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A SOA-based framework for e-procurement in multi-organisations

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Abstract: The lack of standard platform for application-to-application interaction between the procurement systems of subsidiary organisations of a multi-organisation limits transparency of procurement procedures, and uniformity in the procurement patterns and practices, even when there are cross-cutting concerns. In this paper, an SOA-based e-procurement framework is proposed for effective e-procurement in a multi-organisational context. The e-procurement framework leverages SOA's inherent capability for addressing problems of heterogeneity, interoperability and dynamic requirements. An empirical case study showed that the framework is effective for achieving the corporate goal of promoting transparency, and enhancing uniformity of corporate procurement management in a multi-organisational context.

Keywords: business-to-business; e-procurement; SOA; service-oriented architecture; web services; multi-organisation; e-finance; goal question metric; SOA evaluation; interoperability; procurement management.

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1 Introduction

The existing models of procurement in most multi-organisations are plagued by inefficiency and fraud because of the structural complexity, and heterogeneous nature of a multi-organisation. A multi-organisation is one that comprises several units, departments, branches, divisions, and subsidiaries, all of which exhibit a considerable degree of (if not absolute) independence from the parent organisation (Dobson et al., 2005). Although these independent divisions of a multi-organisation are bound to have their individual expenditure patterns, in many cases, cross-cutting concerns (viz. concerns that are common to several divisions of the organisation) do exist across the different divisions of the multi-organisation. This could be in terms of the common needs for certain kinds of goods and services, technical and manpower needs, tools, contracts, or nature of recurrent expenditure. What exists in most cases is that much of the procurement activities are done manually, which makes the procurement process labour-intensive, repetitively expensive, inefficient, and error-prone (Vitkauskait and Gatautis, 2008). There is also a high tendency for non-compliant buying, mostly as a result of employees' desire to get incentives from suppliers (Katri et al., 2009; Gelderman et al., 2006). The challenge of how best to initiate an effective e-procurement policy in a multi-organisational context is one that existing models of e-procurement are yet to adequately cater for Engström et al. (2008).

Service-Oriented Architecture (SOA) is an architectural style (Diao and Ma, 2008) that enables the engagement of concepts of the Service-Oriented Computing (SOC) paradigm in solving the problems of heterogeneity, interoperability and dynamic requirements in e-business applications (Ashoori et al., 2009; Rabhi et al., 2009). SOA is a business systems architecture that allows application services to be loosely coupled, location transparent, and protocol independent. It is an evolution of the component based architecture, interface based design, layered application architecture, distributed systems and the internet. It is an approach for building a distributed system that delivers application functionality as services to either end-user applications or other services (Sprott, 2004; Natis, 2003). SOA enables the interoperability of disparate systems by addressing the requirements of loosely coupled, standards-based, and protocol-independent distributed computing. The underlying principle of SOA paradigm

is that a system is designed and implemented using loosely coupled software services with well defined interfaces that can be accessed without any knowledge of their implementation platform. These characteristics make SOA potentially suitable for the establishment of an effective e-procurement model in a multi-organisational context. An SOA-based approach to e-procurement holds the promise of enabling the creation of a uniform model for handling cross cutting concerns, and promoting transparency of procurement activities in a multi-organisation. This is because, it provides a virtual platform for accessing relevant information on procurement activities which will facilitate reduction in cost of purchase, promote transparency by reducing off-contract buying (Ho et al., 2008), promote maintenance of standards and quality, and provide good Quality of Services (QoS). This perspective of the application of SOA is one that has not been adequately exploited by previous e-procurement approaches so far reported in literature (Chen and Meixell, 2003; Panayiotou et al., 2003; Cheung et al., 2004; Assar and Boughzala, 2008; Ashoori et al., 2009).

In contrast to previous approaches, this paper proposes a SOA-based e-procurement framework for realising effective e-procurement in a multi-organisational context. Also, an empirical case study of the implementation and evaluation of the proposed SOA-based e-procurement framework was conducted to assess its viability. The rest of this paper is structured as follows: Section 2 is a review of literature on enterprise e-procurement and SOA. In Section 3, an overview of the adopted methodology in terms of the design and implementation of the proposed e-procurement framework is presented, while Section 4 give details of the evaluation of the proposed framework and a discussion of results. The paper is concluded in Section 5 with a brief note.

