RHODES UNIVERSITY

A FRAMEWORK FOR SUCCESSFUL SOA ADOPTION IN SELECTED SOUTH AFRICAN UNIVERSITIES

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Abstract

The demand for systems integration has become more and more significant in higher education as institutions want systems that provide coherent information with data that is up to date and not redundant and can seamlessly support the end user experience. Institutions have become more reliant on information systems to support both administrative functions and those involved in teaching, learning and research, but because each department supports a diverse array of computing platforms and applications, it becomes very difficult to integrate these systems.

SOA is classified as an innovative approach to integrating existing systems involving the use of independent services that can be accessed without knowledge of the underlying platform implementation.

Unfortunately, the SOA initiative will not be success if it is not understood and used correctly by various applications and systems throughout the organisation. SOA introduces complexity and challenges in systems integration, acceptance, governance, data, development planning, security and external opportunities. If an organisation does not embrace or enable change in each of these areas, it is not ready for the adoption of SOA.

This research investigates the systems integration challenge in selected South African universities and explores factors for SOA adoption. The framework for the adoption of SOA comprises seven factors, of which Systems Integration is the most significant and represents an efficient starting point for institutions considering SOA adoption. Acceptance, Governance, Data, Development Planning, Security and External Opportunities are other factors of SOA adoption that require careful and thorough consideration before an institution can successfully adopt SOA.

The results of this research emphasise the importance of being able to embrace change and innovation and modify strategies in order to reflect the constant changes required for the adoption of SOA.

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To all the respondents who participated in this study, I feel honoured and privileged to have been able to discuss the intricacies of systems integration in your institutions. I enjoyed our discussions immensely and appreciated your interest and feedback.

Declaration

I acknowledge that all references are accurately recorded and that, unless otherwise stated, all work contained herein is my own.

Carmen Jacobs

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Chapter 1: Introduction

This chapter introduces the research. The context of the research is presented, as well as the statement of the problem. The results of the research are also presented, together with details of the organisation of the thesis.

1.1 Introduction

Traditionally, computers in organisations were used to automate certain business processes using applications that were developed using procedural languages like COBOL and C. Silo-to-silo batch transfers were used to allow these monolithic applications to communicate (Lam & Shankararaman, 2007, p. 256). Since applications are being more closely tied to business processes, the ability for them to respond more readily to changes in the organisation is becoming a necessity (Erl, 2007, p. 79).

Service-Oriented Architecture (SOA) is a new development approach to building IT systems, one that allows organisations to leverage existing systems and easily enable the inevitable changes required to support the organisation (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 7).

This chapter provides an introduction to the research study. The research context is first explored, followed by the goals of the research with questions that guide the study. The research methodology adopted is also briefly described, followed by a summary of results and finally the thesis organisation is outlined.

1.2 The Problem and its Setting

The systems integration challenge has emerged in higher education as institutions have become more reliant on information systems to support both administrative functions and those involved in teaching, learning and research (JISC, 2007, p. i).

It is becoming increasingly important that information in institutions is coherent and efficiently managed; the duplication of data is eradicated; and systems can 'seamlessly' support the end user (student or staff) experience (JISC, 2007, p. i). Overall, very little systematic assessment exists of how prevalent or successful certain approaches to integration are. In 2006, JISC commissioned a research study in the UK based on the issue of effective integration of ICT-based information systems. The study was called MUSIC (Measuring and Understanding the Systems Integration Challenge in Higher and Further Education) (JISC, 2007, p. i). The research group developed an instrument to measure the extent and nature of systems integration in higher education; discovered organisational factors that encourage or inhibit integration; and explored the attitudes of organisations to better integrating their systems using shared services, much like those enabled through SOA principles (JISC, 2007, p. v).

Service-orientation is conceived as a conceptual and technological innovation that encapsulates a number of design principles building on previous approaches as a means of avoiding problems associated with silo-based systems development (Erl, 2007, p. 84).

Lam & Shankararaman (2007, p. 260) suggest that SOA is concerned with building standard interfaces to access different business processes from a variety of backend systems through the use of services. These services are defined as a way of structuring work in which a service provider performs a function to assist the service consumer (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 19). In organisations, services encapsulate business processes making them easier to understand, manage and change (Schulte & Abrams, 2006, p. 2) .

The main benefit is that SOA reduces the effort and time needed to change systems to support changes in the business (Schulte & Abrams, 2006, p. 3). Organisations across the world are gradually embracing SOA, facing its challenges and taking advantage of its benefits (Malinverno, 2008b).

Following the market hype in favour of SOA, a growing amount of management and developer cynicism is evident. Organisations adopting SOA solutions are realizing that it is not easy to do well despite the promised benefits (Schulte & Abrams, 2006, p. 3). SOA introduces challenges in governance, testing, configuration, version control, metadata management, service-level monitoring, security and interoperability. SOA is not the cause of these problems, but with the adoption of SOA these problems become apparent (Schulte & Abrams, 2006, p. 3).

1.3 Goals of the Research

1.3.1 Problem

The purpose of this research is to explore the extent of systems integration in selected South African universities and to develop a framework of factors for successful SOA adoption in order to improve levels of integration.

1.3.2 Sub-Problems

The following research questions guide the research study:

- *What is the extent of systems integration in the selected South African institutions?*

  This research is driven by an exploration of systems integration through structured interviews with four selected universities in two South African provinces. It is important to understand how an institution's systems are currently integrated and whether or not that has an effect on their attitudes to further integration through SOA.

- *What critical success factors should be considered for the adoption of SOA in these institutions?*

  A framework will be developed through a critical review of the important considerations for SOA in order to expand on existing theory and to explore new theoretical concepts. The resulting framework will provide a set of successful SOA adoption factors for South African institutions aiming to improve systems integration through SOA.

1.4 Research Methodology

The methodology adopted in this research will be qualitative and follow an interpretive approach. Such qualitative research involves the extraction of data from interviews, questionnaires, documents and participant observations in order to understand and explain social phenomena (Myers, 1997, p. 242). The interpretive approach attempts to examine such phenomena by exploring and understanding the context of a situation as it emerges and how people assign meanings to it (Myers, 1997, p. 242). This research seeks a relativistic, shared and deeper understanding of the factors involved in the adoption of SOA.

1.4.1 Literature Review

- An analysis of the current systems integration problems evident in organisations and universities in particular.
- An analysis of the Service-Oriented Architecture (SOA) phenomenon, key concepts and associated technologies and keywords.
- An analysis of the impact of SOA on the organisation, its importance, benefits, challenges and requirements for successful SOA; including an exploration of how SOA is currently being adopted and implemented in some higher education institutions.

1.4.2 Preliminary Framework and Pilot Study

- An initial list of factors affecting SOA adoption is developed into a preliminary framework.
- Questions and key concepts are extracted from the preliminary framework and transformed into an open survey which will be used as a guide in semi-structured interviews with participants in four selected South African universities.
- A pilot study is conducted with a participant from one of the universities, who assists in the preliminary testing of the framework, which is refined and modified as necessary.

1.4.3 Empirical Work

- A theoretical framework is then developed based on previous literature as well as emerging issues identified in the pilot study.
- The survey instrument is then refined as needed and used in the collection of data through semi-structured interviews with participants in each of the four universities.

1.4.4 Findings and Analysis

- Once data collection in the field is complete, it is analysed in each of the cases and reports are written identifying the emerging categories of data.
- Adaptations are made to the theoretical framework which enables an exploration of factors required for the successful adoption of SOA.

1.5 Delimitations

While this study focuses specifically on universities, it is important to note that a number of large organisations are structured much the same as any university with a number of departments, each with a need to transfer data between their separate, unique and customised systems.

Due to the interpretive nature of this study and the length of time normally required to implement SOA, it is not possible to test integration before and after the adoption of SOA.

1.6 Summary of Results

The framework for the adoption of SOA comprises seven factors:

1. Systems Integration

Systems integration represents the most significant area that institutions should investigate before the other factors of SOA adoption can be considered. This involves an analysis of the extent of systems integration in terms of the core and supporting systems used at the institution; as well as an indication of the institution's attitude to systems integration. Provided an institution's systems integration efforts are concentrated on their core systems and the institution actively seeks to be innovative and adopt service-oriented principles, then it is well on its way to successfully adopting SOA.

2. Acceptance

Organisational wide acceptance, support and excellent communication between the business and IT units are also required before SOA can be considered.

3. Governance

Due to the fact that new technologies and innovations entail new risks and challenges, the institution needs to enable the constant change and refinement of the governance strategy to reflect the changes required for SOA.

4. Data

The quality, flexibility and trustworthiness of data in systems need to be reviewed when adopting SOA. If business rules are embedded within the code of systems, the departments that maintain these rules need to ensure that they can be efficiently recorded and tracked so that data integrity is preserved.

5. Development Planning

An institution's existing approach to new developments and their ability to embrace new technologies that challenge the status quo should be reviewed before considering SOA.

6. Security

An analysis of system security in terms of access control, application trustworthiness and audit tracking is required to ensure that access to data is a priority before considering SOA.

7. External Opportunities

Institutions that are open to the sharing of information between themselves and other institutions and organisations are more likely to be successful in their adoption of SOA.

These factors may be considered independently of one another, but it is important for the institution to take into account each of these before they consider the adoption of SOA to improve their integration approach.

1.7 Thesis Organisation

This thesis is organised into 12 chapters.

Chapter 1: Introduction

This chapter introduces the research. The context of the research is presented, as well as the statement of the problem. The results of the research are also presented, together with details of the organisation of the thesis.

Chapter 2: The Systems Integration Challenge

This chapter highlights issues of systems integration. The need for and importance of systems integration in the organisation are analysed. Data integration and aspects relating to the processing and delivery of data are also discussed. Various approaches, patterns and technical styles of systems integration are identified and compared.

Chapter 3: SOA Overview

This chapter investigates the evolution of SOA from traditional systems design approaches. In doing so, it recognises the importance of systems integration and how SOA allows systems to communicate through standardised services. A definition of SOA is provided; the impact of SOA on the organisation is explored, as is the importance for and benefits of a successfully implemented SOA approach. Finally, some examples of institutions making use of SOA are provided.

Chapter 4: Preliminary Framework

This chapter analyses how systems integration in an organisation or university environment is measured based on the MUSIC report (JISC, 2007). Factors relating to an organisation's readiness for SOA in order to promote its adoption are also identified. The chapter concludes with the development of a preliminary framework that identifies the key components for measuring systems integration and an organisation's readiness for SOA in order to determine the feasibility of SOA adoption to improve integration.

Chapter 5: Research Methodology

This chapter examines the research paradigm used in this study with a thorough investigation into why a qualitative interpretive approach is the most appropriate for the means of this study. This chapter highlights the research questions and the research method including the approach used; the unit of analysis; the research instrument; and the approach to analysing data. The chapter concludes with a summary of the research design in three phases.

Chapter 6: Exploratory Pilot Study

This chapter presents the details of an exploratory pilot study conducted through an interview with a systems expert at Institution #1. The extent of systems integration and the factors that affect SOA adoption at the institution are explored.

Chapter 7: Theoretical Framework

This chapter adjusts the preliminary framework based on the results from the exploratory pilot study and proposes a new theoretical framework that identifies the key components that affect the adoption of SOA in an organisation.

Chapter 8: Design of the Empirical Study

This chapter details the design of the empirical study. The empirical study is intended to further explore the theoretical framework proposed in the previous chapter. The design of the survey instrument is discussed in detail. A full copy of the survey is attached in Appendix A.

Chapter 9: Results of the Empirical Study

This chapter presents the results of the empirical study. The responses from the interviews with each institution are presented and discussed with respect to the level of integration in each institution; the respondents' attitudes to further integration; and an analysis of the factors that affect SOA adoption. A detailed copy of the interpretive results is attached in Appendix B.

Chapter 10: Analysis of the Results of the Empirical Study

This chapter analyses the results of the empirical study and discusses the impact that they have on the research and the theoretical framework. A comparative factor analysis is made of each of the factors of SOA adoption. A summary of the analysis is also provided.

Chapter 11: Revisions to the Theoretical Framework

The previous chapter provided a thorough analysis of the results of the empirical study and their impact on systems integration and the factors of SOA adoption. Based on the results and analysis, this chapter details the revisions to the theoretical framework proposed in Chapter 7.

Chapter 12: Conclusion

This chapter concludes the research. It discusses the contributions and limitations of the thesis and presents possible further research areas.

Chapter 2: The Systems Integration Challenge

This chapter highlights issues of systems integration. The need for and importance of systems integration in the organisation are analysed. Data integration and aspects relating to the processing and delivery of data are also discussed. Various approaches, patterns and technical styles of systems integration are identified and compared.

2.1 Introduction

Traditionally, data is tightly connected to applications for specific business processes. This data may be monitored and entrusted to a single business entity. However, confusion and quality problems arise when this data is spread across separate business entities (Kaufman, 2006, p. 2). The demand for information systems integration comes from a number of sources. Institutional management needs coherent information from its systems with data that is up to date and not redundant. Organisations need systems that can seamlessly support the end user experience. System developers and architects need to develop ways to eradicate duplication or the expensive re-keying of data (JISC, 2007, p. i).

This chapter describes the systems integration challenge as well as other problems associated with inefficient integration among disparate systems. The importance of integration is discussed as is the relevance of data integration. Various approaches and patterns to integration are identified with a focus on the move to SOA. Finally, the integration approaches are compared and it is concluded that systems integration is an important consideration that needs to be understood as it enables the evolution of a variety of integration approaches, with an emphasis on SOA as an emerging systems integration methodology.

2.2 The Need for Integration

Organisations are composed of numerous applications that are custom built, acquired from a third party, part of a legacy system, or a combination thereof, operating in multiple tiers on different operating system platforms. Creating a single, big application to run a complete organisation is next to impossible, not to mention a very archaic way of developing systems (Hohpe, Brown, & Woolf, 2005, p. 1).

Most systems operate independently – each with its own version of data to meet certain processing needs. As the number of applications grows, a complex network of point-to-point interfaces emerges, creating silos of redundant and inconsistent data, with multiple, conflicting, versions of business entities (Newman & Friedman, 2005, p. 2). Inconsistent versions of the same data are consequently spread across the organisation (Thompson & Schulte, 2008, p. 2).

When organisations merge or acquire new products and processes, their IT departments have to determine which interface or application must change to accommodate the changes in business (Newman & Friedman, 2005, p. 2). These siloed systems and applications compromise the agility, performance and profitability of such organsiations. IT departments are constantly behind schedule and over budget in hand-coding point-to-point connectivity among packaged and custom-built legacy applications (Chong & Kulkarni, 2006).

Universities, for example, traditionally operate as highly decentralised institutions, with faculty and business units allowed considerable autonomy in choosing their computing systems, business rules and operating practices (Eduventures, 2006, p. 3). In such an environment, IT departments find themselves supporting a diverse array of computing platforms and applications, each with its own programming language, tools and training requirements. Many of these institutions are left with aging legacy systems that are hard to integrate because each individual department is allowed to order machines and applications on an ad hoc basis, with little centralised control. Today, these legacy systems pose serious obstacles to seamless cross-application computing, easy-to-navigate interfaces and real-time access to data that is up-to-date and not redundant (Eduventures, 2006, p. 3).

Adding to this complexity is the growth of outsourced application support and the increasing use of external reference data. As a result, maintenance, trouble shooting, transparency and auditing are costly and time-consuming in this type of environment (Newman & Friedman, 2005, p. 2).

Institution and organisation alike, find themselves devoting significant time and money to managing multiple interfaces and communication protocols, solely for the purpose of making sure their systems can talk to one another. Meanwhile, users, management and administrators are frustrated. Users spend too much time navigating multiple logins and unfamiliar applications trying to find the information they need (Eduventures, 2006, p. 3).

In a recent Gartner survey, users reported that they spend five hours per week searching for information (Bell, 2008, p. 2). Too often, they find that data is inaccurate, inconsistent with information from other databases, or too old to meet current requirements. Such systems are classified as "data rich, but information poor" (Eduventures, 2006, p. 3).

Despite large investments in ERP/CRM platforms and applications, organisations are failing to address these fundamental data challenges. This failure is negatively impacting a company's ability to reduce cost, increase market share and improve customer service (Reuters, 2009).

2.3 The Importance of Integration

In order to support common business processes and data sharing across applications, these applications need to be integrated in some way (Hohpe, Brown, & Woolf, 2005, p. 2).

Application integration is defined as "giving applications that were designed independently the ability to interoperate" (Thompson, et al., 2008, p. 4). Spreading business functions across multiple applications provides the organisation with the flexibility to select the best software for each function as needed (Hohpe, Brown, & Woolf, 2005, p. 2).

This integration of an organisation's systems will help them unlock the value of their unstructured data (Bell, 2008, p. 1). Such integration needs to provide efficient, reliable, and secure data exchange between multiple applications (Hohpe, Brown, & Woolf, 2005, p. 2).

Integrating applications helps better align IT with the business. It also helps various parts of the organisation work together better, enabling important business strategies, such as real-time demands, straight-through processing, improved customer service, business activity monitoring, reduced data latency and improved data quality. Most business strategies leverage IT and the integration of IT across disparate application systems and business units (Thompson, 2009, p. 2).

Integration benefits many levels in an organisation. It is used to increase the business value of IT assets and reduce IT costs. According to Gartner (in Thompson, 2009, p. 4), early integration efforts can result in savings of development costs of up to $2.7 million. Consequently, companies continue to enjoy a significant return on investment when using various approaches to integration for medium to large projects (Thompson, 2009, p. 4).

An integration platform should be comprehensive, open, unified and an economical solution for discovering, accessing and delivering complete, trustworthy data. It should support all the steps in the data integration lifecycle, enabling customers to holistically manage and govern data to run more efficient, agile organisations. Such integration would make it easy to reduce costs and improve customer service (Reuters, 2009).

The responsibility for systems integration is almost completely regarded as a matter for the IT department to control. However, wider stakeholder engagement is also recommended including the appointment of representatives of the organisation to manage the integration effort (JISC, 2007, p. 20). The importance of system integration depends in part on the degree of senior management commitment to system integration, as well as the size of the company and their information needs (Mackay & Rosier, 1996, p. 77).

Many organisations indicate that systems integration is considered within their wider IT initiatives as a significant element of specific project plans. According to JISC (2007, p. iii), a number of key drivers affect the adoption of an integration strategy.

2.3.1 Key Drivers for Integration

- More accurate, timely and consistent management information
- Minimising inefficient duplication of effort
- Enhancing the end user (customer and employee) experience
- Generating new information to support business development activity

Most organisations find themselves in a transition between integration strategies as they discover it is an ongoing effort concerning multiple applications and data stores which constantly change with the dynamic nature of changing business processes. Many integration strategies are thus deadlocked between business and technical issues and many legacy applications are consequently prevented from being integrated. Such barriers to further integration are listed below.

2.3.2 Barriers to Further Integration

- Resource issues, including the costs of staff and services (JISC, 2007, p. iv)
- Lack of necessary skills in-house (JISC, 2007, p. iv)
- Resistance from departments determined to maintain their own data (JISC, 2007, p. iv)

- Lack of representation of the integration issue at a senior management level (JISC, 2007, p. iv)
- Lack of appreciation of the multiple uses to which data is put (JISC, 2007, p. iv)
- Lack of communication between systems, business and it departments since integration implies that each application is part of an overall flow of applications and services (Hohpe, Brown, & Woolf, 2005, p. 3).
- Lack of maintaining integrated solution for critical business functions (Hohpe, Brown, & Woolf, 2005, p. 3).
- Limited control in effectively integrating certain legacy systems and applications for technical or political reasons (Hohpe, Brown, & Woolf, 2005, p. 3).
- Shortage of standards with extensions or interpretations of how to deal with integration in an organisation's IT systems (Hohpe, Brown, & Woolf, 2005, p. 3).

In light of the various barriers for integration, it is evident that organisations adopting an integration strategy appear to have a very limited understanding of the right way to integrate their systems. JISC (2007, p. iv) highlights the risks of integrating systems that need to be taken into account.

2.3.3 Risks Involved in Integration

- Tight integration could lead to the propagation of errors
- Successful integration could render the effort to provide that integration invisible and therefore under-appreciated by end users
- Talk of integration could raise end user expectations leading to disappointment
- User engagement and ownership do not automatically follow from systems integration
- The failure of vendors to sustain their enthusiasm for integration projects could leave the organisation with half completed projects or large bills to complete projects
- Problems of scope creep and scope control on integration projects

(JISC, 2007, p. iv)

If integration needs were always the same, there would be only one integration style. However, like any technological effort, integration involves a range of considerations and consequences that should be noted.

2.3.4 Considerations for Successful Integration

Application coupling

Integrated applications should minimise their dependencies on each other so that each can evolve without causing problems to others. Interfaces for integrating applications should be specific enough to implement useful functionality but general enough to allow the implementation to change as necessary. This guideline highlights the adoption of a loose coupling principle (Hohpe, Brown, & Woolf, 2005, p. 39).

Intrusiveness

Changes to the application and integration code should be minimised when integrating applications to have the least impact on the application (Hohpe, Brown, & Woolf, 2005, p. 40).

Technology selection

Different integration techniques and tools are available to help with the integration process but organisations should be aware of cost and possible vendor lock-in (Hohpe, Brown, & Woolf, 2005, p. 40).

Data format

The format of data exchanged between applications should be agreed on. Unifying the format of existing applications may be difficult so translators and data adaptors are available for those applications insistent on different data formats (Hohpe, Brown, & Woolf, 2005, p. 40).

Data timeliness

Data should be exchanged frequently and in small amounts to limit the length of time between applications needing to share data simultaneously (Hohpe, Brown, & Woolf, 2005, p. 40).

Data functionality

Applications should be able to share data as well as functionality to provide better abstraction between different applications (Hohpe, Brown, & Woolf, 2005, p. 40).

Remote communication

Asynchronous processing should be used where a business process may invoke sub-procedures while continuing with its own processing simultaneously. The process needs to be reliable so that access to remote applications is always secure and available (Hohpe, Brown, & Woolf, 2005, p. 41).

As seen, data plays an important role in the successful integration of an organisation's systems. Data needs to be consistent, non-redundant, loosely-coupled, delivered in real-time, in the correct format, connecting multiple disparate applications and still provide information that meets the constantly changing demands of the organisation and the users of its systems. The growing complexity in the way in which business services and applications are deployed and integrated implies a pervasive need for data integration (Thoo, 2008, p. 2).

2.4 Data Integration

Pancha (in Reuters, 2009) describes data as "the lifeblood of any organisation engaged in satisfying customers, building market share, collaborating successfully with partners and running an agile, streamlined business."

The access, aggregation and synchronization of data between multiple and independent data stores are contained within the concept of data integration (Bell, 2008, p. 6).

The discipline of data integration comprises the practices, architectural techniques and tools for achieving the consistent access and delivery of data across all data subject areas and structure types to meet the data consumption requirements of all applications and business processes in an organisation (Thoo, 2008, p. 8).

Examples of data integration, according to Friedman (2006, p. 2) are the:

- Extracting, transforming and loading (ETL) of data from operational sources to a data warehouse, data mart or other structure
- Replication of data between two or more databases
- Access by one application to data stored within the database of another application
- Creation of integrated views of data from disparate databases

In a Gartner study, 60% of organisations expect an increase in data integration investments, the majority of which reside in the financial services, energy and telecommunications industries (Friedman, 2006, p. 3). Contemporary pressures are leading to this increase, making data integration a critical component of an overall enterprise information management strategy and putting it at the core of an information-centric infrastructure (Thoo, 2008, p. 8).

Gartner (in Friedman, 2006) identifies specific business drivers for the adoption of a data integration strategy.

2.4.1 Drivers for Data Integration

- The demand for data integration has often been driven by the need to organise data for Business Intelligence (BI), analytics and system migrations (Friedman, 2006, p. 3).
- Data integration is being increasingly applied to issues with cost reduction, master data management and regulatory compliance (Friedman, 2006, p. 3).
- Since organisations require rapid response and reduced cycle times, latency times are being restricted to within an hour for core processes and applications. Low-latency data delivery enables organisations to achieve better integration, leading to a closed-loop continuous flow of information (Friedman, 2006, p. 4).
- Data integration is often implemented in response to competitors implementing data quality programs (Friedman, 2006, p. 4).
- It is also implemented in response to a major business failure due to not addressing fundamental issues of consistent information, delivery and quality improvement of data (Friedman, 2006, p. 4).

Data integration with prebuilt connectivity and a visual mapping environment allows architects and developers to access information from a variety of sources, including packaged and home-grown applications like SAP, mainframe systems such as IMS and VSAM, relational databases such as Oracle and Sybase and unstructured and semi-structured data (Chong & Kulkarni, 2006). DataBase Management System (DBMS) vendors are currently the most common source from which organisations purchase data integration technology, followed by generic business application vendors like SAP and also BI tool vendors (Friedman, 2006, p. 6).

When considering the implementation of SOA in an organisation, data integration is often overlooked (Friedman, 2006, p. 7). Only a third of organisations worldwide consider data integration as a significant component of their SOA initiatives (Beyer, 2007, p. 5). The skills and technologies required to support a robust data integration infrastructure are, however, vital to success with BI, master data management, compliance initiatives and the move toward SOA (Friedman, 2006, p. 7).

Organisations can use data integration to reach into multiple systems to fetch data, cleanse and transform it into the appropriate formats and semantic definitions and propagate it across multiple distributed systems (Chong & Kulkarni, 2006).

At the core of data integration is an engine that provides organisations a host of options for moving, integrating and delivering data among various applications. Its flexibility is important in letting IT professionals architect a system optimised for high-volume batch transfers, near-real time data capture, movement and delivery (Chong & Kulkarni, 2006).

2.4.2 Data Integration Principles

Data integration also offers functionality to help an organisation against future rising data volumes, meeting the requirements for reduced data latency and demands for improved security and privacy (Chong & Kulkarni, 2006). Data profiling, cleansing, transformation, movement and auditing are some of the principles within the data integration framework that help an organisation's integration efforts meet its full success potential.

- Data profiling: the process of assessing and understanding the content, quality, and structure of enterprise data.

- Data cleansing: the process of ensuring the validity and consistency of information.
- Data transformation: the services that enable data to be transformed from one form to another to allow reconciliation between data elements from different information sources.
- Data movement: the mechanisms for high-volume bulk data movement, near-real time capabilities, data federation to accelerate load times and minimise operational impact.
- Data auditing: the in-depth lineage of when data was changed, how, by whom, and across which applications to enable auditing, reporting and analysis essential to meeting the demands of regulations and internal or external auditors.

  (Chong & Kulkarni, 2006)

A unified data integration platform will improve data quality, deliver data at any required speed and protect an organisation against future data latency, data quality and data volume demands.

Realising that effective business decisions hinge on reliable, accurate and timely data, companies are rethinking their approaches to data integration. The uncertain economy, globalisation, mergers and acquisitions and increasing compliance demands are driving companies to be more agile for the SOA, BPM, CRM, ERP, multi-enterprise data exchange and other projects that support them. Conventional approaches to data integration are rarely able to provide the data quality levels and varying data latencies required by today's business dynamics (Reuters, 2009).

2.5 Integration Approaches and Methodologies

The challenge of systems integration has made organisations become more reliant on computer-based information systems to support their core business functions. Such systems have proliferated, often initially replacing paper or ad hoc email-based practices but this proliferation has not been efficiently managed and coordinated. On the contrary, most institutions have combined a set of systems, often with little consideration of purchasing or development decisions and have then been confronted by a range of pressures to integrate them (JISC, 2007, p. 3).

Different departments within an organisation use different integration methods for different purposes. All of these departments share an interest in deriving more value out of their existing systems. The main barrier to such projects is that business leaders do not understand the potential locked up in poorly integrated systems (Bell, 2008, p. 5).

Organisations need to integrate data and content of all types from various sources. These include structured data and content both internal and external to the organisation (Bell, 2008, p. 2).

A few years ago, very little systematic assessment existed of how prevalent or successful certain approaches to integration were. As a result organisations did not have the information to benchmark or position themselves within their competitive industries and they lacked the materials to help them to weigh up the costs and benefits of particular courses of action (JISC, 2007, p. i).

A fundamental shift has occurred in organisations' approaches to integration. Integration is now recognised as a driving force in planning for application development and deployment. This does not mean that integration is easy. However, increasingly mature integration adapters, translation mapping tools, packaged integrating processes and the emerging SOA methodology have made integration easier than it was several years ago (Thompson, 2009, p. 2).

Each integration approach has its advantages and disadvantages. Applications may even integrate their systems using multiple styles, taking advantage of the style that suits each situation best. Many organisations thus use a hybrid of multiple integration styles (Hohpe, Brown, & Woolf, 2005, p. 42).

2.5.1 Approaches to Integration

According to JISC (2007, pp. iii-iv), five approaches to integration are identified as the most common means by which an organisation can choose to integrate its systems.

Integrated In-House (JISC, 2007, p. iii)

These organisations have a DIY approach to systems and therefore to integration. This is beneficial in supporting rapid change and adaptation. However, this option is quickly becoming unsustainable as the costs and complexities of systems increase.

External Systems from a Limited Number of Vendors (JISC, 2007, p. iii)

This approach is akin to a classic ERP approach, consisting of the use of prepackaged solutions to meet the integration needs of many common business functions. Organisations try to minimise the number of vendors used in order to control any possible integration issues. The disadvantage of this approach is that organisations may be subject to vendor lock-in, in which case it is not usually easy to transfer to another vendor's solution.

Best of Breed with Ad Hoc Integration (JISC, 2007, p. iv)

In this approach each system is selected on the basis of its specific functionality and subsequent integration is handled in an essentially ad hoc manner through a mixture of bilateral periodic data dumps and live data adaptors which allow the unified translation of different data formats between different systems and applications which can then communicate with one another.

Best of Breed with Central Coordination (JISC, 2007, p. iv)

In this approach some form of central co-ordination, often referred to as a Single Point Of Truth, a central hub or central bus, mediates between systems when they share data. Here data is often located in a shared database or data warehouse which is consequently connected to all relevant applications.

Service Oriented Architecture (SOA). (JISC, 2007, p. iv)

This approach (which will be discussed in detail in Chapter 3) involves resources on a network which are made available as independent services that can be accessed without knowledge of the underlying platform implementation. This emerging methodology is generally noted as an aspiration or destination rather than a currently existing strategy in many organisations.

Organisations generally describe their integration approach as some form of 'Best of Breed' or ad-hoc approach. Often organisations use a combination of styles to suit their particular integration needs (JISC, 2007, p. 22).

Following the various approaches to integration, Gartner (in Thompson & Schulte, 2008), define the three patterns of integration with respect to the data, processes and applications being integrated.

2.5.2 Patterns of Integration

The three fundamental objectives driving systems integration are making data consistent across applications; getting applications to support multistep business processes; and using developed application logic and data interactively to support a new application (Thompson & Schulte, 2008, p. 1). The patterns of integration are known as the fundamental building blocks of all application architecture and either one or a combination of all three should be followed to ensure each application is as efficiently integrated as it can be.

