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Leveraging the capabilities of service-oriented decision support systems: Putting analytics and big data in cloud

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ABSTRACT

Using service-oriented decision support systems (DSS in cloud) is one of the major trends for many organizations in hopes of becoming more agile. In this paper, after defining a list of requirements for service-oriented DSS, we propose a conceptual framework for DSS in cloud, and discus about research directions. A unique contribution of this paper is its perspective on how to servitize the product oriented DSS environment, and demonstrate the opportunities and challenges of engineering service oriented DSS in cloud. When we define data, information and analytics as services, we see that traditional measurement mechanisms, which are mainly time and cost driven, do not work well. Organizations need to consider value of service level and quality in addition to the cost and duration of delivered services. DSS in CLOUD enables scale, scope and speed economies. This article contributes new knowledge in service science by tying the information technology strategy perspectives to the database and design science perspectives for a broader audience.

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1. Introduction

In today's very complex business world, organizations must find innovative ways to differentiate themselves from competitors by becoming more collaborative, virtual, accurate, synchronous, adaptive and agile. They need to be able to rapidly respond to market needs and changes. Many organizations noticed that the data they own and how they use it can make them different than others. Data and information are becoming primary assets for many organizations. That's why, today, most organizations try to collect and process as much data as possible. According to the Gartner Research, the worldwide market for data warehousing and business intelligence solutions is forecasted to reach US$10.8 billion in 2011 [34]. And it is ranked number five on the list of the top ten technology priorities for chief information officers in 2011. That's why having efficient and effective decision making processes with right data that is transformed to be meaningful information with data-driven discoveries (e.g. analytics) are becoming mainstream processes for companies to run smarter, more agile and efficient businesses [13].

There also are data related challenges for organizations. For instance, there is the challenge of managing large amounts of data (big data), which is getting increasingly larger because of cheaper storage and evolution of digital data and information collection devices, such as cell phones, laptops, and sensors. For example, Facebook, a social-networking website, is a home to 40 billion photos, and Wal-Mart handles more than 1 million customer transactions every hour, feeding databases estimated at more than 2.5 petabytes. There are 4.6 billion mobile-phone subscriptions worldwide and 1–2 billion people use the internet [46]. There is no question that we are living in an era of data and information explosion. Also, there are more people who interact with information, and more information is shared. According to the Economist Report [46] between 1990 and 2005 more than 1 billion people worldwide entered the middle class, and by 2013 the amount of data transferred over the internet will reach 667 exabytes annually, and according to Cisco the quantity of data continues to grow faster than the ability of the network to carry it. Companies like Amazon's Web Services, AT&T's Synaptic Hosting, AppNexus, GoGrid, Rackspace Cloud Hosting, the HP/Yahoo/Intel Cloud Computing Testbed, the IBM/Google and MicroStrategy BI Cloud are providing various types of clouds services to ease the data storage problems.

Besides the challenges posed by fast growing amount of data, there are also ample opportunities for the world as it becomes more and more digital allowing context-specific aggregation and analysis of data. For example, information and/or knowledge extracted from digital records can make doctors' job easier in accurately diagnosing and treating illnesses, and bring down healthcare costs for providers and patients, and hence improve the overall quality and efficiency of healthcare [15]. Similarly, digitized data (institutional and public—mostly internet-based) can be accessed and analyzed to bolster success on fighting crime more effectively and efficiently.

Service-oriented thinking is one of the fastest growing paradigms in information technology, with relevance to many other disciplines such as accounting, finance and operations [16]. According to Babaie

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et al. [4], worldwide end-user spending on IT services will grow at a 6.4% compound annual growth rate through 2010 to reach US $855.6 billion, with positive growth in nearly all market segments. As a future trend, Gartner predicts that at least one-third of business application software spending will be on software-as-a-service, instead of as product licenses, by 2012. Also, 40% of capital expenditures will be made for infrastructure as a service by 2011 [38]. And more recently, Pike Research expects the growth in cloud computing revenue to continue worldwide between now and 2015 at a compound annual growth rate of 28.8%, with the market increasing from $46.0 billion in 2009 to $210.3 billion by 2015 [37].

For many companies (especially small and medium size), the pay-as-you-go service-oriented computing model (cloud computing), with having someone else worrying about maintaining the hardware and software are becoming very attractive [31]. Cloud computing is reminiscent of the software-as-a-service, infrastructure-as-a-service, database-as-a-service paradigms [6]. Cloud computing platforms, like those offered by Amazon Web Services, AT&T's Synaptic Hosting, AppNexus, GoGrid, Rackspace Cloud Hosting, and to an extent, the HP/Yahoo/Intel Cloud Computing Testbed, and the IBM/Google cloud maintain more than the hardware, and give customers a set of virtual machines in which to install their own software. Resource availability is typically elastic, with a seemingly infinite amount of computing power and storage space available on demand, in a pay-only-for-what-you-use pricing model [1]. In this paper, we adopt and use the National Institute of Standards and Technology's (NIST) definition for "cloud." NIST defines cloud computing as "… a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (for example, networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [33].

