International Journal of Research in Management, Science & Technology (E-ISSN: 2321-3264)
Vol. 3, No. 3, August 2015
Available at www.ijrmst.org

Critical Success Factors (CSFs) of Service-Oriented Architecture (SOA) in BIG DATA Systems

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***Abstract* — The objective of this study is to find out the critical success factors that are needed to implement Service-Oriented Architecture (SOA) in BIGDATA systems such as Cloud Enterprise Resource Planning (CERP) in India. A survey has conducted and data has been collected through online blog from India, particularly cities such as Chennai, Mumbai and New Delhi. The data is analysed using partial least square (smartPLS) statistical package and results are discussed. The analysed results would be very useful for academicians and researchers who would like to write articles in terms of implementing SOA with BIG DATA systems.**

***Keywords*—** Enterprise Resource Planning (ERP), Service-Oriented Architecture (SOA), BIG DATA Systems (BDS), smartPLS, Framework, India, Quantitative Research, Legacy Systems

I. INTRODUCTION

The growth of Business Intelligence Systems (BIS) is faster and plays a vital role in almost all organizations across the world. The Service-Oriented Architecture (SOA) is an improved approach which will solve the issues in legacy or old systems and handles huge volumes of data such as BIG DATA systems. SOA also ensures efficiency, agility, productivity and integrity of an enterprise through multiple tasks or subsystems in the business processes of an organization. The main purpose of this study is to identify the important factors that are needed to implement SOA in BIG DATA systems such as cloud ERP (CERP).

Service-oriented is splitting the problems into entity and related smaller parts of logic or service. Service orientation standard proposes the organization needs to explain businesses tasks, entity, or process into well grained service granularity from the perspective of IT/IS. SOA adoption is an evolutionary process and there are many reasons for SOA gaining particular interest towards the research context (Naghmeh et al. 2014). SOA has been widely stimulated by computer analysts and vendors because of its architecture which is adaptable to address the firm's business expectations in a low cost and just-in-time (JIT) manner. SOA lead numerous advantage such as value-added flexibility and appropriate alignment among business processes and the supporting enterprise applications, as well as reduced cost of integration and maintenance.

SOA unlike ERP systems could use existing systems without forcing the enterprise to build their services from scratch by leveraging existing software, data and this ability reduces the amount of budget that required for SOA transformation project, decrease risks of designing new systems (Zadeh et al. 2013). Many organizations in Australia (32.9%) and the USA (40.6%) had used a business unit SOA application in IT control and some of the organizations in the UK (40.6%) had used an SOA application as a part of an enterprise wide initiative. Also organizations in Germany (30.6%) and France (45.2%) had their SOA applications in the pilot level (Naghmeh et al. 2014).

II. LITERATURE REVIEW

Recent surveys have shown importance of SOA with BIG DATA systems such as Cloud ERP (Neaga & Hai, 2013; Zadeh et al., 2012; Nicolescu et al., 2007). SOA provides a new Business Process Reengineering (BPR) which covers organizational, technical and project aspects (Alwadain et al., 2011). Zhang and Yang (2004) suggests a reengineering approach which will restructure the legacy systems that leads to Service-Oriented Architecture (SOA) by considering the business requirements of an organization.

IBM presented some of their experience with a number of organizations which adopting SOA and recommended four areas of adoption challenges: program management, organization, technology, and governance (Naghmeh et al., 2014). They have identified 32 most potential and challenging factors for SOA adoption in organizations.

To succeed at Service-Oriented Architecture the first step is to educate the organization and do not attempt to introduce SOA globally through a big-bang effort. Start with a pilot project that showcases what SOA has to offer. Extend the success of your pilot SOA project by attempting a slightly bigger or more complex one.

Governance is needed to control the service lifecycle (as a start) and then to begin to hammer out policies and procedures that must be followed in order to develop, publish, and consume services (Adrian).

Wang (2013) adopted the SOA for the analysis and design of business processes such as service identification, specification and realization. He also used top-down, bottom-up and meet-in-the-middle to identify the required service. The service specification helps to align business and technology to improve the efficiency of the firm.

