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Systems Analysis and Design for Service Oriented Architecture Projects: A Case Study at the Federal Financial Institutions Examinations Council (FFIEC)

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ABSTRACT

Problems with consolidating, disseminating, and ensuring integrity of corporate data management continues to confront the information systems leadership in organizations. To address these problems some organizations are employing Service Oriented Architectures (SOA) as a paradigm, which is enhanced by the use of Web services to provide a lightweight means of leveraging resources. The Federal Financial Institutions Examinations Council (FFIEC) is one such organization. In this paper, we have used the traditional systems analysis and design (SAD) principles to frame how the FFIEC employed SOA as a new paradigm of conducting business with Web services enabled by a particular XML based instantiation: eXtensible Business Reporting Language (XBRL). Using qualitative methods, we provide a methodological guide in the form of questions organizations should address in SOA projects that particularizes SAD principles for SOA. The questions derive from merging analysis of the data collected regarding the SAD efforts at the FFIEC coupled with principles asserted in traditional SAD literature. We also present lessons learned by the FFIEC while progressing through the planning, analysis, design, and implementation phases to achieve quality and flexibility in its information supply chain.

Keywords: *Service-oriented architectures (SOA), Systems Analysis and Design (SAD), XBRL, information supply chain*

1. INTRODUCTION

Service oriented architectures (SOA) and Web Services projects are typically undertaken to bring changes in processes to overcome problems associated with corporate data management, communicating and institutionalizing standards. IS leadership is therefore striving for flexible, yet parsimonious, ways of overcoming these information management and delivery problems. The leadership also seeks more effective planning for just-in-time services that enable rapid deployment of IS across the enterprise for which SOA is particularly useful [1].

Organizations are employing SOA with Web services to bring about increased business efficiency [2], [3],[4],[5].The concept of SOA surfaced over 10 years ago with a description of a utopian state of enterprise flexibility in information delivery and software development [6]. Nowadays, Internet-based technologies and protocols have matured to make SOA a reality [1]. However, there is still surmountable ambiguity as to its definition and components [7].

One prominent misconception is that SOA is interchangeable with Web services. Web services are self-contained, platform-independent, XML-based implementations of specific business processes that can be consumed and reused by various applications and systems. They provide services, such as delivering the most up to date inventory levels to various supply chain applications that need to use the information to complete their portions of a business process. In this manner processes for Web services are independent and typically do not depend on the state of other Web services. SOA, on the other hand, can simply represent the architectural framework or method that affords information exchange between disparate, distributed systems [8]. It is also a term used to describe the architectural style for building software applications that use Web services across a network [9]. As a result of the confusion of what SOA is there is also confusion as to how to create SOA or why an organization even should employ SOA [2].

Web services are becoming more commonplace as an instrument to disseminate and consume corporate data [10]. However, having Web services does not necessarily imply that an organization is employing SOA. SOA is not equivalent to a collection of Web services that organizations employ— even though some make this claim [9]. Minimal benefit is derived from simply having

Web services alone without embedding them as a mechanism to bring about identifiable improvements in process efficiency and data management [10]. This misunderstanding could be due to the lack of a keen methodology for implementing SOA [11],[12],[13].

To overcome this problem, applying traditional systems analysis and design (SAD) principles for the SOA project can be a fruitful approach for selecting appropriate standards and establishing governance structures [14]. This paper provides a guideline for implementing SOA in the form of pertinent questions to ask to drive the SOA implementation effort. The questions are the result of qualitative methods that merge the SAD principles from literature [15],[16],[17], and analysis of data collected from a case study involving an SOA project18. The case study involves a SOA project at the Federal Financial Institutions Examinations Council (FFIEC), which involves various stakeholder organizations that consumes information from or supplies data to the FFIEC. The SOA project employs a new paradigm of conducting business facilitated by a specific XML technology variant (i.e., the eXtensible Business Reporting Language (XBRL)) see Appendix 1 for an XBRL technical overview) for creating Web services dealing with business financial information. The FFIEC project is supported by XBRL International, a global consortium advancing the adoption of XBRL to transform business reporting (see http://www.xbrl.org/Home/ for more details). The intent is for the FFIEC project to serve as proof of concept for XBRL in SOA as an emerging technology poised for widespread use in industry regarding business data reporting (i.e., financial, accounting, etc.). The research inquiries are: (1) what are the applicable questions to ask during the planning, analysis, design, and implementation phases particularized for an SOA project? and (2) What generalizable lessons were learned pertaining to insights gained at the FFIEC while progressing through the various phases? The questions alluded to for the first research inquiries serve as guidelines for what is of concern for SOA projects. The lessons learned have generalities applicable for others working on SOA projects or researching the topic.

2. EXISTING SERVICE-ORIENTED ARCHITECTURE (SOA) METHODOLOGIES

Much of the research regarding SOA addresses more granular technical issues of development and implementation of Web services, which may be a result of the aforementioned misconceptions [19]. Few papers e.g., [20],[21], deal with the much larger problem of defining what SOA means to the organization and how this definition should then provide the guidance for the development of components to meet business information needs [12]. The IT adoption literature targeting a methodology for development states that there are five categories of factors influencing the decision to adopt SOA (i.e., environmental, organizational, individual, technology, and task characteristics [22]. These same factors should be addressed by the methodology for implementing SOA projects [23]. We now discuss three fairly well known SOA methodologies that attempt to embody some or all of these factors.

Teti (2006), an industry analyst, provides a methodology, which entails creating a vision, construction, and execution. He suggests that this model is applicable to many projects, but specifically addresses SOA. The vision creation is driven by a number of inter- and intra-organizational issues that define tasks important to the individuals and the firm (i.e., the constituency); the construction addresses the technology required to accomplish the tasks; and execution seeks to ensure that SOA will facilitate information exchange in the environment.

Zimmerman et al. (2004) provide yet another model that integrates business process modeling (BPM), enterprise architecture design (EAD), and object-oriented analysis and design (OOAD) as a methodology for SOA projects. The authors argue that their model provides a starting point for defining SOA. Defining SOA methodologies should entail (a) determining a holistic view of the business processes or tasks ongoing in the organization, (b) identifying the type of environment within or across organizations in which these processes occur to construct the architecture, and (c) designing reusable components that share common elements across the enterprise [13].

Bell (2008) provides a SOA methodology that takes a more technical approach. It professes that all software can be considered as services that are designed based on the informational tasks of the organization, configured for transmission in the working environments, constructed with available technologies, and deployed for use by individuals. The methodology represents a conceptual structure that brings together distributed services based on the functionality [24].

All of these methodologies address the major categories that traditional IS literature claims to influence methodology adoption decisions. However, the actual guidance for answering the basic questions regarding why adopting a SOA project should be undertaken in the first place and what are the likely outcomes are still lacking [25]. In this paper, we argue for a need to decrease the complexity while relying on a familiar and well-proven methodology that can be adapted for SOA employing Web services. Thus, we propose the relevance of basic System Analysis and Design (SAD) principles and apply them in (1) exploring relevant questions needing to be addressed during the planning, analysis, design and implementation phases particularized for SOA projects and (2) describing SAD efforts in the SOA project at the Federal Financial Institutions Examinations Council (FFIEC).

