *adaptive* in order to obtain the various resources needed in the decision making process [2] and to cope with changing decision making requirements for different people. *Adaptive systems* must have the capability to support users at different locations to access various resources across networks to enable them to participate in synchronous or asynchronous decision making processes. Decision oriented systems must also provide iterative methods such as what-if analysis to help users fine-tune their decision making. They must be able to adapt to changes in the external, internal, and system environments, as well as in the users themselves. Furthermore, these systems should enable the flexible manipulation of components and processes. For example, there should be no restrictions imposed by the system on users for the selection/integration of decision making components, nor should there be restrictions on acquiring the necessary resources from heterogeneous distributed systems. Equally, the architecture should allow the addition of new components into the system at run time.

The problem that we address in this paper therefore can be captured as follows. We propose that current organizational realities necessitate an extension of conventional thinking about decision support systems along multiple dimensions. First, collaborative decision making among organizations requires effective exchange of information among them. Second, such exchange can be usefully facilitated through proper systems design that views information exchange as the provision of appropriate services. Third, systems must be adaptive to accommodate the needs of dynamic and heterogeneous organizational entities. These problems and the issues that arise from them motivate us to propose a high level service oriented decision support conceptual framework. In this paper, we outline the development of an agent-enabled framework and architecture to support the service oriented requirements of modern collaborative organizations. We adopt a design science paradigm [20] to develop a framework and implement a prototype that emphasizes service delivery as a key guiding principle for DSS development.

2. Design issues

The recent literature on developments in DSS design recognizes the need for building on early design proposals to accommodate a new technical landscape. For example, Bhargava, Power, and Sun [5] review DSS design developments that are web enabled and note that while the use of the web as an interface has been embraced, more complex designs are still lacking. The need for supporting distributed decision making is a major development in DSS design. They also note that discussions about design architectures and guidelines are scarce in the academic literature on DSS design. A discussion about design architecture by Zhang and Goddard [43] outlines a layered software architecture for building web based distributed DSS with a data oriented emphasis. Several authors have embraced the web services idea to propose different approaches to DSS design. Madhusudan and Uttamsingh [28] advocate a largely automated process for web service composition as an approach to overcome human intervention in decision processes. The automation of decision processes is also offered as a design principle in conjunction

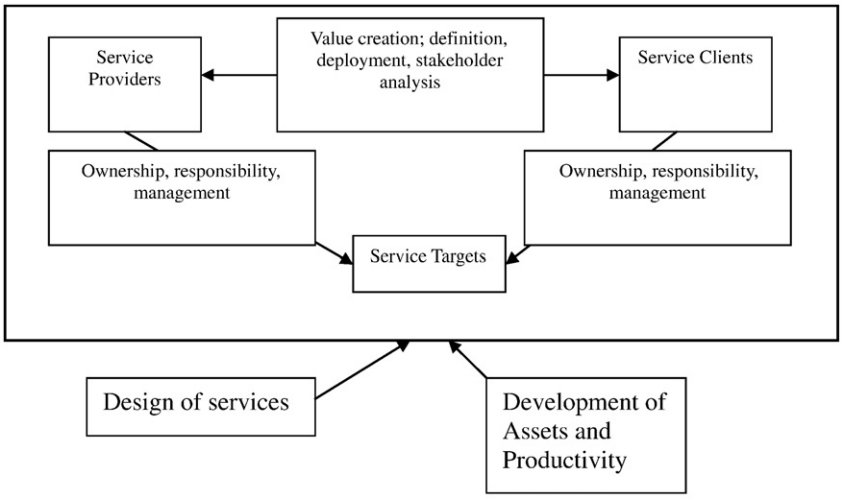

Fig. 1. Characterizing service systems.
Adapted from [29].