2 Literature review

2.1 Related work

Procurement is an integral part of the B2B process and an essential part of any organisation's ability to function effectively (Panayiotou et al., 2003). With the use of the internet as a medium of interconnectivity, various implementations of the e-procurement system have been carried out. A number of significant efforts in the area of enterprise e-procurement have been reported in literature. The following are noteworthy:

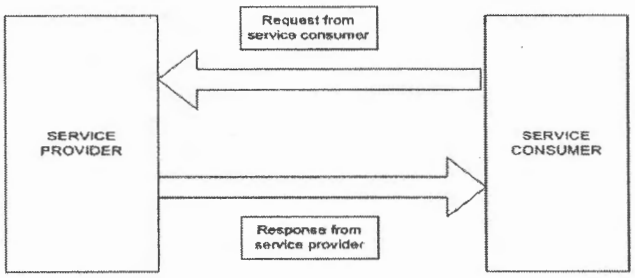
Government e-procurement system of Republic of Korea (GePS) (Iqbal and Seo, 2008) is a single portal for all public procurement in the Republic of Korea. It processes ebXML documentation and provides B2B capability for business. GePS is linked to 53 external systems through the internet for sharing information with relevant groups and associations. Electronic documents for message exchange in GePS uses the World Wide Web Consortium recommended XML schema and the core components of ebXML. Cheung et al. (2004) implemented the Agent-Oriented and Knowledge-Based System for Strategic e-procurement (AOKBS). The AOKBS is based on a component-based architecture, and was designed to capture the knowledge of an enterprise using agent technology. It also employed the use of case-based reasoning to generate rules for effective procurement strategy. The e-*Purchase SA* is an initiative of the Department for Administrative and Information Services (DAIS), South Australia (Australian Government – Department of Communication Information and Arts, 2004). It is an online e-procurement system with message routing and automated workflow capability.

The *e-purchase SA* provides electronic catalogues with 'punch out' capability for buyers to access product catalogues and make requisitions. Sheldon et al. (2002) implemented the B2B e-commerce System Specification and Implementation Employing Use-Case Diagrams, Digital Signatures and XML (Sheldon et al., 2002). It is a remote order and delivery web-based B2B e-commerce system for an auto-parts manufacturing company. In achieving B2B interaction, the system exchanges only server programs and encoded files while communicating with other business companies. The XML documentation is transmitted by using a socket on the application. The DTD and XSL are saved in a global repository and are used by the web browser's parser for validation based on the information in the XML documentation itself that is sent and received. Chen and Meixell (2003) proposed an architectural design for web service enabled procurement through a private supplier web services registry database although it was not addressed to a multi-organisational setting. Ashoori et al. (2009) implemented an e-procurement framework that supports dynamic acquisition of procurement services from different suppliers dealing with changing procurement requirements based on an extension to Web Services Business Process Execution Language (WS-BPEL) standard. The Web Service Interoperability (WS-I) Supply Chain Management (Endrei et al., 2004) is based on the WS-I Basic Profile V1.0 (Web Services Interoperability Organisation, 2006). The WS-I Basic Profile V1.0 specifies a set of usage scenarios and web services standards that can be used to integrate systems. It focuses on the core foundation technologies upon which web services are based: HTTP, SOAP, WSDL, UDDI, XML, and XML Schema. The B2B scenario for WS-I supply chain management is such that, the retailer system through web service requests fulfilment of a consumer's order from the internal company warehouse, which responds as to whether line items from the order can be filled. Similarly, the WS-I standard has been adopted in this work to achieve enterprise application integration for e-procurement but specialised for a multi-organisational setting. In summary, literature revealed that many of the existing e-procurement models are not SOA-based, although quite a number were based on the use of web services. Also, none of the existing e-procurement models have been specifically addressed to a multi-organisational context. Hence, as a contribution this work offers a demonstration of the application of SOA in making procurement information accessible across disparate domains, and technology and platforms in the context of a multi-organisation.

2.2 Overview of SOA

SOA is an approach to designing integration architecture based on the concept of service. It is a software architecture that starts with an interface definition and builds the entire application topology as a topology of interfaces, interface implementations and interface calls. To create applications that are free from the underlying IT infrastructure, SOA utilises the concepts of services. Services are software modules that are accessed by name via an interface, typically in a request-reply mode. A service is a unit of work such as a business function, a business transaction, or a system service completed by a service provider to achieve desired end results for a service consumer. Figure 1 shows the model for basic services interaction in a SOA.

Figure 1 Basic services interaction



Source: Göknur (2008)

The six main service-related entities for SOA are: service provider, service consumer, service registry, service contract, service proxy and service lease for this interaction. The services have the following basic characteristics:

- Discoverable and dynamically bound
- Self-contained and modular
- Interoperable
- Loosely coupled
- Have a network-addressable interface
- Have coarse-grained interfaces
- Location-transparent
- Can be composed into new applications (Sprott, 2004; Endrei et al., 2004).

