INFORMATION QUALITY ACTIVITIES WITHIN THE INDUSTRY INITIATIVE OF SERVICE-ORIENTED ARCHITECTURE IMPLEMENTATION

(Research-in-progress)

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Abstract: Service-oriented architecture (SOA) offers a way to accommodate evolving information management needs in order to make business agile and flexible in pace with dynamic business conditions. Adopting, implementing and running SOA require significant attention and effort in order to deliver high-quality data and realise the full value of SOA. In this paper, we examine the information quality related issues that have been investigated in four case studies in Australia organisations in order to uncover the activities in regard to information quality within their initiatives of implementing SOA. These information quality activities that solve certain information quality issues therefore, can be readily established across any industry to support the building of high-quality next generation SOA solutions.

Key Words: Data Quality, Information Quality, Service-Oriented Architecture

INTRODUCTION

A growing number of organisations are increasingly investing in implementing service-oriented architecture (SOA) initiative for greater agility and for unprecedented level of flexibility in order to compete in fast-changing global marketplaces. Many organisations that implement SOA initiative are gaining SOA value. But many misunderstood what is SOA all about and might caused problems. Some SOA initiatives success does not mean all SOA initiatives success. There are still a large number of SOA initiatives implementation disappointments. Any SOA initiative that ignores information issues is likely to fail and this bring to one key problem that is information quality issue [10]. Incomplete, outdated, incorrect or inconsistent information are examples indicating poor information quality [31]. These issues have many possible solutions in which these solutions could be perceived as activities in regard to information quality (IQ) that SOA team i.e. managers, architects and developers of SOA initiatives carried out throughout the SOA implementation journey.

In this paper we identify some information quality issues that evolve out of the implementation of SOA initiative from four large organisations in Australia through nineteen interviews using semi-structured approach. We also discover the activities taken by their SOA team in regards to information quality to react to these issues for quality management. Responding to these issues within each organisation is a complex process in terms of the number of stakeholders, information systems and interactions between them [22]. Furthermore, affected information quality dimensions that derived from identified information quality issues may guide organisations to improve information management aspects of SOA initiatives. Other relevant information at strategic, tactical and operations levels in relation to implementation of SOA initiative were also considered.

The paper is structured as follows: first, we provide a literature overview on information quality models and SOA initiatives implementation and summarise the issues identified to date. Next, we consecutively step through the research methodology used to meet research objectives. Then, we discuss the results based on interview data collected in a very large-scale SOA initiative implementation pursued in four Australian organisations during the past years. We systematically analyse the interview data, qualitatively evaluate and interpret accordingly with the assistance of NVivo software program. Last, we conclude the paper and present our ideas for future work.

RELATED WORK

Service-oriented architecture has become a well-known acronym in the modern business and information technology world as year on year leading vendors of SOA proved its worth in any industry to leverage business agility and flexibility [20]. Defining SOA is simply not easy as one may describe it as a technology for enabling business [6] while another look to SOA as aligning technology with business [12]. The challenge of answering what is SOA actually has become so important for many organisations to clearly understand what it means and leverage the full value of SOA. Gartner simply defined SOA as "an architectural approach to building systems" [8] whereas Forrester defined SOA as "a style of design, deployment, and management of software infrastructure and applications" [19]. This clearly means that both leading analyst firms recognise SOA as a business philosophy and approach in organising the business and its processes because SOA needs vary from one organisation to another that benefits both business and information technology. This is supported by academics who study on adoption of SOA into organisations [23][35].

Organisations that are pursuing an SOA initiative and building and integrating systems using SOA approaches need to undertake several steps derived from leading SOA vendors; IBM, SAP, Oracle, Accenture, SoftwareAG and TIBCO according to two evaluation studies by Forrester research [20][42]. These steps are grouped into four distinct phases with its basic processes as illustrated in Figure 1.

