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A Comparative Study of Service-Oriented Architecture Maturity Model

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ABSTRACT

Service-oriented Architecture (SOA) maturity model is a benchmark for evaluating and assessing the maturity of SOA adoption. Several of SOA maturity models have been constructed by the academia and industry. However, these models contradict with each other in determining "what" need to be assessed in SOA adoption. Therefore, the aims of this study is to review and compare the existing SOA maturity models that were commonly referred such as SOAMM, SIMM, CSOAMM, Inaganti's Model, iSOAMM, Welke's Model and SOASMM in order to determine which model should be enhanced to reflect the true definition of SOA. The findings implies that the existing models have their own strengths and weaknesses and based on these findings, this study identify that Welke's model is the most suitable model that should be enhanced. This study has successfully analyze the existing models and identify an issue that deserve future investigation such as the need to provide two dimensional evaluations for both IT benefits and business benefits and the need to improve the evaluation processes in the SOA maturity model.

Keywords: Service-Oriented Architecture, Service-Oriented Architecture Maturity Model, SOA, SOAMM.

I INTRODUCTION

Nowadays, we have seen the migration of legacy systems towards Service-Oriented Architecture (SOA). SOA is an architectural style for developing software systems that use accessible services in a network (Papazoglou, 2008). It is a paradigm for business and Information Technology (IT) people that guide and integrate distributed capabilities of services under different ownership regardless of different platforms, operating system and languages (Baghdadi, 2014; Kontogiannis et al., 2007). The benefits of this migration include improving reliability, reducing development cost and the ability of reuse. Many organizations in several different domains have successfully adopted SOA especially in healthcare (Ganapathy, Priya, Priya, Prashanth, & Vaidehi, 2013), supply chain management (Cheng, Law, Bjornsson, Jones, & Sriram, 2010) and e-government portal (Sedek & Omar, 2013). Yet, there are still many more that have been unwilling to adopt SOA (Feuerlicht, 2007). This reluctance might due to immaturity of SOA practices (Ciganek, Haines, & Haseman, 2009).

The SOA adoption involves a transformation process that affects the social and technological structure of organizations (Sutawijaya & Chiok, 2010). SOA also has been touted as "the next big thing" for designing, implementing and deploying large scale service provision software systems (Konigsberger, Silcher, & Mitschang, 2014). Still, many SOA efforts were failed to meet the business objectives which is a problem that still exists today (Konigsberger et al., 2014). Thus, in order to solve this problem, previous industry and academia had introduced SOA maturity models which can be used to provide a roadmap for successful SOA adoption (Ameller et al., 2015; Söderström & Meier, 2007).

SOA maturity model can be used to control and to measure the progress of SOA adoption. However, previous models contradict with each other in determining "what" need to be assessed in SOA adoption. Therefore, the focus of this study is to review and compare the existing SOA maturity models in order to determine which model can be enhanced to reflect the true definition of SOA. The structure of this paper is organized as follows: section 2 and 3 provides an overview of SOA adoption and SOA maturity model. Section 4 and 5 presents the findings and discussions. Section 6 concludes the study with a brief summary.

II OVERVIEW OF SOA ADOPTION

There have been many definition of SOA from different perspectives but still there is no common understanding of what SOA is (Erl, 2005). However, this study has found that they all shared some common principles where majority of researchers have stated that as to truly achieved the SOA adoption concept, the organization should treat and view SOA from both IT benefits and business benefits (Baghdadi, 2014; Borges & Mota, 2007; Derler & Weinreich, 2007). The benefits of adopting SOA for both parties is that business people can achieved the flexibility and agility of business processes whereas IT people can take advantage of SOA characteristics such as reuse, composition of application and integration of data to develop a new application. Furthermore, Joachim, Beimborn, Hoberg and Schlosser (2009)

stated that the term adoption refers to the decision to make full use of an innovation. The adoption of SOA also can lead to a major transformation of an organizations IT architecture (Joachim et al., 2009). Next section discuss on SOA maturity model which can be used to guide the adoption of SOA.

