ASSESSING THE QUALITY OF ENTERPRISE SERVICES
A Model for Supporting Service Oriented Architecture Design

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Abstract: Enterprise Services have been proposed as a more business-friendly form of web services which can help organizations bridge the gap between the IT capabilities and business benefits of Service Oriented Architecture. However up until now there are almost no methodologies for creating enterprise services, and no lists of definite criteria which constitute a "good" enterprise service. In this paper we present a model which can aid Service Oriented Architecture designers with this by giving them a set of researched criteria that can be used to measure the quality of enterprise service definitions. The model and criteria have been constructed by interviewing experts from one of the big five consultancy firms and by conducting a literature study of software development lifecycle methods and Service Oriented Architecture implementation strategies. The results have been evaluated using a quantitative survey and qualitative expert interviews, which have produced empirical support for the importance of the model criteria to enterprise service design. The importance of business ownership and focusing on business value of enterprise services is stressed, leading to suggestions of future research that links this area more closely with Service Oriented Architecture governance, Service Oriented Architecture change management, and Business Process Management.

1 INTRODUCTION

Service Oriented Architecture (SOA) development and deployment generally builds on a service view of the world in which a set of services are assembled and often reused in different ways, allowing organizations to quickly adapt to changing business needs (Cox and Kreger, 2005). This type of architecture ideally allows IT systems to be integrated and re-used in a standardized way bringing benefits to businesses such as faster time to market and lower development costs. SOA is not just yet another change in your IT systems architecture: it also requires that organizations evaluate their business models, come up with service-oriented analysis and design techniques, deployment and support plans, and carefully evaluate partner, customer, and supplier relationships (Papazoglou and van den Heuvel, 2006). However despite the perceived importance of business involvement in SOA design, organizations are easily tempted to approach SOA from an IT perspective, and ignoring the business models and needs.

For the most part the problem is not that web service technology can't support more granular business functionality. As early as 2003, IBM researchers noted that web services were moving from their initial "describe, publish, interact" capability to a new phase in which robust business interactions are supported (Curbera et al., 2003). The last few years this has led to the start of a new trend in the SOA market to create more granular services called "enterprise services" (SAP, 2004; Freemantle et al., 2002), "meta-services"

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(Cherbakov et al., 2005; Crawford et al., 2005) or even "business services" (Wang et al., 2005). In this paper we promote the use of the term "enterprise services", because this term has the most value to business users, where as "meta" is not as clear to most people and the term "business service" can be confused with more traditional types of services not related to SOA.

For clarity within this paper, we have defined an enterprise service as:

"*A special type of web service where the operations form a functional piece (steps or tasks) of a business process. Enterprise service operations may be composed of more fine-grained web services which provide business-agnostic functionality, such as basic data access.*"

It has been stated that business services execute the functionality of the steps, tasks and activities of one or more business processes and that fine-grained components and services provide a small amount of business-process usefulness, where as larger granularities can be compositions of smaller grained components or other artifacts (Papazoglou and van den Heuvel, 2006). It has also been said that coarse granularity can be defined as such that services are related to the individual steps of a business process (Kimbell et al., 2005).

One of the problems though for enterprise architects is that an enterprise service has many characteristics that must be considered, and it is a fallacy to believe that all services require the same level of definition (Jones, 2005). It is therefore not a trivial exercise to determine what the necessary criteria are for a "good" enterprise service, to ensure the expected value is achieved for organizations. This paper focuses on this problem by addressing the following research question:

What are the (quality) criteria and method by which an organization is able to accurately create and assess high quality Enterprise service definitions?

In this paper a model is presented containing criteria that can be used by organizations to evaluate the quality of their enterprise service definitions and align them with their Business Process Management (BPM) initiatives in order to increase business understanding and value of SOA implementations. The research of identifying the right phases and criteria for the model was done in consultation with a focus group of SOA experts at one of the big five consultancy firms.