Figure 1. SOA initiatives implementation phases

In SOA, information plays a key role in achieving successful information management through effective information quality management in SOA initiative implementation. Information is the most useful and valuable which can be exchanged, combined and made available. Information quality, therefore, is critical to effective SOA initiative in an organisation.

There are a number of previous works that study the critical success factors for SOA strategy and implementation. The studies found that information management and information quality are among the success factors that makes SOA implementation initiative a success. Lawler et al. [24] have examined the procedural factors of SOA success and discovered that information management contributes to the extent to which procedures are evident for ensuring data integrity and quality for technical and business functions. Besides procedural factors, one study indicates a higher quality output of services as one of application design success factors for SOA implementation [29]. In addition, Rice [34] defines correctness, performance, security, interoperability, usability, maintainability, reliability and portability as some major critical success factors for testing successful SOA. Furthermore, a study stated that in order to be successful in SOA implementation, the critical success factor would be accurate data infrastructure [39].

As SOA involves an architectural approach to information systems development [38], it is important to look at information quality applied in information systems research. Basically, information quality is defined as "fitness for use" where information that is appropriate for a specific uses and satisfies the requirements of its consumers [15]. In other words, in short, information quality is "the fitness of information for an intended use" [37].

Accordingly, information quality has been studied widely and as a result multiple frameworks have been proposed that provide information quality requirements (i.e. dimensions) to improve the effectiveness of information systems. The information quality dimensions proposed are different for each of the various contexts and thus, this study need a more in-depth understanding of SOA context from identified information quality issues in order to define key information quality dimensions. For this purpose, four case studies of large Australian organisations were carried out in the study. By reviewing literature, there are many information quality dimensions proposed but the most comprehensive list of information quality dimensions by Wang and Strong [43] is considered, but not limited to, for this study as shown in Table 1. As the term „information quality" and „data quality" is used synonymous by most researchers, this paper uses both terms interchangeably.

Table 1. Information Quality Dimensions [43]

IQ Dimension	Brief Description
Believability, Accuracy, Objectivity, Reputation	It denotes that data have quality in their own right.
Value-added, Relevancy, Timeliness, Completeness, Appropriate amount of data	It highlights the requirement which states that data quality must be considered within the context of the task in hand.
Interpretability, Ease of understanding, Representational of consistency, Concise representation	It denotes that the system must present data in such a way that they are interpretable, easy to understand, and concisely and consistently represented.
Accessibility, Access Security	It emphasises the importance of the role of systems; that is, the system must be accessible but secure.

Current literature indicates that there are many information quality issues in the SOA context:

- From a security angle, problems of messages being exchanged in an insecure environment between services, and unauthorised access to data or services may arise [14][33] and have to be treated seriously to maintain security by having security policies in place [27].
- Services that are irregularly updated, out of pace with business change, may contribute to information quality problems in some instances when employing these services [28].
- While SOA helps in breaking down application silos, it has no way of validating source data at the

point of entry. In other words, it follows the popular information technology chant 'garbage in, garbage out' [25].

Whilst these information quality issues can be generic and commonly occur in information systems, the literature tends to address these issues in relation to SOA, in which the emerging information systems may be considered part of SOA initiatives. However, despite the multiple contributions on information quality within SOA, we still lack of understanding from the business aspect rather than the technical aspect of SOA initiative. Accordingly, this paper highlights the information quality activities found in the case study solving information quality related issues during implementing SOA initiatives.

METHODS

To investigate more deeply not only into the implementation of SOA initiatives, but also the participants" viewpoints with respect to how they perceived information quality would be embedded within the SOA implementation, the case study [44] and interview [30] methods were used, to enable them to reflect on their experiences freely and at ease. Participants were sought from four large organisations as industrial cases; two were financial institutions – Case A and Case B, the other two were in retail industry – Case C and a state government-owned enterprise – Case D, respectively. They were assured of anonymity where the participants were identified only by their job position. This assurance was crucial as the participating organisations were under highly secured and confidential environment. The background of industrial cases and its SOA initiatives implementation were described in Table 2.