3. BACKGROUND ON THE FEDERAL FINANCIAL INSTITUTIONS EXAMINATIONS COUNCIL (FFIEC)

The Federal Financial Institutions Examinations Council (FFIEC), comprised of regulators for banking from the Federal Deposit Insurance Corporation (FDIC), the Office of Comptroller of the Currency (OCC), and the Federal Reserve System (FRS), are charged with assessing the financial performance of all federally regulated financial institutions. The FFIEC also publishes standards for how banks conduct business as well as report fiscal activity. These tasks hinge on collection of Call Reports, i.e., a quarterly data series about the fiscal condition of a financial institution. The report consists of approximately 2,600 variables from all 8,200 FDIC-insured banks and all FDIC-supervised savings banks. These banks produce the report via specialized vendor software that often requires data extraction from multiple internal legacy systems. Reports are electronically submitted to the FFIEC call agencies. The FFIEC uses the Call Reports to develop the Uniform Bank Performance Report, which publicizes the risk and financial health of the entire U.S. banking industry [26]. When electronically submitted, the data validation for the call reports falls upon the FFIEC agency staff. The FFIEC's process for collecting, analyzing, and disseminating data evolved over several decades starting in the 1980s. This process has been plagued by inefficiencies in information management such as 75 to 80 day cycle times for reporting after a financial quarter [26]. The FFIEC SOA project manager reflects:

> *"Back then, it may have been acceptable but the impact of the Internet and the digital economy has made it unacceptable to take that long to respond to users of our data – we want data quicker and our stakeholders demand data faster."*

FFIEC realized inefficiencies in the information supply chain, which involves the transfer of information concerning operational processes to the various participant stakeholders facilitated by information systems and technology (see Figure 1). The FFIEC's goals regarding their information supply chain were to (1) provide timely guidance to the banks so that they can correctly perform daily operations regarding funds management, (2) receive timely and less error prone reports from the banks, and (3) identify problems with the data or banking procedures as well as guidance to the banks on how to correct the errors. Prior to implementing SOA, the FFIEC faced the following problems that constrained the ability to consume data in a timely fashion and to respond appropriately to problems detected in the reports for the following reasons: (1) a time lag in delivering quarterly updates to allow banks sufficient time to prepare Call Reports with new standards, resulting in the FFIEC's receipt of outdated reports

(2) 80 percent erroneous Call Reports as a result of banks using out of date standards or miscalculations, and

(3) Facing an overbearing task for analysts to identify and correct errors of severely backlogged Call Reports.

All of these issues contributed to extremely late Call Reports and late or outdated publication of the fiscal assessment for the banks by the FFIEC. Thus, prior to the SOA project, the FFIEC spent an excessive amount of time and resources on the issue, still resulting in poor data quality overall.

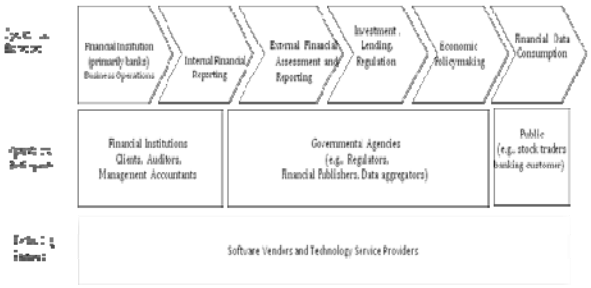

Figure 1. Financial Information Supply Chain (adapted from FFIEC (2006) archived report)

In addition to exploring the development of the SOA project, the FFIEC also examined the use of the eXtensible Business Reporting Language (XBRL). XBRL is an XML-based technology for extracting and supplying information between various stakeholders in the information supply chain [27]. XBRL promotes information interoperability between disparate data repositories through standardized formats and data structures expressed in taxonomies (e.g., standards for tagging data elements to define its purpose, structure, and use) [27]. SOA project employing XBRL use various taxonomies for the structuring of data across and within enterprises, in which Web services are defined by the process they facilitate. Starting in June 2009, XBRL was highly encouraged to be the reporting standard for financial institutions in the US by the Security and Exchange Commission (SEC). According to Reuters (2009), "these XBRL financial statements represent almost $7 trillion in market capitalization, over 50% of the total market cap for all publicly traded companies reporting to the SEC." Even though XBRL is specifically designed for financial data and reporting processes, the structure of the taxonomy, i.e. a format outlining the data elements and location of the associated meta data for each element, is flexible enough to support data from other contexts (e.g., business, medical, etc.) requiring extraction, consumption, manipulation, and validation. XBRL was developed as an open standard—and is maintained—by XBRL International, a non-profit consortium of 450+ organizations involved in international business information supply chains [27].

4. RESEARCH METHOD

In order to explore the relevant questions applicable during the lifecycle of an SOA project, we used a case study methodology for exploratory and descriptive

purposes similar to that professed by various qualitative researchers e.g., [28],[29].We had a base knowledge of generic questions or factors to consider in systems implementations *a priori* based on SAD literature e.g., [15],[16],[17]. Specifically for SOA SAD, projects we synthesized insights from others e.g., [12],[30],[33]. Interview and document analysis of archived case reports and project documentation were the primary data collection techniques used to gather data at the FFIEC approximately one year post implementation.

Interviews took place at times convenient for the interviewees over a three months period, in which we sought to understand the focus and concerns at the FFIEC suggesting the guiding questions the organization had during each phase of the SOA project. We interviewed the SOA project manager at the FFIEC, four business functional managers, three data analysts responsible for report error correction, and the outsourced consultants responsible for the technical development. Interviews lasted on average one hour. For document analysis, we reviewed the project documentation, archived documents such as transcripts from conferences, organizational press releases stated on their websites, and case reports completed by the consultants.

In analysis of the data, we applied System Analysis and Design (SAD) principles and coded data accordingly. SAD differentiates between four phases in the Systems Development Lifecycle (SDLC): planning, analysis, design, and implementation [15]. We used these phases to categorize the data much like the intent of open and axial coding as described by Strauss and Corbin to identify concepts and their relationship. Specifically we interpreted descriptions of activities or concerns at the FFIEC from the data sources as they pertained to questions or concerns for each of the phases. Each of these phases has its own objectives. For example, the objective of planning is to determine why an organization should pursue a project (or not) by using tools such as feasibility analyses. The great value of traditional SAD is that it has been successfully used across a wide range of industries and IT projects. Even though specific instruments within the SAD methodology can differ (e.g., to accommodate for a specific context), enterprises still obey its generic principles for the implementation of IT projects. We use the planning, analysis, design and implementation phases to frame the relevant concepts developed for the SOA project at the FFIEC. Interview questions were open-ended and began with determining the primary concerns during each phase (e.g., What major concerns drove the planning, analysis, design, and implementation? What concerned you more than other IT/IS projects implemented before?). We also were focused on understanding these concerns while reviewing the archived documents that afforded triangulation with the interview data.

Thus, we deduce questions (whether implied by the organization or derived from existing SAD literature) and particularized these for the SOA project. Two of the authors composed the questions based on analysis of the data, from the interviews and archived documents, and integration with defined questions/factors of interest from existing literature. Those were then examined by the third author who is one of the co-founding members of XBRL International (a consortium of practitioners promoting the use XBRL in SOA projects such as the FFIEC project). This approach promoted face validity regarding the development and resulting list of the applicable questions to be addressed during each SAD, particularized for SOA projects. We then discerned what the organization learned from their efforts that are applicable to general businesses. The following sections detail how we applied SAD to explore and describe the SOA project at the FFIEC.

Our contribution is the uncovering of questions that—when sufficiently answered in the context of implementation— should help to provide a methodological basis for approaching SOA projects. Additionally, the lessons learned proposed later in the paper provide insights concerning benefits and challenges realized in the SOA project that are generalizable to other contexts.

5. PLANNING PHASE IN SERVICE-ORIENTED ARCHITECTURES (SOA)

In traditional SAD approaches, the planning phase entails identifying why an organization should pursue the project. More specifically, it entails analyzing a project's economic feasibility (i.e., cost-benefit analysis, or cost of not implementing), technical feasibility (i.e., does the technology exist, and what are the necessary resources for building the system), and organizational feasibility (i.e., will the system be effectively utilized if implemented) [15].