We assess the research question by constructing a model which provides SOA designers with a set of criteria they can use to measure the quality of enterprise service definitions. The model is framed through interviewing experts at one of the big five consultancy firms and by conducting a literature study of software development lifecycle methods and Service Oriented Architecture implementation strategies. The results are evaluated using a quantitative survey and qualitative expert interviews. In section 2 we present a generic approach for enterprise service application design, resulting in the Enterprise Value Delivery Lifecycle. Section 3 provides the model (Enterprise Service Definition Model), which includes the criteria for "good quality" enterprise service determination. In section 4 we present the validation of the model, followed by a discussion in section 5. Section 6 contains conclusions and further research.

2 ENTERPRISE SERVICE CREATION: APPROACH

In essence there are three main strategies for developing SOA-based enterprise applications: top-down, bottom-up, and meet-in-the-middle (Perepletchikov, 2005; Arsanjani, 2004). It is a key decision whether service creation should begin from the bottom-up or top-down. Since this research focuses on enterprise services, which are defined to be in line with "steps or tasks" of business processes, a more top-down approach is taken. In practice it will always be a balancing game as to how extensive the top-down modeling should be. A wide scale business modeling exercise could be too expensive and make the SOA implementation have a low ROI. This can be minimized if certain business domains/processes are selected as a focus in order to narrow the scope of the top-down approach. It is still important though that organizations are aware of their existing legacy systems and plan "agile" activities accordingly. The real goal is to try at all cost to avoid a pure bottom-up approach, which will certainly miss out on achieving valuable benefits for the business.

In order to utilize a top-down approach to enterprise service creation, research was done on lifecycle methodologies. The lifecycle phases for the Enterprise Service Definition Model (ESDM) we developed during this research are based on the successful Enterprise Value Delivery (EVD) lifecycle model, which is a implementation method satisfactorily used by one of the big five consultancy firms. This lifecycle model uses the following phases:

- Vision
- Plan
- Design
- Build
- Deliver
- Operate

The choice of using this approach to enterprise service design was confirmed by a group of 7 SOA experts at this firm who participated early on in this research. Table 1 describes their roles in the organization and experience with SOA.

Table 1: SOA experts participating in Research.

Position in the Firm	**Division**	**Main Expertise related to SOA**
Partner	BusinessIT Strategy	Business Value of technology, Financial Services
Senior Manager	BusinessIT Strategy	Strategic SOA decision making
Senior Manager	Enterprise Applications	SAP and SOA Lead for Europe region
Senior Manager	Enterprise Applications	Oracle Lead for NL SOA
Consultant	Enterprise Applications	SAP and SOA Research
Manager	Development Integration	Various SOA Integration Projects
Manager Specialist	Development Integration	Various SOA Integration Projects

The use of the lifecycle phases for a top-down approach to enterprise service development has been justified by other similar models used for service and component based design, including the top-down process steps of (Erl, 2005), the Rational Unified Process (RUP, 2001), and the web service development lifecycle of (Papazoglou and van den Heuvel, 2006).

After discussions with the 7 SOA experts it was further decided to combine the phases of the EVD lifecycle into the following: Vision & Plan, Design, Build, and Deliver & Operate. This would create 4 primary stages for developing successful enterprise services starting with a vision based on the established business process models of the organization.

The combined phase of Vision & Plan includes the planning and goal setting for the enterprise services being created, and will include a top-down business process analysis that should result in a set of enterprise service candidates.

The Design phase refers to the stage where enterprise service candidates from the Vision & Plan phase are taken and further refined and detailed. This includes the creation of functional and non-functional requirements, inputs, outputs, and formal descriptions of how to use the service. This is a distinct activity that is separate from the business process analysis, and for this reason it was decided to separate it into a different phase than the "Vision & Plan" phase. This also emphasizes the importance of business involvement in the top-down approach, which is strongest in the first two phases.

The Build phase is the most technical phase, as it involves the coding of enterprise services based on the business designed service candidates. This phase focuses on the fact that enterprise services are built technically the same as web services, and as a result they should comply with industry standards, and whether the proposed business design of the enterprise service is technically feasible to be implemented. Enterprise service candidates will not always be in line with the existing applications, and some negotiation will have to take place between business and IT in order to make sure the services are in line with business needs but also can be feasibly delivered.