Table 2. Background of Industrial Cases and its SOA Initiatives Implementation

Characteristics	Case A	Case B	Case C	Case D
Organisation Type & Location (HQ)	Finance; Sydney	Finance; Melbourne	Retail; Melbourne	Public; Adelaide
Background	Nationwide network of 857 branches with approximately 39,000 staffs worldwide.	Lead super regional bank with around 48,000 employees around the world.	Serves 95% of fresh food from domestic sourcing; Employs more than 191,000 people in which 40,000 are shareholders.	Managing one of the most valuable resources to ensure it is sufficient and sustainable for long-term future supplies.
Year Initiated SOA	2009	2010	2007	2009
SOA Implementation	Simplify integration across broaden consumer systems where reuse is one of the key determinants to underpin the delivery of the program by providing a clear integration layer.	Globally deliver information technology solutions and infrastructure include information security.	A strategic initiative to embed a pattern of services re-uses within the IT group; Used a partner based out of Victoria, a SOA subject matter expert to help with some consulting work.	Completed in July 2010 which was funded federally within a certain timeframe; It was actually outsourced to Indian company where a number of contractors were brought in.
Technology Used	IBM	IBM	Software AG and IBM	Microsoft

Through semi-structured interviews, 19 participants who are involved in implementing SOA initiative in their respective organisations were in-depth interviewed. Based on their roles and responsibilities, they were grouped into three teams; management team, architectural team and delivery team as shown in Table 3.

Table 3. SOA Team within Case Studies

Industrial Case	Management Team	Architectural Team	Delivery Team
Case A	Head of SOA; Head of Architecture and Strategy	Lead Architects (3); Solution Architects (2)	Engagement Manager; Service Modelling and Design
Case B	Head of Architecture	Head of Integration Services; Solution Architect	Delivery Manager Integration
Case C	Senior Development Manager	Integration Design Manager	Development Manager
Case D	Chief Information Officer	Operations Manager	GIS Administrator

These participants have extensive in-depth level of knowledge and experience of SOA that come from organisations that have completed or are going through SOA initiative and their feedback provides useful insights for the area of research as a whole. The interviews cover all phases of SOA implementation initiative in order to discover information quality activities and the results are organised in tables in the next section where the information quality activities are presented in association with the basic processes in each phase of SOA initiative resulted from the literature. With the help of NVivo software, the researcher analysed the interviews data in several stages, beginning by transcribing the interviews data, categorising them using thematic approach and interpreting the data according to research questions.

RESULTS AND DISCUSSION

There are number of information quality activities that are found in the case studies, among which related to completeness, accuracy, consistent, availability, accessibility and timeliness that are the most frequently discussed information quality dimensions. Arguably, the rest of the information quality dimensions found in the literature may be affected but since they are less important, the number of information quality activities is still limited. The following sections discuss information quality activities associated with information quality dimensions at each stage of SOA initiative in an organisation. In order to increase statistic significants of the results, a greater variety of participants is covered. As SOA aligns business and IT strategy, the participants involved have both understanding of business and technical aspects of SOA initiative in order to design business solutions and applications [7].