Yavari et al. (2013) proposed a method named Service-Oriented SysFailRate Measurement for measuring the failure rate of the system in service-oriented architecture using fuzzy logic. In this system, incomplete description of a service, lack of integration, incorrect format, and being out of the pre-determined time out factors were used to measuring the failure rate. Testing rests demonstrated that this approach is promising to significantly improve measuring the failure rate in Service-Oriented Architecture.

Bakar et al (2013) explored the important factors on to implement Service Oriented Architecture/Service Oriented Enterprise Architecture (SOEA) in the firm and recognized the maturity models used to measure the architecture effectiveness in the organization.

Zdravković et al. (2007) designed an architectural model which concentrated more towards technological infrastructure focused on migration from legacy ERP functions of small enterprise to SOA-based environment.

Fazlollahtabar et al. (2013) developed a framework towards serving distributed communication based on real time behaviors of service. They also suggest a service oriented framework for ERP and Decision Support System (DSS) of manufacturing organizations. Furthermore, they presented business process reengineering techniques for manufacturing enterprises to improve the firm's performance.

Zadeh et al. (2013) carried out an analysis of Enterprise Resource Planning versus Service Oriented Architecture in small to medium-sized firms. This study showed that it is easy to understand at the first glance that SOA capabilities will prepare better infrastructure than object oriented systems such as ERP.

Alwadain et al. (2011) suggest that SOA is needed because the modern enterprise deals with complex systems to align the business function with fast growing technological changes. When enterprise uses SOA, it is called as Service-Oriented Enterprise Architecture (SOEA). It transforms the enterprise in terms of business process engineering and agility for the organization's competitive advantage. In order to support decision-making and ever-changing business needs, SOEA is essential to achieve firm's business objectives. BIG DATA systems help create business value through ERP transformation by means of increased velocity and agility, improved reliability and support as well as enhanced cost efficiency. SOEA strategies also support to maximize the transforming efforts from the legacy systems to new ERP systems. This transformation will take full advantage of return-on-investment (ROI) and Total Cost Ownership (TCO) in terms of implementing cloud ERP (CERP) projects.

As highlighted by Galinium and Shahbaz (2009, p.16), legacy systems are applications which are based on mainframe or client-server application designs, such as Cloud ERP, supply chain management (SCM) or Supplier-Relationship Management (SRM) in order to run the business process to make appropriate ROI. Bisbal (1999) suggest that organizations has to keep original data and functionality while it transforms to new system from the legacy system because the legacy systems is very important as it has the organization's information flow.

SOEA is essential, in particular for implementing BIG DATA systems such as Cloud ERP because the firm needs to collaborate third party vendors to create customer value, maximize the profit and explore new business ventures with other multinational organizations globally (Shu and Chuang, 2010). Cloud ERP is essential as it create new services without any financial constraints such as server cost and high maintain capabilities and allows firms to concentrate its core business functions.

SOEA is a part of technology perspective and the overall aim is to restructure the entire firm and to synchronize the firm's vision and needs which can drive technology towards the organizational goals.

SOEA is greatly changing the way that IT vendors build and use BIG DATA applications such as Cloud ERP (CERP) because all the broken part in the legacy systems are considered as layers that consists of services and components to be reused.

Although there were many articles published so far in SOA, there is still a lack of empirical evidence for factors implementing BIG DATA systems such as cloud ERP (CERP). This study would be very useful for academicians and practitioners who intend to write articles on SOA in near future.

Issues in Legacy Systems

The following are the issues related to legacy system: Very close linkage between systems modules; Design time sharing of semantics; Pre-defined set of users and

usage patterns; System modules owned by same firms (Lewis and Smith, 2008). Whereas SOA systems are loosely coupled between services and service consumers; Semantics shared at all times which smoothen communication between service developers and service consumers; potentially unidentified set of users and usage patterns; System modules owned by many organizations.

The following sections will highlight issues in process, requirements, architecture and design in legacy systems: Processes must reflect the expected strategic approach and must be iterative in terms of software development life cycle; Processes must satisfy the needs of both internal and external services; and there must be a need of technology evaluation. Require a focus on how to manage a business process; must deal with large number of investors; Responsibilities of each system component such as consumers, services and infrastructure need to be clearly defined; technology need to be evaluated at constant intervals; implications of external services and consumers need to be analysed in order to check whether it meets expected quality of service; final decision lead to promote reusable components.