2.2.1 Collaboration between SOA entities

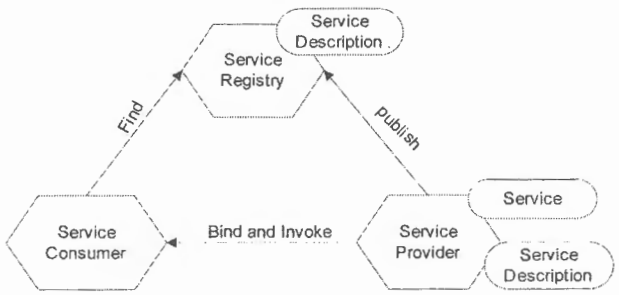
The collaboration between SOA entities follows the "find, bind, and execute" paradigm (Sprott and Wilkes, 2004). The basic operations in a SOA are:

- *Publish*: For a service to be accessible, the service provider publishes the service description so that it can be discovered and invoked by service consumers
- *Find*: Service requester locates a service by querying the service registry for a service that meets its criteria
- *Bind and invoke*: After successful retrieval of the service description, the service consumer then invokes the service based on the information provided by the service description.

SOA allows the consumer of a service to ask a third-party registry for the service which it intends to bind to. If the registry has such a service, it gives the consumer a contract and an endpoint address for the service (see Figure 2). The three entities of a SOA are (Singh and Huhns, 2005):

- *Service consumer*: The service consumer is an application, service, or some other type of software module that requires a service. It is the entity that initiates the location of the service in the registry, binding to the service over a transport, and executing the service function. The service consumer executes the service by sending it a request formatted according to the contract.
- *Service provider*: The service provider is a network-addressable entity that accepts and executes requests from consumers. It can be a mainframe system, a component, or some other types of software system that executes the service request. The service provider publishes its contract in the registry for access by service consumers.
- *Service registry*: A service registry is a network-based directory that contains available services. It is an entity that accepts and stores contracts from service providers and provides those contracts to interested service consumers.

Figure 2 Collaboration in service oriented architecture



The interaction among SOA entities is based on the principle of service by contract. A service contract specifies the way a consumer of a service will interact with the provider of the service. It specifies the format of the request and response from the service. A service contract may require a set of pre-conditions and post-conditions. The pre-conditions and post-conditions specify the state that the service must be in to execute a particular function. The contract may also specify Quality of Service (QoS) levels. QoS levels are specifications for the non-functional aspects of the service. For instance, a Quality of Service attribute is the amount of time it takes to execute a service method.

2.2.2 Service provider and service consumer relationship

The relationship between service providers and service consumers in a SOA can be broadly categorised into two types. These are:

- *Negotiated Relationship*: In this case, both consumer and provider jointly agree to how the services should work. In scenarios where there are many participants and where services are common to many providers, it is important that the industry considers standardising those services. This could be by way of:

  - close partners agreeing on the service interface as a natural part of reaching and implementing a commercial agreement
  - forming a standard for vertical sectors in the industry.
- *Mandated Relationship*: This is kind of a take-it or leave-it scenario. An instance is when a very large or dominant organisation(s) dictates the business practice in the industry (Singh and Thomson, 2002). Examples include provider-led situations, and consumer-led situations.

2.3 Web service

The concept of web services is the foundation for a SOA. A web service is a software system designed to support interoperable machine-to-machine interaction over a network. According to W3C (David et al., 2004; Champion, 2002), a web service is a software application identified by a URI, whose interfaces and bindings are capable of being defined, described, and discovered as XML artefacts. A web service supports direct interactions with other software agents using XML-based messaging via internet-based protocols (Stevens, 2004; Endrei et al., 2004). It has an interface described in a machine-processable format (specifically WSDL). Other systems interact with the web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialisation in conjunction with other web-related standards (Gebauer and Segev, 1998).

Web service is a useful tool for enabling collaboration and sharing of business process between two or more enterprises. It offers technology neutrality and standard approach than using proprietary integration technologies (Endrei et al., 2004). Web services promises to offer enterprise application the capability that World Wide Web did to interactive end-user application. Primarily, web service is a technique that allows disparate server systems to communicate with each other and exchange information for which the web, and traditional web browser, is the primary data access point (Stevens, 2004). Web service is a good beginning toward implementing service-oriented architecture because its concept supports many of the characteristics of service-oriented architecture.