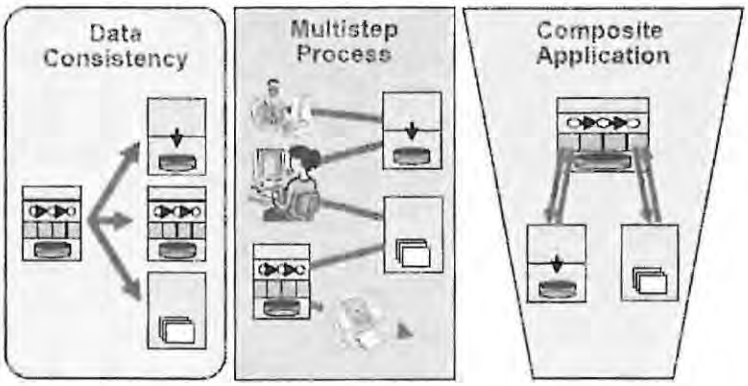


Figure 2.1: Integration Patterns (Thompson & Schulte, 2008, p. 2)

Data Consistency

The objective of data consistency integration is to make data across all applications consistent (Thompson, et al., 2008, p. 4).

Data consistency is about keeping multiple, diverse data stores with overlapping information models in a consistent state. It is usually based on exchanging data (in batch transfers or in near real time) between applications so they can synchronize the data store they handle.

Generally, human intervention is not required in data consistency scenarios, other than for management or exception-handling purposes (Pezzini, 2008, p. 7).

The most common method of ensuring data consistency is for the application that captures the new information to create a batch file and transfer the updates to the target application periodically. The update to the target application is usually performed independently of the update to the source application where the change originally was captured. Therefore, it is apparent that updates to the source and target application are asynchronous (Thompson & Schulte, 2008, p. 2).

If applications share the same database, the data consistency problem is alleviated. If applications are distributed with multiple copies of data, data consistency is a problem.

Updates received by one application must be propagated among disparate databases using batch file transfers. However, if data models and semantics are compatible, less transformation is needed. It becomes an issue when applications and databases are built on considerably different platforms.

Multistep Process

The objective of multistep process integration is about automating the flow of long-lasting business processes (Pezzini, 2008, p. 8).

This pattern of integration entails orchestrating the execution of the activities of a business process, regardless of whether those activities are performed by software, humans or even intelligent devices, in a manner that automates the flow of execution through instances of that business process (Thompson, et al., 2008, p. 4).

The steps in a business process are typically real-time, atomic transactions exposed by autonomous, "stand-alone" applications or activities carried out manually (Pezzini, 2008, p. 8).

Traditional multistep processes rely on a person to manually re-enter the data between each step. Modern multistep processes are fully automated from end to end, reducing not only elapsed time and data entry costs, but also data entry errors. In principle, these processes can use batch file transfer, but new business strategies demand immediate transfers of individual transactions. These generally use messages to communicate between disparate applications or by posting transactions to a database (Thompson & Schulte, 2008, p. 3).

Like data consistency integration, multistep processes are asynchronous, using one-way interactions among the participating applications. However, the success of the overall process requires that the final step runs successfully. This is in contrast with a data consistency situation, where a source application may accomplish its complete process regardless of whether or not other target applications receive and apply the updates (Thompson & Schulte, 2008, p. 3).

If a business process is implemented using two-way interactions, where the first application waits for a response from a second application before it can complete its process, then it is a composite application (Thompson & Schulte, 2008, p. 3)

Composite Application

The objective of composite application integration is to implement a set of independent but related functions where the component parts are heterogeneous in their information architecture (Thompson & Schulte, 2008, p. 6).

Composite application integration is growing rapidly as organisations seek to leverage existing assets (including the services created using SOA) and to minimise the amount of new code that must be developed and maintained (Thompson, et al., 2008, p. 4).

Composite applications represent the most closely knit and hardest-to-implement integration pattern. A composite application appears to the user as one application, but its business logic essentially connects its components to multiple applications. Disparate components are partially or fully synchronous. A client component sends a message to one or more server components, which perform some work and return a response to the client (Thompson & Schulte, 2008, p. 4).

A composite application is not obtained by merging the source code of the component parts into a single, executable program. The component parts still run independently and communicate with each other in various ways to perform the required business function. As a result, minimal architectural coherence and consistency in the presentation layer is agreed on and disparate applications still maintain their individual information architectures (Pezzini, 2008, p. 2).

Contrast between Patterns

Each of the above-mentioned patterns of integration is compared in the following table:

Table 2.1: Integration Pattern Comparisons (Thompson & Schulte, 2008, pp. 4-5)

Style	Latency	Prevailing Interaction Style	Flow Management	Application Dependencies
Data Consistency	Scheduled to immediate	Asynchronous, one way	Generally, simple scheduled batch jobs or immediate messaging	Applications remain logically and physically independent
Multistep Process	Scheduled to immediate	Asynchronous, one way	More-complex batch job streams; long sequences of multiple hand-offs or sophisticated orchestration using BPM technologies	Applications remain physically independent but are logically dependent from the perspective of completing the process
Composite Application	Immediate	Two-way synchronous and partially synchronous	Complex interactions may be controlled by application code or using BPM technologies or other tools	Applications are logically and physically highly dependent

The goal of the data consistency pattern is to make redundant data that is stored in multiple systems consistent. In the multistep process pattern, activities are orchestrated in a way that automates the flow of execution of parts of a business process. The composite application pattern is the most closely knit. This type of application appears to end users as one application; however, it uses data from one or more applications. These applications may be hosted in heterogeneous environments on different operating systems and platforms. Complex IT projects often employ all three patterns to meet different systems integration requirements (Thompson & Schulte, 2008, p. 2).

The Future of these Patterns

During the past five years, composite application projects have become more widely adopted because of the availability of better development tools and the maturation of middleware technology making it easier to integrate new applications with legacy systems.

Composite applications are being endorsed by mainstream organisations as they move toward SOA, favouring the rapid creation of new applications by aggregating existing applications exposed through well-defined services (Pezzini, et al., 2007, p. 5).

Gartner (in Sholler, 2008a, p. 6) predicts that the three classic patterns of integration will merge. The technology associated with each pattern and the patterns themselves will change.

Data consistency is evolving from high latency batch synchronization to modern master data management, which shares the characteristics of a multistep process. As multistep processes expand to encompass more applications, they take on more and more characteristics of a composite application. In turn, composite applications often demand extensive data synchronization to operate effectively. In each case, the three patterns of integration need to be executed in combination. The goal is to get to a compatible set of application infrastructures that give the flexibility to choose which style to use when and which mechanism to use to implement that style (Sholler, 2008a, p. 6).

2.5.3 Technical Integration Styles

The sections above have discussed approaches to integration in terms of how organisations choose to holistically integrate their systems, as well as patterns for integrating the data, processes and applications of a system. These approaches and patterns all use underlying technical styles for integrating systems.

Manual Re-Keying of Data

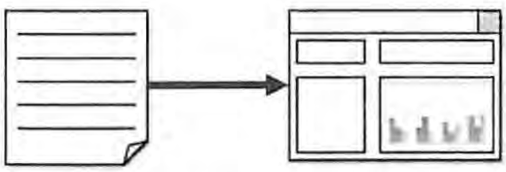


Figure 2.2: Representation of Manual Re-Keying of Data

The paper-based manual entry of data is the most traditional means by which organisations have chosen to solve integration issues (JISC, 2007, p. 11). While this style is very rarely used in systems today, it is still an option for those systems that do not require extensive integration capabilities.

Data Dumps/Batch Transfers

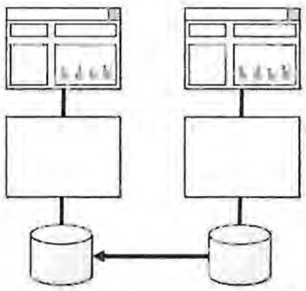


Figure 2.3: Representation of Data Dumps (Hohpe, Brown, & Woolf, 2005, p. 7)

Batch file transfers are used to dump information from one application's database into another application's database (Hohpe, Brown, & Woolf, 2005, p. 43).

This style is recommended when a common transfer mechanism with minimal software is required utilising existing systems independent of operating system, platform or language. It involves the integration of applications and the sharing of data using files.

Each application does not require knowledge of the internal workings of another application and as such, the applications are loosely coupled.

However, high resource costs are involved when producing batch files with more information than may be necessary. In addition, data formatting is not enforced so the data between different applications may not be compatible - Mainframe systems use COBOL, UNIX systems use text-based files and most current systems tend to use XML data formats (Hohpe, Brown, & Woolf, 2005, p. 43).

Data may also become old or redundant if files are only transferred periodically. Unless an organisation addresses its variable data latency needs, business agility is at risk. The accelerating pace of business is driving companies to move as close to real time modes as possible (Reuters, 2009). When the latest information about a given business entity is not updated in all dependent systems, a loss of business opportunity, decreased customer satisfaction and increasing problems are evident (Lam & Shankararaman, 2007, p. 257).

It is necessary to change this style of integration when data needs to be made available more quickly with agreed data formats or when application functionality rather than their data need to be integrated (Hohpe, Brown, & Woolf, 2005, p. 43).

Data Warehousing

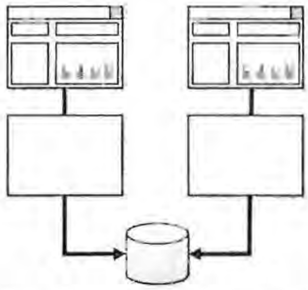


Figure 2.4: Representation of Data Warehousing (Hohpe, Brown, & Woolf, 2005, p. 7)

Through data warehousing, applications have access to a single database or a collection of data marts to extract information when needed (Hohpe, Brown, & Woolf, 2005, p. 7).

This integration style is recommended when information is required to be shared rapidly and consistently through multiple applications built independently on different platforms. It involves the widespread use of SQL-based relational databases and the sharing of data between multiple applications (Hohpe, Brown, & Woolf, 2005, p. 47).

File formats are no longer an issue with this style as all development platforms can work with SQL-based databases and since all applications use the same database, redundant, duplicated data can be eliminated (Hohpe, Brown, & Woolf, 2005, p. 47).

Organisations use data warehousing for discerning which information is valuable, tagging it, managing it and discarding the rest. They can streamline and modernise their systems by identifying redundant information and eliminating applications retained to handle it (Bell, 2008, p. 3). This style of integration can potentially control costs, improve quality, make information more available and provide a single view of core business data. Data warehousing generally helps organisations convert content into XML, consolidate it into a database - using extraction, transformation and loading (ETL) tools - parse it and derive meaning from the metadata (Bell, 2008, p. 3). This allows the synchronisation of data from various data stores in one accessible place for analysis (Chong & Kulkarni, 2006).

However, if simultaneous updates are made to a single piece of data from different sources, performance deadlocks could occur as multiple applications try access the same data (Hohpe, Brown, & Woolf, 2005, p. 7). All data is essentially coupled to a single database so this style fails to handle collaborative behaviour between disparate applications.

In addition, designing a unified schema for the data marts, meeting the needs of all applications is difficult and software vendors tend to have their own schemas which differ between applications and vendors (Hohpe, Brown, & Woolf, 2005, p. 47).

It is necessary to change this style of integration when application functionality rather than their data need to be integrated or data need to be exchanged in real-time in small amounts to invoke remote functionality.

Portals

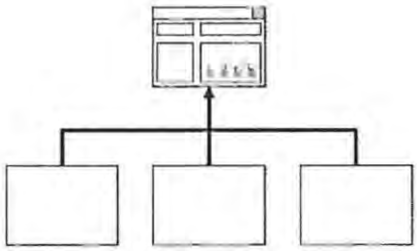


Figure 2.5: Representation of Portals (Hohpe, Brown, & Woolf, 2005, p. 6)

Portals aggregate information from multiple sources into a single display to avoid having the user access multiple systems for information. The screen is divided into multiple zones, each of which displays information from a different system (Hohpe, Brown, & Woolf, 2005, p. 6).

This integration style is recommended when application functionality needs to be integrated with encapsulated data. It involves invoking a function in another application, passing shared data, processing it and aggregating it on a single display. This method is also often referred to as Remote Method Invocation (RMI). Examples of this style is found in CORBA, COM, .NET Remoting and Java RMI, as well as in Web services using SOAP and XML standards (Hohpe, Brown, & Woolf, 2005, p. 50).

Through portals, each application maintains the integrity of the data it owns and can alter its internal data format without affecting other applications. An addition, through aggregation, multiple interfaces to the same data are allowed.

However, applications utilising this style of integration are generally tightly coupled as each application is dependent on the connection it has to another. It is thus an unreliable solution for application execution or development. Remote calls between applications are also slower and more likely to fail. The failure of a single application may cause a domino effect on all other applications it is connected to. While each application maintains the integrity of the data it owns, it also knows the details of every other application which is not recommended for successful systems development (Hohpe, Brown, & Woolf, 2005, p. 50).

Portals could deliver huge business value in areas such as customer self-service in retail banking or travel. Currently, the complexities of the conversion, availability, viewing, aggregation and analysis of content keep many organisations from engaging the entire spectrum of information via a portal. Few best practices have been established, but customer engagement via portals, rich Internet applications, new browser and mobile technology requires content to be better integrated with data for improved end-user capabilities (Bell, 2008, p. 4).

It is thus necessary to change this style of integration when small amounts of data need to be frequently exchanged or the integration of applications and systems needs to provide a more robust and reliable solution (Hohpe, Brown, & Woolf, 2005, p. 50).

Messaging

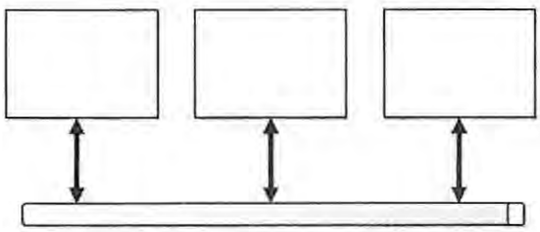


Figure 2.6: Representation of Messaging (Hohpe, Brown, & Woolf, 2005, p. 53)

Messaging involves the process of sending small messages or packets of data between applications frequently, immediately, reliably and asynchronously.

It involves the sharing of processes and is recommended when data and processes need to be shared responsively (Hohpe, Brown, & Woolf, 2005, p. 53).

Messaging protocols are built on top of transport protocols and offer better features and flexibility. When applications need to communicate, they would use a common messaging protocol (Lam & Shankararaman, 2007, p. 258). The transfer of data can be done quickly and efficiently and since data transfer is asynchronous, the functionality between applications is not prone to failure. The internal concerns for storing data are also hidden from applications which are thus loosely coupled, allowing developers to easily change the storage schema if necessary (Hohpe, Brown, & Woolf, 2005, p. 53).

Problems occur with this integration style when either application is built on different platforms and cannot communicate. In this case, the applications could be adjusted to communicate in a standard language or using a bidirectional translator (or data adaptor) as a standard communication protocol (Lam & Shankararaman, 2007, p. 258).

However, messaging does not solve all problems with integration. Inconsistency problems are not entirely removed and some latency may be experienced with systems that are not being updated in real-time (Hohpe, Brown, & Woolf, 2005, p. 53). A data transformation and formatting issue is also a problem because each application can only accept data in a certain format and data transformations between applications have to be carefully managed to ensure the correct data is being transferred (Lam & Shankararaman, 2007, p. 259).

The asynchronous design of this integration style is not often used in development which places a steep learning curve on organisations adopting this method. In addition, the independence of each application may require more integrating code between them to ensure each can communicate in the most optimal way (Hohpe, Brown, & Woolf, 2005, p. 53).

Pre-Packaged Suites

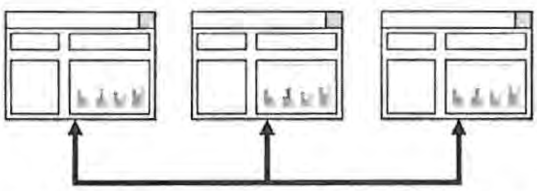


Figure 2.7: Representation of Pre-Packaged Suites

Integrated suites of application infrastructure components offer the required end-to-end set of functionalities of user interface management, composition and orchestration, integration and adapters, interoperability and messaging protocols, container technology and development tools (Pezzini, et al., 2007, p. 4).

Organisations generally purchase key components from a single vendor offering an integrated suite of application infrastructure products. In this way, organisations reduce the time and costs associated with selecting the necessary components and look for a simpler way to manage and maintain infrastructure than a collection of best-of-breed products.

The strategic application infrastructure suite will be used to support multiple projects with different technical and business requirements. Hence, a functionally rich and broad suite is required to support such a potentially wide variety of scenarios (Pezzini, et al., 2007, p. 4).

However, many of these projects have stringent time-to-deployment requirements, are budget constrained and must support only a well-defined and relatively narrow set of technical requirements. Such a suite suggests exhaustive costs and complexities and return on investment is almost impossible to justify – whether it supports individual projects or larger, long-term processing needs (Pezzini, et al., 2007, p. 4).

Faced with the afore-mentioned complexity issues and driven by demands for improving agility in response to rapidly changing business opportunities or threats, many IT organisations are looking at SOA as the answer (Newman & Friedman, 2005, p. 2).

SOA

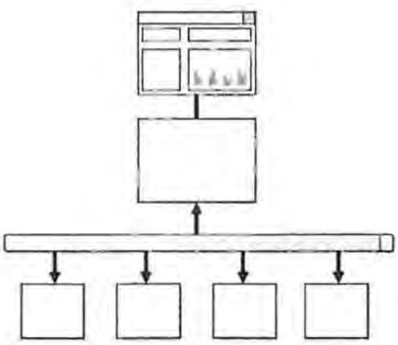


Figure 2.8: Representation of SOA (Hohpe, Brown, & Woolf, 2005, p. 8)

SOA involves integrating critical business processes and applications by engineering a loosely coupled infrastructure, with reusable services based on XML and standard Web services protocols such as SOAP and WSDL (Chong & Kulkarni, 2006).

This emerging integration style is recommended when an organisation requires an approach that enables IT to leverage legacy environments (application systems, business intelligence systems and content management systems) and new application systems through the use of services (Thompson, 2009, p. 5). Organisations recognise an opportunity to reduce the cost of application and middleware development and accelerate time to market by loosely coupling siloed applications (Chong & Kulkarni, 2006).

SOA implementations contain a service directory with a centralised list of services and a communications contract which describes how an application can make use of a particular service. An application can be developed using services provided by another application. Calling a service is considered as "integration" between two different applications. The process of developing an application through SOA resembles building a composite application (Hohpe, Brown, & Woolf, 2005, p. 8).

The value of an application that implements a specific process is proportionate to how well it supports that process. SOA can enhance this value by making support more flexible and by enabling faster changes in the business logic or in the detailed functionality (Malinverno, 2008b, p. 4). By abstracting the underlying business logic, SOA enables services to be wrapped, reused and orchestrated to give both IT and business far greater responsiveness, flexibility and speed of execution (Chong & Kulkarni, 2006).

However, it must be noted that it is more difficult to implement SOA than vendors and the trade press claim. SOA does not make integration problems disappear, but using services to improve business processes can achieve organisational benefits a lot quicker than conventional integration styles. Integration is thus foundational to the implementation of SOA (Thompson, 2009, p. 5).

SOA is a best practice for developing composite applications and some multistep processes because of its modularity, service metadata, the reusability of software components and because the interface is separated from the implementation.

In other words, to realise the full potential of SOA, including loose coupling and reusability, it is critical that applications access data wherever is resides, in whatever form is required, in a consistent and accurate manner (Chong & Kulkarni, 2006).

B2B Applications

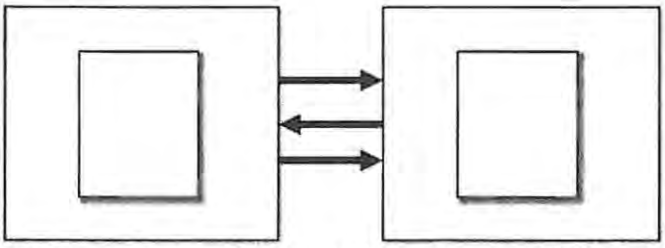


Figure 2.9: Representation of B2B Apps (Hohpe, Brown, & Woolf, 2005, p. 10)

This is an alternative integration style purely for organisations that wish to make their business functions available between external business suppliers or partners.

Integration may be required between different organisations for price/availability/status information. B2B interactions extend across the virtual enterprise to external business partners, Software-as-a-Service (SaaS) applications and software services hosted "in the cloud." (Thompson, 2009, p. 2)

This style, however, raises issues related to transport protocols and security in communicating across the Internet (Hohpe, Brown, & Woolf, 2005, p. 10). For example, using XML to transfer files requires a need for accelerated parsing and security measures for malicious code and intrusion detection (Kenny, 2008, p. 2).

According to JISC (2007, p. 25), it appears that many larger organisations seek to make much stronger external linkages between their suppliers or partners. As these linkages develop, they are generating new demands for information systems to support such activities which go beyond the boundaries of the organisation. Part of the appeal of SOA is that it may enable such collaborative ventures to be more easily supported (JISC, 2007, p. 25). SOA efficiently connects internal and external sources and the processing of information across business domains (Bell, 2008, p. 5).

2.5.4 Comparison of Integration Approaches, Patterns and Styles

The following table shows how each technical integration style is classified according to integration approach and pattern. Classifications are marked with an **X** in the associated cell. The BoB approaches to integration refer to Best-of-Breed.

Table 2.2: Comparison of Integration Approaches, Patterns and Styles

Technical Integration Styles	Approaches to Integration					Patterns of Integration		
	Integrated In-House	Systems from Vendors	BoB - Ad-Hoc Integration	BoB - Central Coordination	SOA	Data Consistency	Multistep Process	Composite Application
Manual Re-Keying of Data	X					X	X	
Data Dumps/Batch Transfers	X		X			X	X	
Data Warehousing	X			X			X	
Portals	X		X				X	X
Messaging	X		X				X	X
Pre-Packaged Suites		X						X
SOA	X				X		X	X
B2B Applications			X					X

As seen in Table 2.2, each technical integration style can be associated with more than one approach to or pattern of integration.

- Manual Re-Keying of Data can be classified as in-house integration following the patterns of data consistency and multistep process.
- Data Dumps can be classified as in-house or ad-hoc integration following the patterns of data consistency and multistep process.
- Data Warehousing can be classified as in-house or central coordination integration following the multistep process pattern.
- Portals and Messaging can both be classified as in-house or ad-hoc integration following the patterns of the multistep process and composite applications.
- Pre-packaged suites can be classified as a system from a vendor following the composite applications pattern.
- SOA can be classified as in-house or SOA integration following the patterns of the multistep process and composite applications.
- Business-2-Business Applications can be classified as ad-hoc integration following the composite applications pattern

2.6 Conclusion

Systems integration is an essential discipline which increases the value of an organisation's IT systems and better positions those systems to deliver higher and improved business value. However, resource issues, resistance from departments and limited control prevent further advances in integration. Organisations need to consider technology, data and interoperability issues to ensure that multiple disparate applications are integrated and can still provide information that meets constantly changing demands.

As predicted, SOA is an emerging methodology for systems integration that enables more agile and flexible business processes represented through services. The adoption of SOA for improving the integration among disparate systems can enable far greater responsiveness, flexibility and speed of execution for both IT and the organisation as a whole. This concept will be further analysed in the next chapter.

Chapter 3: SOA Overview

This chapter investigates the evolution of SOA from traditional systems design approaches. In doing so, it recognises the importance of systems integration and how SOA allows systems to communicate through standardised services. A definition of SOA is provided; the impact of SOA on the organisation is explored, as is the importance for and benefits of a successfully implemented SOA approach. Finally, some examples of institutions making use of SOA are provided.

3.1 Introduction

Earlier silo-based application design approaches have persisted as the most common means by which applications are developed (Erl, 2007, p. 76). While these approaches have been accepted and proven to provide tangible business benefits, today, many of these legacy systems pose obstacles for cross-application capabilities, easy-to-navigate interfaces and real-time access to data that is up to date and not redundant (Eduventures, 2006, p. 3).

SOA (Service-Oriented Architecture) is conceived as a conceptual and technological innovation that encapsulates a number of design principles building on previous approaches as a means of avoiding problems associated with silo-based systems development (Erl, 2007, p. 84).

This chapter first focuses on the evolution of SOA from traditional design approaches like silo-to-silo circulation and object orientation. Various associated technologies, methodologies and standards that have influenced the evolution of service-orientation are also examined. SOA is then defined along with its associated principles of design. The impact of SOA on organisations, its importance, benefits and challenges are also outlined and a framework for successful SOA is introduced. Finally, examples of SOA implemented in universities throughout the world are identified and it is concluded that SOA is established as a leading business and technology concept that, if implemented correctly, can significantly deliver sustainable business benefits.

3.2 The Evolution of SOA

Organisations in this technologically advanced world require the delivery of solutions that are capable of automating common business tasks or processes. The majority of these solutions, over the course of IT's history, have been created through the process of identifying business tasks to be automated; defining their business requirements; and then building the most efficient corresponding solution logic (Erl, 2007, p. 76). This proven and accepted approach through the use of technology has provided relatively predictable and tangible business benefits. However, gaining further value from these applications is inhibited since their capabilities are tied to specific business processes. When new requirements or processes are introduced, significant changes need to be made to the initial application or a new application needs to be built altogether. By continually building and rebuilding logic that already exists elsewhere, the process is not as efficient as it could be if the creation of redundant logic could be avoided (Erl, 2007, p. 79).

3.2.1 Silo-to-Silo Circulation

Traditionally, computers in organisations were used to automate certain business processes and it was common to find traditional monolithic applications and programs built using procedural languages like COBOL and C (Lam & Shankararaman, 2007, p. 256). These business applications could no longer function as independent silos; they had to communicate with one another to complete the desired business process (Lam & Shankararaman, 2007, p. 256).

Silo-to-silo circulation of batch files is used for separate systems to communicate. For example, at a university, if the campus counselling centre required information about a number of students from the Student Management System, it would request the student records from the IT department in the form of a batch file in which all student records at that university would be sent and loaded into the campus counselling centre's database just to be able to view the data of a few students. This data could be easily misinterpreted because different departments often use different business rules, which are versions of the same data that have been altered to suit different departmental needs (Eduventures, 2006, p. 7). For example, academic departments may define an "authorised student" as one who is not only enrolled, but who has also paid all outstanding fees. The campus counselling centre, on the other hand, may define an "authorised student" as one who is enrolled, but who may or may not have paid all fees.

Inconsistent business rules across silos, coupled with batch transfers, create inconsistencies and different versions of "the truth". Following the example, universities traditionally operate as highly decentralised enterprises with faculty and business departments allowed autonomy in their computing systems, business rules and operating practices (Eduventures, 2006, p. 3). IT managers at these institutions find themselves supporting a diverse array of computing platforms and applications, each with its own programming language, tools and training requirements. Today, many of these legacy systems pose obstacles for cross-application capabilities, easy-to-navigate interfaces and real-time access to data that is up to date and not redundant. Users have to navigate through multiple logins and unfamiliar applications to find the information they need. Once the information is found, it is often inaccurate and inconsistent with that from other databases, or is too outdated to meet requirements. Many university administrators find their systems integration "data rich, but information poor" (Eduventures, 2006, p. 3). More of these silo-to-silo interfaces are being developed with communication across many different systems. It is becoming more difficult to maintain, comprehend and understand the data passed between these applications (Lam & Shankararaman, 2007, p. 257).

3.2.2 Object-Orientation

In the 1960's and 1970's, application generators were an early attempt at developing modular software. In the 1980's and 1990's, software development utilised the concept of objects because they were modular (TechTarget, 2006).

Object-orientation was embraced as a philosophy that would define how distributed solutions were built (Erl, 2007, p. 97). This methodology uses objects as self-contained entities that encapsulate both data and process (Percy, 1996, p. 1). The concept of objects provides a more natural model for representing the "real world" as opposed to traditional relational modelling.

Object-oriented applications use "classes" to depict business entities. A graphical representation of these classes is designed in a Unified Modelling Language (UML) diagram. Classes have attributes (member variables), operations (member functions) and relationships with other classes (Martin, 1997).

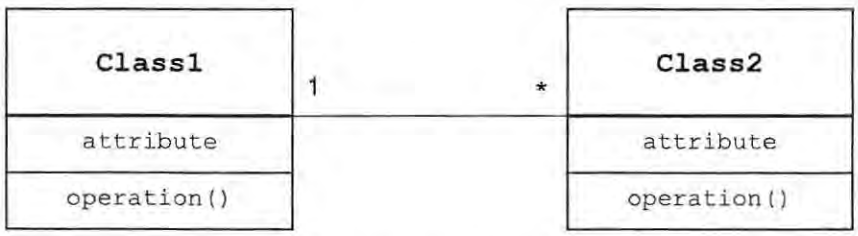


Figure 3.1: UML Class Diagram

As seen in Figure 3.1, each class (an object) has its own attributes and operations and a class may be connected to another class through a relationship (Martin, 1997).

Object-orientation offers the potential to improve the quality, maintainability and extensibility of software by utilising the concepts of inheritance, encapsulation and polymorphism (Kleinberg, 1998, p. 1). Inheritance allows for the creation of subclasses which inherit their structure and methods from the originating superclass. Encapsulation describes data which is owned by an object and can only be accessed via the owning object. Polymorphism allows objects to send messages to new types of objects which respond accordingly depending on a given context (Kleinberg, 1998, p. 1). Object-orientation is most suited to intra-application development, where class hierarchies and the performance of these systems can be carefully controlled. When larger development projects spanning several departments are required, object-oriented principles become less desirable (Kleinberg, 1998, p. 2).

Standards problems were later evident, such as the distributed computing environment and the common object request broker architecture which weren't always compatible. These standards were surpassed when the Web arrived (TechTarget, 2006).

3.2.3 Web Services

After the foundation of the World Wide Web in the 1990's, it did not take long for organisations to deliver services via the Web to other organisations or software applications. For example, IBM captured foreign exchange rates from a website to help process their staff expense reports (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 36). The technologies that performed these services on the Web became known as Web services.

Web services are defined as any piece of software that uses standard Web interfaces to communicate with other software containing Web service interfaces (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 36).

This provides a framework that allows different people from all over the world to write their own Web services that could potentially talk to other Web services written by other people through a common interface. After different browsers could communicate with any website, it became possible for any program to communicate with any other program, provided they used the Internet as a standard interface (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 36).

Web services include a rich body of standards that are being developed to enable interoperability. Through the Web, previous standards issues were alleviated with the introduction of a ubiquitous transport medium called HTTP (HyperText Transfer Protocol).

HTTP essentially displays web pages on web browsers, but can also be used to transfer program requests between programs using SOAP (Simple Object Access Protocol).

SOAP is a standard language which defines how to use HTTP to enable communication between the Web and application servers on a computer (TechTarget, 2006). In 2000, the SOAP specification was submitted by the World Wide Web Consortium (W3C). It was originally designed for data transmitted between components to be serialised into XML, transported and then deserialised back into its native format (University of Camerino, 2006b, p. 1).

The messages transferred between the Web and application servers are formally written in XML (eXtensible Markup Language). This enables programmers to define data in a way that a program can understand and to standardise commands that programs send to each other (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 38). Through the use of XML, developers were able to attach meaning and context to any piece of information transmitted across Internet protocols (University of Camerino, 2006b, p. 1).

The most important part of a Web service is its public interface which assigns the service an identity and enables its invocation (University of Camerino, 2006b, p. 1). All the available Web services are theoretically published in a directory using the UDDI (Universal Description Discovery and Integration) protocol.

A Web service should be able to locate another Web service in the UDDI directory and invoke it to perform a function (TechTarget, 2006). Services in a UDDI directory or registry are described through another industry standard called WSDL (Web Services Description Language).

WSDL describes all the commands and data that a program can accept from another (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 38). This allows all users to locate, discover and use these services if they wish to. These standards have been adapted by the IT industry and supported by nearly every software vendor (TechTarget, 2006).