The main goal of SOA adoption is improving business processes in an integrated environment within and outside the organization. The main barrier is finding people with right skills and lack of SOA governance.

III. Research Questions and Framework

In a client-server architecture, the business process activities are tightly coupled, data and application are totally independent which leads to lack of coordination among services and high maintenance costs of the machines.

The above issues will further create cross-platform/language and interoperability as well as security issues for the business process activities. All these issues will be solved using SOA in implementing BIG DATA systems such as cloud ERP. SOA brings in more reusable units called services which represent business concept that can be reused to create new business process activities over a network.

This research aims to shed light on the area of SOA with BIG DATA systems from the perspective of organizational needs. The main research question of this study is as follows: What are the important factors that are necessary to implement Service-Oriented Architecture (SOA) in implementing BIG DATA Systems?

The research framework for this study has been adopted from Galinium and Shabaz (2009) as shown in Figure 1.

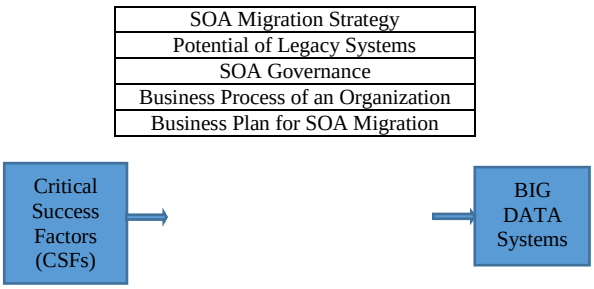

Fig.1 Research Framework (Source: Galinium and Shabaz, 2009)

IV. SOA Migration Strategy

Because of day-to-day change in technology, the organization is expecting management change in terms of business process analysis to come up with data definitions and standard schemas. Furthermore, the design and architectural model need to be built-in so that the technical gap is narrowed to help vendors to minimize the implementation issues, in particular BIG DATA systems such as ERP. The migration strategy of SOA is required to minimize cost, increase network security, reduce data redundancy, gain transparency and reusability of services from the legacy systems.

Potential of Legacy Systems

This is one of the important factors need to considered before the migration stage is considered. During the integration process, some of the services or components may not be reused due to the technical constraints or incompatibility with the operating system of the legacy systems. The second reason is that some of the services or components transformation cost may go higher.

SOA Governance

SOA governance is just how a service can be shared according to the set of rules and policies which is applicable to all of the stake holders and in turn improve the business processes in an organization. It also helps improve visibility control of SOA in order to minimize risk and total cost ownership (TCO). It will further align with business goals as well as helps streamline the operations of an organization. In terms of enterprises, it creates reusable network with interoperable services which is really very helpful for vendors in implementing BIG DATA systems such as cloud ERP.

Business Process of an Organization

Business Processes in an organization need to be aligned across organizational divisions, systems and related applications to streamline business operations in order to increase efficiency of an organization. Organizations need to correct and improve business process before automating them. Furthermore, firms need to standardize the business processes across the enterprise to its competitive advantage. This will further reduce the overall IT costs and redundancy

which will improve customer service and retention. SOA combined with appropriate business processes enable IT agility.

Business Plan for SOA Migration

Organizations worldwide start looking for an architectural model such as SOA that will provide a competitive edge among its competitors and at the same time provide a single integrated reusable services from the legacy system to avoid long implementation delays and reduce maintenance costs. The business plan should consists of a clear assessment of the SOA that will address key business process activities of an organization, evaluation and recommendation on the status of enterprise architecture, requirement analysis that helps reduce project risks in the enterprise's project lifecycle, and managing business processes that will streamline and align with the firm's goals to implement the big data system smoothly.

V. Data Analysis and Interpretation

A survey of questionnaire has been sent to 320 organizations and data received (response rate of 71.3%) has been collected through online blog from India, particularly cities in Chennai, Mumbai and New Delhi. The data has been analysed using partial least square (smartPLS) statistical package and results are discussed as well as concluded.