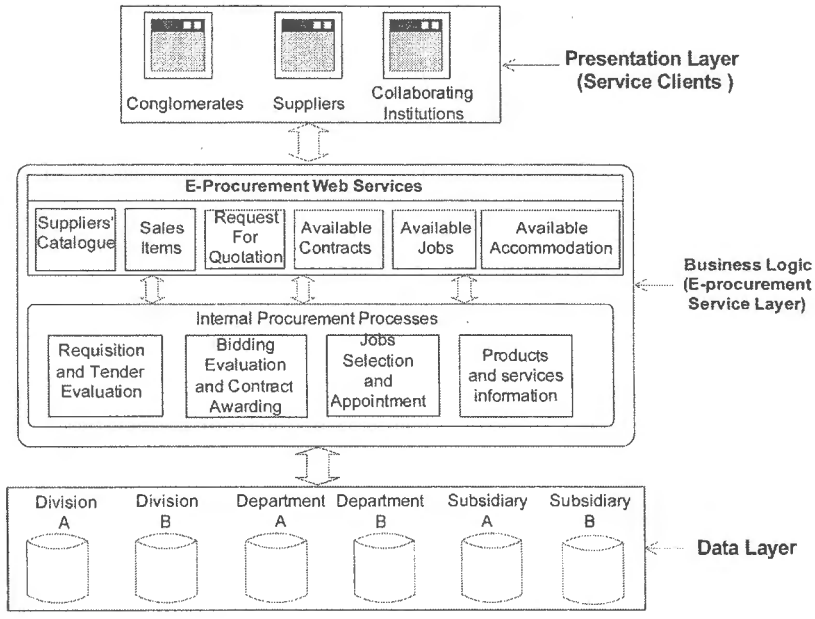
3 Methodology

3.1 The SOA-based e-procurement framework

A multi-organisation is a conglomerate of several institutions which consists of departments, units, divisions and subsidiaries all of which have to interact frequently with numerous procurement outlets for the purpose of purchasing of goods and services. Since transparency, prudent spending, and efficient management of resources are the bedrock of good management, the need to evolve uniformity of standards and openness in corporate procurement activities is imperative. SOA provides a good platform through which the objective of a uniform standard for corporate procurement could be realised. This is because a SOA-based e-procurement framework will ensure open access to all procurement information from disparate locations which will aid procurement activities, and also assist in the regulation and coordination of procurement activities by the

monitoring agencies. The conceptual SOA-based e-procurement framework is shown in Figure 3. It is a 3-tier architecture which is used to model B2B interaction between the several departments of a multi-organisation and its trading partners.

Figure 3 SOA-based e-procurement framework for multi-organisations (see online version for colours)



A 3-Tier Architecture (3TA) is customarily used when building web applications. It makes a logical separation between the presentation layer, the business logic layer, and the database layer. The SOA builds on top of the 3TA. Instead of considering IT infrastructure as a set of application tower, SOA looks at a set of services and applications. Services implement some kind of functionality and are used by applications and other services. Services communicate between each other and with applications by exchanging XML documents. As shown in Figure 3, the data layer comprises various corporate divisions that can use the e-procurement web services to access procurement information. The application layer shows the business entities that can be service consumers (clients) of the e-procurement applications through remote invocation of the web service methods. The e-procurement web service module lists the service interfaces used to publish procurement information for sourcing tender. The internal procurement processes of the architecture shows the procurement functions that are to be carried out between requesting departments and the organisations' procurement officers.

3.2 An implementation of the e-procurement framework

A pilot study was conducted at Covenant University (CU), Nigeria, using the proposed SOA-based e-procurement framework to model the University's B2B interaction with suppliers, remotely located affiliates and collaborating Universities for a period of

five months (October–February 2008). The study was conducted as trial of the viability of a platform independent interoperable e-procurement model in a multi-organisational context. All the information relevant to procurement within the institution were identified and published as web services. The CU e-procurement framework provided a distributed computing platform that integrates heterogeneous applications over the Internet for effective management and retrieval of procurement information.

The e-procurement services layer of the SOA framework was implemented as .Net web services using Microsoft C#. The functionalities of the web services in the e-procurement services layer were exposed to the clients through the web services interfaces but the business logic of those services was internal to their implementation classes. This offers the advantage of adaptability and dynamism in that the implementation of the web service methods could be changed in future while keeping the web service interface stable. The implementation class for each of the web methods exposed by the web service calls the database (SQL Server) class, wraps the corresponding SQL statements that controls the retrieval of data from the database and consist of corresponding classes that get input and return output to the users.

An overview of the class structure of the e-procurement web services layer of the CU e-procurement framework is shown in Figure 4. Also, Figure 5 is a listing of the web services that make up the e-procurement services layer of the CU e-procurement framework, while Figure 6 shows a snapshot of the web service "*SupplierCatalogue*" that provides information about suppliers of various types of goods and services. The web service displays suppliers' information including name, address and phone number of suppliers of products.