These are the basic standards which are used to create, manage and publish messages between service components. Web services can be used for services within an organisation, between organisations, or publicly on the World Wide Web.

A new addition to these standards is WSI (Web Services Interoperability), which include a number of evolving standards for managing Web services. These standards deal with issues of security, policy, reliability, transactions and resource specification. The WSI standards have not, however, been widely adopted as most organisations begin with the core, basic standards first (TechTarget, 2006).

The Web service technology platform is primarily responsible for the popularity of Service-Oriented Architecture (SOA) and therefore, is a significant influence on service-orientation (Erl, 2007, p. 100). SOAP and Web services are the most common implementations of SOA. This protocol independence means that different consumers can use services by communicating with the service in different ways. A management layer between the provider and the consumer is also required to ensure flexibility (TechTarget, 2006).

Security concerns are evident, however, due to the shortcomings of standards in identifying applications that are requesting services. Only approved and authorised applications should be able to access the UDDI directory. If many Web services are contained on a network, changes need to be tracked to ensure that the services are available at any given point. Experts suggest that silos need to be disbanded, departmental thinking needs to stop and everyone needs to be involved in building Software as a Service (SaaS) (TechTarget, 2006).

3.2.4 SOA Modelling

It wasn't long before organisations began to realize that instead of just accommodating existing distributed applications, Web services could be used as a basis for a separate architectural platform that could leverage the benefits of Web services and their associated technologies to realise the concept of services in the enterprise (University of Camerino, 2006b, p. 2).

Service-oriented modelling is a software development practice that uses modelling disciplines and principles to provide strategic and tactical solutions to enterprise problems. This personified modelling paradigm promotes a holistic view of the analysis, design and architecture of all organisational software entities, conceiving them as service-oriented assets, namely services (Bell, 2008, p. 2).

Service-orientation applies to enterprise logic. It introduces new concepts that change the way in which this logic is represented, viewed, modeled and shared. Enterprise logic can be divided into business logic and application logic.

Business logic is a documented implementation of business requirements. Structured processes encapsulate these requirements, along with any associated constraints, dependencies and outside influences (Erl, 2005, p. 281).

Application logic is an automated implementation of business logic. Business process workflows are presented through packaged or custom solutions (Erl, 2005, p. 281).

Service-oriented principles can be applied to both business and application logic. The concepts introduced by service-orientation are realised through services (Erl, 2005, p. 281). Figure 3.2 shows how services are located within the overall structure of an automated organisation.

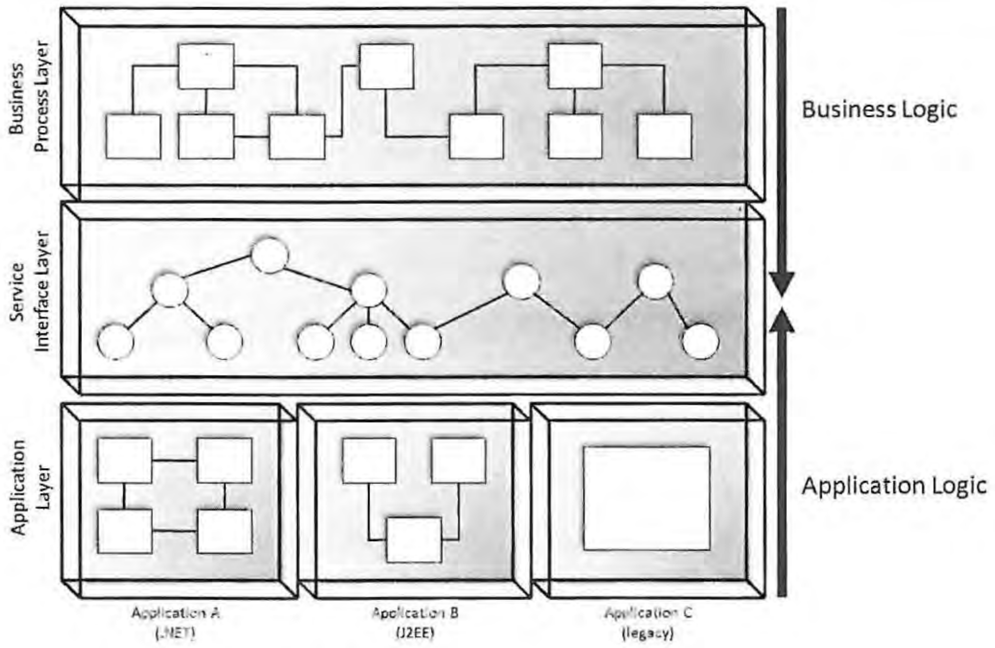


Figure 3.2: The Service Interface Layer (Erl, 2005, p. 282)

Services establish a high form of abstraction between traditional business process and application layers, thus encapsulating physical application logic as well as business process logic (Erl, 2005, p. 281).

While services are shown here to exist in a single, continuous layer, services can, however, communicate through service interfaces and open protocols (Erl, 2005, p. 282)

First generation SOA was an initial representation that shows one application (service requestor) directly invoking a Web service offered by a second application (service provider).

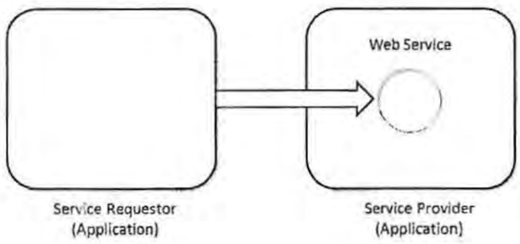


Figure 3.3: Client-Server SOA (Ryan, 2006)

In this case, the URL of the service being invoked is known by the service requestor. It is either embedded in the source code of the service requestor or in a database. Changing the

URL of a particular service would cause problems as the change would need to be coordinated with every single service requestor that utilised that service (Ryan, 2006). A different approach was required.

Second generation SOA made use of Enterprise Service Bus (ESB) middleware to solve problems that arose when service requestors invoked service providers directly.

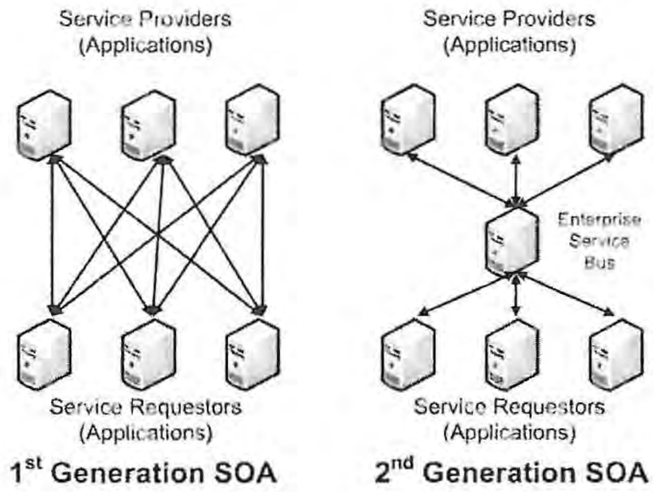


Figure 3.4: 1st and 2nd Generation SOA (Ryan, 2006)

As Figure 3.4 depicts, 1st generation SOA shows a set of complex integration webs, while 2nd generation uses the idea of ESB middleware to manage complexity by providing a centralised point between service requestors and service providers to manage and monitor integrations across the enterprise (Ryan, 2006).

An ESB is a subset of SOA that provides a foundation for messaging. It uses Web services standards to transport and direct messages according to their content (TechTarget, 2006).

An ESB can be implemented by middleware technologies to facilitate communication among different services and applications. ESB includes a collection of key services to assist the SOA developers in building and managing the services, as well as a set of services to support better decision-making with real-time information. The components or services in the ESB can be varied according to the system or customer requirements. In comparison with monolithic systems integration, ESB is thus more adaptable and flexible to ever-changing business environments (Chung & Chao, 2007, p. 94).

As the concept of an ESB developed, middle-tier services were introduced to encapsulate the services that live on the ESB. Application services are those that are hosted by service providers. The ESB offers a number of reusable components that may be strung together to actually implement the ESB service. The Validate, Enrich and Transform components are implementation options available to middle tier service composers (Ryan, 2006). Data sent by the service requestor is validated, enriched and transformed before it is passed to the service provider as in Figure 3.5.

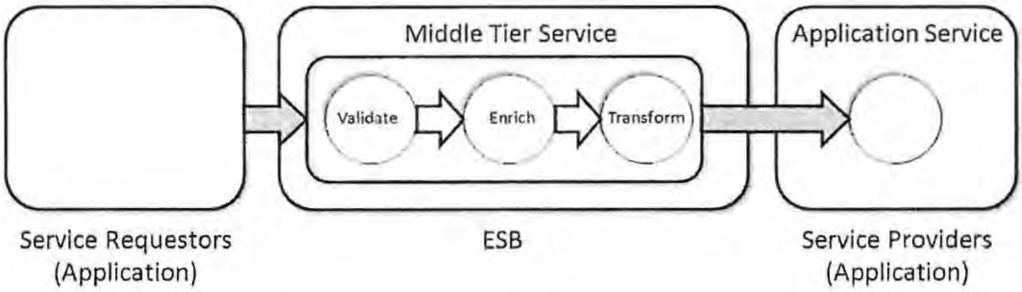


Figure 3.5: Validate, Enrich and Transform (Ryan, 2006)

In order to understand the Web services standards involved in an SOA, an early model is defined in terms of the service requestor, the service provider, and the service registry (University of Camerino, 2006b, p. 2).

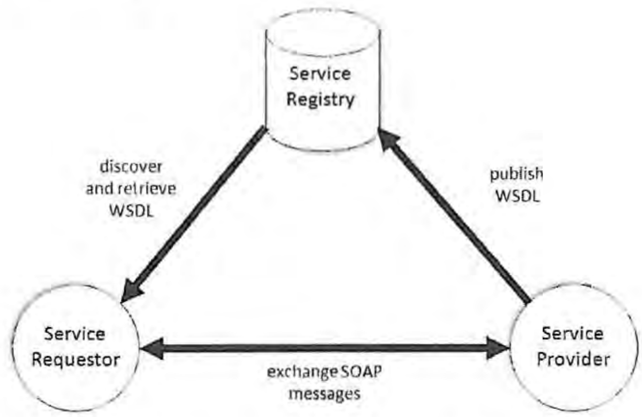


Figure 3.6: An early incarnation of SOA (University of Camerino, 2006b, p. 2)

As Figure 3.6 depicts, SOAP provides the message format used by the service and its requestor, WSDL describes the service to be processed and UDDI provides the standardised service registry format.

The evolution of SOA is more clearly defined in Schaffner (2003)'s representation:

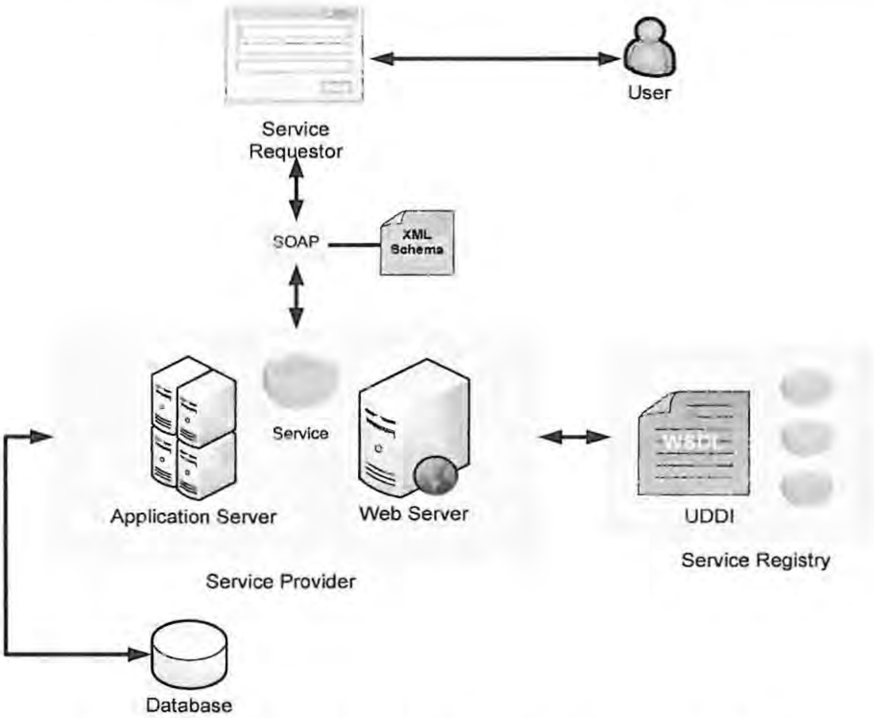


Figure 3.7: SOA and Web Services – adapted from Schaffner (2003)

Figure 3.7 shows that as a service is requested, the request is transferred through SOAP messages via HTTP and delivered in an XML representation. The application and Web servers deliver the service provider. The Web server provides the HTTP network transport for accessing the service. The UDDI registry is queried and the WSDL document for the associated service is returned. Using the information contained in the WSDL, the requestor will understand how to access the service, what methods it has and what parameters need to be sent. The application server hosts the SOAP interface and object components that make up the service. The requested data is then extracted from the respective database and returned to the service requestor (Schaffner, 2003).

The entities described above - either through legacy applications or diverse empowering platforms and middleware - should all take part in an SOA modelling framework. Most important, they should be treated equally in the face of analysis, design, and architectural initiatives, and should simply be recognized as services. This SOA modelling approach is well suited to provide tactical, short-term solutions to enterprise concerns, yet it furnishes strategic remedies to persistent organisational problems (Bell, 2008, p. 2).

With the evolution of SOA representations and the growth of real-time computing and the Internet, it has become increasingly vital to ensure that data from an application can be efficiently and effectively communicated between all connecting applications and systems (Malinverno, 2008b, p. 257). While the fundamental concepts of SOA have been introduced in terms of Web services, it is now important to discuss how several management principles have assisted in the evolution of SOA as it is defined today.

3.2.5 Business Process Management

Business Process Management (BPM) is a management practice that was conceived as a way to better manage the business operations of an organisation (Schurter, 2009). Technologies involved in BPM include process modelling, rule engines, process simulation and those that enable flow management. Flow management refers to conditional, metadata-based sequencing of resources (Hill, Pezzini, & Natis, 2008, p. 2). BPM is followed as a methodology to improve the performance of business processes or create new processes and provide new value (Rosser & Apfel, 2008, p. 2).

Typical BPM results are highly visible, near term, focus on strategic business value and are based on applying existing technologies (Rosser & Apfel, 2008, p. 2). The emphasis of BPM is placed on streamlining business process logic to improve efficiency and establish processes that are adaptable and extensible enough to be augmented in response to business change.

Business processes are core to any SOA. In order to create a highly agile environment capable of adapting to change, business process logic needs to be abstracted, thereby relieving other services from replicating process logic (Schulte & Abrams, 2006, p. 98).

BPML (Business Process Modelling Language) is an aspect of BPM and is used for the modelling of business processes. It models collaborative and transactional business processes that span multiple applications and business partners (TechTarget, 2006).

Various techniques for modelling business processes are available for representing how work gets done in an organisation. Most organisations are, however, not efficient at combining human capabilities with system level capabilities in the same model. Organisations need to model both process-oriented capabilities as well as service-oriented capabilities to provide a holistic view and mechanism whereby they can define the interactions between human and IT systems. This type of model can be leveraged across an organisation showing what work is getting done and how it is getting done (Woodhull, 2009). BPM is thus a vital management component in ensuring an efficient and successful SOA practice.

3.2.6 Enterprise Application Integration

Integration between disparate applications became a focal point in the late 1990's. Many systems were built with little consideration given to how data could be shared between various systems (Erl, 2007, p. 98). Problems associated with a lack of stability, extensibility and interoperability as mentioned in 3.2.1 became evident. Enterprise Application Integration (EAI) platforms introduced adapters, brokers and orchestration engines to abstract proprietary applications, resulting in more adaptable and robust architectures (Erl, 2007, p. 99).

EAI includes the plans, methods and tools aimed at modernising, consolidating and coordinating applications in an organisation. Existing legacy applications and databases should be able to communicate to other applications in the organisation by adding to or migrating to a new set of applications that exploit the Internet and other new technologies (SearchSOA, 2008a). This integration methodology was, however, very complex and expensive, requiring long-term commitments to vendor platform and roadmap (Erl, 2007, p. 99).

3.2.7 Data Integration

SOA systems should be designed to deal with the complexities of heterogeneous, inconsistent, dirty data that lies fragmented across the enterprise. A Data Services layer built upon an enterprise data integration platform is required (Chong & Kulkarni, 2006).

A data integration platform can, and should, enrich an SOA with sophisticated data services beyond the scope of application integration-centric technologies (Chong & Kulkarni, 2006).

Organisations pursuing SOA are urged to leverage the data consolidation and integration lessons of the Business Intelligence (BI) team to determine which business processes reuse or share the same information assets (Beyer, 2007, p. 2).

SOA provides an ideal framework for data integration and EAI to complement one another, with EAI managing transactions and processes among applications and the data integration platform performing the atomic-level data processing that is generally beyond the scope of EAI systems (Chong & Kulkarni, 2006).

The services and benefits that a data integration platform delivers for an SOA are outlined below (Chong & Kulkarni, 2006):

- *Data profiling:* Data profiling is the process of assessing and understanding the content, quality, and structure of enterprise data. It is an essential step in reconciling semantic differences in common business vocabulary such as customer, address and product that varies among applications. If unaddressed, contradictory information is scattered across the enterprise.
- *Data cleansing:* Once data is profiled, a data integration platform can execute data cleansing functions to ensure the validity and consistency of information. It standardizes name, address and other values and resolves missing data fields, parses data elements and corrects poorly formatted or conflicting data.
- *Data transformation*: Data transformation services enable data to be transformed from one form to another to allow reconciliation between data elements residing in different information sources. The transformation services leverage pre-built and customized mappings that take into account complex data hierarchies and relationships.
- *Data movement*: Data integration offers flexible mechanisms for "right-time" data delivery in an SOA, including high-volume bulk data movement, near-real time capabilities, data federation and changed data capture that handles only information that has been updated to accelerate load times and minimize operational impact.
- *Data auditing*: Data integration provides in-depth lineage of data - when it was changed, how, by whom and across which applications - to enable auditing, reporting and analysis essential to meeting the demands of legislated regulations and internal/external auditors.

(Chong & Kulkarni, 2006)

Without an understanding of different types of data services, success in loosely coupled Service-Oriented Business Applications (SOBAs) becomes more difficult, because each design point has to verify it own semantics, context and data structures (Beyer, Newman, Sholler, & Friedman, 2006, p. 2).

SOBAs require a robust set of services that capture, manipulate, transform and reconcile data and semantics. Data services that accomplish detailed transaction manipulation and provide a transparency of business rules, semantic mappings and metadata management enable the necessary linkage and binding between process and information when deploying composite applications via SOA techniques (Beyer, Newman, Sholler, & Friedman, 2006, p. 2).

3.2.8 Aspect Oriented Programming

Aspect-Oriented Programming (AOP) is another SOA management principle based on the radical exploration of modularity in software development (Kiczales, 2006). Modules in a program represent a separation of concerns where a program is composed of several modules. This improves maintainability by enforcing logical boundaries between modules so if changes are required, only the corresponding module is modified, not the entire program. Each module in an application defines its own interface with surrounding modules. Some situations are, however, difficult to design in a single module. The concept of AOP suggests a change in structure by "cross-cutting" module boundaries in situations where concerns are common to multiple applications (Kiczales, 2006). The corresponding solution logic developed for cross-cutting becomes naturally reusable. AOP demonstrates a common goal with SOA in emphasising the importance of units of solution logic that are reusable, allowing developers of differing expertise to collaborate (Erl, 2007, p. 99).

SOA is truly an evolution. Its prominence today is the result of many interrelated initiatives driven by a variety of standards organisations and software vendors. The concepts and principles of SOA are being strategically adjusted and extended in a volatile and changing environment, each defining a specific part of what is termed the "contemporary SOA technology platform" (University of Camerino, 2006b, p. 3).

3.3 SOA Concepts and Definition

A number of definitions for SOA exist that are understood and interpreted differently by different people and organisations. These definitions are briefly stated below, followed by a generic and all-encompassing definition on which this research is focused.

Firstly a definition of "service" and "service orientation" is required in order to define the context surrounding SOA.

3.3.1 Definition of Service

A service is a way of structuring work. The service provider performs a function to assist the service consumer. A business service is a logical encapsulation of business function. For example, a restaurant provides a number of services that could be divided into a *waiting service* and a *meal-preparation service.*

Figure 3.8: Abstract Restaurant Services

Figure 3.8 shows an abstract representation of how services can be used in a restaurant environment. The various services pass information, ask for tasks to be performed and serve up the results (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 19).

These services make business processes and functions easier to understand, manage and change. Complex business processes can be coordinated by combining many simpler services. Services are described and presented in a contract that shows *what* will be done, not *how* it will be done. This means that services are essentially associated with flexibility and can be shared by multiple people, departments or even organisations (Schulte & Abrams, 2006, p. 2).

In SOA, business services interact with each other to perform specific business functions using a variety of computer applications. It is important to stress that SOA is not a technology. It is an architectural approach built around existing technologies. Disparate applications would need to make use of one or more services to communicate with other applications. Each service should be built around an existing business process that can be made available to all applications. The service, as shown in Figure 3.9, has to consist of: a definition of input and output data formats; a definition of the transport protocol to invoke this service; a service implementation to accept the request, invoke it on behalf of the caller, get back the response, format the response and send it back to the calling client (Lam & Shankararaman, 2007, pp. 261-262).

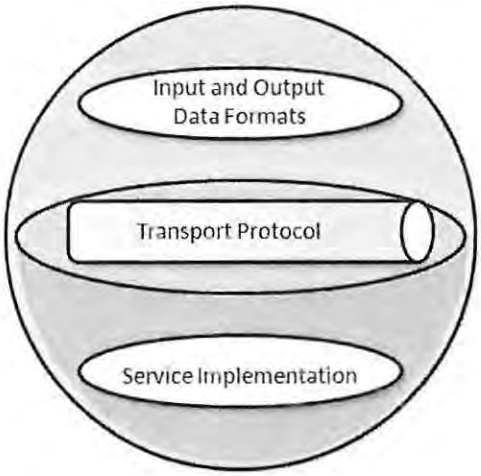


Figure 3.9: Components of a Service

The definition and description of the service is defined in a WSDL document which may be contained within the repository or UDDI directory. The service may be invoked in XML through HTTP and SOAP transport protocols. The registry allows for the registration of services, discovery of metadata and classification of service particulars involved in the service implementation (Franzén, 2008, pp. 14-15).

Now that the service itself has been defined, the concept of service-orientation is introduced and outlined.

3.3.2 Definition of Service-Orientation

Service-orientation presents an ideal vision of a world in which resources are cleanly partitioned and consistently represented. When applied to IT architecture, service-orientation establishes a universal model in which automation logic and business logic conform to this vision (Schekkerman, 2006).

Service-orientation owes much of its existence to object-oriented concepts and theory. The two methodologies are not necessarily competitive, as service-orientation is seen as more an evolution of object-orientation. It introduces contemporary solutions consisting of a mix of services and object-oriented components. A common set of design principles can be properly positioned to leverage and support both paradigms (Erl, 2005, pp. 321-324).

The concepts introduced by service-orientation are realised through the introduction of services. As mentioned, services encapsulate application logic as well as business process logic and are positioned between the two layers. In this way, services consist of multiple layers of abstraction (Erl, 2005, pp. 281-282).

Service-orientation is comprised of a number of design principles, the application of which results in service-oriented solution logic encapsulated in services (Erl, 2007, p. 39). These design principles are introduced and described below.

3.3.3 Service-Oriented Design Principles

The service-oriented approach to modelling business automation logic has influenced and promoted several commonly accepted design principles, including Service Abstraction, Service Autonomy, Service Composability, Service Contract, Service Discoverability, Service Interoperability, Service Loose Coupling, Service Reusability and Service Statelessness (Erl, 2007, p. 98).

This set of principles can be applied to each unit of logic that constitutes a service within an SOA. It is through the application of these principles that the primitive components of an SOA (services, descriptions and messages) are shaped in support of service-orientation (Erl, 2005, p. 280).

Service Abstraction

The only part of a service that is visible to the outside world is what is exposed via the service contract. Underlying logic, beyond what is expressed in the descriptions that comprise the contract, is invisible and irrelevant to service requestors.

This principle allows services to act as black boxes, hiding their details from the outside world with no limit to the amount of logic a service can represent and no restriction as to the source of application logic a service can draw upon. A single service can thus expose logic from two different systems (Erl, 2005, pp. 298-299).

Service Autonomy

Autonomy requires that the range of logic exposed by a service exist within an explicit boundary. This allows the service to self-govern all of its processing and eliminate dependencies on other services (Erl, 2005, pp. 303-304).

Service Composability

Services may create or "compose" other services. This allows logic to be represented at different levels of granularity and promotes reusability and the creation of abstraction layers. Composability is simply another form of reuse and therefore operations need to be designed with an appropriate level of granularity to maximize composition opportunities (Erl, 2005, pp. 301-302).

Service Contract

For services to interact, they do not need to share anything but a formal contract that describes each service and defines the terms of information exchange.

Service contracts provide a formal definition of:

- The service endpoint
- Each service operation
- Every input and output message supported by each operation
- Rules and characteristics of the service and its operations

Service contracts therefore define almost all of the primary parts of an SOA. This information establishes the agreement made by a service provider and its service requestors (Erl, 2005, p. 295).

Service Discoverability

Services should allow their descriptions to be discovered and understood by those who may need to make use of their logic. Discovery helps avoid the accidental creation of redundant services or those that implement redundant logic. Since each operation provides a potentially reusable piece of processing logic, metadata attached to a service needs to sufficiently describe the service's overall purpose and the functionality offered by its operations (Erl, 2005, p. 309).

Service Interoperability

Interoperability refers to the sharing of data. The more interoperable software programs are, the easier it is for them to exchange information. Software programs that are not interoperable need to be integrated. This establishes an environment wherein services produced disparately at different times can be repeatedly assembled together into a variety of compositions to help automate a range of business tasks (Erl, 2007, pp. 56-57). Service-oriented computing fully leverages the interoperability potential of Web services. For example, when exposing reusable logic as Web services, the reuse potential is significantly increased (Erl, 2007, p. 50).

Service Loose Coupling

Services must be designed to interact without the need for tight, cross-service dependencies. Being able to ultimately respond to unforeseen changes in an efficient manner is a key goal of applying service-orientation. Realizing this form of agility is directly supported by establishing a loosely coupled relationship between services. Loose coupling is a condition wherein a service acquires knowledge of another service while still remaining independent of that service. Loose coupling is achieved through the use of service contracts that allow services to interact within predefined parameters (Erl, 2005, p. 297). Programs in an SOA are typical loosely coupled, meaning that a program written in one language may communicate with a program written in another language by sending requests over the network (TechTarget, 2006). Loose coupling provides important benefits such as flexibility and scalability, but it introduces a more complex programming model and can make designing, building and debugging solutions much more difficult (Hohpe, Brown, & Woolf, 2005, p. 15).

Organisations are shifting their development strategies from tightly coupled and hardwired development to loosely coupled, dynamically configurable applications. In theory, if the application components were distinct and separate, it would be easier to reconfigure or assemble services on-demand. The data repository is, therefore, no longer tightly bound or limited to any specific application. Each layer then provides high-value and maximum reusability because it is only "loosely coupled" to the one above and below (Beyer, Newman, Sholler, & Friedman, 2006, p. 2).

Service Reusability

Regardless of whether immediate reuse opportunities exist, services are designed to support potential reuse.

As established earlier, a service is simply a collection of related operations. It is therefore the logic encapsulated by the individual operations that must be deemed reusable to warrant representation as a reusable service (Erl, 2005, p. 292).

Service Statelessness

Services should not manage state information, since that can impede the service's ability to remain loosely coupled. Services should be designed to maximize statelessness even if that means deferring state management elsewhere.

Statelessness is a preferred condition for services and one that promotes reusability and scalability. Services should minimize the amount of state information they manage and the duration for which they hold it. If a service is responsible for retaining state for longer periods of time, its ability to remain available to other requestors will be impeded (Erl, 2005, p. 307).

Of these nine design principles, abstraction, autonomy, loose coupling and the need for a formal contract can be considered the core principles that form the baseline foundation for SOA (Erl, 2005, p. 292).

3.3.4 Definition of SOA

SOA definitions from various sources are outlined below in chronological order to show how the concepts of SOA have evolved from programs designed to communicate, to methodologies and best practices completely independent of underlying technologies:

TechTarget (2006)'s definition:

SOA is a way of designing programs as a set of services that can be organised, conveniently located and then can communicate with each other in a standard way (TechTarget, 2006).

Beyer, et al. (2006)'s definition:

SOA is an architectural style in which certain discrete functions are packaged into modular, shareable, distributable elements ("services"), which can be invoked by consumers in a loosely coupled manner (Beyer, Newman, Sholler, & Friedman, 2006, p. 3).

Schulte & Abrams (2006)'s definition:

SOA is a durable change in application architecture in which applications should be modular; modules must be distributable; services should be accessible; the service interface must be separate from the underlying implementation; and service providers must be shareable (Schulte & Abrams, SOA Overview and Guide to SOA Research, 2006, p. 2).

OASIS-Open (2006)'s definition:

SOA is a paradigm for organising and utilising distributed capabilities that may be under the control of different ownership domains. Services are the mechanism by which these needs and capabilities are brought together (OASIS-Open, 2006, pp. 8-9).

Eduventures (2006)'s definition:

An SOA is the standards-based backbone that makes Web services possible by serving up "fused" applications from multiple vendors through a single portal interface with a master registry to authenticate system users' access to data and applications (Eduventures, 2006, p. 4).

University of Camerino (2006a)'s definition:

SOA represents a model in which automation logic is decomposed into smaller, distinct units of logic (services) which can be distributed. These services are encouraged to exist autonomously yet not isolated from each other and should evolve independently while maintaining a sufficient amount of commonality and standardisation (University of Camerino, 2006a, p. 2).

JISC (2007)'s definition:

SOA is a software development approach in which resources on a network are made available as independent services that can be accessed without knowledge of the underlying platform implementation (JISC, 2007, p. iv).

Lam & Shankararaman (2007)'s definition:

SOA is concerned with building standard interfaces to access different business processes from a variety of backend systems through the use of services (Lam & Shankararaman, 2007, p. 260).

Phelps & Busby (2007)'s definition:

SOA presents well-defined business functions as services which are made available to multiple applications through standard protocols. SOA allows different kinds of systems and platforms to communicate with each other in a common language, without custom interfaces (Phelps & Busby, 2007, p. 56).

Chung & Chao (2007)'s definition:

SOA can be viewed as an IT architectural style that supports service orientation. Service-orientation is a way to integrate business as linked services which bring about the desired outcomes. SOA provides flexible connections to allow integration among distributed and heterogeneous components and enable real-time monitoring of them as well (Chung & Chao, 2007, p. 93).

Chung & Chao (2007) also describe SOA in terms of a life-cycle where SOA is an architecture supporting an iterative development process where software systems are created through four stages: *model, assemble, deploy,* and *manage* as depicted in Figure 3.10.