The final phase of the ESDM combines the Deliver and Operate phases of the EVD. It was recognized that the "Deployment" phases of other service design methods are important, but nevertheless rather trivial to the importance of creating high quality enterprise service definitions. It was therefore decided that this could be combined together with the Operate phase. During Operation is when performance and business value of the services must be monitored.

3 MODEL CONSTRUCTION

Initially several literature sources were examined as a way of collecting lists of the most commonly referenced service criteria (Papazoglou and van den Heuvel, 2006; Erl, 2005; Bloomburg, 2005; Deloitte, 2004; Freemantle, 2002). The originating separate lists were merged into one.

This list was further refined and challenged by the group of 7 SOA experts. After several interviews and brainstorming sessions with these experts, the

enterprise service design criteria were refined and enhanced from the initial literature search. Figure 1 shows the model created including which criteria belonged in which of the service design lifecycle phases, as agreed upon by the experts. It should be noted that several of the criteria repeat in various phases of the model. During discussions with the experts, it was concluded that many of the important criteria, i.e. "reusable", should be re-visited several times at different points of the design process. This list of criteria was combined with a list of key questions and tasks for each phase to form the Enterprise Service Definition Model (ESDM), shown in figure 1.

The model consists of 20 criteria for the enterprise service creation phases (vision & plan, design, build). These include criteria for example that say services should be designed to be Reusable, and they should Business Owners who are heavily involved in the visioning of their design. Along with this, 5 key aspects to monitor services were created (e.g. Services should follow Service Level Agreements (SLA)). The monitoring aspects apply once the enterprise services are delivered and in operation. Each phase also contains key questions that should be addressed by service designers during the creation of new services. It should be noted that some of the criteria identified were deemed to be important in multiple phases of the design process, and hence are revisited multiple times (e.g. Reusable). Also, the validation process produced evidence showing that some criteria are more important than others in each phase (this is described in more detail in section 4.3).

It may be noticed that some commonly identified service criteria were left out of the model. In particular, we discuss the ideas of "loose-coupling" and "coarse granularity" more closely, because these are often cited criteria which were not included. In fact in (Erl, 2005) loose coupling is cited as one of the four most important principles of service orientation. After extensive research though, it turns out there are several good reasons for leaving these criteria *off* the list. One of the problems with both of these terms is that nobody can define them in an objective manner easily. Both of these terms are subjective trade-offs without useful metrics, and furthermore they are very application context dependent (OASIS, 2006; Papazoglou and van den Heuvel, 2006). Coarse Granularity of services is relative to the level of problem being addressed and defining the optimal level is not as simple as counting the number of interfaces that a service has.

Loose Coupling can be difficult to determine. "This is because loose coupling is a methodology or style, rather than a set of established rules and specifications" (Kaye, 2003). In this research we consider the more tangible criteria that we defined as this established set of specifications. So, although Loose Coupling and Coarse Granularity are necessary for a well-defined enterprise service, the proper level will be obtained when the other (easier measured) criteria are adhered to.