III SOA MATURITY MODEL

A SOA maturity model is a model that was used to clarify and provide common definition of SOA inside an organization (Meier, 2006; Sonic Software, AmberPoint, BearingPoint & Systinet, 2005). The most often mentioned benefit of SOA maturity models is that they can help to guide the adoption of SOA (Meier, 2006). Furthermore, these benefits of adopting SOA in organization can be distinguish into IT benefits and business benefits (Baskerville, Cavallari, Hjort-Madsen, Pries-Heje, & Sorrentino, 2005; Becker, Buxmann, & Widjaja, 2009; Joachim, 2011; Yoon & Carter, 2007). Therefore, this study discuss on the SOA maturity models that were commonly referred by the researchers such as SOAMM (Sonic Software, AmberPoint, BearingPoint, & Systinet, 2005), SIMM (Kreger et al., 2009), CSOAMM (Söderström & Meier, 2007), Inaganti's Model (Inaganti & Aravamudan, 2007), iSOAMM (Rathfelder & Groenda, 2008), Welke's Model (Welke, Hirschheim, & Schwarz, 2011) and SOASMM (Kassou & Kjiri, 2012). Next section provides details discussion on each model.

A. SOAMM

The SOA Maturity Model (SOAMM) (Sonic Software, AmberPoint, BearingPoint, Systinet, 2005) was published in 2005. The model was created based on the response of nearly 2000 developers, architects and industry analyst reports that showed a successful adoption of SOA. SOAMM is intended to prepare organizations for successful SOA adoption, to set a SOA vision and to measure the progress. SOAMM consist of five maturity levels as shown in Figure 1: Initial services, architected services, business services or collaborative services, measured business services and optimized business services.

Maturity Level	Evaluation Dimension				
Initial Service	Prime Business Benefits	Scope	Critical Technology Success Factors	Critical People & Organizational Success Factors	Selected Relevant Standard
Architected Services					
Business Services					
Collaborative Services					
Measured Business Services					
Optimized Business Services					

Figure 1. SOAMM (Sonic Software, AmberPoint, BearingPoint & Systinet, 2005).

As shown in Figure 1, SOAMM aligned their maturity levels across a set of evaluation dimensions such as prime business benefits, scope, critical technology success factors, critical people and organizational success factors and selected relevant standards. SOAMM also view their maturity model in a way to increase the positive impact which SOA adoption can have from a business perspective. This can be seen by each of the maturity levels that try to assess and increase the levels of business benefits from the adoption of SOA. Based on Figure 1, the prime business benefits such as functionality, cost effectiveness, business responsiveness, business transformation and business optimization can be achieved as the level of maturity increase.

B. SIMM

The Service Integration Maturity Model (SIMM) (Kreger et al., 2009) was published by IBM in 2005. IBM created a maturity model in order to provide a ways to access a corporation's service maturity. The model consists of seven levels of maturity presented in Figure 2: silo, integrated, componentized, simple services, composite service, virtualized services, and dynamically reconfigurable services.

Maturity Level	Evaluation Dimension						
Silo	Business view	Governance & organization	Methods	Application	Architecture	Information	Infrastructure & management
Integrated							
Componentized							
Service							
Composite Services							
Composite Services							
Dynamically re-configurable Services							

Figure 2. SIMM (Kreger et al., 2009).

SIMM is a maturity model that used services as major structuring component to increase business flexibility. They link their maturity levels with the desired business outcomes across different types of evaluation dimensions. SIMM also focuses on legacy systems transformation towards a service-oriented application. However, SIMM focuses more on the benefits and results of achieving a maturity level versus solely improvement of the process. In addition, SIMM are more on providing a maturity for service integration rather than a SOA maturity itself.

C. CSOAMM

Söderström and Meier (2007) construct a Combined Service Oriented Architecture Maturity Model (CSAOMM) in order to facilitate, interpret and compare the SOAMM with SIMM. Figure 3 show their CSOAMM in the middle irrespective to SIMM on the left and SOAMM on the right.

SIMM	CSOAMM	SOAMM
7. Dynamically reconfigurable services	7. Dynamically reconfigurable services	5. Optimized business services
6. Virtualized services	6. Measured service	4. Measured business services
5. Composite services	5. Internal and external services	3. a. Business services 3. b. Collaborative services
	4. Architected services	
4. Simple services	3. Institualisation	2. Architected services
	2. First published WS	
3. Componentized	1. Technology tests	1. Initial services
	0. Component	
2. Integrated	-1. Integrated	
1. Silo	-2. Silo	

Figure 3. CSOAMM (Söderström & Meier, 2007).