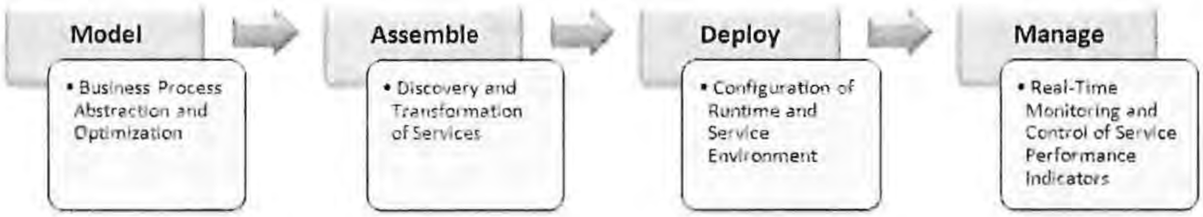


Figure 3.10: SOA Life Cycle (Chung & Chao, 2007)

In the *model* phase, business processes are abstracted to reach a common understanding of the objectives and outcomes between business and IT. The business abstraction in SOA starts by analysing business requirements by gathering and eliciting business process and related data. The resulting requirements and gathered information can be used to model and optimize the business processes after simulating them. Consequently, the model can be used as a benchmark to measure business performance.

In the *assemble* phase, existing services, resources and applications are enabled for maximized reusability. Existing services and applications are discovered and transformed or wrapped into services. In the case that there is no existing functionality which can satisfy the new business process requirement, new services are created. Prior to their delivery, these services are tested to ensure their reliability. The services are then orchestrated for deployment.

Before the *deploy*ment of the business process, the process requires a robust, scalable, and secure services environment for execution. The runtime environment is configured and scaled to a level that meets quality requirements of the business process. A services environment provides the flexibility to make updates dynamically in response to changing business requirements. Once the service environment has been configured appropriately, it facilitates numerous point-to-point integrations to reduce maintenance cost and to manage system complexity.

The objective of the *manage*ment phase is to allow developers and users to perform real-time monitoring of key performance indicators to make better business decisions. Root causes of

problems are identified and fed back to the business process model which enables continuous improvement. This phase also includes the control of service version issues and the provision of good performance by improving service availability and response time.
(Chung & Chao, 2007, pp. 93-94)

Erl (2007)'s definition:

SOA is an architectural model designed to support the implementation of services and the creation and evolution of a service inventory (Erl, 2007, p. 41). SOA aims to enhance the efficiency, agility and productivity of an enterprise by representing solution logic through services that conform to a number of service-oriented design principles (Erl, 2007, p. 38).

Hurwitz et al. (2007)'s definition:

SOA is a software architecture for building applications that implement business processes or services by using a set of loosely coupled black-box components orchestrated to deliver a well defined level of service (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 15).

Here a software architecture describes the overall design and structure of a computer system, including the components of a computer system and how they interact (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 17).

Business services are the logical encapsulation of business functions and processes (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 19).

Black-box components are those whose inner workings are not understood or accessible by users. A separation of concerns is evident in which business logic is separated from application logic (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 25).

SOA creates a simple arrangement of components that can collectively deliver a very complex business service while ensuring dependable business service levels through Business Process Management (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 28).

Malinverno (2008b)'s definition:

SOA is an architectural style for business applications that are modular, distributable, clearly defined, swappable and shareable (Malinverno, Measuring the Value of SOA, 2008b, p. 3).

SearchSOA (2008b)'s definition:

SOA is the underlying structure supporting communication between services. It defines how programs interact in a way that enables each program to perform work on behalf of the other program (SearchSOA, 2008b).

And finally,

McKendrick (2009)'s definition:

SOA is a philosophy, methodology and a set of best practices or patterns that shapes the way enterprises and government agencies address problems through IT. The mix of technologies and approaches employed to work toward SOA will change since SOA is meant to be independent of the underlying technologies or protocols (McKendrick, 2009).

Using the concepts and perceptions of SOA outlined above, an all-encompassing definition is now stated which will be used as the sole classification of SOA throughout this research.

SOA definition for the purposes of this research:

> SOA is an architectural methodology for building business applications that implement business processes through well-defined services to allow integration among disparate and heterogeneous components by adhering to a set of service design principles.

The *architectural methodology* defines a philosophy and set of best practices describing the overall design of a computer system and how its components interact.

Business applications are those encapsulating core business functions or processes in an organisation.

Business processes are abstracted from business requirements and can be used as a benchmark to measure business performance.

Well-defined services are the logical encapsulation of business processes and are modular, distributable, accessible and shareable, describing *what* work will be done and *not how* it will be done.

Integration among disparate and heterogeneous components is enabled through the use of services. Applications are able to communicate independent of programming language, platform, vendor, system configuration, location and network connectivity.

Service design principles need to be adhered to in order to ensure successful SOA implementation. These principles include service abstraction, service autonomy, service composability, service contract, service discoverability, service interoperability, service loose coupling, service reusability and service statelessness.

Using SOA as defined above, its impact on the organisation, importance, benefits and challenges are discussed below.

3.4 SOA and the Organisation

Chief Information Officers (CIOs) are constantly under pressure from their business leaders to show the business relevance and value of IT. In a current globally weak economy, this pressure has increased for them. IT leaders must therefore focus on managing IT in a way that enables them to clearly communicate the business relevance and value of IT. Leading and successful CIOs in industry are using enterprise architecture as a key technique to transform the direction of IT to better accomplish this (Bittler, 2009, p. 2).

Business leaders are coming to the realization that application-centric silos no longer make sense in the Internet age and it is time to shift to a computing environment that more closely resembles popular web-based commercial businesses (Eduventures, 2006, p. 3).

By developing single sign-on portals, IT departments can deliver services together in one place. Users will no longer face the hassles of having to pull data from disparate, unfamiliar systems, making calls to other departments to get missing data or to the IT staff for help working across systems. With Web services, data can be extracted dynamically from various applications and databases and streamed to users regardless of where they are how they access the service (Eduventures, 2006, p. 4).

Key to this solution's return on investment is that it does not require removing existing legacy systems. Web services built on a SOA backbone, allow organisations to integrate legacy and packaged applications from multiple vendors and back-end platforms. For instance, SOA makes it possible for a department that prefers the Windows operating system to stick with Windows, or Apple, Unix, Linux, or Solaris (Eduventures, 2006, p. 5).

It is very important to view and position SOA as an architectural model that is independent of any one technology platform. By doing so, an organisation is given the freedom to continually pursue the strategic goals associated with service-oriented computing by leveraging future technology advancements (Erl, 2007, p. 46).

With high expectations of following the SOA approach, the effects that service-orientation have on applications, integration and enterprise architecture and how each of these concepts affect the organisation must now be examined.

3.4.1 Applications

Establishing service inventories with many reusable services based on existing, new and augmented business processes are now automated through service composition. Business requirements are fulfilled by composing existing services instead of building or extending legacy applications. The traditional concept of an application actually begins to fade, along with the silos that contain them (Erl, 2007, p. 91).

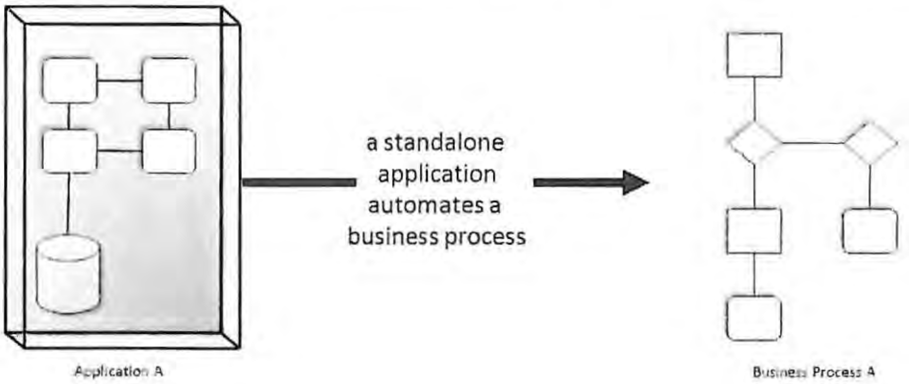


Figure 3.11: Automation of specific business logic (Erl, 2007, p. 91).

In Figure 3.11, traditional applications contain programming logic responsible for automating a specific set of tasks.

Alternatively, a service composition, as in Figure 3.12, is made up of services that very likely participate in other compositions. The composite application is representative of one which loses its individuality in this environment. The business process is now executed using a variety of applicable services which can be separately configured to apply to more than one business process (Erl, 2007, p. 92).

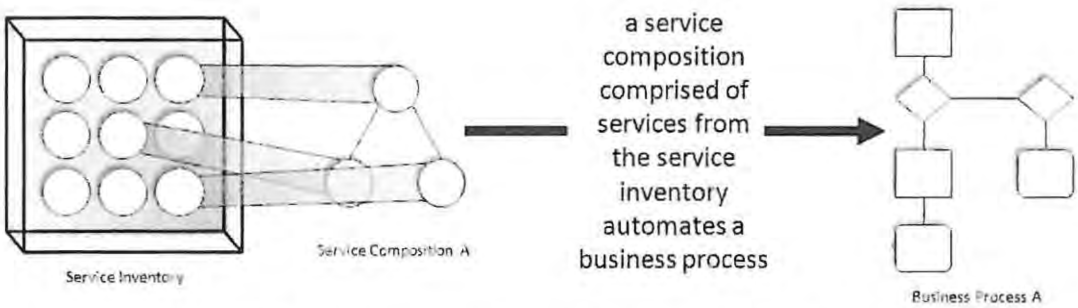


Figure 3.12: Service-composition automates business logic (Erl, 2007, p. 92).

3.4.2 Integration

Traditionally, integration implied that applications were connected, whether or not they were compatible, as in Figure 3.13.

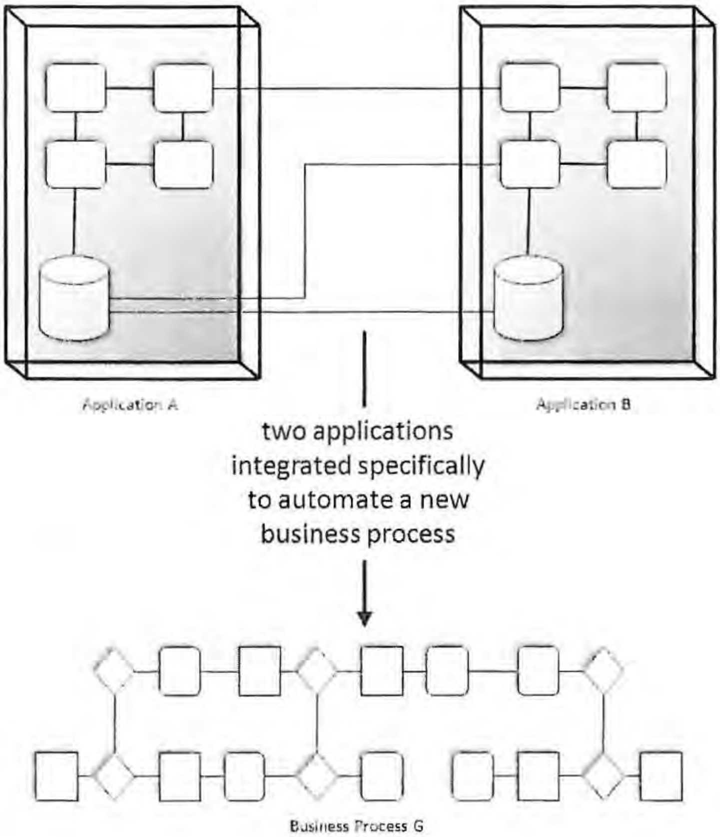


Figure 3.13: Two connected applications to allow automation (Erl, 2007, p. 93)

In Figure 3.13: Two connected applications to allow automation (Erl, 2007, p. 93)two applications are integrated specifically to automate a single business process. The increasing need to connect disparate pieces of software to establish a reliable level of data exchange, made integration an important, high profile concept in IT (Erl, 2007, p. 92).

Exchanging data between different applications became a natural design characteristic with the introduction of services which were designed to be intrinsically interoperable. In working to achieve this environment, existing legacy applications needed to be able to integrate with these services (Erl, 2007, p. 93).

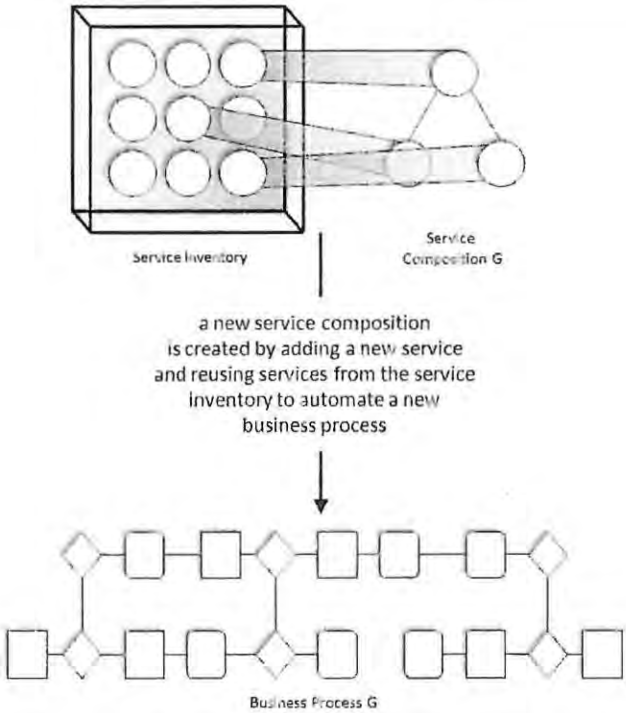


Figure 3.14: A combination of services (Erl, 2007, p. 94).

In Figure 3.14, a variety of services are combined, reusing existing services from the service inventory to execute the desired business process.

3.4.3 Enterprise Architectures

Traditionally, technology architectures viewed individual or integrated applications and the enterprise as a whole, separately. With service-orientation, the enterprise-level perspective is dominant as it represents a master view of the service inventory.

A service composition architecture is now required which details the planned composition of services into new configurations. Message designs, messaging routes, exception handling and several policies need to be considered in making a composition automate a desired business process (Erl, 2007, pp. 95-96).

In the transition toward SOA, it is useful to make a clear distinction between a traditional legacy application and an application with a service-composition. The composition architecture can identify the service and point to the application architecture, which can identify the application (Erl, 2007, p. 96).

Since the effects of SOA and its impact on the organisation have been outlined, a study on the importance of SOA to the development of a single integrated architecture is required.

3.5 The Importance of SOA

As new requirements are introduced, organisations need to either make significant changes to current systems or build new applications altogether. According to Erl (2007, pp. 78-80), this introduces several problems:

- The creation of new solution logic often results in a significant amount of redundant functionality.
- By continually rebuilding logic that already exists elsewhere, the process is not as efficient as it could be.
- New or extended applications inflate an IT department's budget, resources and size to the extent that it becomes a significant drain on the overall organisation.
- Hosting numerous applications on different technology platforms can result in complex infrastructures and convoluted enterprise architectures.
- Integration between many disparate applications becomes a constant challenge.

(Erl, 2007, pp. 78-80)

After repeated generations of traditional distributed solutions, the severity of these problems has been amplified, which has motivated the conception of service-orientation. It combines successful design elements of past approaches with new design elements that leverage conceptual and technology innovation (Erl, 2007, p. 81). Many of the design principles mentioned earlier change the complexity of an enterprise resulting in:

- Increased consistency in how data is represented.
- Reduced dependencies between units of solution logic.
- Separation of concerns of underlying implementation details.
- Increased opportunities to reuse existing solution logic.
- Increased predictability, availability and scalability.

(Erl, 2007, p. 82)

SOA is an important consideration for those organisations that want to achieve large gains in productivity. The exciting part of SOA is the possibility of using it to completely change the way organisations create software. SOA can also be the backbone for communications between software from different people or vendors. It can thus address the huge integration problems faced by IT organisations today (TechTarget, 2006).

Organisations across the world are gradually embracing SOA, facing its challenges and taking advantage of its benefits (Malinverno, 2008a, p. 2). Schulte and Abrams (2006, p. 2) estimated that SOA would be used in more than 50% of applications designed in 2007 and more than 80% by 2010. The adoption of SOA is accelerating in response to escalating business requirements (Schulte & Abrams, SOA Overview and Guide to SOA Research, 2006, p. 3). The speed at which SOA is adopted depends on a complex set of factors, including attitude to change, availability of skills, currency of IT infrastructure, level of investment in IT and business pressure (Malinverno, 2008a, p. 2).

A service-oriented approach promotes the following distinct qualities:

- Increased reusable solution logic
- Reduced application-specific logic
- Reduced volume of overall logic
- Inherent interoperability

(Erl, 2007, pp. 82-84)

SOA is the pragmatic, foundational architecture that enables reusable, flexible, sustainable systems. According to Hurwitz, Bloor, & Baroudi (2006, p. 2), it is composed of three fundamental components:

- A flexible infrastructure with standardized interfaces.
- A set of business services.
- Business process management.

SOAs enable organisations to reuse existing IT infrastructure, leverage key business services based on existing IT capabilities and leverage established processes to bring the right services together in the right ways to solve business problems (Hurwitz, Bloor, & Baroudi, 2006, p. 2).

SOA transforms IT in the enterprise from a model of concatenated silos to a model where standardized, interoperable business services can be easily linked to match the business process they are designed to automate (Hurwitz, Bloor, & Baroudi, 2006, p. 2).

A primary goal of SOA is to enable business leaders to better evolve their businesses. Unlike traditional IT, SOA focuses on business drivers and aligns key IT assets with these business drivers. SOA approaches both business and IT from the point of view of reuse. Because business and IT are inextricably tied together, SOA holds the business and the IT view of the organisation simultaneously. SOA is about renewable, reusable, sustainable business and how to get there from where the organisation is (Hurwitz, Bloor, & Baroudi, 2006, p. 7).

Bittler (2009) recommends five ways that Enterprise Architecture (EA) - and thus SOA - can help organisations increase the business relevance of IT:

1. Reducing Costs via Better Efficiency

EA should be used to quickly analyse the integration issues in the organisation in order to provide further insight into projects and programs that should be cut where strategic alignment is low. EA can guide the consolidation and rationalisation of technology, information, processes and solutions to save money (Bittler, 2009, p. 3).

2. Retaining and Enhancing Existing Customers

Retaining existing customers and expanding those relationships are essential in managing customers effectively. The average cost of replacing a customer is higher than the cost to retain one. EA can increase the customer's value perception of the organisation through enterprise information architecture, which identifies areas where the organisation can offer improved access to information related to the products and services being bought from suppliers. Information and solution architecture can also be used to improve the sharing of information across the enterprise to enable a more holistic view of customers (Bittler, 2009, p. 3).

3. Attracting New Customers

EA can determine customer growth targets with added clarity. Information architecture would be used to produce models identifying data sources external to the enterprise. This data can then be combined with existing information to provide a future-state application portfolio. Sales personnel can be equipped with the information needed to impress prospects and win new business (Bittler, 2009, pp. 3-4).

4. Building a Responsive, Flexible Organisation

A highly agile EA is required in order to build a responsive, flexible organisation. The pace of business change is higher than ever and continues escalate. EA can help by focussing on creating carefully chosen and rigorously enforced interface standards. These interface standards improve the integration of processes, data, software applications and customer-to-supplier relationships. This enables flexibility to implement changes with minimum impact and risk to other parts of the organisation and other systems (Bittler, 2009, p. 4).

5. Maintaining Competitive Advantage

An EA can articulate a sustainable competitive advantage proposition for the enterprise and the implications in terms of the changes needed in processes, information, technology and solutions. EA guides projects, using requirements, principles, standards and models toward not only maintaining, but also evolving its competitive-advantage position into the future (Bittler, 2009, p. 4).

The above 5 principles show that EA is strictly about driving higher business value from IT. An EA utilising the benefits of SOA can improve the business value of IT via technology, information and solution architectures.

SOA enables the consideration of the dynamic operations of an organisation, not just a set of static requirements. This allows the organisation to expose information and data sharing and focus development on the best ways to improve overall operations (Fronckowiak, 2008, p. 1).

SOA lays the foundation for flexible, renewable systems critical to business longevity. The promise of SOA is compelling, but achieving SOA is challenging. Hurwitz, Bloor and Baroudi (2006, p. 10) provide ten aspects critical of SOA understanding:

- ***SOA is a journey.***

SOA is a journey of transformation that requires considerable planning and continual focus on optimizing processes will drive out cost, improve efficiency and reduce maintenance.

- ***SOA is technically elegant.***

SOA is based on traditional development approaches which have evolved to highly distributed computing environments that take load balancing, software distribution, security and data management into account, all of which are achieved incrementally through SOA.

- ***Manageability of the whole must be a priority.***

SOA will only work if organisations focus on the manageability of the whole IT resource.

- ***SOA requires defined business process.***

SOA will only work if it is implemented within the context of business process.

- ***The atoms of a business process are business services.***

SOA is based on leveraging business services that represent the business processes.

- ***SOA involves standard components.***

SOA assumes that each service component has a clearly implemented Web services interface based on standards.

- ***SOA demands different application design.***

SOA applications are a series of tightly defined services intended to be loosely coupled within a container.

- ***SOA requires containers.***

Business process must be contained in a well-defined process flow or application.

- ***SOA must be standardized.***

SOA requires standardization across all vendors' implementations of SOA.

- ***SOA facilitates change.***

Under SOA, change is the norm, as its intention is to give business the ability to change easily when needed. If an SOA does not easily accommodate change, it is flawed.

(Hurwitz, Bloor, & Baroudi, 2006, p. 10)

Using the above guidelines and concepts about the importance of SOA in an organisation, its benefits are now derived.

3.6 The Benefits of SOA

SOAs allow organisations to reuse existing IT infrastructure, leverage key business services based on existing IT capabilities and control established processes for bringing the right services together in the right ways to solve business problems (Hurwitz, Bloor, & Baroudi, 2006, p. 2). The main benefit is that SOA reduces the effort and time needed to change systems to support changes in the business (Schulte & Abrams, 2006, p. 3).

The vision behind service-oriented computing is extremely ambitious and therefore also very attractive to any organisation interested in truly improving the effectiveness of its IT enterprise. A set of common goals and benefits has emerged to form this vision. These establish a target state for an enterprise that successfully adopts service-orientation (Erl, 2007, p. 55).

3.6.1 Architectural Benefits

Service-oriented architecture (SOA) is emerging to provide an architectural solution for businesses and it has attracted great attention from both industry and research communities due to its promise of achieving innovative business value by minimizing the gap between software systems developments and the way businesses operate (Chung & Chao, 2007, p. 93).

The EA process plays an important role to demonstrate the improved business relevance and value of IT (Bittler, 2009, p. 2). This process promotes the overall IT environment as a network of services that communicate and intermingle with each other. Services, however, exist within a hierarchy of functions that brings structure to the composition and orchestration process for business applications (Beyer, Newman, Sholler, & Friedman, 2006, p. 3). The challenges of tightly coupled software are also addressed through SOA, in which an architecture that relies on the loose coupling of assets is envisioned (Bell, 2008, p. 1).

SOA also promotes increased intrinsic interoperability. The more interoperable software programs are, the easier it is for them to exchange information. Interoperability is specifically fostered through the consistent application of design principles and design standards (Erl, 2007, pp. 56-57).

3.6.2 Financial Benefits

On the financial front, SOA tackles budgeting and return-on-investment issues (Bell, 2008, p. 1). SOA can aid organisations in reducing development budgets through reuse of services. This means that the more services that are reusable from system to system, the greater the return on investment (ROI) (Franzén, 2008, p. 13).

Measuring the ROI of automated solutions is a critical factor in determining just how cost effective a given application or system actually is. Traditional, silo-based applications tend to get extended over time, resulting in potentially complex environments with intensive maintenance requirements. Service-oriented computing advocates the creation of independent solution logic that is useful for multiple purposes. This reusable logic fully leverages the intrinsically interoperable nature of services (Erl, 2007, p. 61).

3.6.3 Business Benefits

SOA provides the opportunity for organisations to get a huge strategic advantage by being able to change their IT infrastructure faster than before. This ability to shift the needs of the business quickly, will give organisations a better chance of survival in the long-term (Franzén, 2008, p. 13).

SOA bridges the gap between business and IT by widening collaboration and drawing together the expertise from business and IT (Chung & Chao, 2007, p. 94).

By abstracting the underlying business logic, SOA enables services to be wrapped, re-used, and orchestrated to give both IT and business far greater responsiveness, flexibility and speed of execution (Chong & Kulkarni, 2006).

SOA practices are designed to streamline, enable, accelerate and evolve client capabilities by providing a strong differentiating solution to address marketplace needs (EMS Consulting, 2007, p. 2).

SOA also reduces the burden on IT departments. The application of service-orientation concepts results in an IT enterprise with reduced waste, redundancy, size and operational cost. In essence, the attainment of the previously described goals can create a leaner, more agile IT department; one that is less of a burden on the organisation and more of an enabling contributor to its strategic goals (Erl, 2007, p. 64).

According to Erl (Erl, 2007), SOA fosters increased federation, vendor diversification, business and technology domain alignment and business agility.

A federated IT environment is one where resources and applications are united while maintaining their individual autonomy and self-governance. SOA aims to increase a federated perspective of an enterprise through the widespread deployment of standardized and composable services each of which encapsulates a segment of the enterprise and expresses it in a consistent manner (Erl, 2007, p. 58).

Vendor diversification refers to the ability an organisation has to pick and choose "best-of-breed" vendor products and technology innovations and use them together within one enterprise. By designing a service-oriented architecture in alignment with major vendor SOA platforms with service contracts as standardized endpoints across an enterprise, service implementation details can be abstracted. This provides organisations with constant options by allowing them to diversify their enterprises as needed (Erl, 2007, p. 59).

Although initial applications have traditionally been designed to address immediate and tactical requirements, it has historically been challenging to align applications with business needs when the nature and direction of the business changes. Service-oriented computing introduces a design paradigm that promotes abstraction through the establishment of service layers that accurately encapsulate and represent business models. By doing so, existing representations of business logic can be implemented as physical services (Erl, 2007, p. 60).

Another feature that benefits both the technological and business communities is a reduction of time to market and business agility (Bell, 2008, p. 1). Business agility refers to the efficiency with which an organisation can respond to change. An IT department can sometimes be perceived as a bottleneck, hampering desired responsiveness by requiring too much time or resources to fulfil new or changing business requirements. When service-orientation is applied throughout an enterprise, it results in the creation of services that are highly standardized and reusable and therefore independent of parent business processes and specific application environments (Erl, 2007, p. 63).

3.6.4 User Benefits

SOA also empowers users to have sufficient control over business processes through event-driven interactions among users and services so that the users can receive information and respond to the system in time (Chung & Chao, 2007, p. 93).

Business users are able to do what they need to do without involving as many technology people. Seamless orchestration of business processes across the organisation from a user-perspective is possible with a SOA implementation (EMS Consulting, 2007, p. 2).

3.7 Current SOA Challenges

While service-orientation can solve some of the most significant historical problems in IT, its application in the real world can have some serious impositions. It is necessary to be aware of these challenges ahead of time because being prepared is essential to overcoming them (Erl, 2007, p. 85).

3.7.1 Data Integration

Data integration has not begun to pursue a more active role in information delivery and management and as such, SOA implementations are avoiding the issue by treating data integration as a separate initiative. Business Intelligence and/or Data Warehousing, separately or in combination, are the most frequent drivers for implementing a data integration program. SOA and data integration are not tightly linked in most organisational planning, contrary to Gartner recommended best practices (Beyer, 2007, p. 1).

Most organisations believe their infrastructure is not ready to support SOA, as it includes more than just data integration. In fact, less than half of organisations worldwide consider data integration in any significant manner under their SOA efforts (Beyer, 2007, p. 5).

3.7.2 Complexity of SOA Implementations

One of the biggest advantages of SOA is that it enables business to operate more flexibly. Applications should be developed and changed more quickly because the organisation can utilise pre-existing services. However, this introduces complexity. The more services in the directory and the more communication between services, the more difficult SOA is to manage (TechTarget, 2006).

When implementing SOA, it is important to understand that it is not an application, and it is less about employing technology and more about building a competency (Malinverno, 2008b, p. 4). An SOA initiative will not be a success if it is not understood and used correctly by various applications and systems throughout the organisation (Lam & Shankararaman, 2007, p. 270). The implementation of the first SOA application will generally be as complicated and difficult as building any other application. However, subsequent applications and changes to the initial SOA application are easier, faster and less expensive because they leverage the previously built services (Schulte & Abrams, SOA Overview and Guide to SOA Research, 2006, p. 3).

Since SOA applications are composed of many parts, they are inherently more complex than traditional monolithic applications. SOA applications are more likely to be:

- Spread across many computers in distant locations
- Composed of separately maintained parts
- Running on numerous servers, programming languages and operating systems
- Subject to frequent change because of constantly changing business requirements

(Schulte & Abrams, SOA Overview and Guide to SOA Research, 2006, p. 3)

These requirements introduce complexity and challenges in governance, testing, configuration, version control, metadata management, service-level monitoring, security and interoperability. SOA is not the cause of these problems, but with the adoption of SOA these problems become apparent (Schulte & Abrams, SOA Overview and Guide to SOA Research, 2006, p. 3).

The service inventory in a SOA can consist of services capable of fulfilling requirements for multiple applications. This may introduce:

- Increased performance requirements
- Reliability issues of concurrent usage of services
- Single point of failure issues with excessive reuse of services
- Increased demands on hosting environments

- Versioning issues for service contracts

The design principles of service autonomy, service statelessness and service composability can help in solving these issues (Erl, 2007, p. 85).

3.7.3 Standards and the Design of Services

Design standards can be set to increase the consistency and compatibility of solution designs but are difficult to incorporate into an organisation with pre-existing policies. Architects and developers also sometimes believe that these standards can interfere with their ability to be creative and innovative in their solutions. The best way of incorporating some design standards is to communicate and educate to overcome the cultural resistance to this change (Erl, 2007, p. 86).

The best way to deliver services is to conceptualise a service inventory with a blueprint of all planned services, their relationships, boundaries and initial service models. This top-down approach requires a significant amount of up-front analysis and effort from many members of the organisation which may be restricted by budget and time constraints.

Iterative and phased delivery approaches are another option but not recommended as services may require more revisions later if the holistic blueprint is not visualized first (Erl, 2007, p. 86).

When considering all of the design principles, both the overall time and cost to deliver service logic is increased. The initial effort required to design and build services, as opposed to developing non-service-oriented solution logic may actually make the SOA approach seem counter-agile.

The most effective approach is to build SOA services in conjunction with maintaining old legacy applications, thus helping the organisation work toward a phased transition to service-oriented computing (Erl, 2007, p. 87).

3.7.4 Governance demands

The management and evolution of services in the service inventory is one of the most challenging aspects of implementing a service-oriented solution. Traditionally, applications were maintained by a single project team supervising a single business process. Services are, however, intentionally positioned not to belong to any one process as the service logic should repeatedly get utilized by other applications, processes and systems (Erl, 2007, p. 88). The widespread acceptance and adoption of these services may overwhelm the organisation's ability to manage and orchestrate the use of services throughout the environment (Hurwitz & Kaufman, 2008, p. 5). A governance structure is needed to control these issues and help the IT environment to adapt to changes in business (Erl, 2007, p. 88).

Since SOA is designed to cut through an organisation horizontally and vertically, it presents much cultural, cooperation, ownership and budget issues. Strong leadership must be in place, and executive support must be clear and evident in order for any SOA implementation to be a success (Fronckowiak, 2008, p. 2)

3.8 Successful SOA

Successful implementation of SOA relies on a careful and holistic approach to business planning. The promise of business agility, improved customer service and competitive advantage with SOA is genuine. What vary between projects are the time, cost and ease of SOA implementation (Fronckowiak, 2008, p. 2).