IQ Activities in Planning Phase of SOA Initiative

Planning is a starting point for implement SOA initiative systematically across organisation. It is imperative that business and IT operations are aligned in the SOA implementation; this is enabled by thorough planning of the policy development and service delivery model [11]. A number of organizations have been surveyed in 2008 and results in a dramatically decline in planning their SOA initiatives [36]. This might be because of poor quality of information that can cause unnecessary cost overruns. Information quality, therefore, is important to be embedded in the SOA initiatives in order to best deliver SOA effectively. In planning SOA, three key processes involved as illustrated in Figure 2. During this phase, a number of information quality related issues were identified and Table 4 represents some information quality activities that were undertaken to enable an organisation to plan successful SOA.
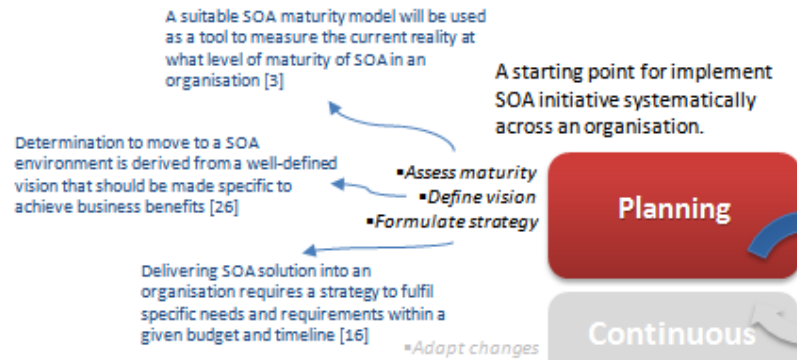
Figure 2. Key processes of Planning phase

Table 4. IQ Activities at Each Process of Planning Phase

Process	IQ Activity	Solving Issue	Dimension affected	Case Participant
Access maturity	The focus should be on the information of having necessary maturity checking which measures SOA and state of SOA governance or delivery.	All the maturity statements are not really at the point of SOA context.	Relevancy	Head of SOA (Case A)
Define vision	Stress on investing the application integration that coupled from broader systems to build reusable components to provide good customer solutions.	Lack of investment in integration leads to inconsistent view of customer information.	Consistent representation	Lead Architect (Case A)
Formulate strategy	Establish an Information Management Program which setting up all of information components to support all the projects in the entire organisation.	Shortage of information architects across organisation limits capability.	Value-added	Solution Architect (Case B)

IQ Activities in Building Phase of SOA Initiative

In this phase, through three key processes as shown in Figure 3 means building SOA services and infrastructure with the support of information technology are to achieve business goals [7]. This stage begins with an exhaustive inventory of all resources that are required for the development of the required models and their subsequent deployment. Platforms, standards and technologies are used as tools in the development lifecycle; from planning to implementation for building SOA services according to business processes and functions. During the development stage of SOA services, there are many issues related to information quality such as in the area of data integration [21] and data interchange [40]. Having a proper procedure and methodology and considering information quality techniques will enable an organisation to build successful SOA services [17]. The table below (Table 5) provides some information quality activities to solve certain issues found in the case study.
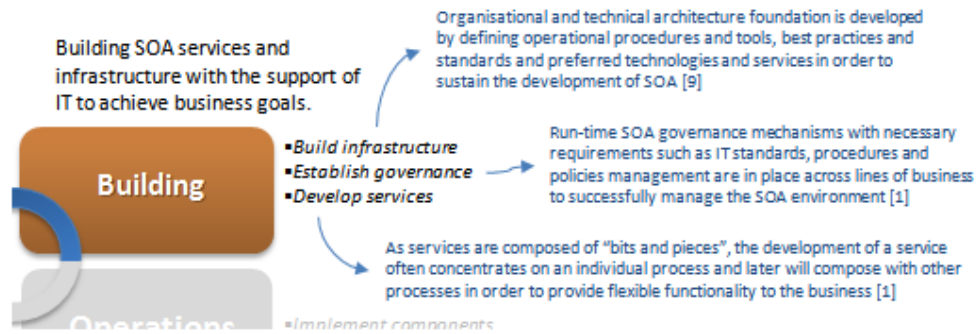
Building SOA services and infrastructure with the support of IT to achieve business goals.