Figure 4 Class structure of the e-procurement services layer of the framework

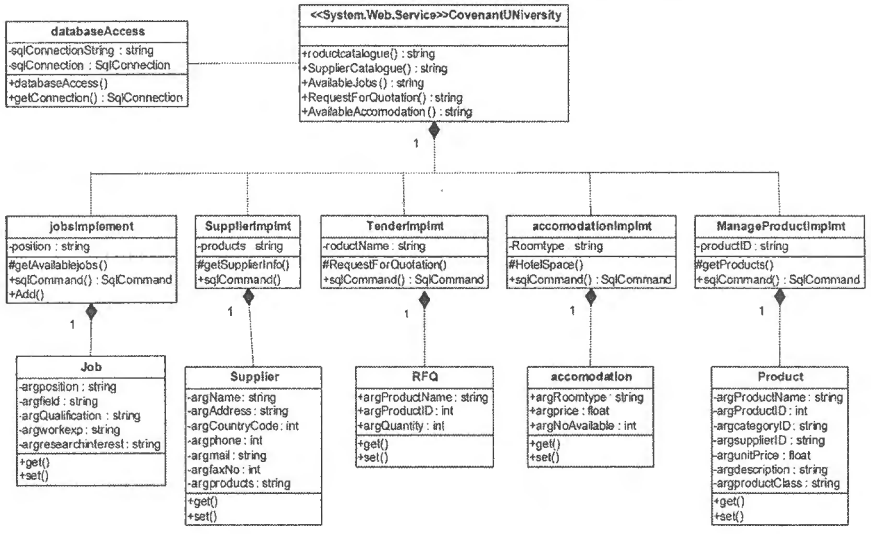


Figure 5 A view of CU e-procurement web services (see online version for colours)

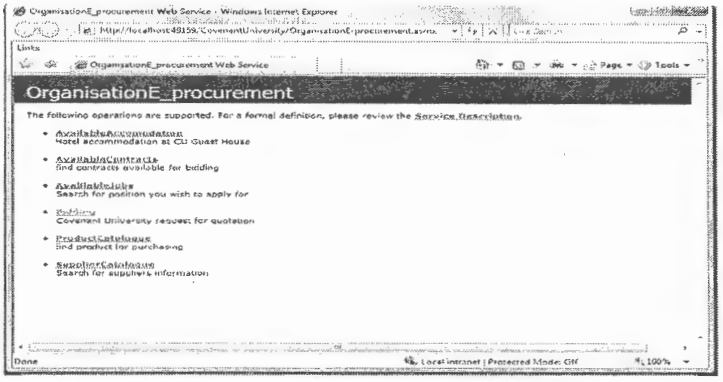
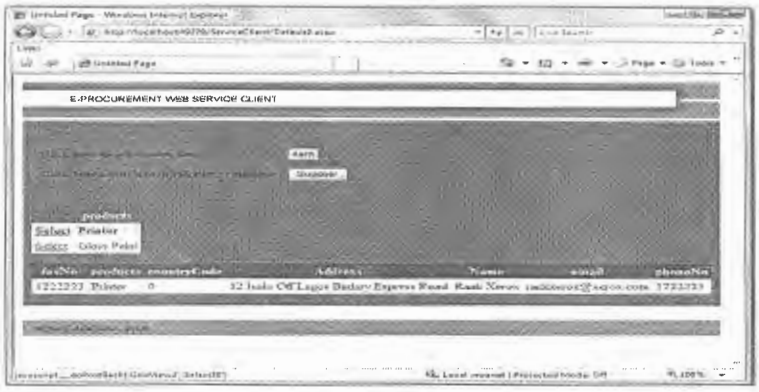


Figure 6 Client invocation of *SupplierCatalogue* service (see online version for colours)



4 Evaluation of the SOA-based e-procurement framework

Aier et al. (2007) proposed the use of the Goal Question Metric (GQM) paradigm (Basili, 1992; Basili et al., 1994) for the evaluation of SOA in an Enterprise Architecture (EA) context. The GQM is a mechanism for defining and evaluating a set of operational goals, using measurement. It represents a systematic approach for tailoring and integrating goals with models of software processes, products and quality perspectives of interest, based on the specific needs of an organisation (Basili, 1992). The GQM is a 3-level process that entails the identification of the key goals of a process, the formulation of goal-specific assessment questions, and the definition of metrics to generate data to answer the goal-specific questions in a quantitative way. We selected to use the GQM paradigm for the evaluation of the SOA-based framework for effectiveness. An SOA is deemed effective if it meets the objectives for which it was instituted and contributes significantly to the attainment of the strategic goals of the organisation (SOA Governance Survey Report, 2008). The GQM model used to evaluate effectiveness of the SOA-based e-procurement framework is shown in Figure 7.