Successful SOA should focus on business process interactions and application interfaces, as well as the intricate incompatibility issues of data among the disparate IT systems participating in those processes (Chong & Kulkarni, 2006).

Using a set of best practices from the experiences of those organisations which have succeeded and the pitfalls to avoid from those which have failed, success in SOA can be realized earlier and more dramatically.

Franzén (2008) identifies exercising governance and the facilitation of reuse as the most essential ingredients to SOA success.

Governance and control are important for a successful SOA implementation and also a complex issue for organisations to manage. As SOA is adopted in organisations, the IT department is responsible for creating and managing business services. Business leaders understand the requirement to provide more structure and accountability as part of managing these valuable business resources (Hurwitz & Kaufman, 2006, p. 1). SOA governance is about providing methods and approaches that help organisations effectively create, manage and safeguard their movement to SOA. The approach requires collaboration across business and IT to determine what services will be used throughout the organisation (Hurwitz & Kaufman, 2006, p. 2)

From an additional perspective, when consumers request a service, they are often provided with a completely new service satisfying particular needs instead of being provided with existing services that facilitate reuse.

To fulfil the promise of SOA, superb governance mechanisms are necessary to break up organisational silos and maximize software asset reusability (Bell, 2008, p. 1).

Many of the success factors below focus on exercising governance with an SOA implementation, but can also assist in the facilitation of reuse.

3.8.1 Understand Goals and Objectives

Each business goal should be decomposed to identify how each goal impacts the way business operates on a daily basis (Hurwitz & Kaufman, 2006, p. 5).

SOA may turn out to be little more than a technological fire drill if organisations are ambivalent about the roles and responsibilities of legacy software in their existing and future development strategies. If organisations fail to tie together past, present and future software development initiatives; and if they disregard the contributions of previous generations of architectures to today's business operations, the SOA implementation will not be successful (Bell, 2008, p. 1).

The strategy and roadmap document explains the goals and objectives of the SOA implementation. It evolves through acquisitions and implementation processes and addresses the architectural view of the design, as well as risks, security and management issues. Creating a common vocabulary across organisational boundaries is important for providing a shared understanding of the services and information that will be provided (Fronckowiak, 2008, p. 4).

3.8.2 Central SOA Function

A coordinating unit should be used to govern the adoption of SOA. This unit can be responsible for reviewing projects and planning services in the architecture. Difficulties of providing direction and enforcing policies will be reduced and processes that promote the reuse of services will be established. This unit is often referred to as a SOA Centre of Excellence (CoE) (Franzén, 2008, p. 43).

A central unit accountable for the quality of services can ensure that all services developed achieve the right level of granularity and a satisfying level of reusability (Franzén, 2008, p. 48).

3.8.3 Principles, Standards, Contracts and Guidelines

Principles are required to determine how to develop services so that they can serve multiple business processes. Standards are vital to the success of SOA as they imply a common working environment for organisations to adhere to. A common classification of terminology, business rules and contracts are also required, stating what services are expected to be delivered.

Clear policies identify the model and architectures that will be implemented across the organisation. Security and risk mitigation is also assessed and these considerations are fed back into the policies. These policies should be driven by a central team and referenced to from all implementations of SOA in the organisation (Fronckowiak, 2008, pp. 4-5).

Such governance guidelines form the fundamental basis for decision-making. The solution is shaped and the way in which business and IT collaborate is defined (Franzén, 2008, p. 44).

There is a common misperception that unless design standardisation is achieved throughout the entire enterprise, SOA will not succeed. Although it is a critical success factor for SOA projects, design standardisation only needs to be realised to a meaningful extent for service-orientation to result in strategic benefit. The goal is not always to eliminate problems entirely, it is sometimes to just minimise problems by taking special considerations into account during service design. Design patterns exist for organizing the division of an enterprise into more manageable domains. Data standardization can then be more easily attained within each domain. Even though this does not achieve a global data model, it can still help establish a very meaningful level of interoperability (Erl, 2007, p. 89).

To effectively deliver standardized services in support of building a service inventory, it is recommended that organisations adopt a methodology specific to SOA consisting of structured analysis and design processes.

Within SOA projects, these processes are centred on business logic, which requires that business analysts play a more active role in defining the conceptual design of solution logic. This guarantees a higher degree of alignment between the documented business models and their implementation as services (Erl, 2007, p. 52). Figure 3.15 shows how collaboration practices differ from traditional to SOA projects.

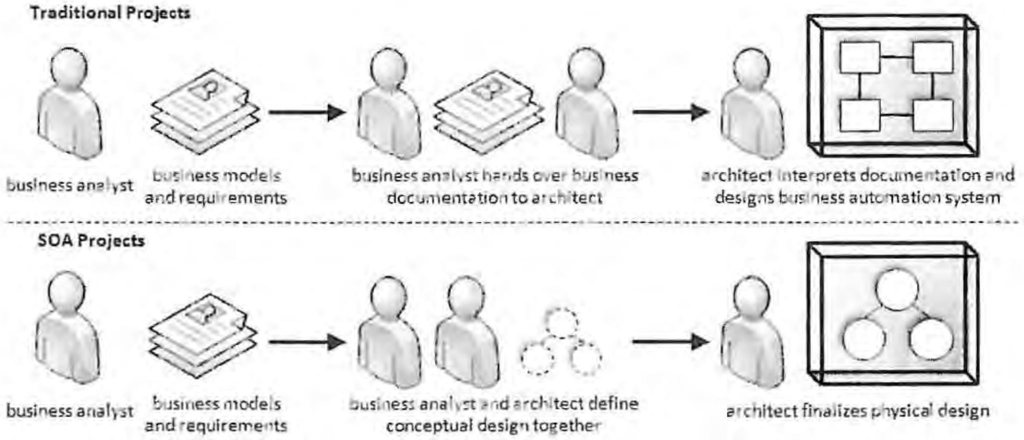


Figure 3.15: Changing collaboration between business and IT (Erl, 2007, p. 53).

Service-oriented processes use a set of predefined conceptual services that have not been implemented as a starting point from which they are shaped into actual physical service contracts.

Figure 3.16 depicts the traditional means by which Web service contracts are generated resulting in services that continue to express the proprietary nature of what they encapsulate.

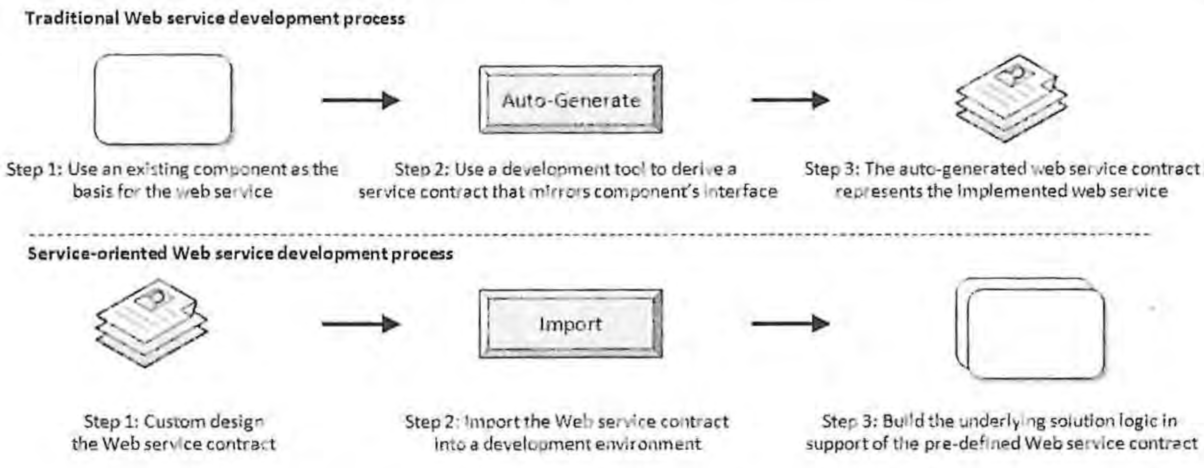


Figure 3.16: Changing development processes (Erl, 2007, p. 54).

By creating the Web service contract *prior* to development, standards can be applied so that the federated endpoints established by Web services are consistent and aligned. This "contract first" approach lies at the heart of service-oriented design and has inspired separate design processes for services based on different service models (Erl, 2007, p. 53).

Since the main benefit of SOA utilizes the reuse of services, it is important to maintain a directory of available services that is readily accessible so that developers are aware of existing services.

Organisations should also update existing services that need additional functionality. For example, a single "Get Customer" service should exist, rather than having several services that get different subsets of customer information (Fronckowiak, 2008, p. 6).

Setting such principles of how to develop services ensures that they can serve more than one specific need, thus also facilitating reuse (Franzén, 2008, p. 48).

3.8.4 Funding and Ownership

When certain applications need to expose services to others, financial and ownership structures need to be reviewed and adapted.

A financial model rewarding reuse may be established making consumers pay for the services they use instead of exposing services to business units.

Information owners responsible for certain services can also be nominated. They will be responsible for the processes and information contained in these services and know which business processes they address (Franzén, 2008, p. 45). Each business service should add value to the business and be consistent and predictable (Hurwitz & Kaufman, 2006, p. 5).

3.8.5 Communicating the SOA Vision

The organisation needs to understand and embrace the concept of SOA and the changes required in the transition toward the new approach.

Collaboration between business and IT units is required to attain a common view of how to develop this kind of architecture. A conceptual SOA cannot be realized unless it is communicated to the business users, developers, architects, business analysts, close trading partners and business and IT executives (Franzén, 2008, p. 46).

The governance and acquisition process must be flexible to meet the market's frequent changes. Organisations must collaborate with standards bodies and user communities to ensure the right implementation choices are made. Such governance should embrace open-standards, loose coupling and a modular service approach (Fronckowiak, 2008, p. 5).

3.8.6 Leadership

In successful SOA, someone needs to be in charge of and supervise what services are being exposed between different systems. Business units should not be allowed to develop their own services freely. They should collaborate with other units through an authoritative figure. Without the buy-in from the executives of the organisation and the political will to embrace change, it is impossible to succeed with SOA (Franzén, 2008, p. 47).

Leadership is extremely important in the face of cultural resistance, because users are moving from a comfort-zone state to one that requires cooperation for greater cross-functionality. An evangelist should promote the values in information sharing across the organisation and listen and respond to users' criticisms (Fronckowiak, 2008, p. 3).

Key to successful SOA is executive support and a development environment in which software reuse is encouraged (Franzén, 2008, p. 49).

The leadership, planning and design considerations are actualized in the operations and implementation of the SOA. Implementation should follow an agile development approach, in which services are built quickly and incrementally. Services that are the easiest to implement, but also provide the greatest business value should be focused on first.

Franzén (2008, p. 50) depicts a governance model in which the relationship between each of the above factors is visualized, as in Figure 3.17.

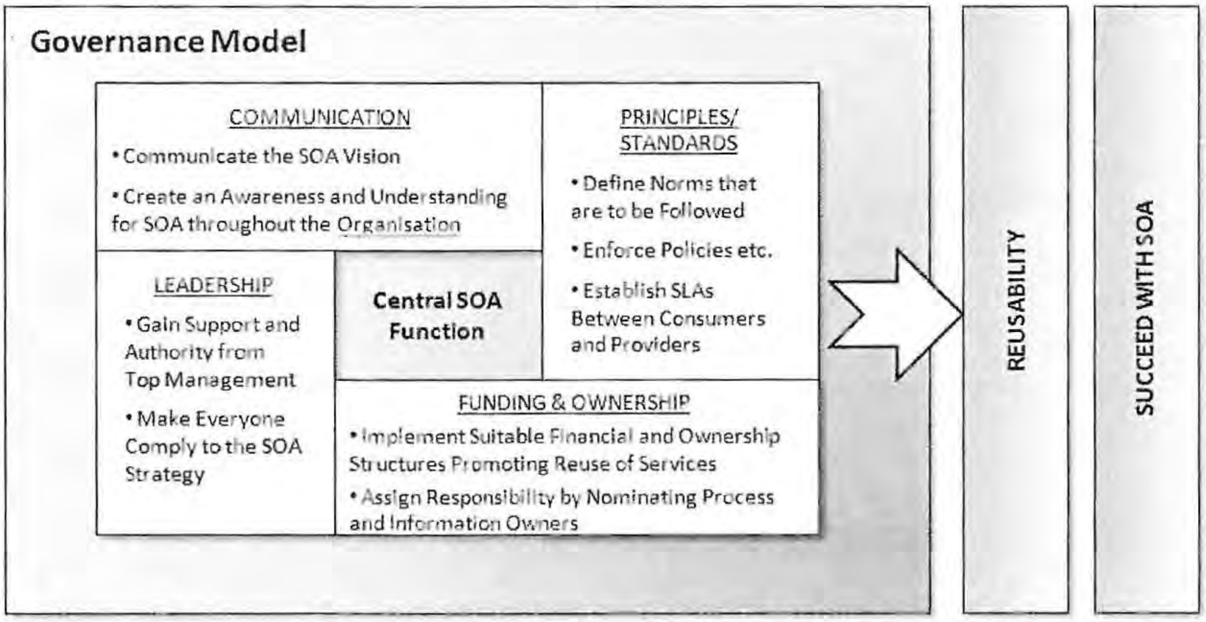


Figure 3.17: SOA Governance Model (Franzén, 2008, p. 50)

In the model, a central function is needed to govern, control and review the process of developing services. Leadership and authority is taken by defining and enforcing policies, standards, contracts and guidelines. Existing models for funding and ownership should be reviewed and revised to ensure the exposure and reuse of services. The central function should also be responsible for communicating what SOA is and how it can bring value to the organisation. By implementing this holistic approach to SOA, organisations will be better equipped to handle the difficulties of attaining high levels of reuse and to accomplish the successful adoption of SOA (Franzén, 2008, p. 51).

While IT governance is concerned with the overall operation of IT, SOA governance is the approach needed to create business services that will be reused throughout the organisation. SOA governance is about providing methods and approaches that help organisations effectively create, manage and safeguard their movement to SOA. Therefore, more than any other area of IT, SOA is an approach that requires collaboration across business and IT to determine what services will be used throughout the organisation (Hurwitz & Kaufman, 2006, p. 2).

3.9 A Framework for SOA

SOA resolves the inflexibility of existing IT applications without the need to remove and replace them. It creates a framework for the standardized integration of all aspects of the software environment, from the management of software through to the execution of business transactions. A framework for defining and implementing flexible, adaptable, end-to-end business processes is created through SOA (Hurwitz, Bloor, & Baroudi, 2006, p. 4).

Lack of software asset reusability standards, absence of software interoperability disciplines, and incoherent business and technology strategies drove the enterprise to establish a more suitable model that promised to foster business agility and increase return on investment.

This model also galvanized the development of SOA governance best practices, introduced SOA products and promoted new service-oriented modelling disciplines (Bell, 2008, p. xv).

The SOA Maturity Model has been developed as a 5-step framework for IT organisations to get to successive stages of SOA deployment, as in Figure 3.18 (TechTarget, 2006).

Figure 3.18: SOA Maturity Model

- *Level 1* defines simple Web services that an organisation needs to get started with SOA.
- *Level 2* specifies a set of standards and architected services that an organisation needs to foster reuse of software.
- *Level 3* applies SOA to business tasks using collaborative feedback to constantly improve the organisation.
- *Level 4* improves business services by following a top-down BPM approach.
- *Level 5* is the stage where organisations are so adaptive and responsive that they can change their processes in real-time.

(TechTarget, 2006)

This maturity model introduces a framework by which SOA can be adopted and implemented in an organisation.

Since the challenge of systems integration is also evident in higher and further education, we identify if and how a number of institutions have adopted or may adopt SOA to improve their integration problems.

3.10 SOA in Universities

In higher education, systems are required to support both administrative functions and those involved in teaching, learning and research. Systems developed in-house as well as those purchased from vendors need to work together to manage administrative and student-related processes (JISC, 2007, p. i). While some vendors provide a number of these systems, no single vendor can provide all the functionality required in an institution and so a range of common integration problems emerge between the offerings of a restricted set of system vendors. Institutions are confronted by a range of pressures to integrate an amassed set of systems, often with little coordination of purchasing or development decisions (JISC, 2007, p. 3).

University IT managers find themselves supporting, at a relatively high cost, a diverse array of computing platform and applications, each with its own programming language, tools and training requirements. Many higher education institutions use legacy systems that are difficult to integrate because individual departments are allowed to order and implement applications and machines on an ad-hoc basis, with little centralised control. These legacy systems make it cross-application computing difficult with a lack of easy-to-navigate interfaces and real-time access to data that is not redundant (Eduventures, 2006, p. 3).

University leaders are coming to the realisation that silos no longer make sense in the Internet age and they need to shift to a more web-based computing environment. These solutions can be solved through Web services where students, faculty, job applicants, staff and others can access the information required to complete a task quickly. Users no longer need to pull data from disparate, unfamiliar systems. The data can be brought forth dynamically from various applications and databases and streamed to campus users, regardless of the location or device used. A number of leading universities have embarked on implementation projects transforming obsolete architectures (Eduventures, 2006, p. 4).

3.10.1 The University of Wisconsin

The Division of Information Technology (DoIT) at the University of Wisconsin-Madison in the United States of America, spend a significant portion of its budget on integration and interfaces. They needed to get control over their enterprise data to ensure that campus users were working with accurate versions and only the official data they were authorised to access (Eduventures, 2006, p. 6). DoIT began transitioning to a SOA model because of the growing burden of managing multiple interfaces and communication protocols among complex enterprise systems. SOA was the suggested future integration architecture for this university, offering a way out of integration gridlock (Phelps & Busby, 2007, p. 56).

3.10.2 The Embry-Riddle Aeronautical University

The Embry-Riddle Aeronautical University used SOA as a solution to building better business processes for its global "extended campus", including 130 off-campus teaching facilities and a distance learning program with tens of thousands of constituents. The university combined key legacy and best-of-breed applications with Oracle systems by implementing SOA and making all these applications available to authorised campus constituents as Web services (Eduventures, 2006, pp. 8-10).

Other universities considering a SOA approach should identify small steps toward the larger goal to ensure success (Phelps & Busby, 2007, p. 58)

3.10.3 The University of Illinois

The University of Illinois decided on a SOA ERP project to provide campus departments with administrative, financial, personnel and student data. The data was shared between multiple disparate campuses in Champage-Urbana, Springfield and Chicago, as well as the online campus. Instead of accessing the departmental databases directly, SOA would allow access via JMS and Web Services protocols for each of the departmental applications. This allows the IT units to provide information in a secure and reliable way without having a huge impact on the ERP system's resources. Furthermore, SOA provides the ability to maintain and update the ERP system without impacting the hundreds of applications that interact with it (Seeley, 2008).

3.10.4 Cornell University

Cornell University had a collection of silos creating an integration burden for the IT team and inefficient business process for users. The department also had the added pressure of complying with the USA Patriot Act as existing systems were not agile enough to deliver real-time data access to students. Cornell's systems essentially duplicated central administrative systems and generated multiple versions of the same data. A SOA initiative was put in place with a focus on business process improvement to allow users to view data dynamically across silos with access to applications as needed. In addition, since the US Patriot Act requires data capture on specific types of students, Web services were assembled to extract data from existing data sets quickly and aggregate just the relevant data, thus facilitating and reducing the cost of regulatory compliance efforts (Eduventures, 2006, p. 11).

3.10.5 Northwestern University

Northwestern University implement a variety of different software systems including asset and facilities management, as well as those functions specific to higher-education. EMS Consulting-Intelligent Chaos embarked on a SOA approach to Northwestern's system development process. The SOA project promises a cost-effective alternative to investing into high maintenance, no reusable vendor specific ERP customisations, taking advantage of decoupled, more flexible and adaptable solutions. The university's business processes are being seamlessly orchestrated across the institution from a user perspective (EMS Consulting, 2007, pp. 1-2).

Since Web services and SOA offer standards-based, cross-platform computing, universities and higher education institutions are able to select among best-of-breed applications from diverse vendors and legacy systems. Universities can thus build and operate customised processes that conform to their unique needs without compromising the internal standards needed to maintain centralised data (Eduventures, 2006, p. 13).

3.11 Conclusion

Not long after the beginning of the current decade, organisations began to notice the benefits of delivering and executing their business processes through services via the Web. These services allowed organisations to leverage their existing systems by abstracting application and business logic from a service interface layer which enabled the execution of multiple business processes on different platforms. The use of design standards allowed an increase in the consistency and compatibility of SOA solutions, which enabled better integration between existing legacy applications. The SOA paradigm soon picked up interest and was established as a leading business and technology organisational concept, but its successful adoption requires careful consideration of governance and collaboration issues across business and IT. If SOA is applied correctly, it can naturally deliver sustainable businesses benefits by leveraging best practices and integrating application components together with business and technology interacting in seamless partnership.

Universities are realising that they need to make a shift from traditional silo-based applications to those more suitable for a web-based computing environment that allows students, faculty, staff and members of the public to access the information required to complete a task quickly and efficiently.

This chapter has outlined the importance of adopting SOA in an organisation today and elaborated on the many benefits of using a service-oriented approach to systems development. Understanding the concepts of systems integration and SOA can provide a foundation for developing a framework that identifies factors for successful SOA adoption in universities.

Chapter 4: Preliminary Framework

This chapter analyses how systems integration in higher education is measured and how organisations can test their need and readiness for SOA. Key factors that are considered across the literature are identified as part of the process of developing a preliminary framework of factors for successful SOA adoption in higher education institutions.

4.1 Introduction

SOA's success depends on its widespread adoption throughout an organisation, but very little systematic assessment exists of how best to measure systems integration and which factors should be analysed when planning the adoption of SOA in an organisation. While the previous chapters highlight issues of systems integration and the emerging adoption of SOA, this chapter analyses how systems integration can be measured and identifies factors that affect an organisation's readiness to adopt SOA.

This chapter initially explores an instrument by JISC (2007) used to measure the extent of systems integration in higher education. An SOA Self-Test by Hurwitz, et al. (2007) is also described which organisations may use to help them evaluate their need and readiness for SOA. Subsequently, a comprehensive review of factors relating to an organisation's readiness for SOA in order to promote its adoption is provided.

Finally, a preliminary framework is developed that identifies the key factors required for successful SOA adoption. It is concluded that this framework serves to inform this research study of the fundamental factors necessary for SOA adoption in higher education institutions.

4.2 The MUSIC report (JISC, 2007)

In 2006, the Joint Information Systems Committee (JISC) commissioned a research study in the UK based on the issue of effective integration of ICT-based information systems. The study was called MUSIC (Measuring and Understanding the Systems Integration Challenge in Higher and Further Education) (JISC, 2007, p. i). The research group developed an instrument to measure the extent and nature of systems integration in higher education; discovered organisational factors that encourage or inhibit integration; and explored its benefits and risks (JISC, 2007, p. i).

4.2.1 Methodology

The study used a variety of social-science techniques to extract feedback from its respondents in the form of a web-based survey for Information Systems managers; telephone interviews in twenty-nine institutions with these respondents and other senior managers; and site visits to five institutions (JISC, 2007, p. i).

The study aimed to answer a number of open-ended questions (JISC, 2007, p. 4):

- To what extent can the institution's systems share data?
- What demand is there for these systems to share data?
- To what extent do these various systems share data?
- How, technically, is such data sharing achieved?
- How is data-sharing related to business process integration?
- Is there an identifiable integration approach?
- How is responsibility for integration distributed and managed?
- Is there convergence, parallel paths, or divergence in approach across the sector?
- What are the attitudes and rationales underling this pattern?

4.2.2 Survey and Interviews

The web-based survey mapped the pattern and extent of systems integration and interoperability in the various institutions. A description of the variety of systems used are documented, as well as an indication of which functions are most typically integrated, along with the means by which integration is achieved (JISC, 2007, p. ii).

The key functions in a typical institution comprise administrative functions (Finance, Human Resources, Estates and Student Management) and teaching and learning functions (Library, Timetabling, etc), all of which require significant integration with the Student Management System. The extent of such integration looks at types or approaches of integration already in place (integrated internally on an ad-hoc basis or through strategic plans and projects), and attitudes of organisations to better integrating their systems using shared services, much like those enabled through the introduction of SOA principles (JISC, 2007, p. v).

The survey itself covered:

- The roles and responsibilities of the respondent and characteristics of the institution.

- The product and vendor (or in-house development) of applications for a set of nine standard functionalities (Finance, Human Resources, Estates, Student Management, Timetabling, Teaching & Learning, Library, Research Support, and e-portfolios)
- The presence of integration/interoperability between each possible pairing of these functions, and how it is achieved (e.g. data adaptor; periodic data dump; re-keying; portal/screen level, etc.).
- The respondent's attitude to systems integration (drivers, barriers, enablers).

(JISC, 2007, p. 5)

The survey was distributed via a web link in an email to three main contacts from each institution (head of IT, Corporate Information Systems representative and an IT strategist). The senior individual responsible for information systems was then identified and contacted by telephone.

The telephone interview was designed to explore the attitudes and rationales behind the patterns of integration indicated in the survey. The interview covered:

- Rationales, priorities, benefits and barriers for systems integration.
- Examples of integration experience and lessons learned.
- Proposed or attempted integration without success and the reasons therefore.
- Future potential for integration improvements.
- Collaboration between different institutions through shared-services.
- Overall criteria for successful integration, achievements and considerations.

(JISC, 2007, p. 7)

The site visits were used to gather more fine-grained detail about the experience of integration through on-site observations.

4.2.3 Results

Response Rate

Respondents noted that much of the requested information in the survey was not possessed by one person resulting in incomplete results. This highlights the problem of systems integration that is characterised by the way in which this knowledge is dispersed in silos across institutions (JISC, 2007, p. 5).

A trade off had to be made between the level of detail required in the responses and the likely response rate. The research group thus opted for quality of information knowing that the quantity of responses would be sacrificed (JISC, 2007, p. 5). It was thus not possible to extrapolate statistically from the survey responses to make confident assertions about the proportion of institutions in the UK that adopted particular technologies or approaches to integration (JISC, 2007, p. 5).

The research group eventually received twenty-nine responses from universities and twenty-one from colleges across the UK. The response was disappointing reflecting either the unwillingness or inability of respondents to engage with the project. Of the fifty responses, forty-six contained enough information to be used for analysis (JISC, 2007, p. 6).

Where the web-based survey concentrated on data level integration, the telephone interview covered integration at the level of business processes and in terms of the staff and student experience of systems. Respondents in the interview were helpful and eager to participate with the assurance that their identities would remain anonymous (JISC, 2007, p. 7).

Range of Systems

The web-based survey was used to identify the variety of systems used in each institution for key functions as well as which functions were most typically integrated and the means by which that integration was achieved.

It was found that higher education institutions use many IT-based information systems, some developed in-house, but most purchased from vendors. While vendors are able to supply the sector in a number of key areas (Finance, HR, Student Management, etc), no single vendor can provide all the functionality required by an institution (JISC, 2007, p. 8). Some of the noted suppliers of Finance systems were Agresso, CODA, ORACLE, SAP and Symmetry. HR systems were mostly supported by Northgate, while Estates systems were supported by MASS Systems and Planon, along with some in-house development.

Student Management and Teaching and Learning systems had a much more limited set of vendors. Student Management was mostly supplied by Tribal or through in-house development. Teaching and Learning systems were heavily dominated by Blackboard (JISC, 2007, p. 9).

Extent of Systems Integration

In order to measure the extent of systems integration in the various functional areas, a matrix of nine functionalities was elicited. Respondents were asked to indicate, for each possible pairing, if and how systems in their institution were currently integrated. First, only the presence or absence of the passing of data between systems was considered.

High levels of data sharing were evident between Student Management, Finance, Teaching and Learning, Library and Timetable. Furthermore the Finance and HR functions were also linked with each other. Less integration was, however, identified between Library, Teaching and Learning and e-Portfolios (JISC, 2007, p. 10).

Technical Method of Data Sharing

A number of methods by which systems interoperate were noted: the manual re-keying of data; periodic data dumps; portals; data adaptors provided by vendors; in-house data adaptors; data warehouses; and pre-integrated suites of systems.

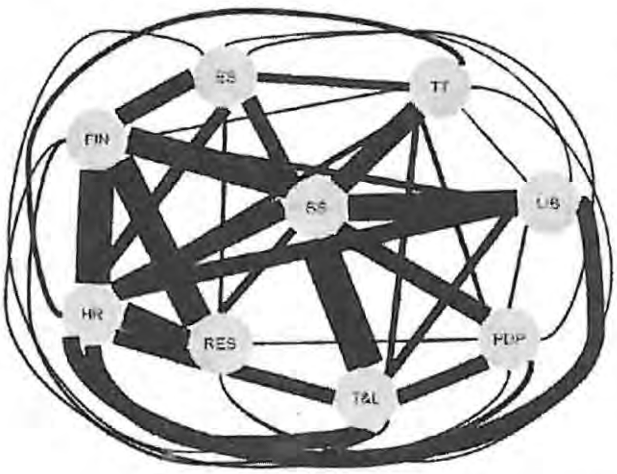
Respondents noted the technical method of integration between each pairing of the nine functions in the same matrix (JISC, 2007, p. 13). The traditional manual re-keying of data in these institutions was very rare, while the most typical method of sharing data between systems was noted as the use of periodic data dumps.

Each technical method of integration was then weighted in order to produce an indication of how tightly coupled the institution's systems were as shown in Table 4.1.

Table 4.1: Tightness of Integration Weightings

Means of Integration	Weight
A. Not applicable	0
B. Not integrated	0
C. Manual Re-keying	1
D. Screen/presentation level integration	5
E. Via Periodic direct data dumps	10
F. Via Period data dumps to a common "data warehouse"	15
G. Via Direct data adaptors	20
H. Via "Universal" data adaptors	25
I. Pre-integrated/same package	50
J. Other	0
K. Don't Know	0

An index was then calculated by summing the weighted values for each institution, dividing by the total number of institutions and then dividing by a constant. Figures with were then produced to indicate the tightness of integration between systems supporting the nine functional areas. The thickness of the lines between the circles indicates the tightness of integration between those systems. An example is provided in Figure 4.1.



Key

Fin:	Finance
HR:	Human Resources
ES:	Estates System
SS:	Student System
RES:	Research
T&L:	Teaching & Learning
TT:	TimeTabling
LIB:	Library
PDP:	Personal Development Planning

Figure 4.1: Tightness of Integration between systems (JISC, 2007, p. 15)

It is immediately clear from this diagram that, on average, universities are relatively tightly integrated, with a clear centrality of the Student Systems in these institutions (JISC, 2007, p. 15).

Demand for Systems Integration

The majority of respondents noted that integration is a priority for their institutions and an issue of increasing importance. The current state of systems integration was regarded as unsatisfactory and the users in these institutions requested change. The survey did not allow for in-depth perceived difficulties of integration, but respondents commented that institutions were moving toward more integrated systems while others indicated the barriers of further integration. Further insight was obtained through the follow-up telephone interviews conducted with a few of the institutions.

Interviewees discussed a diverse range of factors driving the tendency to consider integration issues. Among these were more accurate, timely and consistent information, minimised duplication of effort, enhanced user experience and business development.

The most significant barriers to achieving this integration were identified as a lack of user community engagement and ownership, resource and cost issues, lack of senior management support and a lack of data integrity appreciation (JISC, 2007, pp. 18-19).