Building
- *Build infrastructure*
- *Establish governance*
- *Develop services*

Organisational and technical architecture foundation is developed by defining operational procedures and tools, best practices and standards and preferred technologies and services in order to sustain the development of SOA [9]

Run-time SOA governance mechanisms with necessary requirements such as IT standards, procedures and policies management are in place across lines of business to successfully manage the SOA environment [1]

As services are composed of "bits and pieces", the development of a service often concentrates on an individual process and later will compose with other processes in order to provide flexible functionality to the business [1]

Operations
- *Implement components*

Figure 3. Key processes of Building phase

Table 5. IQ Activities at Each Process of Building Phase

Process	IQ Activity	Solving Issue	Dimension affected	Case Participant
Build infrastructure	Test the system by having testing structures work which is to ensure what in production environment does not get changed.	No information about services in a directory for service registry and repository lead to unable to discover it.	Availability	Head of Architecture (Case B)
Establish governance	Use information management tool for reference data.	Service catalogue is not well presented makes difficult to understand.	Consistent representational	Solution Architect (Case A)
Develop services	Adopted the IBM data model, IBM services layer and exposed it to the rest of the systems.	Data in storage is tied to implementation / application that do not provide a clean reusable interface for the major system services.	Compatibility	Integration Design Manager (Case C)

IQ Activities in Operations Phase of SOA Initiative

In this phase, all processes, applications and services are continuously operated and services are improved to adapt to changes. Running a SOA system is critical and should be implemented with minimal risk and at the lowest cost which requires participation by information technology personnel [18]. This means that to gain the full benefits of SOA, all services need to operate according to operation guidelines. However, there are certain information quality issues that may affect the performance of SOA systems. For instance, an interoperability issue can cause some services unable to share information and to connect to other services from other systems [32]. Figure 4 illustrates key processes involved during SOA operations where some activities in regards to solving information quality issues found in case study are described in Table 6.
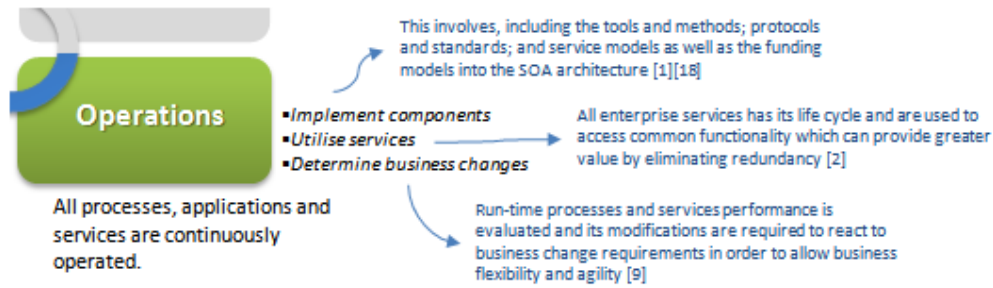
Figure 4. Key processes of Operations phase

Table 6. IQ Activities at Each Process of Operations Phase

Process	IQ Activity	Solving Issue	Dimension affected	Case Participant
Implement components	To maintain and make sure the servers are comfortably running – provide necessary space to accommodate necessary services.	Application servers that contain services are running out of space lead to lost information.	Performance	GIS Administrator (Case D)
Utilise services	Separate the two transactions out on to the broker and put in two new servers for horizontally expandable.	Errors in data transactions of reward points increase the traffic to the servers.	Timeliness	Development Manager (Case C)
Determine business changes	Come up with a plan of migration of the systems into the new infrastructure, and there is a plan how to actually technically implement that.	Information systems that may no longer be required are still exists.	Redundancy	Operations Manager (Case D)

IQ Activities in Continuous Improvement Phase of SOA Initiative

The operations of SOA are continuously evaluated to allow adaptation to changing business pressures and having mechanisms to allow for evolution of change in business processes. Ultimately, for continuous improvement in operating fully service-oriented, its special importance is to identify added value to the organisation and seek new business opportunities that relate to ongoing operation and IT management [18]. However, it has raised information quality issues such as data or information is not available when needed affects the delivering of services [13]. This may cause the services inability to optimise themselves. Through key processes as described in Figure 5 and by having information quality activities associated with the processes that reflect to information quality dimension can solve related information quality issues as shown in Table 7 (but not limited to).
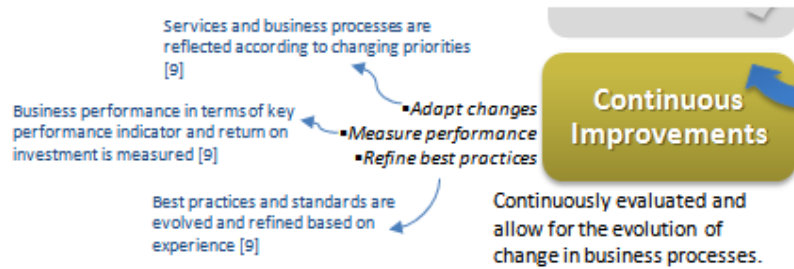
Figure 5. Key processes of Continuous Improvement phase