Figure 7 GQM model for measure of effectiveness of SOA-based e-procurement framework

Goal **Purpose** **Issue** **Object (Process)** **Viewpoint**	Evaluate the effectiveness of SOA-based Framework for e-Procurement from the stakeholder's (architects, users) viewpoint
Question	Quantify your experience with e-Procurement
Metrics M1	Subjective rating per person 5 – quite enormous 4 – measurable 3 – average 2 – below average 1 – negligible 0 – none x – no response
Question	State the extent of your desire for e-Procurement in a multi-organisation setting
Metrics M2	Subjective rating per person 5 – strongly desired 4 – desired 3 – weakly desired 2 – neutral 1 – opposed to it 0 – strongly opposed to it x – no response
Question	Characterise the extent to which the SOA framework has enhanced transparency and uniformity in procurement across divisions in the organization
Metrics M3	Subjective rating per person 5 – very high 4 – high 3 – average 2 – low 1 – very low 0 – none x – no response
Question	Give an assessment of the quality of service provided by the SOA framework
Metrics M4	Satisfaction factor = (number of satisfactorily functional services) / (number of service invocations) *100
M5	Subjective rating per person 5 – very high 4 – high 3 – average 2 – low 1 – very low 0 – dissatisfied x – no response

4.1 Evaluating the effectiveness of the SOA-based framework

The SOA-based e-procurement Framework Effectiveness Model is given thus:

Let:

$M1_c$ = Stakeholder rating for M1

$M2_c$ = Stakeholder rating for M2

$M3_c$ = Stakeholder rating for M3

$M4_c$ = Satisfaction Factor

$M5_c$ = Stakeholder rating for M4

Let $\{WSQ_i\}$ be set of Weighted Service Quality per stakeholder [each $WSQ_k = (M1_c * M4_c * M5_c)$]

Where Maximum $(WSQ_k) = 125$ [for a perfect stakeholder rating], $k \leq i$

Let $\{SIF_i\}$ be set of SOA Impact Factor per stakeholder [each $SIF_k = [WSQ_k/(M2_c * M3_c)]$

Where Maximum $(SIF_k) = 5$ [for a perfect stakeholder rating], $k \leq i$

Interpretation Algorithm for Effectiveness of SOA-based framework for e-procurement

If 70% or more of $\{WSQ_i\}$ >= 62.5 then SOA framework is a perfectly effective process

If 60%–69% of $\{WSQ_i\}$ >= 62.5 then SOA framework is a very effective process

If 50%–59% of $\{WSQ_i\}$ >= 62.5 then SOA framework is a mostly effective process

If 45%–49% of $\{WSQ_i\}$ >= 62.5 then SOA framework is a barely effective process

If less than 45% of $\{WSQ_i\}$ >= 62.5 then SOA framework is not an effective process

Using the GQM model in Figure 7, a first-cut evaluation experiment was undertaken with 20 stakeholders, who were requested to evaluate the SOA-based framework based on their interactions and experience with it over a 5-months trial period. The participants comprises 10 persons from 5 contractor organisations (2 persons per organisation) that have ongoing supply contracts with Covenant University, 5 procurement officers from 5 divisions and subsidiaries of the University, and 5 IT Architects, who have been part of the team responsible for the design, implementation and management of the SOA framework over the 5 months period. All the participants gave their informed consent to participate in the experiment. Questionnaire based on the developed GQM model was then given to each of the participants to capture their assessment of the SOA-based e-procurement framework. In the experiment, the data collected was partitioned into two (viz. C1 and C2) for analysis. C1 (5 participants) represents the class of developers stakeholders (IT Architects), while C2 (15 participants) represents the class of user stakeholders. For C1, 60% of the computed Weighted Service Quality (WSQ) per user was above the benchmark value of 62.5 which typifies the SOA framework as a very effective process; while for C2 53.1% of the computed Weighted Service Quality (WSQ) per user was above the benchmark value of 62.5, which typifies the SOA framework as a mostly effective process. Also, the mean SIF (SOA Impact Factor) computed for all

20 participants was 3.54 (relative to the perfect score of 5). Based on the results obtained from the evaluation experiment the SOA-based e-procurement framework can be generally characterised as an effective process.