An essential step in the planning stage is identifying core processes that require interchanging data between disparate environments and assessing the adequacy of the available information—ultimately making the business case for economic feasibility. In this phase, applying the SOA does not call for all processes to be conducted via Web services [12]. With traditional business solutions like an ERP system, the focus is on enterprise data which represents a largely historical views, whereas SOA can also afford cost effectiveness in accessing information to provide a more market-oriented view. For example, Cartesis, a financial and performance management software provider, enables SOA with Web services by extracting data from internal resources as well as external resources, such as Edgar Online [31]. It allows the application of business logic, as defined in an organization's taxonomy, to analyze the data and to report not only the organization's financial standing, but also competitive data for benchmarking and assessing market competitiveness which are provided via Web services. In this case, SOA in the planning phase should not simply be regarded as a technology player, but rather as an effective instrument to exchange the information contained within systems, thus providing more flexibility in addressing future information needs that are both enterprise and

market oriented.

Some augmenting questions for assessing the business value for SOA in the planning phase are geared towards identifying overarching deficiencies in the information supply chain. In the following, we will present questions that we derive from exploring how the FFIEC addressed issues related to the planning phase of their SOA project that incorporated Web services.

In the following sections we first provide the resulting questions to address in each phase particularized for SOA. In doing so we note generic questions from the existing SAD literature and present data from the FFIEC that aided us in developing the more particularized questions specific to SOA.

Questions to Address during the Planning Phase

The planning for SOA projects should originate with questions regarding the business value to substantiate the need for the system or technical solution such as "What is the expected value (either tangible or intangible)?" [15],[16],[17]. Hau et al. (2008) also suggest discerning the value to the organization is a critical component for driving the SOA project and defining the scope, which is often neglected or not fully explicated.

The FFIEC focused on articulating the proposed value added in accessing data across the continuum of stakeholders. Specifically, stakeholders that were directly impacted from the FFIEC's consolidated financial institution assessment report sought timelier access to the data. Banks also requested a notification of errors and updates as well as a more streamlined method for providing these updates to the FFIEC as indicated by the following:

> *Former FDIC Chairman: "A principal reason it (the Call report process) takes so long to release information is that banks have between 30 and 45 days at the end of each quarter to report it...an XBRL system would help regulators do their jobs better and give banks a better gauge of their competitors."*

Based on the aforementioned we present planning question (PQ) 1 as:

(PQ1) Is there an inability to meet the information needs of the organizational stakeholders (e.g., has a business partner asked for more accessibility to data, are lag-times in data exchange slowing throughput, etc.)?

Willis and Hannon (2005) suggest the need for particularizing the data needs across an information supply chain that entails defining who needs the data as well as its meta-data (formulas supporting how values are derived, explanations for why certain algorithms are used, etc) for decision-making at various levels internal and external to the organization.

The FFIEC regulators experienced a wide range of challenges in their reporting functions. For example, securely obtaining data from the banks that could be entered automatically without manual re-keying or re-formatting in a timely and less error prone manner presented a major challenge. Also, reducing costs through the automation of repetitive tasks as well as validating, analyzing, and comparing data more efficiently were desirable objectives to achieve error free reports [26]. The following alludes to desirable objectives of the FFIEC:

> *FFIEC Analyst: "All banks have to do the same process of preparing the Call report. We need to know exactly how they come up with the report content. It is supposed to be based on our guidance but often we don't know what version of the guidance they are using. We need a deeper look into the data and how it was applied to make better assessments."*

Based on the aforementioned we present planning questions (PQ) 2 and 3 as:

(PQ2) What is the need for interactive data (e.g., real-time data with readily accessible meta-data) across the enterprise and amongst the organizational partners?

(PQ3) Are the same types of data being disseminated among multiple partners, internal or external customers, or across the information supply chain with identifiable duplicative effort?

The special issues and constraints such as identifying mission and time critical processes is essential in relation to the value lost if these processes are not adequately facilitated by the technological solution is a major concern in SAD [15],[16]. Hau et al. (2008) also suggest ensuring that the solution is aptly positioned to address critical quality issues associated with data transfer.

While there were time criticality issues associated with assessing the financial health of the banks via the Call report, the mission of the FFIEC was to render quality assessments, which also drove the need to provide a mechanism for banks to deliver cleaner data to the FFIEC, thereby reducing the manual burden of the FFIEC analysts in cleaning the data prior to assessment. This, in turn, contributed to a timelier publication of the bank assessments to be used for its valuation. The following elaborates on this issue:

> *Business Functional Manager: "We simply had to figure out a way to do work it takes too long to get the information from the banks. The analyst productivity was low, the turnaround time for report assessment was high, and we weren't utilizing peoples' analytical skills best because we were inundated with data quality issues."*

Based on the aforementioned we present planning

question (PQ) 4 as:

(PQ4) What is the mission criticality of the services currently being provided, indicating a prioritization sequence for correcting the deficiencies?

System security concerns should be addressed early in the planning stages, which can impact project scope, technical feasibility, and cost [15],[16]. System security and threats to organizational data is a major contributor to apprehension about providing corporate access to data. However, with the appropriate planning and execution for security mechanisms, this apprehension can be thwarted, even in the particularly protective financial industry [32]. XBRL as an open standard and implemented as a Web service is prone to this scrutiny. Its widespread adoption is only possible with ample focus on securing information delivery and guards against network breeches [32]. The technical consultant working with the FFIEC and all of its stakeholders were very adamant about including a high level of security for all phases of the data transmission, as suggested here:

> *Business Functional Manager: "Everyone involved this process questioned how secure the data transmission would be. The banks are concerned with the data being corrupted in transmission, the vendors are concerned with ensuring they are get the right taxonomy that hasn't been tampered with, onto us knowing that the data isn't compromised or any messages back and forth to the banks are exposed before we want to publicize any information."*

The FFIEC assured all technical enabling parties that a high level of secure transmission was guaranteed at every information entry and delivery point in the architecture. The essential requirements are noted as follows [26]: (a) sender and data authentication with role-based access (i.e., no one financial institution could review another's information or file documents), (b) data confidentiality during delivery and storage, and (c) data integrity to ensure no inadvertent or unauthorized deliberate modifications.

Based on the aforementioned we present planning question (PQ) 5 as:

(PQ5) What is the propensity for using open standards for application development? In other words, how can security of the information delivery be a constraining factor?

Discerning the technical feasibility of implementing the project is of the utmost concern [15]. [16]. In this regard the technical capabilities should be determined as sufficient or not, such as the state of the IT architecture, in-house or external IT prowess needed for implementation, and the fiscal capacity to invest in required technical elements to support the project. Costs are considered nominal for banks that already possess sophisticated legacy systems and architectures prone to supporting the basic technical functions needed for SOA [33],[34]. However, while the XBRL functionality can be coded in the software used by the banks, the FFIEC realized the need to not put undue financial stress on the banks, particularly if the banks did not possess the technical prowess for using XBRL. Thus, it considered the most economical means of providing the needed software to promote its adoption and decided to enlist the support of the existing software vendors that supplied the banks with their legacy reporting capabilities and who possessed the aforesaid capabilities.

With the inclusion of the software vendors, all stakeholders were deemed to have sufficient technical capabilities for participating in the information delivery process, enabled by XBRL functionality accessible via an FFIEC provided Web services. The following elaborates on this point:

> *Consultant: "Getting the software vendors on board was critical. They were supplied with the taxonomy including the data validation criteria, all capabilities for exception reporting and reporting discrepancies via a Web service. The Web service reduces the workload on the vendors to get the most up to date guidance for how to build the Call report in the software and submit it. Since it was new to the vendors we had to promote it in this way so it would not be seen as overbearing and damaging for their relationship with the banks."*

Based on the aforementioned we present planning question (PQ) 6 as:

(PQ6) What are the capabilities of information stakeholders to access and consume the data via Web services in an SOA?