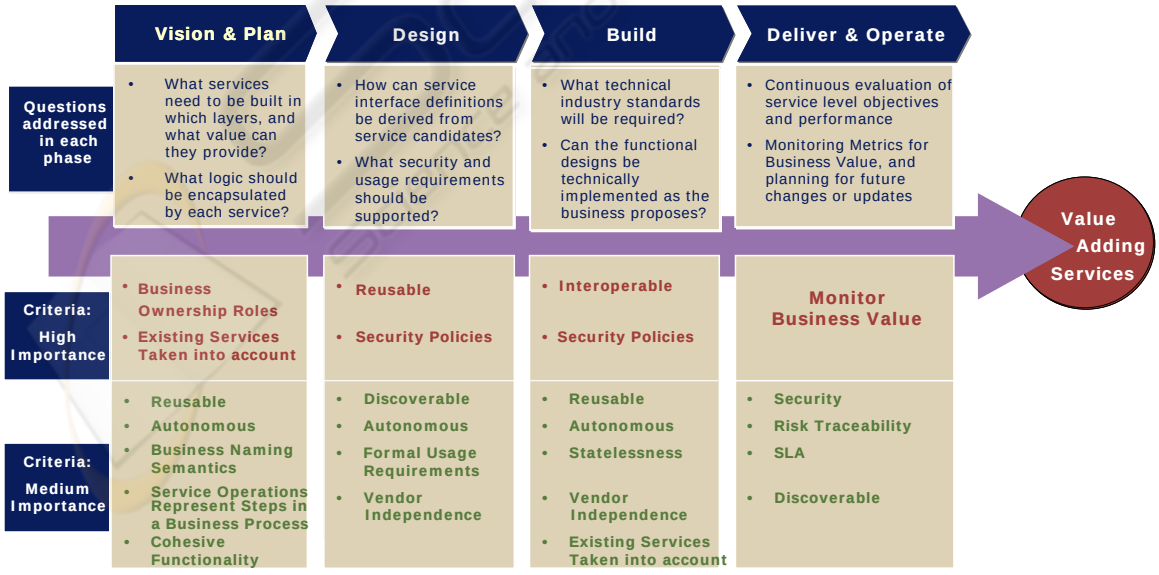

Figure 1: Enterprise Service Definition Model (ESDM).

4 MODEL VALIDATION

Two methods of empirical research were done to validate the phases for enterprise service design and their criteria. The first method was a quantitative analysis, which consisted of a survey that was distributed to SOA experts from consultancy firms worldwide. The results will be discussed below, including reliability test and factor analyses that were done to examine the data. In order to avoid bias, the respondents for this survey did not include the initial group of 7 experts who offered input into the model creation. The second method was a more qualitative analysis, which consisted of expert interviews that were conducted with SOA industry experts. The interviews were used to gain insight on the state of SOA in these organizations, and at the same time to present the ESDM and get feedback on how useful they felt this type of design model would be for their organizations. Subsequently we will discuss the approaches of both validations.

4.1 Survey Design & Population Sample

In total 306 invitations to conduct in the survey were sent to big-five consultancy firm employees. The respondents were received from the community of practice "eRooms" on SOA, as well as from direct contact of several consultancy firm partners around the world.

The survey created consisted of 27 questions. The first 5 were intended to gather background information, and the remaining 22 questions made up a measurement questionnaire for the criteria of the Vision & Plan, Design, and Build phases of the ESDM (not including the Delivery&Operate phase; this phase was not tested as we focus on *creating and assessing* enterprise services during development). These three phases of the ESDM have 20 criteria and every one had one (in two cases two) questions designed to measure it on the survey. The questionnaire was reviewed over a period of two months by the 7 SOA experts, as the criteria for the model were developed and changed. Each question used a 1-7 Likert scale to ask the participant how important they felt the measurement question (and hence the criteria it was measuring) was to each phase of enterprise service development. The average scores would be used to determine whether certain criteria are more important than others to enterprise service design, and also whether some were of a very low importance and should be removed completely from the model.

The survey data was collected over a 3 week time period, and the total number of respondents was 99 (a response rate of 32%). The survey contained a very good distribution of respondents, with knowledge of SOA being almost evenly split between minimal, average, and advanced. There was a good balance between very technical SOA experts (those who have programmed and built services) and more functionally oriented experts who have spent more time designing service functionality.

4.2 Reliability Test

One of the popular methods to determine reliability of survey results is through "internal consistency", which is reflected in the high correlation among items or subsets of items, signifying that the items on a scale behave equivalently as though they were a single measure (Tinsley and Brown, 2000). In order to test internal consistency, it was decided to first test the Cronbach's alpha for all variables together, and then for each dimension of the model separately. Overall the results were very high, with $\alpha = .851$ when all 22 questions in the model were taken together. This indicates that the survey taken as a whole is reliable in measuring enterprise service definitions. This doesn't in any way indicate if it is valid, but it does show a high level of consistency amongst the survey respondents (N=99).

The second step was to measure the reliability of each of the 3 tested dimensions of the model separately: vision & plan, design, and build. It is desirable to show reliable results within each dimension as well, because the big challenge is to try to show that these identified criteria are valid to measure the creation of enterprise services during *each phase* of service creation. Table 2 shows the alpha statistics for all dimensions of the model.