Their aims was to show that two different SOA maturity models can be combined. They also claimed that their CSOAMM provide a better overview of the SOA maturity and adoption processes. However, their model is not actually a SOA maturity model because they do not provide any evaluation dimension. Their model is just a tool for a communication between SOAMM and SIMM.

D. INAGANTI'S MODEL

Inaganti and Aravamudan (2007) develop a SOA maturity model in order to assess the current state of SOA adoption of an organization. Their ultimate aim is to achieve optimized business services that can quickly adapt to changing business requirements.

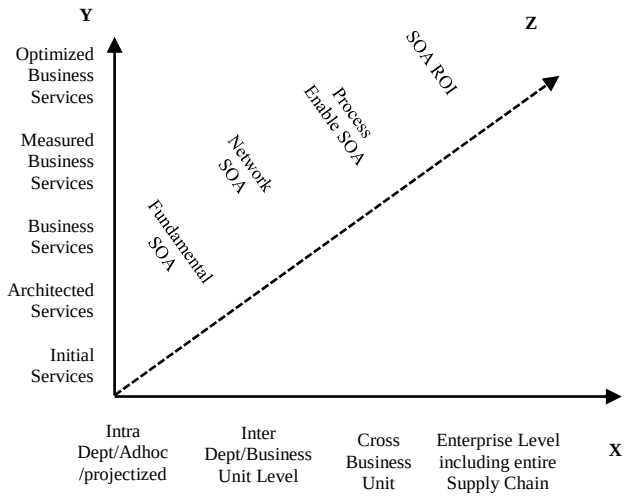

Figure 4. Inganti's Model (Inaganti & Aravamudan, 2007).

Inaganti's model consist of 3 axis where X axis depict the scope of SOA adoption, Y axis depicts the SOA maturity level and Z axis depicts the SOA expansion stage. However, Figure 4 shows that Return on Investments (ROI) can only be achieved after the organization has reached both enterprise level of SOA adoption and level 5 maturity level or optimized business services. Their model also specified that it is significant to define the service types, characteristics and SOA maturity processes. They also stressed that IT key processes were required in order for an enterprise to successfully adopt SOA.

E. iSOAMM

Independent Service Oriented Architecture Maturity Model (iSOAMM) is the SOA maturity model produced by Rathfelder and Groenda (2008). They claimed that their model is a product and technology independent that consider organizational and technical aspects. Furthermore, they also stated that iSOAMM help the selection of the most adequate maturity level by pointing out the benefits, risks and challenges associated to each maturity level. SOA changes from IT perspective supported by an evaluation dimension. Their maturity model is shown in Figure 5.

Maturity Level	Evaluation Dimension				
On Demand SOA	Service Architecture	Infrastructure	Enterprise Structure	Service Development	Governance
Cooperative SOA					
Administered SOA					
Integrative SOA					
Trial SOA					

Figure 5. iSOAMM (Rathfelder & Groenda, 2008).

Based on Figure 5, the maturity levels and evaluation dimensions were constructed to support SOA structure as a whole in details. However, iSOAMM only evaluate the architectural/IT principles of SOA adoption. They omit the business benefits that can be achieved by adopting SOA. Moreover, iSOAMM also was never tested and validated in a real case study. They only evaluate several SOA projects and present the results without the evaluation details.

F. WELKE'S MODEL

Welke et al. (2011) proposed a SOA maturity model based on the capabilities maturity model integration (CMMI). They also constructed the maturity model by using the same basic CMMI terminology but taking into account different motivation for SOA adoption from the perspective of IT administrator, business manager and enterprise leader. Figure 6 show their proposed SOA maturity model that include five maturity levels: initial, managed, defined, quantitatively managed and optimized.

As shown in Figure 6, Welke's model first view their maturity model as a capability orientation model and secondly they specified that as SOA become more mature, the SOA ability should be fully realized in order to contribute to business operations and organization's service orientation as a whole.

Maturity Level	Evaluation Dimension					
Initial	SOA View	Benefits and Metrics	Business Involvement	Methodology	Service Sourcing	Governance
Managed						
Defined						
Quantitatively Managed						
Optimized						

Figure 6. Welke's Model (Welke et al., 2011).

Furthermore, Welke et al. (2011) also develop a SOA maturity cube that offer a multidimensional view of SOA maturity. The first dimension is for the organization to identify their current levels of SOA maturity according to six defined SOA criteria's and the second is to determine what to do in order to reach the next maturity. However, a fully developed SOA maturity cube is out of scope of their study but the vision is that the organizational can evaluate their SOA-based application on the normal CMMI view or based on how far it progress from the narrowed IT-driven viewpoint toward a broader enterprise transformation viewpoint.