Given the emerging services paradigm, it is time to rethink IT and IS from new organizational and technical vantage points [39]. After briefly reviewing the impact of service-orientation on information systems, herein we present a conceptual model that supports evaluation of theory and methods for the management of service-oriented decision support systems (SODSS). Then, based on the proposed conceptual model, we explore some of the pressing issues and promising opportunities and their potential contributions to the new managerial knowledge of SODSS.

In the next section, we begin with a brief overview of the foundation for "services paradigm" and identify the key requirements for SODSS. In Sections 3 and 4, we conceptualize the SODSS, and review the relevant and leading methods, models and theories, and then discuss about where foundational knowledge of the emerging service-orientation (in cloud type environment) can be developed. The last section summarizes our contributions and lists the limitations of this research.

2. The foundations for service orientation and unique characteristics of service

Growing knowledge of information and communication technology (ICT) design, execution, storage, transmission and reuse along with the evolution of internet is creating opportunities to configure information technologies into service relationships that create new value [12]. More specifically, proper ICT provides the means to improve effectiveness, efficiency, and innovativeness of organizations through: 1) making it possible to commoditize none-core competencies (e.g. outsourcing, out-tasking); 2) improving the collaboration (e.g. inter- and intra-organizational workflows and business processes); 3) decreasing the risk of information security breaches; 4) facilitating new types of services (e.g. Google, online banking); 5) separating production and consumption of a service, allowing better storability, transportability, and access to knowledge-based services (e.g. tax software, online classes); 6) coordinating service systems (e.g. online broker systems, information markets, open innovation platforms) [17]; 7) reducing the costs of service production (e.g. semi- and fully automated call centers); 8) improving customer-perceived service quality (e.g., ability to standardize elements of service as well as customize to the individual's preferences when appropriate); and 9) integrating customers into service creation and delivery (e.g., online educational services, health information systems, business-to-business solutions) [2,5,42].

The convergence of ICT—service-oriented – architecture, – infrastructure and – business processes, the emergent Web applications, Web 2.0, Web 3.0, grid computing, cloud computing, internet-enabled smartphones, RFID, and advanced sensing and data analysis—is driving the next information technology inflection point. And this technology inflection is setting the stage for business transformation. "Services" and "service platforms" are central to this evolution [18].

Spohrer et al. [44] defines a service as the application of competence and knowledge to create value between providers and receivers. This value accrues from the interactions of service systems that involves people, technology, organizations, and shared information in addition to language, laws, measures, models, and so on [44]. Service systems are complex business and societal systems that create benefits for customers, providers, and other stakeholders, and include all human-made systems that enable and/or grant diverse entities access to resources and capabilities such as transportation, water, food, energy, communications, buildings, retail, finance, health, education and governance [43]. When we analyze information systems, we see that there is a fundamental connection between information systems and service systems. Checkland and Howell [10] indicate that a consequence of the nature of the process, in which intentions are formed and purposeful action are undertaken by people who are supported by information, is that 'information system' has to be seen as a service system: one which serves those taking the action. Decision support systems are also types of information systems and service systems.

For many years, various versions of system/software product development life cycles have been used to develop and maintain information systems and decision support systems, e.g. waterfall, rapid, spiral and agile development methodologies. The major limitations of the design principles of these life cycles with respect to decision support systems are as follows:

2.1. Focus

Current system development methodologies are focus on goods (e.g. applications) not on services. They follow traditional product-oriented development logic such as application acquisition, build to handle peak, install, configure and maintain. One of the major questions is that how to capture users' dynamically changing requirements and expectations; support those with dynamic business processes. They need to follow service-oriented platform such as federated architecture, rent instead of buy model, dynamic workflow choreography and orchestration, service level agreements rather than purchase contracts and virtualization.

2.2. Scope

DSS design must take into account that there are multiple channels that may need to be integrated into service deliveries; they can't have conflicts between the channels; they may need to share state among channels; speed and reliability of the channel integration may become the key for adaptive service delivery.

2.3. Standardization

Until recently, standardization has been the key in order to get the benefits of economies of scale and cycle time reduction. Today, users are looking for more customization with personalized services. Also,