Furthermore, the responsibility for data integration was considered as a matter for the IT department to instigate with a lack of stakeholder input and support. A number of respondents also complained of a general lack of support from vendors. Some also suggested that these vendors should collaborate much more with each other in order to overcome integration issues (JISC, 2007, p. 20).

Integration, it was identified, is inherently a risky process and respondents highlighted a number of these risks. Tight integration could lead to a propagation of errors; promises of integration could raise user expectations; vendors could fail to support the integration effort; and scope creep and control may cause problems on integration projects (JISC, 2007, p. 21).

Integration Strategies

Information System managers reported that their institutions did not follow formal integration strategies. However, integration was generally considered a feature of project plans relating to new systems development initiatives.

General approaches to integration were identified as some form of 'best of breed' approach, either through ad hoc integration of data dumps and adaptors or through a central hub or bus. Other approaches or patterns to integration are systems that are integrated in-house;

packaged from a limited number of vendors; or the emerging SOA strategy. The latter was noted as more of a destination than a currently existing strategy (JISC, 2007, p. 23).

Generally the pathways to integration are identified as a rough chronology in the following steps seen in Figure 4.2.

Figure 4.2: Pathways to Integration adapted from JISC (2007, p. 24)

These can be regarded as successive stages of systems development or a maturity model with broad currents of overlap. A general pattern of movement is identified which is characterised using the notions of residual, dominant and emergent approaches.

Building systems in-house is considered residual and an increasingly difficult option to sustain. Of the three dominant approaches (ERP packaged suites; best of breed with ad hoc integration; and best of breed with central coordination), the majority of institutions generally follow an ad hoc approach to their systems integration initiatives. The emergent SOA approach is considered the destination and clear future direction of systems integration strategies (JISC, 2007, pp. 24-25).

Furthermore, respondents were noted to be seeking much stronger external linkages in the domains of teaching, learning and research. The appeal of a SOA solution may allow such collaborative ventures to be more easily supported. Many institutions showed an interest in a 'shared services' model in which institutions supply information systems functionality, over the Web, as a service to other institutions.

The interest in SOA and shared services suggest a decomposition of the current, internally focussed systems integration challenge and the emergence of a new set of issues concerned with standardisation and the sharing of data and services either between departments in an institution or between independent institutions themselves (JISC, 2007, p. 25).

4.3 SOA Self-Test

Integrating data across business entities was previously done by creating a system of tight connections that were fixed. In many cases, they did not (and still do not) provide for two-way communication. Implementing SOA enables the business to share data across the organisation in a repeatable and consistent way (Hurwitz, et al, 2007, p. 158). Hurwitz, et al. (2007) discuss an SOA Self-Test that organisation's may use to help them evaluate their need and readiness for SOA.

Ten questions are solicited with answers based on a standard 1-10 scale. 1 if the question does not resonate at all with the organisation and 10 if the organisation is at the high-end of the spectrum. Each question also has a certain weighting as some factors are considered more important than others. The following table identifies these questions and their weightings.

Table 4.2: SOA Self-Test Questions adapted from Hurwitz, et al. (2007, pp. 200-206)

Question		Description	Weighting
1	Is your business ecosystem broad and complex?	Relationships between suppliers, customers and partners.	If > 2, add 5 points
2	Is your industry changing quickly?	SOA requires investment in time and effort.	If > 2, add 6 points
3	Do you have hidden gems of code?	Complex applications that drive competitive advantage.	If > 2, add 5 points
4	Are your computer systems flexible?	Modular applications that can easily adapt to change.	If > 4, add 3 points
5	How well is org prepared to embrace change?	Each department needs to collaborate with a beneficial plan.	If > 4, add 10 points
6	How dependable are services provided by IT?	Poor quality of service will hamper SOA effort.	If > 4, add 5 points
7	Can your company's technology support governance standards?	Need authorised people to lead the SOA effort.	If > 4, add 10 points
8	Do you know where your business rules are?	Rules may be embedded in code making them hard to find.	If > 3, add 10 points
9	Is your corporate data flexible and quality trustworthy?	The ability to move data out of its isolated applications.	If > 4, add 15 points
10	Can you connect software assets externally?	Plan for emerging opportunities with suppliers, customers, etc.	If > 3, add 5 points

A respondent scores each of the above questions on a scale of 1 to 10. If their score is greater than the value in the Weighting column, they add the corresponding number of points. For example, if for question 1, a respondent scores their organisation as being relatively broad and complex with a chosen value of 6, they can add 5 points to that score to make 11 for the first question and continue scoring themselves with the rest of the questions in the same manner.

At the end, the scores are tallied and the range of values are categorised within four levels of maturity. Maturity Level 1 describes an organisation that is not ready for SOA, while Level 2 organisations may begin their education on the benefits and potential of SOA. Level 3 organisations may begin planning their integration with SOA, while Level 4 views an organisation as possibly already using some form of SOA in their integration efforts.

Table 4.3: Maturity of SOA Readiness adapted from Hurwitz, et al. (2007, p. 206)

Level	Total Score	Maturity
Level 1	Under 34	The organisation is just not ready for SOA or SOA may not be the right approach for that organisation at all.
Level 2	34 – 116	The organisation may still not be ready for SOA but can be educated about SOA and gain an understanding of where the organisation is and where it should be.
Level 3	117 – 150	The organisation is at a good stage to start concrete planning for the movement to SOA and must concentrate on the questions where they scored the lowest.
Level 4	151 – 174	The organisation is in good standing and may already be somewhere along the movement to SOA. These expertises must be shared with peers or external partners.

Using the MUSIC study analysed in 4.2 along with the questions in the SOA Self-Test and a number of other considerations, we can identify the primary factors that affect an organisation's adoption of SOA.

4.4 SOA Factors of Adoption

SOA is not just about the architecture of systems development through the use of services. A number of other factors are all critical elements to successful SOA adoption and implementation (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 130).

4.4.1 Integration

The MUSIC report (JISC, 2007) explicitly identifies a number of factors that are taken into account when analysing the extent of systems integration in a higher education institution.

Types of Systems

The nine key functions of the institution are first identified as administrative (Finance, Human Resources, Estates and Student Management) and teaching and learning functions (Library, Timetabling, Virtual Learning Environments, E-Portfolios and Research) (JISC, 2007). The variety of systems used for each of the key functions is identified as well as an indication of which functions are most typically integrated with one another. Additionally, the proportion of systems developed in-house as well as those purchased from vendors needs to be determined (JISC, 2007).

Extent of Integration

A matrix of the nine functionalities is used to measure the extent of systems integration. Systems experts at the institutions indicate, for each possible pairing, if and how systems in their institution are integrated. The passing of data between systems as well as the technical method of that integration is considered.

The experts note the technical method of integration from a list of pre-defined methods between each pairing of the nine functions in the same matrix. Each technical method has a weighting, the combination of which determines how tightly coupled the institution's systems are with one another (JISC, 2007).

Demand and Drivers

The demand and drivers for integration are then discussed with the various systems experts at the institutions. The current state of integration as well as the institution's attitude to further integration is also considered. Factors driving the consideration of integration issues and its benefits are then noted.

Barriers and Risks

The most significant barriers to achieving integration are then identified along with the possible risks affecting the institution and its constituents. These risks may include tight integration, failed promises, lack of support and scope creep.

Responsibility

The responsibility for data integration is also considered and whether or not it is seen as a matter for the IT department to instigate. The potential lack of support from senior institution members, stakeholders or vendors is also noted.

Strategy

Furthermore, the institutions strategy to integration or lack thereof is identified. The stage of development of integration followed by the institution is classified as one of the pathways to integration identified in the MUSIC report (JISC, 2007).

Attitude to Further Integration

Finally, institutions are given the opportunity to reflect their attitudes to a SOA solution in support of more collaborative development ventures. The option of a shared services model, in which institutions supply information systems functionality through Web services to allow the sharing of data between departments, is discussed (JISC, 2007).

Determining the extent of systems integration and discussing its related factors is the most important step in an organisation's consideration of SOA as a solution for its integration issues. Once SOA is identified as a possible consideration for further integration, an organisation must then focus on getting enterprise-wide acceptance for the adoption of SOA.

4.4.2 Acceptance

Many organisations do not have the structure, skills and, in some cases, desire to make a transition to SOA. In recent years, these organisations have often struggled and invested substantial time and money without much success. It is clear that organisations not ready to pursue SOA would take a cautious approach (Sholler, 2008b, p. 15). SOA transforms business and IT culture, processes and language and is the embodiment of change, which is not always readily embraced (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 207). A number of factors should be considered in attaining enterprise-wide acceptance for the adoption of SOA.

Communication

The key to adopting a SOA solution is communication. Communicating the existence and relevance of SOA is essential to ensuring its successful adoption (Lam & Shankararaman, 2007, p. 270). IT team members should become savvy in presenting the needed overhaul to business leaders in order to create an environment in which everyone is working together throughout the implementation of the architecture. IT should communicate the benefits of SOA in non-technical business terms to win over the administration and business services departments (Phelps & Busby, 2007, p. 58).

Communicating SOA involves explaining the business benefits and knowing how implementing SOA will improve an organisation's ability to service its customers as well as how much it will cost, if it will pay for itself and how long it will take? (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 210).

In order for the sceptics of today to see SOA not as a silver bullet, but as an evolutionary step into the future of systems development, it has to be effectively sold and defended to senior stakeholders in the organisation. Management should be convinced that services can execute specific business processes following a set of rules and policies to implement them. This not only makes the systems more responsive to business needs but also makes corporate governance more predictable and less cumbersome (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 209).

The idea is to convince management about the overall enterprise scope of SOA, why it is better than the current approach and how they want all subsequent projects to adopt this methodology (Lam & Shankararaman, 2007, p. 264).

Education

Ensuring that the knowledge of SOA is well-understood and used by independent project teams is vital to its success. Seminars, technology update sessions and other relevant means should be adopted on a continual basis to ensure that all the key stakeholders of IT are aware of SOA as well as the immediate services that are in development (Lam & Shankararaman, 2007, p. 270).

Document and Market

The organisation's departments need to know that each stage of the SOA implementation will provide results and business benefits over a number of years. In order to ensure that everyone is engaged, the achievements of the initial efforts should be documented through reviews of benefits tied to both cost savings and revenue enhancements (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 214).

SOA case studies and success stories should be collected in the development of a comprehensive, enterprise-wide business case (Malinverno & Barnes, 2006, p. 2). The SOA team should prepare a business paper that puts forth the formal SOA proposal for management's approval. All the different aspects of enterprise SOA implementation needs to be considered. A solid understanding of current architecture, potential future architecture and various steps in achieving the desired architecture should be clearly defined (Lam & Shankararaman, 2007, p. 263).

Sponsorship

The majority of SOA adopters find their potential sponsors at the executive level. While a third of all sponsors are usually CIOs, other sponsors reside as CFOs and IT Directors. Acceptance of a SOA solution is often hindered by problems of financial justification. This affects funding and threatens plans for further implementation (Ritter & Evans, 2007, p. 3). The overall budget of the enterprise-scale implementation should be projected. This includes the projected budget for hardware, software licensing, professional services from vendors, effort and manpower required from the enterprise (Lam & Shankararaman, 2007, p. 263). Sponsors and stakeholders require confidence in the 'big SOA payoff' before it can be effectively funded and adopted (Ritter & Evans, 2007, p. 3). Senior business executives need to know how the conceptual benefits of SOA can be translated into strategic business benefits (Malinverno & Barnes, 2006, p. 2).

The SOA effort must be driven from the top. To adopt a SOA initiative, an organisation requires an individual with authority insisting that SOA is essential to the improvement of systems development (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 207). This individual will be responsible for the governance of the SOA initiative.

4.4.3 Governance

As organisations attempt to build cross-functional business processes, integration is necessary across multiple domains. This results in the need to bridge islands of technology (different integration methods and approaches) and islands of semantics (different business rules across departments). The main challenge is always governance, because processes are constructed across various spans of control (Sholler, 2008a, p. 9).

The Sun SOA Centre of Excellence solution offers a three-phase, comprehensive approach to institute governance over the delivery of identified SOA characteristics within an enterprise, addressing current and future business integration needs (Sun Microsystems, 2006).

Foundation

While many organisations begin to understand that SOA has the potential to transform the value of their IT assets, the ability to make SOA work is attributed to good governance. Governance requires a consistent process to ensure expected results (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 131).

The first phase focuses on building a shared integration design and runtime foundation in which the scope of governance in the organisation is identified. This can help jumpstart and support the adoption of SOA within the enterprise (Sun Microsystems, 2006).

IT governance involves managing the relationships and processes that control an organisation's use of IT resources so that such resources can better meet the organisation's goals (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 181).

SOA governance involves defining the core values of the organisation; how the organisation deals with its customers and partners; how it ensures fair treatment of shareholders; and how the organisation is structured to ensure business rules and policies are followed (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 132).

Standardisation

An organisation needs individuals who both understand the business as well as how SOA architecture is implemented (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 212).

During this phase, formal enterprise governance roles and responsibilities, people, and processes are identified to support a broader rollout of SOA within the enterprise (Sun Microsystems, 2006).

This is where all the high-level and enthusiastic talks about SOA begin. The enterprise usually formulates a task force consisting of members from various related departments to do enquiries about SOA implementation and select possible approaches and benefits (Lam & Shankararaman, 2007, p. 262). Governance issues are thus handled at the departmental level, defining who is responsible for what (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 132).

The SOA task force begins to understand all the characteristics of SOA from various books, vendors and reports. This phase involves a steep learning curve, but eventually these individuals will pioneer the rest of the journey in SOA implementation (Lam & Shankararaman, 2007, p. 262).

A SOA Competency Centre (SCC) may also be developed to run proactive meetings with project managers to dispel myths and assumptions and ensure that they are comfortable using SOA for their integration needs (Lam & Shankararaman, 2007, p. 270).

Building the right team for SOA is critical for success. Some adopters put more resources into retraining their existing staff than into hiring new people. The more money a company spends on SOA, the less they spend on hiring new people. Governance teams are universally put in place to manage the SOA process (Ritter & Evans, 2007, p. 4).

Enterprise SOA

As organisations get larger, enterprise-wide governance becomes less prevalent. This may be due to the complexity of governance across such a large and diverse body which makes the ability to govern services at the enterprise level an ambition (Sholler, 2008b, p. 13).

This phase is customised to support the broader rollout and optimisation of services and business processes based on business growth target needs, IT responsiveness initiatives, as well as internal and external partner integration needs and challenges (Sun Microsystems, 2006, pp. 1-2)

In traditional IT environments, business units usually make requests from the IT department and then wait for results. When results are late, unpredictable, or unsatisfying, business leaders blame the IT department for not meeting their business needs. Under SOA, the role of the business changes dramatically. SOA requires a business-led team which more easily understand what it means to create business value from IT. SOA spawns a new culture that fosters collaboration between the business and IT organisations (JISC, 2007, p. 213).

Furthermore, a SOA governance strategy is required in which each service contains the business policies, rules and regulations to ensure the appropriate execution of that service. The SOA repository stores information about what is inside each service, while the registry stores definitions of rules about the service. Organisations need to tie the integrity of these services to corporate governance which then becomes a collaborative effort (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 134). SOA needs to be part of the overall corporate decision-making process. Each business service should be defined and verified and both business and technical professionals should be involved at the corporate, departmental and IT level. It is the implementation and automation of policies and best practices that ensure the efficient running of an organisation's computers, applications or data (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 182).

A strong SOA governance strategy will prevent misunderstandings across departments in the future and set expectations across various stakeholders (Lam & Shankararaman, 2007, p. 265). SOA governance is thus closely connected with SOA acceptance and an analysis of both is essential before the consideration of a SOA initiative. Once the integration, acceptance and governance factors in an organisation are addressed, a focus must be made on the data transported and propagated across an organisation's systems.

4.4.4 Data

Much attention is given to how data is transported between an organisation's systems, but the manner in which this data is structured and validated is often neglected (Schekkerman, 2006).

Structure

Ensuring that an organisation's data is both consistent and accurate is essential before considering a SOA implementation. In order to achieve data consistency, data needs to be separated from its tight dependency on the business applications that create and update it. Organisations generally find data silos scattered across departments with the data designed only for a specific context or application. This approach may provide the right information to a particular business unit but inconsistencies are evident when spread at an enterprise level. It is thus difficult to make strategic decisions if data quality is poor and a complete view of business entities is prevented (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 154). It is important to structure data in terms of its business entities and allow disparate access to the data, while maintaining loosely coupled systems.

SOA changes the philosophy and the architectural framework for the data integration process. The key processes for bringing data together in a meaningful way include data extraction, transformation and load (ETL) to ensure that information can be extracted and used between disparate applications (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 157).

Semantics

The semantics of data refer to the rules that govern the meaning of data. These business rules can be spread across the organisation and differ between departments accessing the same bit of data. These semantic differences lead organisations to devote significant resources to interpreting and reconciling differences from various departments (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 154).

A significant objective of SOA is to provide more accurate information about the business to everyone involved. Ensuring data can be used independently from its implementation is important for viewing data as a reusable resource. In order to facilitate this independence, rules, plans and standards need to be set in place to govern the SOA implementation.

4.4.5 Plans and Standards

An organisation should know its intended future direction before starting a SOA venture. The future direction should be scoped out so that an organisation may be in a good position to take advantage of their potential success and move SOA forward (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 215). Business cases, transition plans and standards are all required to ensure that the organisation's intended future direction with regards to SOA is documented.

Business Case

Overall, the two major reasons that organisations choose not to adopt SOA are a lack of skills and expertise, and no viable business case. Many clients are faced with a great deal of confusion about how to construct a business case for SOA and those with a valid business case are often unable to support the required skills, costs and effort required (Sholler, 2008b, p. 15).

Gartner, in Malinverno & Barnes (2006, p. 3) suggest pursuing a much more gradual and progressive approach, which will incrementally demonstrate SOA value, generate support and help to produce a far more effective foundation for ongoing SOA initiatives. While this may require more time to transform core IT infrastructure into SOA, risk is minimal since each small project is linked to business value and quick returns.

Transition

The chances of a successful migration will be severely diminished without the use of a comprehensive transition plan. An organisation may need to redefine its entire IT infrastructure, resulting in a poorly executed migration (University of Camerino, 2006a, p. 29). Transition plans allow an organisation to coordinate a controlled transition to service-orientation and SOA characteristics so that the migration can be planned on a technological, architectural and organisational level (Schekkerman, 2006).

Creating a transition plan avoids the many problems associated with an ad-hoc adoption of SOA. Each plan, though, will be unique to an organisation's requirements, constraints and goals (University of Camerino, 2006a, p. 29).

Standards

In large organisations with a multitude of IT projects, the need for custom standards is vital. If different projects require differently designed applications, future integration efforts will be expensive and potentially fragile. SOA needs to thus be federated across disparate environments. SOA allows the abstraction of back-end implementation details so that it can execute and evolve independently within each application. However, as with other architectures, SOA requires the creation and enforcement of design standards for its benefits to be realised. This standardisation is required to ensure consistency in design and interaction of services that encapsulate this back-end logic (University of Camerino, 2006a, p. 28).

Once an organisation has an indication of its business case, plans and standards for SOA, an analysis of the organisation's current architecture and its management of services is required.

4.4.6 Architecture and Services

A SOA initiative cannot be a success if its architecture and the structure of services are not understood and used by various business applications and projects across the enterprise (Lam & Shankararaman, 2007, p. 270).

Current State

Understanding the fundamental differences between SOA and previous architectures is the key to avoiding a situation in which business and IT teams are unaware of the existence of their SOA infrastructure (University of Camerino, 2006a, p. 28). An organisation needs to identify and understand the performance requirements of the solution and the performance limitations of the current infrastructure ahead of time before building a successful SOA solution (University of Camerino, 2006a, p. 30).

Pilot Project

When piloting SOA, an organisation should pick projects that are relatively small in scope, which can quickly prove the merits of SOA (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 211). As the scope increases and more functionality added, the volume of communication and integration grows (Schekkerman, 2006).

The chosen pilot should provide enough room to test the waters of SOA like the speed of development, reusability and business agility. At the end of the pilot, the task force should be in a position to decide whether SOA can work for enterprise-scale implementations (Lam & Shankararaman, 2007, p. 263).

Good SOA pilot projects are highly visible and at low risk. High visibility relates to the importance of the project to the business to ensure initial funding and attention from the sponsors. Low risk refers to the project not entailing significant modification, extension or enablement of mission-critical business processes, thus minimising the amount of new technology used (Malinverno & Barnes, 2006, p. 4).

Tools and Vendor Selection

The SOA task force should communicate with various known and unknown vendors about tools and methodologies for SOA implementation. The preference usually goes to vendors with whom the enterprise has already been dealing with, but a careful analysis of known market leaders is advised and it is best to keep personal preferences aside and take a pragmatic look at who is leading the pack in terms of integration and implementation methodologies (Lam & Shankararaman, 2007, p. 263).

Services

A mistake that most organisations face when attempting to achieve SOA is building their service-oriented solutions in the same way in which traditional distributed solutions have been built. SOA is a distinct architectural model based on service-orientation following a distinct design paradigm. Understanding that services should be built around existing business processes instead of individual applications is critical to ensuring the solution is truly service-oriented and in alignment with the global SOA industry (Schekkerman, 2006).

Business services could easily be chosen and developed in the wrong way. For example, services could represent small business functions making them difficult to locate and reuse. Developers must thus understand that they need to work in collaboration with the business units to determine exactly what services need to be created and what those services should look like (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 213).

Organisations should extract knowledge and processes from individuals and transform that information into business services. Rules and processes that are scattered in different places across the organisation could be linked using an enterprise service bus based on the issues that are most important to the organisation (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 211).

Solidly linking each service to a combination of business and technology metrics and measuring project success against these metrics in a well-documented approach ensures that SOA is widely understood by IT personnel as well as business sponsors. Although this approach will result in a slower, more iterative adoption of SOA within the organisation, it will also help ensure that this adoption is evolutionary, less risky and ultimately far more sustainable (Malinverno & Barnes, 2006, p. 2).

Once an organisation understands its architecture and the services that it can construct, security issues need to be examined in the process of SOA adoption.

4.4.7 SOA Security

Traditional approaches to security in computing made use of passwords and permissions to grant access to mainframes and networks. Since the inception of the Internet, security issues have developed. Security has evolved to include firewalls, Virtual Private Networks (VPNs) Intrusion Detection Systems (IDSes) and many others. However, in the future, it will be vital to protect all the programs run and information stored on an individual user basis. Identifying the user requesting a particular task to be performed is vital (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 141).

Identity Management

IT specialists use authentication software to identify particular users either through password requests or IP addresses. Identity management systems are used to determine whether or not particular users are authorised to use certain programs or features before they are granted access. Users can access a variety of data, but they may be subject to rules that govern their authority on reading or writing that data (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 144).

Many organisations (and nearly all that are pursuing SOA) use identity management initiatives to create federated identities across applications (Sholler, 2008a, p. 19). With SOA, user credentials and access rights are required before any service can be invoked (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 147).

Security Policies

Security policies can be stored in the SOA registry along with the governance rules where users are authorised based on the business services they can access. Authorisation rules no longer need to be stored within applications; they can be stored in the registry along with the other metadata about that service (Hurwitz, Bloor, Baroudi, & Kaufman, 2007, p. 147).

Since SOA involves the linking of components that are spread across different computing environments, services are more vulnerable to attack than siloed applications. Organisations need to consider identity management; software and data authentication aspects; and audit trails before adopting a SOA strategy.

Finally, the adoption of SOA requires an analysis of the possible external opportunities that this venture may accumulate.

4.4.8 External Opportunities

As mentioned in the MUSIC report (JISC, 2007), organisations seek much stronger external linkages in their various core domains. These linkages generate a demand for information systems to support the activities which go beyond the boundaries of the enterprise.

Relationships

The appeal of SOA allows collaborative ventures between organisations that wish to make their business functions available to one another. This may allow increased collaboration and support of the relationship of an organisation with its external business suppliers or partners (Thompson, 2009, p. 2).

Shared Services Model

A 'shared services' model needs to be envisaged ensuring the connection of internal and external sources and the processing of information across business domains (Bell, 2008, p. 5).

This model should be developed in such a way that it addresses the issues related to transport protocols and security in communications through Web services as well as the standardisation of services and business rules between disparate departments.

The creation of shared services only has value when the services are actually shared. Therefore, scoping the services for the entire enterprise makes sense when trying to maximise the sharing of those services. However, actual sharing usually takes place within a domain or between closely related domains (Sholler, 2008b, p. 9).

Before SOA is adopted in an organisation, the combination of the above mentioned factors will ensure:

- That systems are adequately integrated
- IT's credibility with the business will grow
- The governance strategy is stringent and spans across the enterprise
- Data flows freely and accurately throughout the organisation
- Plans and standards are in place to ensure a successful transition
- The technology infrastructure supporting SOA will grow
- The management and proliferation of reusable services
- The security of users and the organisation is protected
- The external relationships of the organisation are controlled

4.5 Preliminary Framework

The factors and their corresponding elements required for successful SOA adoption are summarised in Table 4.4.

Table 4.4: Summary of Factors for Successful SOA Adoption

Systems Integration	• Types of Systems • Extent of Integration • Demand and Drivers • Barriers and Risks • Responsibility • Strategy • Attitude to Further Integration
Acceptance	• Communication • Education • Document and Market • Sponsorship
Governance	• Foundation • Standardisation • Enterprise SOA
Data	• Structure • Semantics
Plans and Standards	• Business Case • Transition • Standards
Architecture and Services	• Current State • Pilot Project • Tools and Vendor Selection • Services
Security	• Identity Management • Security Policies
External Opportunities	• Relationships • Shared Services Model

Using the factors identified and discussed above, a preliminary framework for the adoption of SOA in an organisation can be developed. This framework is diagrammatically represented in Figure 4.3.

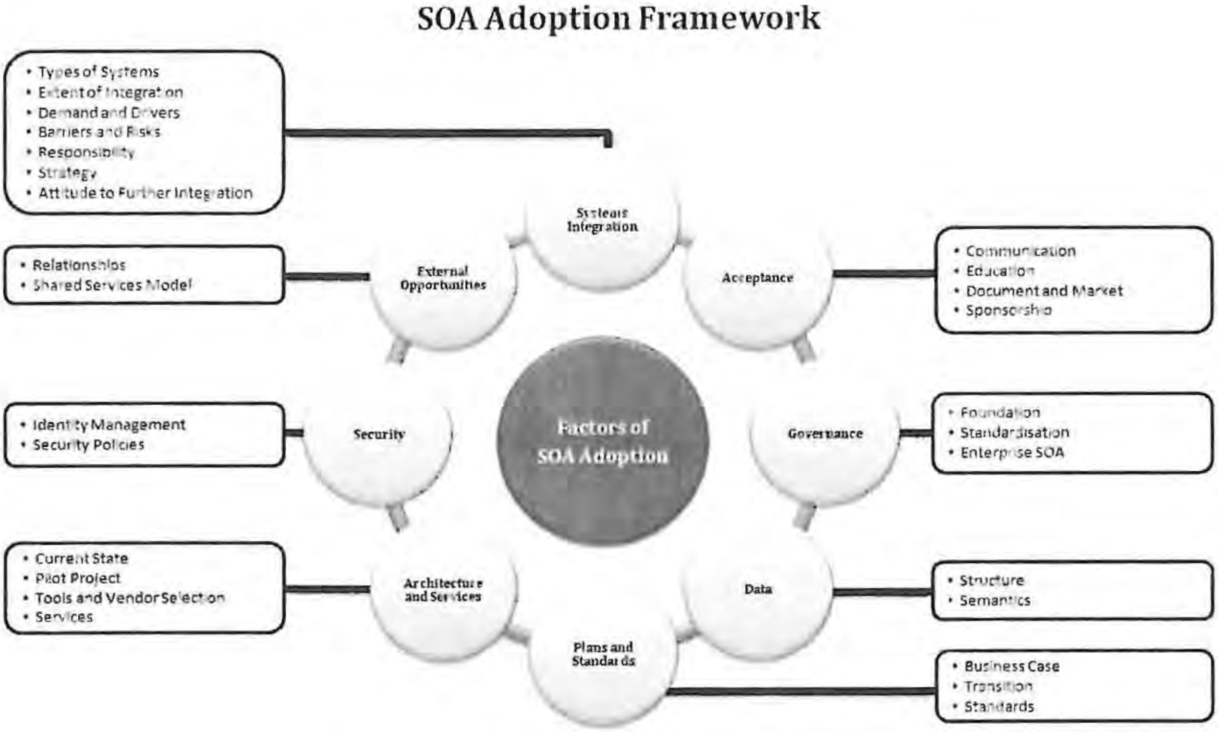


Figure 4.3: Preliminary SOA Adoption Framework

The framework comprises eight (8) factors:

4.5.1 Systems Integration

The extent of systems integration in the institution is measured by the replication of the JISC (2007) study. This involves taking into account a number of factors. The range of systems used and the technical method of integration in an institution are identified, as are demand and drivers for further integration; barriers to and risks of achieving integration; responsibility for integration; the strategy to integration; and the institution's attitude to further integration.

4.5.2 Acceptance

Organisational wide acceptance is explored with an enquiry of an institution's opinions about whether or not they are prepared to embrace technological change in order to promote the adoption of SOA. This takes into account the extent of communication between the business and IT departments; the use of regular seminars to educate key stakeholders and business about SOA; the documentation of developments; and issues related to the sponsorship and funding of new developments.

4.5.3 Governance

SOA governance is explored by determining the efficiency and effectiveness of the institution's current governance strategy. This is informed through an analysis of how IT governance is managed to ensure business rules and policies are followed (foundation); how roles and responsibilities are structured at the departmental level (standardization); and how governance supports the growth needs of the organisation (enterprise SOA).

4.5.4 Data

Data involves an analysis of the flexibility and quality of the institution's system data. This takes into account the structure of data in terms of consistency, flexibility and trustworthiness, as well as an analysis of data semantics in terms of the business rules that govern the meaning of data, which can be spread across the institution.

4.5.5 Plans and Standards

It is also important to discern whether or not plans and standards are followed with the development and adoption of SOA. An enquiry is made of the institution's use of business cases, transition plans and standards that ensure that its intended future direction with regards to SOA is documented.

4.5.6 Architecture and Services

An analysis of the institution's current system architecture and their attitude to services is also required. Here, it is important to determine how the institution identifies the performance requirements and limitations of future developments; as well as whether or not they make use of pilot projects, communicate with vendors and build services based on business processes.

4.5.7 Security

It is also important to identify various security and authentication policies and initiatives used in the institution. This involves an analysis of identity management tools and security policies that govern business rules.

4.5.8 External Opportunities

Finally, the institution's integration with external organisations can be explored. An enquiry is made of the collaborative relationships between the institution and other organisations as well as an indication as to whether or not the institution supports a "shared services" model.

Organisations need to be familiar and experienced with each of the factors mentioned, since it is the accumulation of all the factors that would ensure that an organisation is ready to adopt a successful SOA strategy.

4.6 Conclusion

Many organisations are overwhelmed by the potentially enormous impact of SOA on their integration approaches and the way in which they embrace, develop, govern and secure new systems and technologies. As a result, these organisations effectively delay any SOA-related initiatives based on a lack of clear guidance on how and when to begin.

A combined exploration of systems integration in higher education and factors that investigate an organisation's readiness for SOA highlight key factors that should be considered for the adoption of SOA. These factors include systems integration, acceptance, governance, data, plans and standards, architecture and services, security and external opportunities.