6. ANALYSIS PHASE IN SERVICE-ORIENTED ARCHITECTURES (SOA)

Analyzing the data requirements encompassed in an efficient SOA model should be more broadly scoped than when just revamping one single system. The benefit of SOA is the synthesis of common business logic for manipulating data that exist across disparate systems without having to modify code or encountering constraints exhibited by the various platforms across the existing architecture. Therefore, the following section discusses how the FFIEC performed the analysis phase in relation to the relevant questions to ask at this stage of the project.

Questions to Address during the Analysis Phase

Analyzing system requirements is simultaneously a business and information technology task [15],[16].

System failure is most likely due to an inability to adequately address the true business need of all stakeholders that depend on data provided within the system to perform work. Traditional questions that are raised during the analysis phase are: What does the current system do and how does it do it? What will the new system do? Where and when will the new system be used? [15] The FFIEC determined the processes in the as-is distributed architecture to be flawed or constrained by data access, validation, analysis, and reporting problems, as alluded in the following and illustrated in Figure 2.

> *Business functional manager: "The old way just took too long, had gaps or inconsistencies in the report that could be the result of the banks having the correct guidelines or not knowing how to apply them. It required a lot of manual work on part of the analyst resulting in assessments being made on incomplete or incorrect data."*

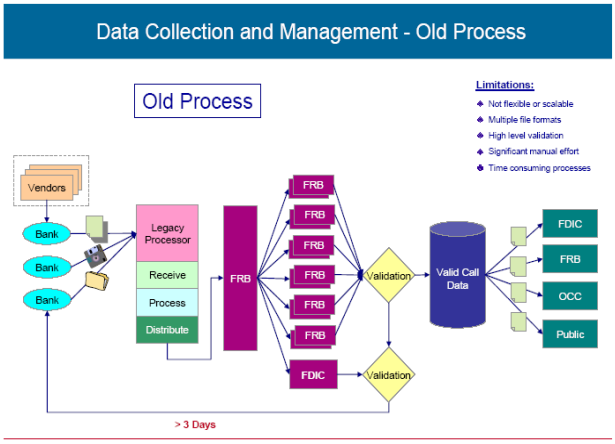

Figure 2. FFIEC's old processes (FFIEC, 2006)

Processes to identify errors and problems with back filings were too time consuming and costly for the regulators—a result of activity-based costing and duration analysis. Therefore, they mandated data quality assessments and error detection responsibilities to be a requirement for the vendor supplied software used by banks to create their filings. Also, they enabled responsible parties to make online corrections to their call report filings as well as created a centralized data repository (CDR) that could be used for call report data interchanges. This enhancement in data collection and validation was also known as the Call Modernization Project.

Based on the aforementioned we present analysis questions (AQ) 1 and 2 as:

(AQ1) What data-oriented problems exist that hinders the ability to access current and timely data and reduces visibility of accurate information across the information supply chain?

(AQ2) What are the most costly, time consuming, and duplicative activities and how can processes be streamlined?

Modeling processes to determine areas of improvement, such as discerning the frequency of duplicative effort and data, is a major component of analysis [15],[16],[35] that can result in the abstraction of shared data elements and processes across multiple entities interacting with the data. Identification of the shared data is one accomplishment, but the process needs to reflect how that data are prepared and used across the continuum to ensure continuity and enable governance, especially in multi-stakeholder organizations [33]. The issues underlying the analysis phase at the FFIEC are noted in the following:

> *Project manager: "The regulators all have common and specific regulations the banks must follow. Keeping up with all of the changes in the processes for preparing reports to all the regulators is difficult enough for the banking institutions at all levels. We need to streamline the reporting processes and indentify the common reports criteria and the underlying equations for deriving these figures. Often the reports conflict, which takes time to manually discover and correct. Fixing the problem with the Call report is a good start that will make it transparent to all involved how to prepare it and enable standardization that puts all of the FFIEC involved agencies, banks, and vendors on the same sheet of music. It was only after we got really deep in the project that we realized some of the problems the banks had that made them feed us bad data...we mainly thought about the problem from our perspective or top down with focus on standardizing and governing the process."*

The FFIEC held joint application design sessions that resulted in the to-be distributed architecture as depicted in Figure 3.

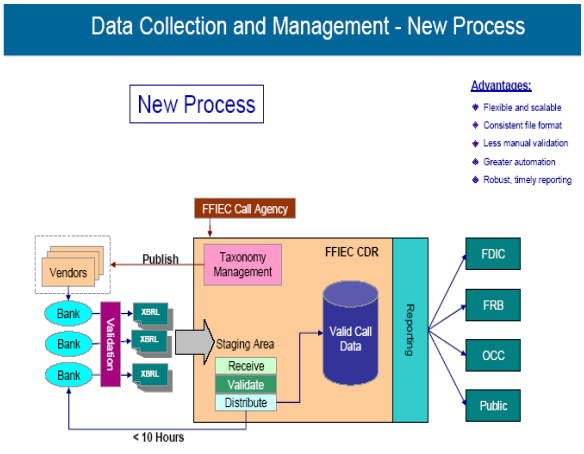

Figure 3. FFIEC's new process (FFIEC, 2006)

In the new architecture, the software vendors supply banks with the appropriate applications to create their filings. For that, the FFIEC specified particular data collection requirements to be incorporated into the vendor software, including FFIEC's standard definitions for attributes and entities. These could then be used by XBRL as elements to validate standards relating to specific business logic for aggregating and manipulating data as well as be used as part of Web services. In addition, they would easily enable a financial institution to make needed changes to a document that had already been submitted to the FFIEC's review process. The alternative (i.e., waiting for the FFIEC to return the document) often caused an enormous time lag in processing.

Based on the aforementioned we present analysis question (AQ) 3 as:

(AQ3) What are the common data elements and parent entities currently being used across the services that can be used as central elements and entities to provide a basis for a logical data model and underlying processes for the to-be architecture?

7. DESIGN PHASE IN SERVICE-ORIENTED ARCHITECTURES (SOA)

The design of a system is only as good as the analysis, and the basic overarching question in this phase is "How will the system actually work?" [15],[16],[36]. Since the purpose of the design phase is to establish how to build the system, the majority of the activity is geared towards evolving analysis specifications into design representations [15],[16]. SOA affords data integrity in that there is an abstraction of data from the disparate systems that serves as a logical repository transforming the data into common elements, which can be used across various services. SOA should also be scalable enough to allow for additional Web services when needed [37]. The following section discusses the design phase at the FFIEC.

The primary advantage in the SOA design at the FFIEC is its ability to support reusable business logic that is incorporated in tasks performed by internal and external consumers of the data. The designs embed business rules within the application layer that are more effectively managed at the abstracted information or taxonomy layer.

Questions to Address during the Design Phase

A critical component of the design phase is the physical implementation of the data repository or the mapping of data resources if they are disparate [15],[16],[31],[38]. Questions involved in this phase concern understanding what data resides in these repositories, how it can be extracted and used to complete a task or process, how the repositories are currently accessed, and how integrated they are [15],[16],[37]. Also the design should capitalize on the best suited technology [15]. In this case, XBRL was deemed most sufficient since it was infeasible and unnecessary for the FFIEC to consolidate data for each bank since each bank was the owner of its own data housed in its local repositories. The FFIEC merely needed a mechanism for retaining the reported data in a form that was easily transportable across all involved factions, as discussed here:

> *Consultant: "They [the FFIEC] needed a solution that allowed for loose coupling of the data required for reporting and analysis. They are the process owner but not the data owner (nor do they need to be) and it really wasn't any advantage to take on a massive systems integration effort. XBRL enables leveraging the current IT resources to extract and render the data in the proper format without having to focus on knowing how to manipulate the underlying applications."*

Data used for the Call reports reside in more than 8000 financial institutions' multiple legacy applications that use vendor software to consolidate source data needed for financial reporting. The FFIEC provided the vendors with an XBRL taxonomy inclusive of the following: (1) element definitions, meta data, and content requirements analogous to a schema or document type definition, (2) business logic in the form of algebraic formulas for data validation purposes with developed use cases, plain English edited messages that alert the institutions when errors occur, as well as requirements for inputting each institution's explanation for valid data discrepancies and fluctuations, and (3) a common instance document output add-on for transmission, most often completed via a Web service [26]. This XBRL taxonomy was published to vendors and consumed as a Web service which enabled easier maintenance as changes occurred. Abstracting the business logic and element meta-data that are physically represented in a centralized data repository afforded standardization while leveraging current IT resources at the institutions.