Table 2: Overall Reliability statistics for ESDM.

Model Phase	Cronbach's Alpha	N of Items
Overall	.851	22
Vision & Plan	.665	9
Design	.706	6
Build	.747	7

As can be seen in the table, the alpha for the Design and Build dimensions is slightly higher than 0.7, whereas the vision & plan dimension is slightly under. This implies that each dimension of the

model consistently was scored similarly, and the data can be taken as reliable.

4.3 Criteria Weighting

The survey was also used as a means to weight the various criterions to determine which ones were more important than the others in each of the phases. It was decided that a simple classification of "low", "medium", or "high" importance would be sufficient to differentiate between the criteria. In order to make the model practical and easy to use, it was determined that categorizing the criteria into easy to remember importance groups was much better than numerically ordering them using the weighted average scores. Also since this is a new area of research and the difference in weight between criteria is relatively small, this made the most sense. Any criteria that had an average score of "low" would be re-evaluated to determine whether it really belonged in that phase. The weightings were defined, based on the 1-7 Likert scale. Any criteria that had an average score of less than 2.5, would be categorized as "low" importance. 2.5-5.5 would be "medium" importance, and over 5.5 "high" importance.

4.4 Industry Expert Interviews

The following table (Table 3) shows where the industry experts came from and what their position was.

Table 3: Industry experts interviewed.

Industry Sector	Organization Size (empl.)	Expert position
Financial Services	98,000	Chief Enterprise Architect
Financial Services	115,000	Manager Information & Application Architecture
Manufact.	24,000	Chief Information Officer (CIO)
IT Consult.	100	Principal consultant
Acc / Consult.	135,000	Manager Technology Integration Consulting
Public Sector	10,000	Senior Advisor Corporate IT

Note that the experts were mostly employed in large organizations. The interviews focused on the practical aspects and 'face-validity' of the model. The interviews lasted about 1 hour, and were held in a two-weeks period time-frame at the location of the experts. Leading questions for each of the interviews were: 1) is the phasing of the model recognizable; 2) do you expect the model to address all important criteria per phase; 3) would you expect the model to be useful.

5 RESULTS OF QUANTITATIVE AND QUALITATIVE VALIDATION

Based on the weighted scores as determined from the survey responses, the full ESDM was constructed to include weighted criteria, as shown in Figure 1. From the calculated average scores of all the criteria on the survey there were 2 "high" importance criteria in each of the creation phases, with the rest being of "medium" importance. There are a few major conclusions that can be made based on the results.

Based on the results of the survey, the first major finding is that none of the criteria should be dropped from the model. If any of the scores were significantly lower than medium importance (less than 4.0), than it was going to be debated whether that criterion should be included. However the lowest average score for any of the criteria was 4.60 (4.0 = medium importance, 7.0 = very high importance). Even after removing any statistical outliers, the scores did not change very much. It was therefore concluded that none of the criteria were "bad" and should be removed, based on these scores. Although the results of the validity analysis were mixed and produced some factors not identified by the ESDM, this does not affect the question of whether to delete any one specific criteria.

There were two criteria in particular which generated discussion both in the survey comments and during a few of the expert interviews. These were "vendor independence" and "statelessness". Most people felt that these were important to their respective phases, however difficult to realize in many practical situations. Here is a brief description of the problems seen with these criteria:

Vendor Independence. According to some of the more technical SOA experts, one of the problems with "vendor independence" is that many of the large software vendors claim to allow their products to work with others, but in reality it is against their interests as a software company to make their

products too friendly with competitors. So as a result the enterprise services they provide follow de-facto web service standards for "interoperable" communication, but they are not truly "vendor independent" because there are still some implementation specifics which make them very difficult and expensive to use with other competitors products. Along with this, many organizations are very committed to one major vendor for the enterprise applications, and building enterprise services that are "vendor independent" is a much lower priority for them. Practical experience will tell how important this criterion is to enterprise service development. For now it is too soon to tell of its impact, and it should be left in the model. Case studies might likely determine what its practical value is for different organizations.