G. SOASMM

The SOA Security Maturity Model (SOASMM) was develop by Kassou and Kjiri (2012) aims to assess the organizations SOA security maturity. Figure 7 shows the SOASMM was constructed by mapping several methods such as iSOAMM, SSE-CMM and ISO 27002. Figure 7 below presented the SOASMM.

Maturity Level	Evaluation Dimension									
On Demand SOA	Business requirement for access	User access management	User Responsibilities	Network access control	Operating system access control	Application and information	Security requirements of IS	Correct processing in application	Cryptographic controls	Security of file systems
Cooperative SOA										
Administered SOA										
Integrative SOA										
Trial SOA										

Figure 7. SOASMM (Kassou & Kjiri, 2012).

As shown in Figure 7 above, it connect the SOA maturity level to the security process maturity and the security control applicability. As presented and describe above, it can be clearly seen that SOASMM can be view as a principles of a tool that support the assessment of the SOA security maturity of organization. The aims and interest is to incorporate information security best practice approaches in the paradigm of SOA. However, SOASMM focused more on assessing the SOA security and neglect the evaluation of SOA maturity as a whole.

IV SOA MATURITY MODEL EVALUATION DIMENSION

The existing SOA maturity models focused on a single evaluation dimension. This single evaluation dimension consist of multiple views in order to evaluate the SOA maturity such as architecture, business, scope, method, governance, infrastructure and etc. Table 1 presented the view that several of the existing SOA maturity models have in common. Table 1 also shows the views that existing models have in their single evaluation dimension.

Table 1. Single View of Evaluation Dimension

Evaluation Dimension View	SOA Maturity Model
Business	SOAMM SIMM Inaganti's Model Welke's Model
Architecture	SIMM iSOAMM Welke's Model
Scope	SOAMM Inaganti's Model
Governance	SIMM iSOAMM Welke's Model
Method	SIMM Welke's Model
Infrastructure	SIMM iSOAMM

The evaluation views that were shown in Table 1 were extracted from existing models that have the same view. For example, the business view were included in SOAMM, SIMM, Inaganti's Model and Welke's Model. Apart from the views shown in Table 1, there are other views that existing models included such as service sourcing, service development, information and application but it were only for one particular model and were not included in other models. Thus, it is not shown in this study.

In addition, this study also identified several of existing SOA maturity models that have two similar views in their evaluation dimension. The aim of identifying two similar views is to see whether existing models do provide both views of IT and business perspectives. Table 2 shows two similar views that existing models have in common.

Table 2. Two Similar Views of Evaluation Dimension

Evaluation Dimension View	SOA Maturity Model
Business and architecture	SIMM Welke's Model
Business and scope	SOAMM
Architecture and scope	Inaganti's Model
Business and governance	SIMM Welke's Model
Architecture and governance	SIMM iSOAMM

	Welke's Model
Business and method	SIMM Welke's Model
Architecture and method	SIMM Welke's Model
Business and infrastructure	SIMM
Architecture and infrastructure	SIMM iSOAMM
Governance and method	SIMM Welke's Model
Governance and infrastructure	SIMM iSOAMM
Method and infrastructure	SIMM

Based on Table 2, SIMM and Welke's model included both business and IT perspectives in their evaluation view. However, this study has identified that these views is just a simple view from business and IT perspectives. Furthermore, SIMM and Welke's model also included another view to their model which can make SOA practitioners confused. Section V discussed on the finding and discussion.

V FINDINGS AND DISCUSSIONS

This section is concern with the findings and discussions of this study. Table 3 below compared the existing SOA maturity models based on their maturity levels, evaluation dimensions and general descriptions.