Based on the aforementioned we present design questions (DQ) 1 and 2 as:

(DQ1) What business systems currently house needed data?

(DQ2) How can XML-based technologies support the extraction and interchange of this data?

Security from unauthorized access should be a consideration in the design of the enterprise system; and questions regarding this issue should concern how to deploy security mechanisms without negative performance impacts [15]. XBRL mainly applies to document rendering or presenting that can be easily distributed and viewed on standard Web browsers with the appropriate plug-in mechanisms [39]. "Security is left to other components of the overall information system" that encapsulates XBRL, the technology for rendering

documents [39]. However, the concern for secure data transmission was a top priority at the FFIEC as discussed here:

> *Project Manager: "The old process entailed the processing vendor to consolidate the bank data received in a number of different formats in hard or soft copy. So security of the data in transmission was difficult to ensure. The FFIEC did not have real control over the security of the entire process. But with the new process for data transmission, the vendors provide the software based on FFIEC instructions accessible via the Web, then the banks transmit the data using browsers and are required to authenticate prior to accessing the FFIEC Call agency to deposit the XBRL based reports. After analysis of the reports they are forwarded to the FDIC, FRB, OCC and the public via similar secured mechanism... so security reached across the entire process facilitated by network security features from data entry to the delivery point."*

Based on the aforementioned we present design question (DQ) 3 as:

(DQ3) Does the existing enterprise security system support standards needed for secure XML-based Web services? If not, how will security be enforced?

The design is sufficiently secured to ensure a sender's authentication as well as the confidentiality and integrity of data while consumed and submitted via Web services and during stored in the centralized data repository. The main goals of secure transmission entailed the following according to the FFIEC: (1) authentication of data senders, (b) confidentiality of the data while in transit on the network, in storage, or while being updated, (c) data integrity assurance to avoid inadvertent modification by the system network or unauthorized users, and (d) role based access based on institution so no one unauthorized organization could see another's data.

8. IMPLEMENTATION PHASE IN SERVICE-ORIENTED ARCHITECTURES (SOA)

The success of the implementation of a system depends on how well the system is constructed, tested, and turned over to the user in a manner that does not invoke resistance. The basic overarching question in this phase is "How it will be integrated into the organization for use?" [15],[16]. In the following, we discuss how the FFIEC addressed the implementation phase.

Questions to Address during the Implementation Phase

During the implementation phase, questions concerning the capabilities of the organization to perform actual construction of the system should be addressed. If the organization does not possess the technical capabilities then technology partners should be engaged [15]. The latter was the situation at the FFIEC as discussed here:

> *Consultant: "No one called for XBRL specifically but there is a pressing need in the financial reporting industry for more efficient processes and transparency of the data behind the reports. The FFIEC, being a regulatory body understood these needs but did not know how to take advantage of technology to solve problems in the reporting process. We provide that technical arm for them and have enough experience with how to deploy to bring the desired outcome to fruition. They don't need to understand the intricacies of XBRL but realize what it can do and allow us to do it."*

The primary advantage of the implementation phase was that the FFIEC partnered with the leading vendors and the consulting firm through a consortium that was actively promoting the use of XBRL. The partners in the consortium (XBRL International) were considered the leading experts on XBRL use in SOA. The software vendors provided software that was sanctioned by the FFIEC for banks to prepare financial reports; they used an XBRL based Web service to more efficiently acquire the meta-data (i.e., guidance published by the FFIEC required to accurately generate reports). Prior to the use of XBRL, the software vendors would update the financial reporting software only after receiving notice from the FFIEC to download electronic files containing the updated guidance. The software vendors were then required to interpret the guidance and update the code in the programs for the financial reporting software. The process was time consuming and often resulted in misinterpreted guidelines by the vendors and late error prone reports, because of the time lag associated with receiving the guidance and updating the software in accordance. This often also resulted in the software generating errors in the reports due to misinterpretations of the FFIEC guidance. Use of the taxonomies with embedded business logic takes the burden off of the vendors for interpretation. This way responsibilities are more streamlined in the process, with every faction performing a role commensurate with their core expertise and their effectiveness in that process much more transparent.

Based on the aforementioned we present implementation question (IQ) 1 as:

(IQ1) How construction of the solution ensure delineation in roles in processes and how will the effectiveness of their activity be made transparent?

In a multi-stakeholder implementation that requires use of data from various repositories, validation of the results can be a complex issue and a major concern amongst adopters of XBRL in SOA projects [40]. Questions regarding testing regards ensuring that all errors

are detected as early as possible, which requires staging and the involvement of the functional users [15]. The following elaborates on this point:

> *Business Functional Manager: "We needed to get all parties [banks, outside regulatory agencies, and the public] involved in the testing to make sure that we did not miss any critical requirements, and we could see the benefit in time saved and quality improvements for generating and disseminating the Call report and associated data."*

Since SOA is only as good as the data it can provide, testing at the FFIEC focused on ensuring that data used across services were common and delivered the reliable results. Data typically resides in multiple repositories in the SOA environments; thus, ensuring integrity is complex. Data element names across repositories may have the same meaning, but have different labels, which creates complexities in coding Web services to run properly. Opposed to changing data element names in each of these repositories to a common name, which can be a costly re-engineering process, the Web service can point to a logical model of the data housed across multiple repositories while simultaneously providing a means of standardizing the data across the enterprise. In this model, a common name for each similar element can be created along with meta data providing the location and name of the associated data elements that are akin to the various repositories. Thus, the testing not only entailed the mechanics of data delivery but also the availability of the underlying shared and specific meanings and guidance for use of the data element by any involved faction.

Based on the aforementioned we present implementation question (IQ) 2 as:

(IQ2) How will the solution (a) employ a logical model for a virtual data repository that reduces complexities in indentifying similar terms and (2) test to ensure that the Web services are using the appropriate data elements?

Implementation success often requires massive efforts in change management. Change management entails questioning what and how to revise policies, motivating adoption with an understanding of the costs and benefits to the functional user, enabling people for the transition to the new system via training and understanding overall resistance to change [15],[41]. The following represents the FFIEC's efforts:

> *Project Manager: "We tried to keep everyone in the loop about what the technology was supposed to do for us as a whole and how they would be affected. There was a lot of concern about the technology allowing us to downsize the analyst workforce but soon it was realized that we could enrich the role of the analyst. The banks were mainly worried about cost and not having the technical expertise. We are the big player and have taken on most of that burden. There is always a fear of transparency whether you are a bank or not, but they have to comply with standards for reporting anyway and the way we present it to them is that this makes it easier for the banks to present correctly, increasing the likelihood that we can act more quickly to help them before little problems become big problems."*

With any information technology implementation, top management support is crucial to the acceptance at the operational level. The FFIEC did not simply mandate banks to use XBRL to interact with the new SOA environment without any constructive guidance and financial support for the banks in making the necessary changes. Instead, the FFIEC included the banks, the software vendors providing the report generating programs to the banks, as well as the analysts assessing the reports from the banks in the all phases of the development. This not only served to educate all the uses about the new technology and processes, but fostered the users to take a vested interest in the success of the project.