4.2 Discussion

Apart from the positive results obtained from the trial evaluation of the SOA-based CU e-procurement framework using the GQM, the advent of the SOA-based e-procurement framework during the 5-months trial period also had positive managerial implications for the University. Some of the benefits observed are profiled as follows:

- The provision of a single access point to procurement information helped to achieve transparency, uniformity and convergence of concerns within the organisation.
- The provision of a distributed computing platform for the advertisement of business services of applications on the internet using standard XML protocols and formats. The information became more accessible to many more interested parties.
- The provision a platform for interoperability and application level integration with other institutions or business entities partnering with the university.
- It enabled the harmonisation and standardisation of e-procurement initiatives in the University within the period, which helped to enhance transparency and a degree of uniformity in expenditure handling.

The experience of this study reveals that the adoption of SOA-based e-procurement models can yield significant benefits in the context of a multi-organisation. It also emphasises the need to more actively embrace such a practise in contrast existing approaches that have not be as effective in terms promoting transparency of procurement procedures and enhancing uniformity in the procurement patterns and practices in corporate procurements.

5 Conclusion

In this paper, the need for a SOA-based framework for e-procurement in multi-organisations has been canvassed. The plausibility of the concept was demonstrated using a case study. As a contribution, this work offers a demonstration of the application of SOA for achieving platform independent interoperability of e-procurement initiatives in multi-tiered organisations.

However, the limitation of the study is that the proposed SOA-framework was deployed and evaluated in only one multi-organisation. To further generalise the result, the study should be conducted in many more multi-organisations. In future work, it would be interesting to evaluate the SOA-based e-procurement framework and its impact along other dimensions such as usability (Casaló et al., 2008), agility, and efficiency apart from effectiveness. Another interesting endeavour would be to evaluate the SOA-based e-procurement framework using specific SOA metrics such as: service quality assurance, service reuse, and service availability in order to determine the ROI and level of maturity of SOA-based e-procurement in the multi-organisation.

References

Aier, S., Ahrens, M., Stutz, M. and Bub, U. (2007) 'Deriving SOA evaluation metrics in an enterprise architecture context', *2nd SeMSoC Workshop, ICSOC 2007*, Vienna, www.alexandria.unisg.ch/EXPORT/DL/54949.pdf

Ashoori, M., Eze, B., Benyoucef, M. and Peyton, L. (2009) 'Toward a framework for dynamic service binding in e-Procurement', *Lecture Notes in Business Information Processing*, Springer-Verlag, Vol. 26, pp.89–99.

Assar, S. and Boughzala, I. (2008) 'Empirical evaluation of public E-Procurement platforms in France', *International Journal Value Chain Management*, Vol. 2, No. 1, pp.90–108.

Australian Government – Department of Communication Information and Arts (2004) *From Paper to Procurement*, www.dbcde.gov.au/data/assets/pdf file/0017/20447/ecatalogue28-4.pdf

Basili, V.R. (1992) *Software Modeling and Measurement: The Goal Question Metric Paradigm*, Computer Science Technical Report Series, CS-TR-2956 (UMIACS-TR-92-96), University of Maryland, College Park, MD, September.

Basili, V., Caldiera, G. and Rombach, H. (1994) *Goal Question Metric Approach, Encyclopedia of Software Engineering*, John Wiley & Sons, Inc., New York, pp.528–532.

Casaló, L., Flavián, C. and Guinalíu, M. (2008) 'The role of usability and satisfaction in the consumer's commitment to a financial services website', *Int. J. Electronic Finance*, Vol. 2, No. 1, pp.31–49.

Champion, M. (2002) *Web Services Architecture W3C Working Draft 14 2002*, http://www.w3.org/TR/2002/WD-ws-arch-20021114

Chen, M. and Meixell, M. (2003) 'Web services enabled procurement in the extended enterprise: an architectural design and implementation', *Journal of Electronic Commerce Research*, Vol. 4, No. 4, pp.140–155.

Cheung, C.F., Wang, W.M., Victor, L.O. and Lee, W.B. (2004) 'An agent-oriented and knowledge-based system for strategic E-Procurement', *Expert Systems*, Vol. 21, No. 1, pp.11–21.

David, B., Haas, H., McCabe, F., Newcomer, E., Champion, M., Ferris, C. and Orchard, D. (2004) *Web Services Architecture. W3C Working Group Note 11*, http://www.w3.org/TR/2004/NOTE-ws-arch-20040211

Diao, L. and Ma, Y. (2008) 'A versatile SOA-based e-business platform', *Proceedings of the 2008 International Symposium on Electronic Commerce and Security, IEEE*, pp.638–641, DOI 10.1109/ISECS.2008.49.