Statelessness. Most of the technical SOA experts agree that it is desirable to have stateless services that are independent from one another and do not maintain information about process orchestration. However again in reality this can be quite difficult, and there may be some situations where it is desirable to maintain state at the individual service level. According to one expert, this can be true in transaction heavy systems where thousands or even millions of messages have to be sent across a network of services. In situations like this, if state management is centralized, it can mean a huge performance bottleneck on the services that must keep track of this information for the whole system. In these complex situations individual state management may be desirable. It is because of this reason that "statelessness" should be evaluated closely on a situational basis. Since it did receive a "medium-high" importance score on the survey (5.28 out of 7), it will definitely be left in the model, but future users of the ESDM should be aware of the situational impact of this criterion.

Another important comment is the necessary focus on Business Process Management (BPM), which was acknowledged with the criterion "Service Operations Represent Steps in a Business Process". Most of those interviewed for this research like the idea of the top-down strategy and they see the value of it. But all of those involved in this project acknowledge that it doesn't work well if the organization has not spent sufficient time developing a sound BPM strategy with properly modeled business processes. Otherwise it is impossible to create high quality enterprise services using this approach. We recognize the inherent link between these two, particularly at the enterprise service vision & plan level.

Common enterprise services must have defined owners with established ownership and governance responsibilities. These owners are responsible for gathering requirements, development, deployment, the boarding process, and operations management for a service. The survey confirmed this importance of "business ownership roles" to enterprise services. This criteria was rated as highly important to the Vision & Plan phase of service design (a score of 5.71 out of 7). Many comments were made that the value of a SOA to the business really depends on who has responsibility for promoting its use. Also if ownership is in the hands of business users, they have a greater incentive to bring the value of the SOA design beyond the project level. This might also explain the significance of the factor "ownership & scope" which was discovered in the validity analysis. The owner of a service goes a long way in determining the breadth of its use and scope in the organization, as well as how well it is "taken into account" in future SOA designs.

This being said there is a learning curve that must take place, and according to one expert interviewed there are recognized challenges where the business might be comfortable owning the design of a service but the implementation done by IT should be owned separately. These are issues that must be worked out as part of SOA Governance procedures. Also the improvement of business value metrics for enterprise services will go a long way in convincing business users the importance of them taking ownership responsibilities in order to promote the widespread use of SOA and enterprise services.

Separate conclusions from the industry expert interviews were: 1) reusability is probably the most important criterion; 2) build/buy decisions for enterprise services will increase in importance; 3) the Vision & Plan phase is probably the most important phase in constructing enterprise services; 4) SOA is considered important also in the long run and future. Finally, all interviewees liked the model, but some stated their worries for its technical emphasis. The conclusions from the expert interviews indicate no specific remarks on particular criteria, yet, additional emphasis on finding more business-value metrics is a valid point.

6 CONCLUSIONS AND FUTURE RESEARCH

Companies more and more see the advantages of SOA; it is increasingly accepted and adopted as an

enterprise architecture paradigm, and is expected to be continuously applied in the long term. The challange is in finding a 'best' set of enterprise services. We have constructed the ESDM model that is interpreted applicable and useful by way of quantititive survey and qualitative analysis; the model is believed to support and be able to monitor the definition, identification and assessment of enterprise services. Utilizing a top-down approach of SOA-based enterprise application development using the EVD lifecycle, the identified criteria in the ESDM can be leveraged.

The following points summarize the areas, which can be researched further to follow up on the results found:

- Business Value Metrics for Enterprise Services should be developed
- Link the ESDM to SOA Governance, Change Management, and BPM modeling techniques
- Conduct Case Studies with the ESDM

One of the biggest conclusions to come out of the expert interviews was the fact that the ESDM provides organizations with a solid structure for creating enterprise services, however in order for it to have maximum usefulness there must be clear business value metrics associated with it in order to allow organizations to see the incentives for them to take this approach to SOA design. Along with this, there could be more SOA governance and change management procedures *linking* to the ESDM. A second area of consideration is the operationalization of the linkage to Business Process Management (BPM), as the top-down approach to enterprise service development requires companies to really have a handle on their business process modeling. Also detailed case studies are vital to understanding how practical it is to use this model in actual enterprise service development.

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