Based on the aforementioned we present implementation question (IQ) 3 as:

(IQ3) How can you enlist the stakeholders to reduce the fear of transparency, promote education of the about how to conduct work, and empower them to take on more intellectually challenging roles because of the data provided and streamlined processes?

9. KEY LESSONS LEARNED FROM SAD FOR THE FFIEC SOA PROJECT

The FFIEC attributes much of its quantitative value realization (see Appendix 2) from the SOA project to its planning, analysis, design and implementation methodology. There were several key lessons learned from a qualitative perspective. We now elaborate on these key lessons learned during each SAD phase that are informative for any organization considering an SOA project to promote efficiencies in their information supply chain.

Consider the Needs of the Information Consumers and Information Providers in the Scope and Definition of the SOA Project

From the outset of planning, the emphasis of the FFIEC as an information consumer was to make the data gathering task much more efficient, allowing an easier means to consume data. Driving their quest to consume data more easily was the FFIEC's discovery of how manually driven and how disjointed their processes were despite having migrated to standardized electronic forms

several years prior. Initially, the FFIEC only viewed the SOA and Web services enabled by XBRL as means to help receive data in a timelier fashion. The major lesson learned was that in order for the FFIEC to receive data in that manner, it needed to provide the information providers (i.e., the banks) with better and timelier meta-data so that they would be able to create the Call reports in accordance with FFIEC regulations. Part of the discovery during the planning phase was the understanding of how much the SOA, and specifically XBRL, would facilitate knowledge management (e.g., dissemination of instructional guidelines for how to use the electronic forms) across their information supply chain partners.

One main issue with determining a methodology for SOA projects in general is that there is inconsistency in what SOA means to the organization [12]. Typically, the SOA project is defined by what is driving the need to implement and often fails to consider rethinking the design of their business from all of the organizational stakeholder views and what form SOA will take in this transformation [2]. Kokko et al., (2009) suggest, from a study of nine different organizations implementing SOA projects, that there are variant drivers ranging from a mere collection of Web services that are cost and time effective for feeding or retrieving data or applications, to a technical solution for aggregating information across disparate systems, to a heterogeneous legacy base, to a means for enacting control within an organization. As with any project, the planning phase should define the scope and should be as comprehensive as the drivers for initiating the project but from this case we see that it takes at least a cursory understanding of why the deficiencies are occurring up front to help develop the scope. Even though the project was supposed to be a collaborative effort, the primary focus of the SOA project was one-sided, biased towards the needs of the regulators as the information consumers (mainly the FFIEC, FDIC, FRS, and OCC); this resulted in the scope not being as comprehensive as it needed to be. The FFIEC, as the primary faction in the project, learned that their inability to consume data was not entirely the fault of the banks who took too long to process the data. Aside from not standardizing the format for delivery and mechanism for secure transmission from the banks to the FFIEC, the problems in receiving data also resulted greatly from the inability of the FFIEC to provide clear, non-conflicting instructions on how to prepare the data in the meta-data, which was often left to the software vendors as opposed to the financial experts at the banks to decipher. Had this been included in the scope earlier, the banks would have been able to better understand the benefits associated with it, benefits that included clearer standards for report development and better coordination for information transfer, lessening the chances of bank penalties from not meeting deadlines and reluctance to comply. The main takeaway is that despite the FFIEC's effort to consider all stakeholder views, inclusive of the banks, the planning, in actuality, was more oriented towards information consumption at the FFIEC.

In general, SOA is about sharing data and moving data from point A to point B. The needs of the information consumers and providers should be balanced and have a clear understanding of the underlying causes as to why the information consumers are not receiving data properly or that it is not meeting quality standards is key. Thus, for any SOA project the idea of determining at least an overview of the root causes of inefficiencies (typically a technique reserved from the analysis phase) earlier in the planning phase will help guide the scope of the SOA project. This contributes to the greater likelihood of attaining the desired outcomes, such as SOA serving as a vehicle for quality data exchange and better coordination, and not merely standardization and governance from a top down perspective.

Balance the need for autonomous use and standardization of data but seek to maintain quality

During the analysis phase, a key lesson learned was the disjoint between the leadership factions, more specifically between the FDIC as the technology leader and the Federal Reserve Bank (FRB) as the administrative coordinator. These two factions received the same consolidated data from the banks via an electronic version of the Call report, but used the data differently. As a result, each had varying business processes that were best facilitated by the use of different taxonomies applied to virtually the same data. The root cause of the disparity between the two factions was their inability to easily transfer information between themselves, and thus to present unified guidelines to the banks. Additionally, the business processes were laden with manual duplicative efforts. For example, the banks transferred the data via electronic forms, generated in specialized software, to the FFIEC at which point the analysts at the FDIC and FRB would often extract data from the forms and re-key data into their respective information systems or data repositories with their own slant on the meaning of the data and instructions for use. This issue is not novel as Henningsson et al. (2007) observed the problem of identifying and eliminating duplicate effort while trying to retain user autonomy with the data in the case of mergers and acquisition. The same is true in another XBRL proof of concept project involving public accounting [42]. Abraham and Reese (2010) uncover this issue in regards to factions within a healthcare system, needing to share data across disparate systems, keeping intact what the data means to each faction (which could vary), and who would have the need to use the data in very different ways for clinical analysis. In these cases, instituting standards for what the data means to everyone can be difficult to achieve and might not be as equally beneficial for all autonomous factions.

Part of the discovery process in the analysis phase for the FFIEC revolved around how to collapse ways of working together while leveraging the respective IT resources with disjointed platforms and maintaining some autonomy in how the data were used. XBRL was the technological mechanism for enabling the aforementioned

and making the information platform more flexible in responding to needs of the constituents. It is a useful mechanism for extracting and disseminating information across disparate systems. XBRL is applicable for all types of data and should be considered as an alternative to costly and rigid point to point integration solutions in SOA projects to deliver desired flexibility and leveraging of existing IT resources. In this regard, flexibility is akin to operational agility [43],[44], enabling firms to easily adjust business processes to attain speed and accuracy in information exchange and reducing information asymmetries between information supply chain partners. Thus, XBRL employed in SOA is particularly prone to promote operational agility and should be considered as a technical component for building Web services regarding business data reporting in SOA projects.

Use software vendors as technical partners as well as change management ambassadors

The use of vendors' software to facilitate the actual ability of the banks to generate the report was deemed critical in the design using XBRL. This design feature presented the opportunity to use the software vendors as ambassadors for change, which is beneficial in implementation and easing transition to a new paradigm, not only from a technical perspective but also from a change management perspective. The need to not disenfranchise the software vendors, who were intermediaries between the banks and the FFIEC, surfaced. The FFIEC realized that the software vendors were the integral components in the supply chain of information that enabled the electronic form generation and data transfer from the banks to the FFIEC. The software vendors and banks quite often had long standing and often highly dependent relationships; and the FFIEC came to see the value in engaging the vendors as ambassadors working on their behalf to smooth the transition for the banks to the new data management paradigm.

As aforesaid, banks had reservations about the changes due to misperceptions of costs they would incur and technological expertise they needed for the implementation. The actual technology partner to the banks were the software vendors who supplied them with the legacy applications for preparing the reports. The FFIEC came to realize that they needed to establish a relationship with the software vendors who supplied the banks. Since vendors worked for the banks, and not the FFIEC, these vendors needed to understand that their contracts with the banks hinged upon the capabilities of the vendor software to enable the banks to be compliant with FFIEC regulations. Costs of the software could vary from bank to bank based on customization requirements, making some implementations more costly to the banks than others, contributing to the reluctance of the banks to convert to processes for information delivery. Therefore, the FFIEC decided to provide the vendors with the XBRL taxonomy to be used via a Web service that negated the substantial vendor fees charged of the banks. Also, the FFIEC fostered a cooperative relationship between its consultants (serving as their technological partners) with the software vendors (as the banks' technological partners) to conjointly design an optimal solution that leveraged IT resources across the information supply chain. In actuality, and since the banks and software vendors typically had a long standing and trusting relationship, the vendors could be used as change management ambassadors to help the banks understand why and how compliance was going to be achieved.