Table 7. IQ Activities at Each Process of Continuous Improvement Phase

Process	IQ Activity	Solving Issue	Dimension affected	Case Participant
Adapt changes	Ensure all architects are up to date with what is happening on the services; Any update on the services should inform the owner of those services in order to do the changes.	An information conflict with different architects when changing customer services that is owned or created by other architect.	Consistency	Engagement Manager (Case A)
Measure performance	Educate the business; senior management and the executive, to focus on the need of maintenance and it is the responsibility of the people who own the systems.	Lack of information to support for maintenance and upgrading systems.	Completeness	Head of Architecture and Strategy (Case A)
Refine best practices	A national strategy to calibrate the standards used for monitoring data.	A standard at the point where data is collected nationally was not a stable standard at the time it is implemented.	Accuracy; Completeness	Chief Information Officer (Case D)

In this study, the activities in regard to information quality have been discovered in four large Australian organisations through identified information quality related issues at each phase of their SOA initiative. Based on the cases, SOA initiative is typically coordinated by information technology. The findings indicate that information quality has been considered as an important aspect for SOA initiative implementation on various types of organisations. Although organisations" top management have paid much attention on the importance of information quality, none of them have proper control or program related to information quality across their organisations. This caused many problems in identifying the right information for used by services and right level of information required. As a result, the reuses of services are not achieved in the organisations.

The study also covers some important information quality dimensions such as accuracy, completeness, consistent and timeliness that were similar to the results presented in other studies [4][5][41], but the coverage is mainly limited to information systems field of research. This does not address beyond the scope of adopting generic information systems that offering a great value of agility and flexibility to organisations which is the SOA. Information quality is a necessity for SOA initiative where information is a part of any SOA implementation. Having information quality activities with associated information quality dimensions makes managing information within SOA initiative possible.

CONCLUSION AND FUTURE WORK

Information quality activities are significant focus which concerns all organisations in various industries to improve SOA initiative. Implementing such activities through each phase of SOA initiative, whilst maintaining information quality dimensions, should conduce to improved SOA implementation. Since providing quality SOA is an on-going and complex task, there is a serious need to develop innovative solutions, which will benefit organisations enabling SOA. This study also indicates that understanding and mapping the key processes at each SOA phase and associated relevant data and information would be critical in establishing the points for assessing the quality of information along the various business processes. With this understanding, the SOA team will be able to define performance standards for key operational processes and determine what actions to take in a reliable way.

Based on the literature, this paper has discovered information quality activities with associated information quality dimensions for implementing SOA initiative. Although these activities are undertaken to solve information quality related issues, the case study in participating organisations indicates lack of information quality program or control widely across organisations. The summary of findings may provide directions for organisations to initiate successful implementation of SOA with high quality. Further work is required to build a framework for enhanced information quality in SOA. More case studies will be conducted to investigate more relevant issues in SOA related to information quality and gather more relevant information about SOA activities, processes and practices that are associated with information quality. The participating organisations will be selected based on opportunistic basis. This means that any invited organisations that are agreed to participate will be selected. The organisations can be similar or related industries that have initiative in implementing SOA such as utility, oil & gas, telecommunication and health industries. Different organisations in diverse settings will allow deeper understanding, description and explanation of the research context to refine the framework. This will obtain compelling rich data, examine the real world practicality and contribute towards the overall study.

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