Dobson, J., Lock, S. and Martin, D. (2005) 'Complexities of multi-organisational error management', *Proceedings of the 2nd Workshop on Complexity in Design and Engineering*, Glasgow, pp.110–119.

Endrei, M., Ang, J., Arsanjani, A., Chua, S., Comte, P., Krogdahl, P., Luo, M. and Newling, T. (2004) *Patterns: Service-Oriented Architecture and Web Services*, www.ibm.com/redbook

Engström, A., Wallström, A. and Salehi-Sangari, E. (2008) 'The evolution of e-procurement within Swedish municipalities from 2001 to 2008', *Collaboration and the Knowledge Economy: Issues, Applications, Case Studies*, IOS Press, Amsterdam, pp.507–513.

Gebauer, J. and Segev, A. (1998) 'Assessing internet-based procurement to support the virtual enterprise', *Electronic Journal of Organisational Virtualness*, Vol. 2, No. 3, pp.30–43.

Gelderman, C.J., Ghijsen, P.W. and Brugman, M.J. (2006) 'Public procurement and EU tendering directives? Explaining non-compliance', *International Journal of Public Sector Management*, Vol. 19, No. 7, pp.702–714.

Göknur, A.A. (2008) *A Survey based Study on the Role of E-Procurement in Integrating ERP (Enterprise Resources Planning) Systems Using e-Supply Chain*, A Master's Thesis, Computer Engineering, Atilim University, Turkey.

Ho, C., Tai, Y., Wu, W. and Jou, J. (2008) 'Exploring the impacts of web-based e-procurement on organizational performance', *PACIS 2008 Proceedings*, Paper 106. http://aisel.aisnet.org/pacis2008/106

Iqbal, M.S. and Seo, J.W. (2008) 'E-governance as an anti corruption tool: Korean cases', *Journal of Korean Regional Information Society*, Vol. 11, No. 2, pp.51–78.

Katri, K., Katariina, K. and Eric, M. (2009) 'Non-compliant work behaviour in purchasing: an exploration of reasons behind maverick buying', *Journal of Business Ethics*, Vol. 85, No. 2, pp.245–261.

Natis, Y.M. (2003) *Service-Oriented Architecture Scenario*, Gartner Research Note AV-19-6751.

Panayiotou, N.A., Gayialis, S.P. and Tatsiopoulos, I.P. (2003) 'An e-procurement system for governmental purchasing', *International Journal of Production Economics*, Vol. 90, No. 1, pp.79–102.

Rabhi, F.A., Guabtni, A. and Yao, L. (2009) 'A data model for processing financial market and news data', *Int. J. Electronic Finance*, Vol. 3, No. 4, pp.387–403.

Sheldon, F.T., Jerath, K., Pilskalns, O., Kwon, Y., Kim, W. and Chung, H. (2002) 'Case study: B2B E-commerce system specification and implementation employing use-case diagrams, digital signatures and XML', *Proceedings of Fourth International Symposium on Multimedia Software Engineering*, Newport Beach, CA, pp.106–113.

Singh, M.P. and Huhns, M.N. (2005) 'Service-oriented computing: key concepts and principles', *IEEE Internet Computing*, Vol. 9, No. 1, pp.75–81.

Singh, M. and Thomson, D. (2002) 'An E-procurement model for B2B exchanges: an australian example', *15th Bled Conference on eReality: Constructing the e-Economy*, 17–19 June, Slovenia, CD ROM, pp.293–307.

SOA Governance Survey Report (2008) *Increasing the Effectiveness and Efficiency of SOA through Governance*, http://www.oracle.com/technologies/soa/docs/oracle-governance-white paper.pdf

Sprott, D. (2004) *Service Oriented Architecture: An Introduction for Managers*, http://www.roadmap.cbdiforum.com/reports/soa/managersintro.php [accessed: 05/02/09].

Sprott, D. and Wilkes, L. (2004) *Understanding Service-Oriented Architecture*, http://www.developer.com [accessed: 05/02/09].

Stevens, M. (2004) *Service-Oriented Architecture Introduction, Part 2*, http://softwaredev.earthweb.com/msnet/article/0,10527_1014371,00.html [accessed: 05/02/09].

Vitkauskait, E. and Gatautis, R. (2008) 'E-procurement perspectives in construction sector SMEs', *Journal of Civil Engineering and Management*, Vol. 14, No. 4, pp.287–294.

Web Services Interoperability Organisation (2006) Basic Profile Version 1.0, http://www.ws-i.org/Profiles/BasicProfile-1.0.html [accessed: 03/05/08].