This suggests that enfolding the software vendors' help to manage the changes in the processes and to promote adoption amongst the target users can minimize vendors' exacting control over target users with proprietary service in the technical design that contribute to escalating costs in multi-stakeholder SOA projects. This issue regards how to more keenly manage costs and barriers to change in SOA projects, which is deemed as a cause of SOA project pitfalls and/or failures as suggested by Benazeer et al. (2008).

Seek Opportunities for Better Work Task and Work Role Alignment in Change Management to Improve the Likelihood of User Acceptance and Performance Outcomes

A key takeaway discerned in the implementation phase regards critical aspects of change management. Despite the differences in the leadership of the FFIEC factions for each organization, there was a high propensity for change and business processes re-engineering, but the underlying architectures and political atmospheres made the transition at the operational level problematic. Even though the leadership envisioned cooperative change on the operational level, the analyst workforce was very skeptical about the underlying motives for the change. Mainly, they were fearful that the technology would enable downsizing. For example, analysts typically had specialized coding skills and would spend the bulk of their time re-keying data, which was often laden with errors induced by the manual process—ranging from forms and writing queries, to inserting data into other data repositories. In essence, the proposed re-engineering eliminated a whole category of errors associated with double-entry. As part of the organizational change solutions, the FFIEC leadership earnestly attempted to convince the analysts that the business process re-engineering would benefit them in terms of decreasing the amount of time to process the data received from the banks and enabling them to re-focus their abilities on other, truly analytical tasks. Additionally, the FFIEC included the analysts in the implementation process via interactive joint application development sessions. Those analysts who did not conform to the changes were presented with separation packets options.

The group of analysts who were formerly responsible for writing specialized code (e.g., COBOL) to generate queries on the mainframe were retrained in Web-

based programming with a focus on natural language processing and maintenance of the XBRL components of the software, which enabled transitioning the technical role from the outsourced consultants to the FFIEC. This opened up a variety of opportunities for the remaining analysts who did not have the specialized coding skills. Compared to only one analyst who would have the skills to work on, for example, the needed changes of a large mathematical algorithm, now several analysts could work various aspects of the algorithm, which were version-controlled. The primary insights from this improvement was that the use of English-based graphical user interfaces enabled better use of the workforce and promoted collaborative efforts for problem solving, which resulted in improved quality for the resulting business logic. This contributed to 10-33 percent increase in staff productivity.

All analysts were empowered to do more complex activities, while mere data cleaning truly became the responsibility of the data entry person at the banks. These bank personnel were now empowered by the technology for ensuring quality of their own reports, with the exception/error management capabilities in the software as well as the guidelines/meta data in each taxonomy. This allowed the bank personnel to see their own potential problems and ask more in-depth questions of the analyst if needed before transmitting the final reports to the analyst at the FFIEC for assessment. Basically, the banks now had the tools to validate more effectively up-front as opposed to validation taking place near the end of the process by a faction, the FFIEC, which was not the process or data owner. This reengineering of the process contributed to nearly 100 percent of the data received at the FFIEC meeting mathematical requirements. The reengineering of the process and subsequent design improvement allowed banks to have more transparency of their own operations and also allowed analysts to focus less on non-analytical tasks and more on complex problems, such as helping banks in jeopardy of folding by suggesting changes in their operations. The change management efforts entailed promoting efficiency in workforce skills and allaying fears of data and process transparency at the banks to reveal the true performance outcomes.

Thus, SOA projects are particularly suited for minimizing the need for *lower complexity* in *data oriented* tasks and maximizing the opportunity for *higher complexity* in *data analytical* tasks. The change management efforts in SOA projects should capitalize on this as an opportunity to empower the workforce to be more proactive in their use of the data, redefine or clarify work roles, and foster talent in analytical processing, which is also a by-product suggested by Bieberstein et al. (2005). In general these activities in change management extend beyond training users on the new system and new processes and making the technology a better fit in the organization to an exercise in raising the collective acumen of the workforce that merely uses the SOA paradigm and technology such as XBRL as a tool.

10. CONCLUSION

SOA is a paradigm particular to the organization that employs it [45]. SOA can provide flexibility while leveraging current IT assets. Hence, it should not be viewed as a "new implementation" for "new implementations," but instead as a way of conducting business [45]. Since the mere mention of reengineering promotes anxiety amongst the information supply chain partners, it should be made clear that SOA is not such an effort. Rather, SOA is an endeavor to promote business value in terms of costly inefficiency reductions related to data interchange while providing asset visibility specific to core businesses. XBRL is poised to be the vehicle for bringing the aforementioned SOA paradigm to fruition that views Web services as a collection of processes with underlying common and unique attributes. SOA with XBRL can promote better internal controls, enhance compliance processes overall to lower the costs associated with data interchange, and make more efficient use of Web services [33],[46],[47],[48]. However, without efficient and effective application of SAD the aforementioned is unlikely to produce the desired outcomes. The questions posed in the paper as guidelines and the lessons learned from the FFIEC in this case provide structure for application of SAD principles particularized for future SOA projects.

REFERENCES

[1] Hirschheim, R., Welke, R., and A. Schwarz (2010) "Service-Oriented Architecture: Myths, Realities, and a Maturity Model," MIS Quarterly Executive 9(1), pp. 37-48.

[2] Hau, E., Ebert, N., Hochstein, A., and W. Brenner (2008) "Where to Start with SOA: Criteria for Selecting SOA Projects," *Proceedings of the 41st Annual*

[3] Koch, C. (2006) "The Truth about SOA," *CIO Insider*, http://www.cio.com/article/21975/The_Truth_About_SOA (current Mar. 5, 2010).

[4] Kumar, S., Dakshinamoorthy, V., and M. Krishnan (2007) "Does SOA Improve the Supply Chain? An Empirical Analysis of the Impact of SOA Adoption on Electronic Supply Chain Performance," *Proceedings of the 40th Annual Hawaii International Conference on System Sciences (HICSS 2007)*.

[5] Lim, B., and J. Wen, J. (2003) "Web services: An Analysis of the Technology, its Benefits, and Implementation Difficulties," *Information Systems Management* 20(2), pp. 49.

[6] Natis, Y. V. (2003). "Service-Oriented Architecture Scenario," http://www.gartner.com/resources/

114300/114358/114358.pdf (current Oct. 15, 2005).

[7] Rotem-Gal-Oz, A. (2006) "What is SOA Anyway?" http://www.rgoarchitects.com/Files/SOADefined.pdf (current Mar. 5, 2010).

[8] Gopalan, S. R., Binod, P.G., Babo, K., and R. Palkovic (2006) "Implementing Service-Oriented Architectures (SOA) with the Java EE 5SDK,"Sun Microsystems,http://java.sun.com/developer/technicalArticles/WebServices/soa3/ (current Oct. 15, 2007).

[9] Lomow, G., and E. Newcomer, E. (2005) "Introduction to SOA with Web Services," in *Understanding SOA with Web Services*, New York: Addison Wiley Professionals, http://www.informit.com/articles/article.aspx?p=357691kr (current Mar 5, 2010).

[10] Glaser, J. P., Halvorson, G.C., Ford, M., Heffner, R., and J. A. Kastor (2007) "Too Far Ahead of the IT Curve?" *Harvard Business Review* 85(7/8), pp. 29-39.