RESULTS, ANALYSIS AND FINDINGS

This research work carries out two assessments: internal consistency reliability and convergent and discriminant validity. The reliability of all variables with values above 0.7 which is adequate for the five factors such as SOAM, POLS, SOAG, BPO, and BPS (Nunnally, 1978).

Variables	**Cronbach**	**Mean**	**SD**
SOA Migration Strategy (SOAM)	0.912	4.64	0.97
Potential of Legacy Systems (POLS)	0.816	4.26	0.84
SOA Governance (SOAG)	0.884	4.11	0.78
Business Process of an Organization	0.802	4.59	1.19
Business Plan for SOA Migration (BPS)	0.897	4.24	1.27

Table 2. Reliability assessment.

The results of the cross loading are shown in Table 3. As suggested by Hair et al. (2009), all the individual item constructs are higher than 0.5 indicating significant convergent validity. Furthermore, it is clearly seen that the five-factor solution is suitable and the items display required discriminant validity.

	Fac1	Fac2	Fac3	Fac4	Fac5
SOAM1	**0.661**	0.210	0.216	0.217	0.228
SOAM2	**0.769**	0.371	0.191	0.094	0.085
SOAM3	**0.686**	0.462	0.101	0.152	0.136
SOAM4	**0.818**	0.352	0.218	0.222	0.235
POLS1	0.413	**0.707**	0.172	0.258	0.138
POLS2	0.416	**0.732**	0.021	0.280	0.119
POLS3	0.357	**0.814**	0.031	0.214	0.033
POLS4	0.444	**0.676**	0.101	0.413	0.236
SOAG1	0.269	0.082	**0.804**	0.480	0.228
SOAG2	0.262	0.191	**0.724**	0.416	0.216
SOAG3	0.204	0.202	**0.826**	0.427	0.024
SOAG4	0.248	0.126	**0.746**	0.079	0.091
BPO1	0.278	0.338	0.453	**0.672**	0.278
BPO2	0.272	0.178	0.594	**0.691**	0.198
BPO3	0.308	0.138	0.275	**0.772**	0.128
BPO4	0.374	0.110	0.227	**0.656**	0.158
BPS1	0.324	0.148	0.059	0.121	**0.692**
BPS2	0.262	0.114	0.107	0.119	**0.739**
BPS3	0.120	0.225	0.366	0.252	**0.752**
BPS4	0.332	0.278	0.478	0.282	**0.818**

Table 3. Results of Validity - Cross Loadings

Recommendations

The following are the recommendations in order to incorporate SOA to solve the issues in legacy systems: Services need to have reusable components; Enable service inputs and outputs that does not require construction of complex consumers; they are of a request-response nature; improve business processes by identifying key business functions, eliminating redundancy in business systems, uniqueness in business processes and all services must accessible with legacy systems.

VI. Conclusion

This study has been conducted to share ideas about the factors of SOA to implement BIG DATA systems. The factors such as SOA Migration Strategy, Potential of Legacy Systems, SOA Governance, Business Process Organization, and Business Plan Organization are very essential and played a vital role in BIG DATA systems which has been revealed through empirical evidence. The business process reengineering (BPR) can be achieved through aligning software reengineering procedures with business process management techniques. The challenge here with respect to BPR is the transformation of legacy code for services that have commercial value. SOA really serves both the purposes of organizational needs such as cross-functional communication; performance and integration with the legacy system; and technical needs such as functional and non-functional requirements of the system; enable distribution of sub systems to be partitioned among multi processors and increasing the reusability of existing components or modules with the legacy or third party application software (Malan, 1996). Furthermore, SOA deliver potential benefits to an enterprise such as

improvement on flexibility, cost reduction in terms of migration from the legacy systems, risk mitigation, increase return on investment (ROI) particularly in supply chain management such as cloud ERP and provide a direction to new products and services (DiMare, 2006). With an SOA, you can create a service then reuse that business functionality for other circumstances or in other third party software applications. This reduce the amount of coding required to create new business processes. Furthermore, SOA permits businesses to rapidly respond to trends in the current market in a cost-efficient manner and improves the Return on Investment (ROI), in particular, BIG DATA systems such as cloud ERP. Cloud ERP is very helpful in terms of the data storage and how it is delivered.

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