This preliminary framework serves to inform this research of the fundamental elements necessary to design a comprehensive theoretical framework of factors for successful SOA adoption in higher education institutions.

Chapter 5: Research Methodology

The research methodology adopted to explore the factors for successful SOA adoption in higher education is described. The research questions; research method; unit of analysis; research instrument; the approach to analysing data; and the research design are discussed.

5.1 Introduction

Yin (2003, p. 20) states that every type of research should have an implicit, if not explicit, research design. This will guide the researcher in the process of collecting, analysing and interpreting observations. The topics that need to be addressed are what research questions need to be studied, what data are relevant, what data to collect, and how to analyse the results (Yin, 2003, p. 21).

This research investigates the extent of systems integration in selected South African universities and explores the factors that affect the adoption of SOA through the observations of current integration practices. This chapter describes the research methodology and strategy to explore the factors for successful SOA adoption in higher education.

The qualitative and interpretive case study research methodology is chosen to enable an understanding of the evaluation phenomenon of systems integration with an exploratory strategy to identify the factors that affect the adoption of SOA. This chapter describes the research paradigm used in this study with a thorough investigation into why a qualitative interpretive approach is the most appropriate for the means of this study. The research questions and the research method are highlighted, including the research approach used; the unit of analysis; the research instrument; and the approach to analysing data. The chapter concludes with a summary of the research design in three phases. This design will guide the collection and analysis of data to present an exploration of the factors required for successful SOA adoption within higher education institutions.

5.2 Research Questions

This research has the intention of expanding knowledge and contributing to the understanding of which factors should be taken into account if an organisation is interested in adopting SOA to improve the integration of its systems.

The research questions that are studied will be used to determine the research methodology most appropriate for this research.

- *What is the extent of systems integration in the selected South African institutions?*
- *What critical success factors should be considered for the adoption of SOA in these institutions?*

It is important to understand how an organisation's systems are currently integrated and whether or not that has an effect on further integration to determine why they would or would not choose to adopt SOA. In order to answer these questions, it is important to understand the issues related to integration and the factors affecting the adoption of SOA from the perspectives of four selected South African institutions in order to expand on existing theory or develop new theoretical concepts (Hunter, 2004, p. 296).

5.2.1 Previous Research and Preliminary Framework

Many problems are evident with current approaches to integration. It is clear that SOA can improve this integration but first it is important to determine why organisations are still using older approaches and what is inhibiting them from adopting SOA. The review of literature showed the general attitude of organisations to integration and to SOA. Some factors and contextual elements influencing an organisation's adoption of SOA were also identified.

The problem of integration may be conceptualized as a process of socio-technical innovation (Rowlands, 2005, p. 85). This judgment is qualified through the review and discussion of definitions of integration, approaches to integration and technologies adopted as well as a case that is argued for the importance of integration when adopting SOA. By focusing on the problem of integration as a process of socio-technical innovation, an initial framework is developed which is comprised of the individual factors that contribute to the unexamined aspects of SOA adoption within organisations. This literature and framework provide valuable tools for the examination and analysis of the decision-making process when adopting SOA. Such a theoretical framework can be used as a base to make some explicit theoretical statements (Rowlands, 2005, p. 86).

This study is, however, not constrained by this framework and these concepts may also be considered as a purpose of the study. The development of a framework which aggregates the factors affecting SOA adoption are seen as a continuous building process (for future research), into appropriating a comprehensive framework for the successful adoption of SOA in an organisation.

It is important to determine the current extent of integration in an organisation as well as the general processes and additional factors that should be taken into account when an organisation analyses its integration and chooses to adopt SOA. This research identifies a need to enable the exploration and explanation of this problem to uncover the reluctance of organisations to adopt SOA and determine the factors that should be considered for successful SOA adoption.

5.2.2 Factors Influencing the Choice of Research Method

Little prior research has been made into using the extent of systems integration to determine an organisation's readiness to adopt SOA. Previous research following positivist approaches only helped identify some of the factors influencing the adoption of SOA and could not explain why these factors were dominant. Very little attention was given to the intentions, actions, context or processes surrounding integration approaches that explained how or why certain approaches were prevalent. Without more emphasis on the factors affecting SOA adoption, organisations would remain with their integration difficulties or attain a misguided understanding of how SOA can improve that integration. More attention should be paid to theory building, not theory testing, for describing and explaining why certain factors are important for SOA adoption.

Positivist research practices use an empirical-analytic paradigm which presumes that the research proceeds through the objective testing of hypotheses. This involves a process of deductive analysis to discover objective findings through scientific research methods (Gasson, 2004, p. 85)

Interpretive research rejects the very idea that one can be objective and neutral in research (Willis, 2007, p. 210). Instead, interpretive research assumes that the researcher participates by describing specific cases through narrative articulation and interpretation (Packer, 1999) offering a perspective that helps the understanding of a particular phenomenon (Willis, 2007, p. 190). This involves a process of inductive analysis to introduce subjectivity into research so that findings are not measured, but rather observed.

The aspects of the phenomena under investigation - the factors affecting the adoption of SOA – are too complex to define and measure with standard instruments. To gain greater knowledge, interpretive research proposes a method capable of capturing social meanings of integration as generated by the selected institutions. These phenomena will be understood by accessing the meanings that participants assign to them (Myers, 1997, p. 242).

This research does not predefine dependent or independent variables, nor does it set out to test hypotheses. It aims to produce an understanding of the social context of the phenomenon and the process whereby the phenomenon is influenced by the social context (Rowlands, 2005, p. 81). The possibility of an objective or factual account of events and situations is thus rejected (Rowlands, 2005, p. 84). This research instead seeks a relativistic, shared and deeper understanding of the factors involved in the adoption of SOA.

An interpretive and qualitative case study research strategy is thus chosen as the method best suited to investigating the extent of systems integration and an organisation's readiness to adopt SOA in a real-life context.

5.3 Research Method

Qualitative and interpretive research offers an approach to investigating subjects in their natural surroundings (Hunter, 2004, p. 292).

5.3.1 Qualitative and Interpretive

Interpretive research involves exploring and describing the decision-making process (Rowlands, 2005, p. 81). The decision making process of adopting SOA is assumed not to be an objective phenomena with known properties or dimensions. Interpretive research is thus consistent and compatible with epistemological assumptions that the world and reality are interpreted by people in the context of social and historical practices (Rowlands, 2005, p. 83). Experience of the world is subjective and best understood in terms of individual subjective meanings rather than a researcher's objective definitions (Rowlands, 2005, p. 83).

Since researchers are closely involved with research participants in a subjective manner, a concern about researcher bias arises. Questions in an interview may be posed in a certain way or certain aspects of the discussion may be pursued more or less intensively. This flexibility is beneficial in allowing the researcher to obtain relevant data. In the end, emphasis should be placed on the research method in order to counteract the potential introduction of bias (Hunter, 2004, p. 292).

Myers (2001, in Rowlands, 2005, p. 87) recommends that interpretive research should be guided by one or more social theories. This research is guided by a conceptual framework that is built on previous research. However, given that this study is based on theory building and not theory testing, the framework is used solely as a guide. It helps to further make sense of what occurs in the field in order to ensure that important issues are not overlooked, provided a set of provisional constraints to be investigated and guided interpretation are the focus (Rowlands, 2005, p. 87).

5.3.2 Case Studies

As this research involves exploration into a fairly new phenomenon, it is appropriate to analyse a range of cases to ensure that what is being described covers the field, at least in a preliminary way (Kelly, 1999, p. 381).

According to Yin (2003, p. 13), a case study is a method of inquiry used to investigate a contemporary phenomenon within its real-life context. The distinctive need for case studies arises out of the desire to understand complex social phenomena (Yin, 2003, p. 2).

Case studies focus on a particular context based on real people and situations. Data can be gathered using several techniques including observations, interviews, historical sources, journals and tests and provide a means of either confirming existing knowledge or discovering new concepts (Willis, 2007, p. 239). Case studies are used to gather rich, detailed data based on human behavior best understood as lived experiences in a social context where there is no need for predetermined hypotheses and goals (Willis, 2007, p. 240). These cases begin with an idea of what data will be gathered but the initial and tentative plans for data collection may change over the course of the research process (Willis, 2007, p. 241).

A case study method is used in this research to enable an understanding of the problem, nature and complexity of the integration process and the move to SOA and to determine valuable insights into new emerging factors that influence the adoption of SOA. This research will contribute to the general pool of knowledge by relating the findings from particular cases in selected South African universities to generalized theory which can be adapted to any organisation with integration issues (Rowlands, 2005, p. 83).

The case study used in this research is characteristically rich, as the empirical investigation is conducted at two levels of inquiry:

- An analysis of the systems integration challenge in four selected South African institutions. This investigation forms an essential understanding of the issues related to systems integration. A case study is thus appropriate for illustrating certain topics of evaluation in descriptive mode (Yin, 2003, p. 15).
- The exploration of factors affecting the adoption of SOA in these institutions. Research enquiry is based on an initial framework of factors which are modified and refined as data is collected and analysed throughout the empirical investigation.

This second level of inquiry serves as the main objective of the case study, to explore the factors affecting the adoption of SOA in selected South African universities.

Since the aim of this research is to gain an in-depth understanding of the factors affecting SOA adoption, it is appropriate to consider a number of semi-structured cases (Kelly, 1999, p. 382).

5.3.3 Unit of Analysis

Selected South African universities are chosen to represent several case studies, which represent an emerging and growing systems evaluation project in South Africa. There are no formalised systems evaluation processes in these universities, which provides a good case to determine the extent of systems integration using the MUSIC study (JISC, 2007), as well as an exploration of the factors that affect SOA adoption.

In conducting multiple case studies among selected South African universities, the aim is to expand and generalise the theory rather than enumerate frequencies (Yin, 2003, p. 10). This offers a situation in which case conclusions are determined based upon similarities and differences among cases involved in the study (Hunter, 2004, p. 296).

Making contact with respondents and gaining their cooperation requires a process of evaluation of potential respondents to determine whether or not they are suitable (Kelly, 1999, p. 384). Consent should then be negotiated with the respondents. Establishing trust with the participants requires a keen political sensibility and understanding of how power relationships are structured. The parameters, objectives and methods of the research should be agreed on at the start (Kelly, 1999, p. 385).

Ethical consent is also required for the study. In some way, the material being covered may be of interest to outside parties and disclosure thereof may be threatening to the participants concerned (Kelly, 1999, p. 385). It is unethical to ask participants to participate without fully informing them of what will be done with the results of the study. Sensitive research includes research into issues where there are strong social alignments and tensions, for example, between the business and the IT people of the institutions (Kelly, 1999, p. 386). Participants need to, at all times, be comfortable with the level of exploration and discussion and should be approached before hand and informed of the type of questions that are to be asked (Kelly, 1999, p. 387).

5.3.4 The Research Instruments

The main instrument that will be used in this research includes a survey within semi-structured interviews with systems experts at the selected institutions.

Interpretive researchers prefer the use of semi-structured or open interviewing methods which address the tensions between the life world, interview situation and the analytical framework (Willis, 2007, p. 245). These interviews allow participants to provide long explanations; deviations from the sequence of questions asked; and answers and opinions from other people. The researcher may suggest, agree or disagree with the answers given and interpret the meanings of the questions. The researcher is at liberty to improvise by adding question categories or making changes to the initial survey instrument where necessary (Willis, 2007, p. 246).

The interviews used in the case study are designed as follows:

a) *The type of Interview:* A semi-structured approach is adopted in which questions in the interview are structured but not restricted. The questions constitute an interview guide, with prompts to explore/probe for other information.
b) *The people to be interviewed:* Systems experts at four selected institutions in two South African provinces are interviewed to determine the extent of systems integration and explore the factors affecting SOA adoption.
c) *How the interview is conducted:* Individual interviews with participants are conducted, the approximate length of which is likely to be 45 minutes long.
d) *The interview equipment:*
    - *Recorders:* Either audio or video recorders to record the interview.
    - *Writing pad, pens, pencils, and highlighters:* For taking notes during the interview based on each interview question.

e) *Consent from the participants to conduct an interview:* An email or letter is sent to the participants to inform them of the research and interview. The letter explains the purpose of the interview and the relevance of the participant's perspective. Other aspects discussed in the letter include the type of questions to be asked, the type of interview, the approximate length of the interview, and the proposed dates of the interview.

In interpretive research, as and when data is gathered from the interviews, it is subsequently analysed. This method ensures that the collection, analysis and write up of data and results are all effectively integrated (Willis, 2007, p. 241).

5.3.5 Approach to Analysing Data

The theoretical orientation of the case study that relies on the application of the conceptual framework shapes the data collection plan and hence guides the analysis of data.

This research follows a grounded theory method to capture the interpretive experiences of participants and develop theoretical propositions from them. This method has been effectively used in recent IS research to develop the theory of IS practice (Rowlands, 2005, p. 87).

The data gathered from interviews is used to develop conceptual categories or to illustrate, support or challenge theoretical assumptions held prior to data gathering (Willis, 2007, p. 243). Elements of the data transcribed from interviews are coded into categories of what is being observed (Gasson, 2004, p. 81). Pattern coding may be used to reduce large amounts of data into a smaller number of units to identify an emergent theme (Rowlands, 2005, p. 88). Patterns and relationships between categories are then identified, followed by a write-up of initial ideas and interpretations concerning cross-category insights (Gasson, 2004, p. 82). These categories may then be refined as necessary. This entire process is iterative, constantly cycling between coding, synthesis and data collection.

Decisions about what data to collect next and where to find it are made according to the researcher's theory development needs (Kelly, 1999, p. 382). The literature review is used as a tentative theory with a basis from which to collect more data to test this theory. If the first collection of data extracted fits the previous theory, the researcher moves on to the next data collection. However, if the data extracted does not bare any similarities with previous research, the researcher modifies the theory so that it fits with the original as well as the new data which is checked against the collection of more data, and so on. The goal is to build a theory that fits with every set of data extracted and which can then be generalized (Willis, 2007, p. 306).

Patterns and similarities across all cases are then extracted. An unordered descriptive meta-matrix is used to cross-analyse the data. This method essentially assembles data from several cases in which the frequency of events are tabulated, drawing attention to dominant issues (Rowlands, 2005, p. 89).

The closure of this theory is guided by the concept of saturation which is reached when no new themes, categories or relationships emerge when collecting more data. Finally, formal theories from the data analyses are developed (Gasson, 2004, p. 84). This process ensures that results are simple, meaningful, broad, explanatory, generalized and internally consistent (Willis, 2007, p. 308).

Conclusions can be drawn from multiple sources of confirmation. Member checks are used to check emerging conclusions with participants involved in the case studies. Participatory research allows the active participation of participants in formulating research conclusions. Extended experience in the environment follows the notion that the more the researcher experiences the environment in each of the cases, the better the researcher understands the dominant topics under investigation. Peer reviews are used to attain the opinions of colleagues about emerging conclusions (Willis, 2007, pp. 220-221). Researcher journaling may be used to analyse the researcher's reflective views made during data collection and analysis (Lee, 1997, in Willis, 2007, p. 221). Finally, audit trails may also be used to document the research process from the gathering of data to the final write up. A record is kept of when ideas emerged along with the supporting data and how these ideas were refined and expanded (Willis, 2007, p. 221).

This research methodology is designed to guide the collection and analysis of data to present an exploration of the various factors, including integration, that affect an institution's readiness to adopt SOA.

5.4 Research Design

The research design for theory building as adapted from Yin (2003) and Eisenhardt (1989) (in Rowlands, 2005, p. 88) uses the interpretive grounded theory approach to multiple case studies which is followed in this study.

5.4.1 Phase 1 – Define and Design

- *Define study area, describe questions and create a conceptual model.*
  In this phase an initial start list of factors affecting SOA adoption are drawn from the preliminary framework. Since this research is non-linear, it does not proceed in a number of predetermined steps so theory and questions may change in unpredictable ways (Willis, 2007, p. 202).

- *Identify participating organisations and select cases*
  The participating organisations are gathered from the four selected South African universities. These institutions represent the four case studies under investigation.

- *Design data collection protocol and instruments to be used*
  Questions and key concepts are extracted from the preliminary framework and transformed into an open survey which will be used as a guide in semi-structured interviews with participants in each of the four cases.

- *Conduct pilot case*
  A pilot study is conducted with a participant from one of the cases, who assists in the preliminary testing of the framework, which is refined and modified as necessary. A second conceptual framework is developed based on the previous literature as well as the emergent data identified from the pilot study (Rowlands, 2005, p. 88). A pilot case helps to refine data collection plans with respect to both the content of the data and the

procedures to be followed (Yin, 2003, p. 79). This process is based on a relatively unstructured approach in preparation for a more structured approach to be taken in the main study (Kelly, 1999, p. 394).

5.4.2 Phase 2 - Data Collection and Case Analysis

- *Conduct case studies in the field*

  The refined framework is used to adjust the survey instrument which is then used in the collection of data through semi-structured interviews with participants in each of the four institutions. The study may involve periodic interviews interspersed with observations so that the researcher can question the subjects and verify perceptions and patterns (Willis, 2007, p. 208).

- *Write individual case reports and analyse data*

  Once data collection in the field is complete, it is analysed in each of the cases and reports are written identifying the emerging categories of data. Working with data during collection allows for emerging insights, hunches and tentative hypotheses which direct the next phase of data collection (Willis, 2007, p. 202).

5.4.3 Phase 3 - Cross-Case Analysis

- *Analyse and draw cross-case conclusions*

  Patterns and similarities across all cases are identified, after which a number of implicit conclusions about the emerging results are determined.

- *Shape propositions, confirm and sharpen emerging theory*

  The iterative process of extracting broad categories and concepts that describe conditions, events, experiences and consequences is used to provide empirically valid accounts of unique data and generalized patterns. Propositions are then made from the analysis of the emergent categories (Rowlands, 2005, p. 89).

- *Build theory and transferability to generalized cases*

  The propositions and discoveries are discussed in relation to literature to note consistencies with and discrepancies from earlier findings (Rowlands, 2005, p. 89).

- *Reach Closure*

  Any conclusions are made with the context fully in mind (Willis, 2007, p. 222). The extent to which each of the propositions is supported by previous research is indicated as well as the extent to which the research has added some new perspective (Rowlands, 2005, p. 89).

5.5 Conclusion

In this research, data analysis follows an interpretive and qualitative approach based on case studies through a number of interviews with systems experts in four institutions. The interviews are guided through two levels of enquiry: 1) An analysis of the systems integration challenge in selected South African institutions, and 2) The exploration of factors affecting the adoption of SOA in these institutions.

Once the extent of systems integration in each of the institutions is determined, interpretive grounded theory techniques are used to identify the concepts and factors relating to their readiness to adopt SOA. This research paradigm provides a guideline to effectively collect and analyse data in order to identify a framework of factors that affect the adoption of SOA in higher education.

Chapter 6: Exploratory Pilot Study

This chapter presents the details of an exploratory pilot study conducted through an interview with a systems expert at Institution #1. The extent of systems integration and the factors that affect SOA adoption at the institution are explored.

6.1 Introduction

Systems integration has been identified as a crucial part of an organisation's successful and efficient move to SOA. Other factors affecting the adoption of SOA are identified in a preliminary framework in Chapter 4. In order to further analyse and explore the factors of SOA adoption, an exploratory pilot study is conducted. The study involves a semi-structured interview with an individual who knows most about the systems used at Institution #1.

This chapter presents a brief design of the survey used in the exploratory study and its results. This is followed by an analysis of the results and a summary of the exploratory pilot study. Finally, it is concluded that the results of this exploratory study form the basis of reflections and enhancements to the preliminary framework before a comprehensive empirical investigation is conducted in all four institutions.

6.2 Survey Design

The survey is divided into four sections. Section A examines the current extent of systems integration in the institution. Section B identifies the institution's attitude to further integration. Section C explores factors affecting SOA adoption, while Section D details the demographics of the respondent and the institution. Section D was chosen as the last set of questions to be asked in order to ensure that the respondent is occupied with the most important questions of the survey first, thus supplying enthusiastic opinions and answers. The questions and their corresponding responses are recorded in section 6.3

6.2.1 Section A – Systems Integration

This section's questions are drawn directly from the MUSIC study (JISC, 2007). The variety of systems used at the institution is documented, as well as an indication of which functions are most typically integrated, along with the means by which integration is achieved.

The first four questions enquire about the systems in use at the institution, based on nine different functional areas shown in Figure 6.1:

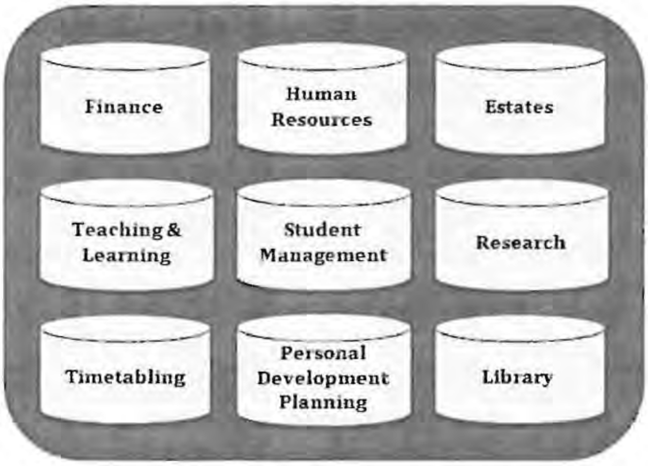


Figure 6.1: Key Functions in an Institution

The questions enquire about the system product and supplier used in each of the functions; whether or not the institution plans on replacing the system; and whether or not the system was recently implemented.

The fifth question, based on a matrix, is used to determine for each pairing of the nine functions, which primary integration approach best captures the institution's current approach. The integration approaches to choose from, as identified in previous chapters, are shown in Table 6.1:

Table 6.1: Integration Approaches

A.	Not Applicable	**F.**	Periodic Data Dumps (to centralized warehouse)
B.	Not Integrated	**G.**	Via Direct Data Adaptors (messages)
C.	Manual Re-Keying	**H.**	Via Universal Data Adaptors (central hub or bus)
D.	Portals/Screen Dumps	**I.**	Pre-integrated Suites
E.	Periodic Data Dumps (between systems)	**J.**	Other or Don't Know

6.2.2 Section B – Attitude to Integration

This section's questions are also drawn from the MUSIC study (JISC, 2007). Some questions were drawn directly, while others were adapted and additional ones that reflect the literature were included. The institution's attitude to systems integration and its current integration practices are documented, as well as its opinions on further integration practices and those involving service-oriented principles.

The first two questions in this section enquire about the institution's attitude to systems integration. The next seven questions enquire about the institution's current integration practices including favoured integration approaches, risks and barriers.

The following two questions extract the institution's drivers and opinions of a better systems integration approach. The final five questions are aimed at determining the institution's opinions about SOA and whether or not they have implemented or will implement such an approach.

6.2.3 Section C – Factors of SOA Adoption

This section is divided into eight subsections based on the preliminary framework of factors affecting SOA adoption. These are outlined in Table 6.2. The questions are based on each of the proposed factors and its corresponding literature in Chapter 4.

Table 6.2: Factors Affecting SOA Adoption

C.1	Acceptance	**C.5**	Architecture and Services
C.2	Governance	**C.6**	Security
C.3	Data	**C.7**	External Opportunities
C.4	Plans and Standards	**C.8**	Additional Factors

Section C.1 enquires about the institution's opinions about whether or not they are prepared to embrace technological change for a new innovation. Section C.2 is aimed at determining the efficiency and effectiveness of the institution's governance strategy. Section C.3 questions the flexibility and quality of the institution's system data. Section C.4 discerns whether or not plans and standards are followed with the development and adoption of new systems and technology. Section C.5 involves a discussion about the institution's relationship with vendors and attitude to business processes and services. Section C.6 identifies the various security and authentication policies and initiatives used at the institution. Section C.7 briefly identifies linkages to external organisations. Section C.8 finally enquires about additional factors that may have been excluded from the selection of factors affecting SOA adoption.

6.2.4 Section D - Demographics

The final section enquires about the respondent's job title and other relevant identifying characteristics, as well as general information about the institution itself.

6.2.5 Survey Delivery

An interview at the systems expert's office at the institution is conducted. Audio recording equipment and a copy of the questionnaire is used during the interview.

6.3 Results

The interview is conducted with the Data Manager at Institution #1. The identity of the Data Manager is concealed. The interview lasted approximately 90 minutes, 45 minutes over the predicted duration. The responses to the survey are discussed below.

6.3.1 Section A – Systems Integration

Section A.1

This subsection enquires about the main systems used for each area of functionality. Information about the main systems is extracted through the following questions:

A.1.1.1.Identify the system product and supplier.

A.1.1.2.Do you plan to replace this system in the next 2 years?

A.1.1.3.Was this system first implemented within the past 3 years?

A.1.1.4.If not yourself, who else is responsible for this system that we may be able to speak to?

The responses are highlighted in Table 6.3.

Table 6.3: Answers to Section A.1

Functionality	System Product/Supplier	Replaceable?	First implemented?	Contact
Finance	Omnix – iSoft Modified with Progress	No	±1996	-
Human Resources	HR Expert	Yes	±2002	-
Estates	Developed in Progress	No	±2000	-
Teaching & Learning	Moodle	No	+5 years	Identity concealed
Student Management	Developed in Progress	No	±1996	-
Research	Developed in Progress Not centralised	Yes - RIMS	+5 years	-
Timetabling	Developed in Turbo Pascal Loaded into Progress	Yes!	+10 years	Identity concealed
Personal Development Planning	Performance management (HR)	-	-	-
Library Services	OPAC – Externally integrated	No	±2007	Identity concealed
Other	Exam Timetabling – ITS	No	+2 years	-
	Switchboard	Yes	+5 years	-
	Residences – Self-developed	No	+5 years	-

The university uses the finance package Omnix, which is modified by using a software package called Progress. Progress provides innovative technologies to deliver flexible application infrastructures, extended visibility, real-time access to data and high-speed event processing. This package is used throughout the university to integrate the various functions and their respective siloed applications. HR uses a stand-alone system, HR Expert, which is to be replaced by a more powerful integrated system. Currently the payroll system is only integrated with the Finance system and not the HR system but it will be integrated once the HR system is replaced.

Interestingly, the Timetabling function is developed completely in Turbo Pascal and then loaded every year into Progress. Increased size and venue allocation issues with this system make it clear that it is outdated and needs to be replaced. The Library Services system, OPAC, externally integrates all the libraries in universities in the province. Moodle is a tool used for Teaching and Learning purposes and, like the Timetabling system, is completely developed and maintained by one person. Personal Development Planning for staff is executed through the HR system's performance management initiative. The Research system is currently undergoing the pilot phase for replacement through a software package called RIMS InfoEd, which promises to increase integration between systems.

Section A.2

In order to measure the extent of systems integration in the various functional areas, the respondent notes the technical method of integration, if applicable, between each pairing of the nine functions on a matrix. The codes for the technical methods of integration were identified in Table 6.1.

A.2.1. For each pairing of the main systems of functionality, please indicate which of the broad integration approaches best captures your institution's current approach.

The responses on the matrix itself are shown in Table 6.4. Some of the functions are abbreviated as follows: HR (Human Resources), T&L (Teaching & Learning) and PDP (Personal Development Planning).

Table 6.4: Matrix of Systems Integration Approaches for Institution #1

	Finance	HR	Estates	Students	Timetabling	Library	T&L	PDP	Research
Finance		E/B	I	I	A	B	A	-	I
HR			B	A	A	B	A	-	B
Estates				I	A	A	A	-	B
Students					E	E	B	-	I
Timetabling						A	B	-	A
Library							A	-	B
T&L								-	A
PDP									A
Research									

Since performance management is maintained through the HR system, as mentioned before, the Personal Development Planning function is no longer applicable.

Strong linkages using the pre-integrated package, Progress, are found between the Finance, Estates, Student Management and Research systems. These all share a common database from which required information is extracted.

As mentioned before, Finance and HR are currently not integrated, but Finance is integrated with the payroll system through periodic data dumps, which will ultimately be connected to the HR system. The payroll system will thus act as an intermediary between the Finance and HR systems.

The Student Management system is integrated with the Timetabling and Library systems through periodic data dumps.

Systems which are currently not integrated but should be integrated include HR and Finance, Estates, Library and Research; Finance and Library; Estates and Research; Students and Teaching and Learning; Timetabling and Teaching and Learning; and Library and Research.

6.3.2 Section B - Attitude to Integration

Section B.1

This subsection enquires about the respondent's attitude to integration at the institution.

B.1.1. Is systems integration a priority in your institution's IT strategy?

According to the respondent, integration is definitely a priority for this institution and an issue of increasing importance. The institution has been trying for the past ten years to continuously integrate its systems.

B.1.2. In your opinion, what are the essential goals of systems integration in your institution?

One goal of systems integration at this institution is having a single data entry point in order to be more business efficient and ensure less conflict with different data sets. The institution aims to ensure that information from one side of the university is easily accessible from any other part of the university, through the use of business processes and the Progress software package. A Data Management Policy is set in place in order to ensure that anyone who wishes to create a new database, must speak to the Data Manager first to ensure that the database is useful and if so, that it can be integrated efficiently.

Section B.2

The respondent is then asked about the current integration practices at Institution #1.

B.2.1. Are you currently satisfied with the level of your systems integration?

The respondent indicated that the institution will never be satisfied with its level of integration, because technology and business processes are always changing and it will always remain a continuous process of improving the systems and their integration - "a system that doesn't change is a dead system that no one is actually using".

B.2.2. Has systems integration proved to be difficult in your institution?

Initially the systems integration challenge was very difficult at this institution with a lot of animosity regarding the new databases and systems in place. It took a long time to convince the university that the data management unit can provide the systems, but they required financial backing and acceptance. Further conflicts about security between the data management unit, the IT department and the Information Systems departments need to constantly be improved and resolved.

B.2.3. Why would you favour a particular integration approach over any other approach?

Sometimes data dumps are the only way to pass data between systems that are located on different platforms and written in different languages. Direct data adaptors are also not always available to communicate between the different systems. Security and validation of data is also another issue when choosing an integration approach. Data received is often inconsistent and that is why data dumps are useful because the data can be validated before it gets integrated into the system.

B.2.4. Is there a strong pressure from users (students and staff) for more information systems integration in your institution?

In the respondent's opinion, the users should be satisfied with the levels of integration at the institution, but it must be made clear that integration is a continuous process of improvement and further integration.

B.2.5. In your opinion, what are some of the risks of systems integration in your institution?

Business owners do not appear to take ownership of their role in the integration process with a lack of documentation and responsibility for certain business processes.

Risks are also evident with the use of data dumps if the data is located on different servers for security reasons. Once information is dumped, there is no control over what is done with the information. Strong relationships between these departments are essential for efficient and secure dumping of data.

B.2.6. In your opinion, what are the main barriers to systems integration in your institution?

The technology barriers are the greatest with regards to integration. Each system is written on different platforms and owned by different vendors. Ensuring that the systems can communicate with these barriers is not easy.

B.2.7. Which committee or post has formal responsibility for systems integration in your institution?

The data management unit is responsible for ensuring that the data is useable and efficient but must report to the IT Steering Committee on a quarterly basis to promote and discuss certain features incorporated into the integration initiative.

Section B.3

The respondent's attitude to further integration practices is then determined.

B.3.1. Do you think that systems integration will become an increasingly important issue over the next five years?

It has been an issue for the past ten years and due to the changing nature of technology and business processes it should continue to be an issue.