[11]Shing-Han L., Shi-Ming H., Yen, D. C., and C. Cheng-Chun (2007) "Migrating Legacy Information Systems to Web Services Architecture," *Journal of Database Management* 18(4), pp. 1-25.

[12] Teti, F. (2006) "Develop a Service-Oriented Architecture Methodology," *Database Advisor Magazine*, http://websphereadvisor.com/doc/17991 (current Oct. 15, 2007).

[13] Marks, E. and M. Bell (2006) Service-Oriented Architecture: A Planning and Implementation Guide for Business and Technology. Hoboken: Wiley.

[14] Maurizio, A., Girolami, L., and P. Jones (2007) "EAI and SOA: Factors and Methods Influencing the Integration of Multiple ERP Systems (in an SAP environment) to comply with the Sarbanes-Oxley Act," *Journal of Enterprise Information Management* 20(1), pp. 14-31.

[15] Dennis, A., Wixom, B. and R. Roth (2009) *Systems Analysis and Design:4th edition*, New York: John Wiley and Sons.

[16] Debreceny, R., Felden, Ochocki, B. Maciej \ Piechocki, Michal Piechocki (2009) *XBRL for Interactive Data: Engineering the Information Value Chain*, Spring-Verlag Berlin Heidelberg.

[17] Debreceny, R. and G. Gray (2001). "The production and use of semantically rich accounting reports on the Internet: XML and XBRL International Journal of Accounting Information Systems 2(1), pp. 47-74.

[18] XBRL International sponsored the FFIEC project as a proof of concept for XBRL in SOA.

[19] Ren, M. and K. Lyytinen (2008) "Building Enterprise Architecture Agility and Sustenance with SOA," *Communications of the Association for Information Systems* 22(1), pp. 75-86.

[20] Papazoglou, M. P., and D. Georgakopoulos, D. (2003) "Service-Oriented Computing," *Communications of the ACM*, 46(10), pp. 24-49.

[21] Schulte, S., Repp, N., Berbner, R., Steinmetz, and R. Schaarschmidt (2007) "Service-Oriented Architecture Paradigm: Major Trend or Hype for the German Banking Industry?" *Proceedings of the 13th Americas Conference on Information Systems (AMCIS)*.

[22] Kwon, T. and R. Zmud (1987) "Unifying the Fragmented Models of Information Systems Implementation," in R.J. Boland and R. Hirschheim (Eds.), *Critical Issues in Information Systems Research*, New York: Wiley.

[23] Haines, M. (2007) "The Impact of Service-Oriented Application Development of Software Development Methodology," *Proceedings of the 40th Annual Hawaii International Conference on System Sciences (HICSS)*.

[24] Bell, M. (2008) *Service-Oriented Modeling: Service Analysis, Design, and Architecture*, New York: Wiley.

[25] Kokko, T., Anitkainen, J. and T. Systa (2009) "Adopting SOA – Experiences from Nine Finnish Organizations," Proceedings of the European Conference on Software Management and Reengineering, an IEEE Computer Society sponsored conference.

[26] Federal Financial Institutions Examinations Council (FFIEC) (2006). Improved Business Process Through XBRL: A Use Case for Business Reporting (archived FFIEC report).

[27] XBRL International (2007) "What is XBRL?" http://www.xbrl.org/WhatIsXBRL/ (current Mar. 5, 2010). Yin, R. K. (2003) *Case study research: design and methods*, 3rd ed. Newbury Park: Sage Publications.

[28] Benbasat, I., Goldstein, D. and M. Mead (1987) "The

Case Research Strategy in Studies of Information Systems," MIS Quarterly 11(3), pp. 369-386.

[29] Eisenhardt, K. (1989) "Building Theories from Case Study Research," *Academy of Management Review* 14(4) 532-550.

[30] Newcomer, E. and G. Lomow (2004) *Understanding SOA with Web Services (Independent Technology Guides*), Addison-Wesley Professional.

[31] Business Wire (2006) "Cartesis Signs Unique Partnership with EDGAR Online to Provide More Comprehensive Views of Financial and Operational Performance," http://findarticles.com/p/articles/mi_m0EIN/is_2006_April_24/ai_n16132357 (current Oct. 15, 2007).

[32] Boritz, J. and W. G. No (2005) "Security in XML-Based financial reporting services on the Internet," Journal of Accounting and Public Policy 24(1), pp. 11-35.

[33] Willis, M. and N. Hannon, N. (2005) "Combating Everyday Data Problems with XBRL," *Strategic Finance* 87(1), pp. 57-59.

[34] Kies, E. (2008) "XBRL's Path to Adoption," *AICPA*, http://www.cpa2biz.com/Content/media/PRODUCER_CONTENT/Newsletters/Articles_2008/CorpFin/Path_Adoption.jsp (current as of Apr. 3, 2008).

[35] Josuttis, N. (2007) SOA in Practice: The Art of Distributed System Design. O'Reilly Media, Sebastopol.

[36] Zimmerman, O., Krogdahl, P., and C. Gee (2004) "Elements of Service-Oriented Analysis and Design: An Interdisciplinary Modeling Approach for SOA Projects," http://www.ibm.com/developerworks/library/ws-soad1/index.html (current Mar. 5, 2010).

[37] Erl, T. (2007) *SOA: Principles of Service Design*, Prentice-Hall, Englewood Cliffs. Federal Financial Institutions Examinations Council (FFIEC) and XBRL International (2006). XBRL Case Studies: Showing XBRL in Use (archived case report provided by XBRL International).

[38] Krafzig, D., Banke, K., and D. Slama (2004) *Enterprise SOA: Service-Oriented Architecture Best Practices (The Coad Series)*, Prentice Hall PTR, Upper Saddle River, NJ.

[39] Strader, T. (2007) "XBRL Capabilities and Limitations," *The CPA Journal*

[40] Gray, G. and D. Miller (2009) "XBRL: Solving real-world problems," *International Journal of Disclosure and Governance* 6(3), pp. 207-223.

[41] Robey, D. Ross, J., and M.-C. Boudreau (2002) "Learning to Implement Enterprise Systems: An Exploratory Study of the Dialectics of Change," *Journal of Management Information Systems* 19(1), pp. 17-46.

[42] Abraham, C. and J. Kull (2008) *XBRL and Public Sector Financial Reporting*, Association of Government Accountants publication series, http://www.agacgfm.org/research/downloads/CPAGNo16.pdf (current Sep 2008)

[43] Sambamurthy, V.; Bharadwaj, Anandhi; Grover, Varun. Shaing Agility through Digital Options: Reconceptualizing the Role of Information Technology in Contemporary Firms. MIS Quarterly, Jun2003, Vol. 27 Issue 2, p237-263

[44] Nelson, Kay and Cooprider, Jay, "The Relationship of Software System Flexibility to Software System and Team Performance" (2001). ICIS 2001 Proceedings. Paper 4.

[45] Knorr, E. and O. Rist (2005) "10 steps to SOA," *InfoWorld*, http://www.infoworld.com/article/05/11/07/45FEsoaintro_1.html (current Oct. 15, 2007).

[46] Maurizio, A., Sager, J., Jones, P., Corbitt, G., Girolami, L., and J. Sager (2008) "Service Oriented Architecture: Challenges for Business and Academia," *Proceedings of the 41st Annual Hawaii International Conference on System Sciences (HICSS 2008)*, 315.

[47] Nerur, S., and V. Balijepally (2007) "Theoretical Reflections on Agile Development Methodologies," *Communications of the ACM* 50(3), pp. 79-83.

[48] Willis, M. and R. Eccles (2006) "What You Should Know About XBRL & EBRC," Presentation at the American Enterprise Institute on this topic titled: The SEC's Interactive Data Revolution: Improved Disclosure for Investors, Less Expensive Reporting for Companies, May 30 2006.