Table 3. SOA Maturity Model Features

	Maturity Level	Evaluation Dimension	Description
SOAMM	1. Initial Service 2. Architected Service 3. Business Service 4. Measured Business Service 5. Optimized Business Service	• Prime business benefits • Scope • Critical technology success factors • Critical people & organization success factors • Selected relevant standard	• Focus on achieving the business benefit from the adoption of SOA. • Does not have a clear mapping to CMMI. • Does not provide an evaluation process.
SIMM	1. Silo 2. Integrated 3. Componentized 4. Simple Service 5. Composite Service 6. Virtualized Service 7. Dynamic Reconfigurable Service	• Business view • Governance & organization • Method • Application • Architecture • Information • Infrastructure & management	• Focus on providing a service maturity model rather than SOA maturity as a whole. • Does not evaluate the maturity of SOA adoption as a whole. • Does not have a clear mapping to CMMI. • Does not provide an evaluation process.
Inaganti's Model	1. Initial Service 2. Architected Service 3. Business Service 4. Measured Business Service 5. Optimized Business Service	• Intra department/ adhoc/ projectized • Intra department/ business unit level • Cross business unit • Enterprise level including entire supply chain	• ROI only become available when organization reached an enterprise level of SOA adoption • Does not have a clear mapping to CMMI. • Does not provide an evaluation process.
CSOAMM	-2.Silo -1.Integrated 0. Component 1. Technology test 2. First Published WS 3. Institutalisation 4. Architected Service 5. Internal & External Service 6. Measured Service 7. Dynamic Reconfigurable Service	Nil	• Aims at providing a communication tool between SOAMM and SIMM. • Clear mapping with CMMI. • Does not have the evaluation dimension elements.
iSOAMM	1. Trial SOA 2. Integrative SOA 3. Administered SOA 4. Cooperative SOA 5. On demand SOA	• Service architecture • Infrastructure • Enterprise structure • Service development • Governance	• Independent from technologies and products. • Do not address from business perspective. • Does not have a clear mapping to CMMI. • Does not provide an evaluation process.
Welke's Model	1. Initial 2. Managed 3. Defined 4. Quantitatively-Managed 5. Optimized	• SOA View • Benefits and metrics • Business involvement • Methodology • Service Sourcing • Governance	• Focus on providing a capability orientation model. • Clear mapping with CMMI. • Does not provide an evaluation process.
SOASMM	1. Trial SOA 2. Integrative SOA 3. Administered SOA 4. Cooperative SOA **5.** On demand SOA	• Business requirements for access • User access management • User responsibility • Network access control • Operating system access control • Application & information • Security requirements of IS • Correct processing in application • Cryptographic control • Security of file system	• Focus only on providing a security maturity model for SOA adoption. • Does not have a clear mapping to CMMI. • Does not provide an evaluation process.

From the comparison made in Table 3, the existing SOA maturity models have their own maturity levels and evaluation dimensions. According to Bloomberg (2005), SOA maturity model need to have comparable levels to CMMI's that serve as an alignments of architectural features and capabilities. Based on Table 3, CSOAMM and Welke's Model were the only models that have a clear mapping with CMMI. Nevertheless CSOAMM is not a complete model because CSOAMM does not provide any evaluation dimension. Thus this study chose to enhance Welke's Model because it is a capabilities-orientation model and can be directly mapped to CMMI.

In addition, the existing models do not follow any standard in providing their own evaluation dimension and this circumstance have made their evaluation dimension to contradict with each other. This study proposed to enhance Welke's model evaluation dimension by providing a two dimensional evaluation dimension that focus on IT benefits and business benefits. The idea was to reflect the true definition of SOA where it should be viewed and treated equally from both IT benefits and business benefits (Baghdadi, 2014; Borges & Mota, 2007; Derler & Weinreich, 2007). Furthermore, this study has found that majority of the existing models do not provide an evaluation processes. The existing models only focus on "what" to evaluate rather than "how" to evaluate the maturity of SOA adoption. Therefore, this study has identified that there is a need to improve the SOA maturity model by providing a systematic evaluation components for SOA maturity model.

VI CONCLUSION

In this study, literatures of SOA maturity model were reviewed and compared. SOA maturity model is important to determine the current state of SOA adoption. The results showed that there was a need to provide two-dimensional evaluations in order to reflect the definition of SOA where it should be viewed and treated equally from both IT benefits and business benefits (Baghdadi, 2014; Borges & Mota, 2007; Derler & Weinreich, 2007). Furthermore, this study chose Welke's model as the most suitable model for further enhancement because this model has clear mapping to CMMI. In addition, this study also identified that there is a need to improve the evaluation process in order to provide a complete and systematic evaluation method. Overall, this study provides preliminary analysis; therefore, an extensive work regarding the evaluation dimension and evaluation processes will be presented in the future report.

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