B.3.2. In your opinion, what are the main drivers for a better systems integration approach in your institution?

The data needs to be at the right place at the right time for planning at all levels in the university.

Section B.4

The respondent's attitude to integration through service-oriented principles is briefly explored.

B.4.1. Has SOA been implemented in some part of your institution?

No.

B.4.2. Are you considering implementing SOA in some part of your institution?

Yes, it is hoped that Web services will be developed and integrated within the administrative functions.

B.4.2.1. In which part/s of your institution do you want to implement SOA?

It is hoped that the Student Management System will be better integrated through Web services. The current system used by students will be rewritten to use a Web service that will allow students to request data directly from the other core systems.

B.4.2.2. Why are you considering implementing SOA in your institution?

The data management unit could manage the data, while the Web developers could manage the Web interface. This ensures a separation of concerns with regards to the implementation of the Web service and furthermore, allows the students to have access to the university facilities and data from wherever they are.

B.4.2.3. How long do you expect the move to SOA to take?

The concept was first discussed in 2005, but it remains an ongoing process.

B.4.3. In your opinion, what are the driving factors that influence your adoption of SOA?

The institution wants to use SOA to streamline much of its business processes. They are at an advantage as they already have the tools available for a SOA implementation - Web Speed (part of the Progress package), which is used to help build Web services for business applications.

B.4.4. In your opinion, what are the barriers that inhibit your adoption of SOA?

Security issues inhibit the institution's adoption of SOA, as well as the fact that it involves a steep learning curve.

B.4.5. If you could alleviate any problems associated with SOA implementation, would you consider it an evolutionary approach to systems development in your institution?

SOA is definitely considered the next evolutionary approach to systems development.

6.3.3 Section C – Factors of SOA Adoption

The following subsections are aimed at determining the institution's attitude to the adoption of a new technological innovation, SOA or otherwise.

Section C.1 – Acceptance

A.2.1. How well is your institution prepared to embrace technological change?

The institution is sufficiently prepared. The IT department challenge the data management unit all the time, which are open to change and improvements in their strategy.

A.2.2. Explain the extent of communication between the business and information technology departments at your institution.

The communication between IT and business are very good. IT offers better ways of doing things and business readily enquires about them.

A.2.3. Does your institution hold regular seminars and technology update sessions to ensure that key stakeholders are aware of potential technological developments?

Update sessions are held with stakeholders only when necessary.

A.2.4. In your opinion, what influences the acceptance of a new technological innovation in your institution?

If the new innovation streamlines users' processes and saves them time, then they are willing to accept it.

Section C.2 – Governance

A.3.1. Does your institution follow some sort of governance strategy to bridge different integration approaches and different business rules across departments?

Yes, it is a centralised database management policy to make sure that the data management unit can connect all the systems and know which rules and procedures to follow.

A.3.2. Does your governance strategy effectively manage relationships between departments?

Relationships between departments manage the governance strategy.

A.3.3. Does your governance strategy effectively manage business rules and policies between departments?

The strategy ensures that rules and policies are followed but if a new request is made, either the strategy or the request is modified to suit both parties.

A.3.4. Is your governance strategy flexible enough to incorporate future growth?

Yes, the institution changes it as necessary.

A.3.5. In your opinion, what influences the governance of a new technological innovation in your institution?

Any system that has information flowing in or out of it requires strict governance.

Section C.3 – Data

A.4.1. Is your institution's data generally flexible?

The data on the main database (Progress) is very flexible.

A.4.2. Is the quality of data in your institution's systems generally trustworthy?

In most cases yes, however, there are areas where data quality may be compromised.

A.4.3. Do you often find inconsistencies in data sets that are spread across silos in the institution?

The institution doesn't often find inconsistencies but the data management unit is available for the purposes of detecting these inconsistencies and to put procedures in place to prevent them – as with the rollout of the integration between the HR and payroll systems.

A.4.4. Do you know where your business rules across all integrated systems are?

All the business rules that integrate the core systems are written in Progress. Each department is responsible for writing their own system's business rules, which the data management unit helps to integrate.

A.4.5. In your opinion, what influences the data of a new technological innovation in your institution?

The data of a new innovation is mostly influenced by poor front-end software with no validation business logic. The data needs to be validated with ownership of the data allocated to respective users.

Section C.4 – Plans and Standards

A.5.1. Are business cases constructed to promote the adoption of any new technological innovation?

There is not really a need to create business cases, but seminars are held with various departments to promote the adoption of a new idea.

A.5.2. Are transition plans used to coordinate controlled transitions to a new technological innovation?

It is absolutely vital to have plans to ensure the smooth transition from one technology to the next. These are generally written in a document which defines the processes involved.

A.5.3. Are design standards followed with the development of each new system or application?

The standards followed are based on each system developed and not on a formal standards document.

A.5.4. In your opinion, what influences the plans and standards of a new technological innovation in your institution?

Anything that is to be adopted has to have event-driven extractive data to allow integration with other systems.

Section C.5 – Architecture and Services

C.5.1. Are pilot projects used to test and prove the merits of particular technological innovations before their adoption?

Yes.

C.5.2. Do you communicate with and analyse various known and unknown vendors for your institution's integration and implementation needs?

Before the implementation of the current centralised database on Progress, a committee discussion was held in which the tool's features and abilities to meet the needs of the university were assessed.

C.5.3. Are the services provided by IT to the rest of the institution dependable?

The IT division is separate from the data management unit and the two should not be confused. The data management unit, however, does provide dependable services to the rest of the institution - "IT must not drive business, business must drive IT".

C.5.4. Are rules and policies scattered across the institution or accessible from some central system or enterprise service bus?

Rules and policies are on the university's Intranet, but business rules are written into the software as explained earlier.

C.5.5. Do you pay more attention to either integrating business processes or business applications in your institution?

The integration process is driven by the need to integrate business processes through the integration of business applications.

C.5.6. In your opinion, what influences the architecture and services of a new technological innovation in your institution?

Cost influences the adoption of new technologies. Since it is a small institution, they are limited by what they can afford.

Section C.6 – Security

A.6.1. Do you use identity management initiatives to identify individual users in your institution and govern their access rights?

The security for users is relatively limited. The IT department handles access on individual PCs, while the data management unit handles login accounts on a one-to-one basis. There is no central repository of information with read or write access roles.

A.6.2. Do you have software or data authentication policies that ensure only trusted applications are executed?

IT mostly manages the back-end integration processes and keys.

A.6.3. Do you use audit trails to regularly monitor staff or students to ensure that potential fraudulent activities are prevented?

Transaction audit trails are currently used. This can be used on the database but one cannot be sure of the impact it will have and so it is never used. Currently only successful transactions are logged.

A.6.4. In your opinion, what influences the security of a new technological innovation in your institution?

Having untrained people in the IT unit who do not know what they are doing could jeopardize the importance of the security of a new adoption.

Section C.7 – External Opportunities

A.7.1. Are your integration needs between your institution and external departments and organisations broad and complex?

It is not necessary to connect with other external systems. However, data can be easily dumped between external systems if required.

A.7.2. Can any of your institution's systems connect to software assets externally?

The OPAC system uses Web-based services to allow institutions in the Eastern Cape to connect to their database directly, but none of the institutions are integrated with one another directly.

A.7.3. Do you support the possibility of integrating your institution's systems with another institution?

If it is of any use to the institution, it will be supported. The problem is that every university uses different systems, but if a centralised system was available and was flexible enough to allow each institution to make changes, it may be useful, but we are still very far from this ideal. Each institution has such different requirements which give them their own edge and competitive advantage.

A.7.4. In your opinion, what influences external opportunities with a new technological innovation in your institution?

When technology changes too fast it is imperative to ensure that the staff change at the same pace - "Long term dreams and goals may be inhibited because the integration process is actually people reliant and not technology reliant".

Section C.8 – Additional Factors

No additional factors of adoption for a new technological innovation were identified.

6.3.4 Section D – Demographics

Section D.1

This subsection extracts demographic information from the respondent.

The respondent is the Data Manager of the Data Management Unit at Institution #1 and has been working in this position since 1995. The respondent reports directly to the Registrar of Finance and Operations and has managerial responsibilities for the provision of business systems and other general data sources.

Section D.2

This subsection extracts demographic information about the institution.

The university is a single campus university. It was merged with another campus, which was subsequently removed in the last ten years.

6.3.5 Further Comments

The respondent notes that the questions in the survey are difficult and it may not be possible to find people at other institutions with as much knowledge about the institutional systems and how they are integrated. Not all institutions have an internal unit that deal with the systems themselves. MIS units at other institutions do not often work very closely with IT, but rather with the business units, which means that they will not know much about the systems used or the technological changes they should be implementing.

SOA is a concept that institutions are working toward all the time, but the actual definition is not as well understood. The terminology and jargon used may be very confusing to other respondents. The questions are fairly repetitive as well, since each answer lends itself to questions that follow later.

6.4 Analysis of the Results

6.4.1 Response Rate

The respondent noted that much of the information requested in the survey is often not possessed by one person in an institution. It may therefore be necessary to discuss the survey questions with more than one person at each institution. A trade off may have to be made between the level of detail required in the responses and the likely response rate. Fortunately however, based on the preliminary framework, sufficient information was extracted from the respondent at Institution #1.

6.4.2 Section A

This institution uses a number of in-house developed applications, but most are developed and maintained by an off-the-shelf package, Progress. It is, however, evident that no single vendor can provide all the functionality required by the institution and so many applications still exist in departmental silos.

High levels of data sharing were evident between Finance, Estates, Student Management and Research Systems. It is interesting to see that the Finance and HR functions are currently not integrated with each other, but rather use a payroll system to pass information between them. It is also evident that there is no Personal Development Planning system in place for students whatsoever with very little integration between the Library, Teaching & Learning and Research systems. It may be useful to discern between which of these systems are core and supporting of the institution's main goals, in order to determine where integration should be focused.

The general approach to integration at this institution is identified as some form of 'best of breed' approach, either through pre-integrated databases or data dumps. Many systems are currently not integrated but a need for this integration has been identified.

6.4.3 Section B

The current state of systems integration is regarded as unsatisfactory owing to the changing nature of technology and business processes. Integration thus requires continuous improvement.

The goal of this institution is to ensure that its systems are business efficient with fewer conflicts between different data sets.

Integration, it was identified, is inherently a risky process with a lack of business ownership and security issues using data dumps as an integration approach. The most significant barrier to achieving this integration is identified as technology itself with each system written on different platforms making it more difficult to communicate with other systems.

Furthermore, conflicts between various departments about the best way to integrate data cause problems in the integration process.

This institution believes that data dumps are often the most efficient way to pass and validate data between disparate systems running on different platforms.

The main driver for a better systems integration approach is the fact that data should be made available at the right place and the right time to ensure the effective and efficient execution of the university's business processes.

The emergent SOA approach is considered the destination and clear future direction of systems integration strategies at this institution. The appeal of a SOA solution may allow for a separation of concerns between backend business logic of individual applications and their associated Web services. Business processes will thus be streamlined to ensure that users may access the university's data from any location at any time.

The interest in SOA and Web services suggest a decomposition of the current, internally focussed systems integration challenge and the emergence of a new set of issues concerned with security issues and knowledge about the new methodology.

6.4.4 Section C

The institution is open to change and improvements in their systems integration strategy provided the new innovation streamlines users' processes and saves them time. The university boasts a good relationship between the systems experts and business people that would enable such technological improvements.

The university follows a strict governance strategy in which rules and policies about the institution's systems are set by the data management unit. The unit does, however, ensure the modification of such policies when new business process requests are made.

The data used in the university's systems is generally trustworthy and flexible, but should inconsistencies arise, the data management unit is prepared to take action. Business rules are written entirely by individual departments and then integrated with other core systems within the central database. This ensures ownership of data and separates the concerns of implementation for the data management unit.

The institution does not appear to follow documented plans and standards with regards to new technological innovations, but treat each project individually and plan for the necessary transitions.

The university is under the firm belief that "IT must not drive business, but business must drive IT". The actual implementation of this statement is, however, difficult to attain. Services provided by IT must be dependable and in turn, support and ownership from business is required to ensure that business processes are efficiently integrated into the institution's systems.

The university does not use a central repository of security roles, but rather provides access rights on a one-to-one basis with each new user. Transaction audit trails also limit the detection of fraud in the institution's systems as only successful transactions are logged. These limitations may cause security issues in the institution, but plans are underway to improve the current security packages in place.

Since data can be easily dumped between systems, a need for external integration is not evident in the university. However, if external integration between universities proves useful, this institution will support the transition. Issues with different systems and business rules between institutions with their own individual competitive agendas make the idea seem improbable. Furthermore, since the adoption of new technologies involves reliance on people's acceptance and not as much on technology, long term external integration goals will be inhibited.

6.5 Summary of the Exploratory Pilot Study

The exploratory pilot study provided interesting and valuable insight into issues related to systems integration and the adoption of SOA. The analysis of the results can be grouped under the following two headings:

- Systems Integration at Institution #1
- Factors Affecting the Adoption of SOA

6.5.1 Systems Integration at Institution #1

The university's main systems are developed and maintained in a central database through a single off-the-shelf package. The HR and Finance systems are, however, not yet fully integrated and there is also a distinct lack of integration between systems that are used to support Teaching & Learning. The general ad-hoc approach to integration at this institution is achieved through pre-integrated databases or periodic data dumps.

The issue of systems integration at this institution is one which is constantly improved owing to changing technologies and business requirements. The risks involved in systems integration include issues with security, business ownership, inter-departmental conflicts and different and disparate technologies between systems.

SOA, however, is considered as the clear future direction of systems integration. The promise of SOA will ensure streamlined business processes and separated concerns between backend business and Web logic.

6.5.2 Factors Affecting the Adoption of SOA

The institution is open to change and improvements in their systems integration strategy, but do not believe that external integration initiatives will be successful, however useful they may appear. A strict governance policy is followed ensuring that the data in the institution's systems are flexible and trustworthy, with business rules written by individual departments and integrated into the central database by the data management unit.

Each new technological improvement is treated as a separate project in which IT and business work together to support and implement a successful transition. The institution's current security defenses are limited, but their plans to constantly improve their systems and software packages aid in their move toward efficient and enhanced systems.

6.6 Conclusion

The exploratory pilot study provides an understanding of the systems integration challenge at Institution #1 with an exploration of the factors that affect SOA adoption. A constantly changing and improved approach to systems integration is the resounding requirement that is confirmed by the exploratory pilot study.

A distinct lack of integration in administrative and teaching & learning systems highlights a need to distinguish between the core and supporting systems of the institution, in order to determine where integration should be focused in higher education.

The majority of obstacles to integration identified in the literature review and confirmed by the respondent, results in barriers to sufficient change, including a lack of security, business ownership, inter-departmental communication and technology constraints.

In accordance with the responses received, certain questions in the survey will be adjusted before a comprehensive empirical investigation is conducted in all four institutions.

Chapter 7: Theoretical Framework

This chapter details adjustments to the preliminary framework based on the results from the exploratory pilot study and proposes a new theoretical framework that identifies the key factors that affect the adoption of SOA in an institution.

7.1 Introduction

Following the preliminary framework introduced in Chapter 4 and the results of the exploratory pilot study presented in Chapter 6, a new theoretical framework is developed.

This chapter provides a discussion of the adjustments made to the preliminary framework based on observations made in the exploratory pilot study. This is followed by the proposal of a theoretical framework of the factors that affect SOA adoption. After further investigation, an important consideration involving the classification of core vs. supporting systems when analysing the extent of systems integration in an institution is also discussed.

7.2 Revisions to the SOA Adoption Framework

Initially, the preliminary framework categorised the analysis of systems integration equally with the other factors affecting SOA adoption. These factors could be addressed independently of one another and in any particular order. However, from the exploratory pilot study, it is evident that understanding the extent of systems integration in an institution is pivotal in the consideration of SOA and should be investigated before the other factors of adoption are considered. This provides a good starting point in understanding the systems integration requirements of the institution and effectively grounds its exploration of the other factors that affect SOA adoption, including acceptance, governance, data, plans and standards, architecture and services, security and external opportunities. Therefore, in the theoretical framework, systems integration is considered as a starting point in the exploration of factors that affect SOA adoption.

Another significant adjustment to the preliminary framework includes the union of two factors, namely Plans and Standards and Architecture and Services. Information obtained from the exploratory pilot study was not substantial enough to keep the two factors separate. Aspects extracted from the two factors relate to the development of new systems and are thus merged into a single Development Planning factor. Additional aspects covered in each of the previous two factors relate to business rules and policies, which are now subsequently included in the Governance factor.

The issues corresponding to each factor are also updated in the theoretical framework to reflect the questions addressed in the exploratory pilot study. The subsequent theoretical framework is presented in Figure 7.1

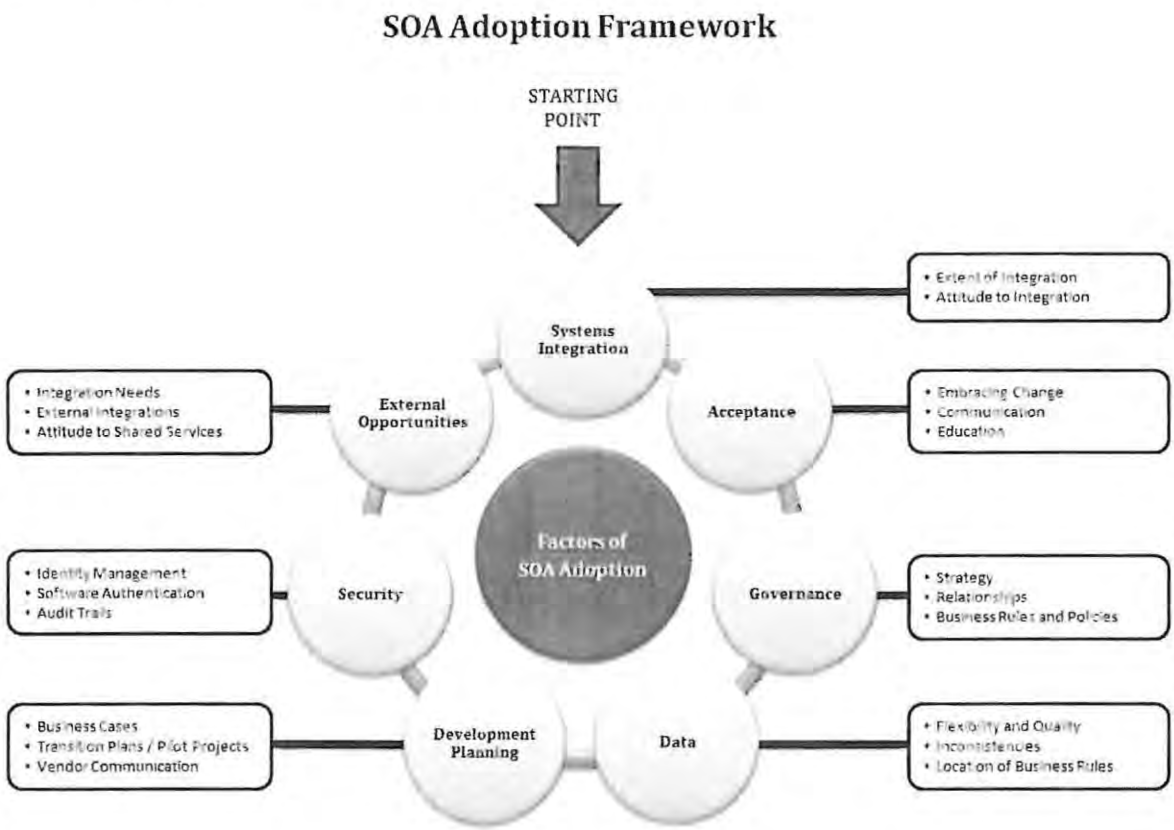


Figure 7.1: Theoretical SOA Adoption Framework

The theoretical framework presented in this chapter recognises that there are now seven (7) factors that affect the adoption of SOA in an institution, beginning with an analysis of Systems Integration, followed by an exploration of Acceptance, Governance, Data, Development Planning, Security and External Opportunities. Provided the extent of systems integration is investigated as a starting point, the remaining factors of adoption need not be addressed in any specific order, neither do they have any specific weightings related to their importance.

The important aspects of each of these factors are now described.

7.3 Systems Integration

The topic of systems integration can be broadly categorized in two sections: Extent of Systems Integration and Attitude to Integration.

7.3.1 Extent of Systems Integration

The extent of systems integration is determined through an analysis of systems used at an institution; which systems are most typically integrated; and the means by which integration is achieved.

The means by which systems integration between systems is achieved is based on a selection of previously identified integration approaches. Reasons why certain integration approaches are favoured may provide a valid indication as to why SOA has not yet been considered.

It is important to analyse which systems in an institution are most typically integrated in order to discern where problems of integration are evident. The exploratory pilot study identified a distinct lack of integration in administrative systems and those involved in Teaching & Learning, with no Personal Development Planning system in place for students. The previous chapters explicitly state a dependence on a suitable systems integration strategy before SOA can and should be considered. A lack of integration between "core" systems poses a threat for the consideration of SOA. However, it may be useful to first identify what constitutes core and supporting systems in a university environment.

Core vs. Supporting Systems

In 1990, Hamel and Prahalad introduced the concept of core competencies in an organisation. They discovered that those organisations that were focused on what they were good at and continually worked to build and reinforce their core competencies, developed more advanced products and services than those of their competitors and customers were prepared to pay more for them (Hamel & Prahalad, 1990).

According to Prahalad and Hamel (2003), organisations consist of core products and end products with core competencies stabilising everything. The core product is the intangible benefit expected by the customer and the end product is the final result or outcome of a series of processes. Core products contribute to the value of end products (Prahalad & Hamel, 2003, p. 8).

Based on the concept of core competencies as defined by Hamel and Prahalad (2003), the core mission of each of the institutions in this study needs to be determined.

Institution #1 strives to produce outstanding internationally-accredited graduates and contributes to the advancement of international scholarship and the development of the province and Southern Africa. Furthermore, the institution supports a research-based teaching and learning environment; access to relevant academic development programmes; inter-institutional collaboration within the province; community development initiatives; a student support system with a diverse array of residential, sporting, cultural and leadership opportunities; and a culture that fosters concern for the environment.

Institution #2 strives to be a dynamic African university, recognised for its leadership in generating cutting-edge knowledge for a sustainable future. They offer a diverse range of quality academic, professional and technological programmes that make a critical and constructive contribution to regional, national and global sustainability. The institution contributes to the development of its students through training and development of student leadership, coordination of student life and events and through the support of student governance structures.

Institution #3 aspires to become an academic meeting point between South Africa, the rest of Africa and the world. They take advantage of expanding global networks and a distinct vantage point in the country to deal with key issues through innovative research and scholarship. Internationally qualified graduates are produced, underpinned by values of engaged citizenship and social justice. A research-led identity ensures the development of teaching, learning and service to the community. They attract a diverse community of scholars and offer a rich array of social, cultural, sporting and leadership opportunities. They strive to expand expertise and networks in the country and around the world in an effort to strengthen higher education in Africa.

Institution #4 strives to create and sustain an environment within which knowledge can be discovered, shared and applied to the benefit of the community. They contribute towards building the scientific, technological and intellectual capacity of Africa with an active role in the development of the South African society. They promote the advancement of staff and students representative of South African society and the development of research, teaching, community service and management throughout the institution.

According to Prahalad and Hamel (2003, p. 7), a core competence is identified as one that provides potential access to a wide variety of markets; makes a significant contribution to the perceived customer benefits of the end product; and is difficult for competitors to imitate.

Competence in tertiary education enables each of the institutions to provide teaching, learning and research resources and development support for its staff, students and the community. The institutions attract a diverse community of scholars in an attempt to offer a rich array of opportunities.

The end product, in tertiary education, is the student graduate. According to the set of institutions in this research, the core areas promoting student benefits are teaching, research, community service, student support, shared knowledge and leadership, social, sporting and cultural opportunities.

While each institution has a complex harmonisation of strategies, their combined goal is to promote the development of well-educated graduates which are representative of South African society. The institutional strategies and methods of providing services to staff and students are, however, different and unique for each institution. This ensures that each institution maintains its own competitive qualities.

In the MUSIC study (JISC, 2007), nine areas of functionality are identified which adequately describe the major functions of generic institutions in the UK. These include Finance, Human Resources, Estates, Teaching & Learning, Student Management, Timetabling, Library, Personal Development Planning and Research. Using the core competencies identified in the above South African institutions, it is possible to distinguish between systems which are core to these institutions' and those which support them. These systems are categorised in Figure 7.2.

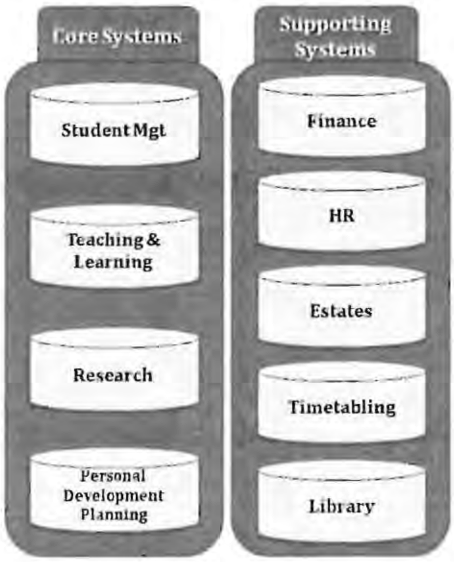


Figure 7.2: Core vs. Supporting Systems in an Institution

Core systems in an institution are defined by those core competencies that make a significant contribution to the perceived benefits of a student graduate. The student graduate is the final outcome of a series of processes that have determined the relative quality and success of the student.

Core areas that have a direct effect on the perceived benefits of a student graduate are Student Management systems, Teaching & Learning systems, Research systems and systems that relate to Personal Development Planning.

Supporting areas have an indirect effect on the perceived benefits of a student graduate. These areas may be vital to the successful functioning of the institution, but according to Prahalad and Hamel (2003), they only support the core areas mentioned.

These supporting systems include Finance, Human Resources, Estates, Timetabling and Library. These systems may not provide direct benefits to graduates, but they are necessary in the process of developing a qualified graduate in a South African institution.

It is important to use the classification of core and supporting systems when conducting the empirical study in order to determine where systems integration is focused in an institution. As mentioned before, the systems integration strategy used has a direct affect on whether or not SOA can and should be adopted. This investigation may influence the extent of systems integration at an institution and its inclination towards SOA adoption.

7.3.2 Attitude to Integration

Besides determining the extent of systems integration in terms of core and supporting systems, it is important to discern an institution's attitude to integration and to current and future integration practices, including the institution's perceived attitude to SOA.

It is important to explore the ways in which integration strategies are approached in order to understand the needs of the institution and its systems and also whether or not they are prepared for integration through SOA. An institution's risks and barriers to systems integration and their perceived drivers for a better systems integration approach will help in determining if the institution can and should attempt the move to SOA.

7.4 Acceptance

Acceptance is another factor that may influence the adoption of SOA. In this case, it is important to determine how well prepared an institution is to embrace technological change. This is discovered by analysing the current relationships and levels of communication between the IT and the business people at the institution. If an institution has good working relationships between departments and is able to embrace new technologies, it is well on its way to adopting SOA.

7.5 Governance

Governance in an institution relates to the strategies that are used to control institutional systems, the addition or modification of business rules and to an extent, the relationships between departments. A lack of an efficient governance strategy in an institution inhibits a successful move to SOA and therefore should be addressed before any change in architecture is considered.

7.6 Data

In order for an institution to ensure successful implementation of SOA, the data of its systems need to adhere to stringent criteria. In this case, an enquiry is made regarding the institution's data flexibility, quality, trustworthiness, inconsistencies, location of business rules and ownership. The assessment of these criteria will help in discerning whether or not the institution is data-ready for the implementation of SOA.

7.7 Development Planning

As mentioned before, the Development Planning factor merges the aspects of both the previous Plans and Standards and Architecture and Services factors. This section analyses the plans and policies followed in an institution's strategy for the development of new systems. An assessment of an institution's use of business cases, transition plans, design standards and pilot projects when considering new developments is made.

The relationship between the institution and its system vendors is also discussed, as are the services provided by the system experts to the rest of the institution.

Provided an institution makes use of extensive planning for each new technological development, building business cases and running pilot projects to promote the adoption of new technologies, it can be ensured that the move to SOA will be relatively straightforward.

7.8 Security

Efficient security measures that manage user and software authentication help to ensure that the institution's systems are protected from malicious or fraudulent activities. The active use of identity management initiatives, software authentication policies and audit trails helps to provide a secure environment in which SOA may be successfully integrated.

7.9 External Opportunities

The final factor for analysis in determining an institution's readiness for SOA involves the institution's attitude to external integration opportunities. An institution with a need to integrate its systems externally requires an efficient approach in place to allow such integration. While data dumps may be used to transfer information between externally located systems, SOA promises direct and non-redundant access to data sources. Before an institution considers SOA, it should identify the possibilities that are enabled for external integration.

7.10 Conclusion

The theoretical SOA Adoption Framework proposed in this chapter represents a synthesis of the various components required for successful SOA adoption. Revisions made to the preliminary framework emphasise that systems integration can be analysed as a starting point to set a foundation for the exploration of the other factors of SOA adoption. By investigating the extent of systems integration in terms of core and supporting systems in these institutions, it is possible to determine where integration should be focused in order to promote the institutions' adoption of SOA.

Furthermore, the framework presented provides the institution with the facility to assess their readiness to adopt SOA.

Chapter 8: Design of the Empirical Study

This chapter details the design of the empirical study. The empirical study is intended to further explore the theoretical framework proposed in the previous chapter. The design of the survey instrument is discussed in detail. A full copy of the survey is attached in Appendix A.

8.1 Introduction

The preceding chapters identify and describe various factors that affect the adoption of SOA. These factors are broadly categorised into Systems Integration, Acceptance, Governance, Data, Development Planning, Security and External Opportunities.

In order to further explore the factors for SOA Adoption and the relationship between the theoretical framework and the attitudes and experiences of institution systems experts, an empirical study is conducted.

The empirical study comprises semi-structured interviews with systems experts at four selected universities in two South African provinces. This chapter describes the final survey design including its structure and context. Each of the sections in this survey is based on previous literature and a review of the exploratory pilot study in Chapter 6. A full copy of this survey is included in Appendix A.

8.2 Survey Design

The survey is divided into two sections. Section A examines and analyses the factors of SOA adoption as described in the theoretical framework. Section B details the demographics of the respondent and the institution.

8.2.1 Section A – Factors of SOA Adoption

Section A analyses each of the factors of SOA adoption. The structure and layout of the section is outlined in Table 8.1.

Table 8.1: Section A

A.1	Systems Integration	
	A.1.1	Extent of Systems Integration
	A.1.2	Attitude to Integration
A.2	Acceptance	
A.3	Governance	
A.4	Data	
A.5	Development Planning	
A.6	Security	
A.7	External Opportunities	

Section A.1 examines the current extent of systems integration as well as the institution's attitude to further integration.

Questions in A.1.1 relating to the current extent of systems integration are drawn directly from the MUSIC study (JISC, 2007). The variety of systems used at the institution is documented, as is an indication of which functions are most typically integrated, along with the means by which integration is achieved.

Following further research, it is evident that institutional systems need to be classified as either core or supporting in order to determine where integration should be focussed. Core competencies are extracted from the institution's mission, while areas which are considered administrative, support the institution's mission.
The nine different functional areas are categorised in Figure 8.1.

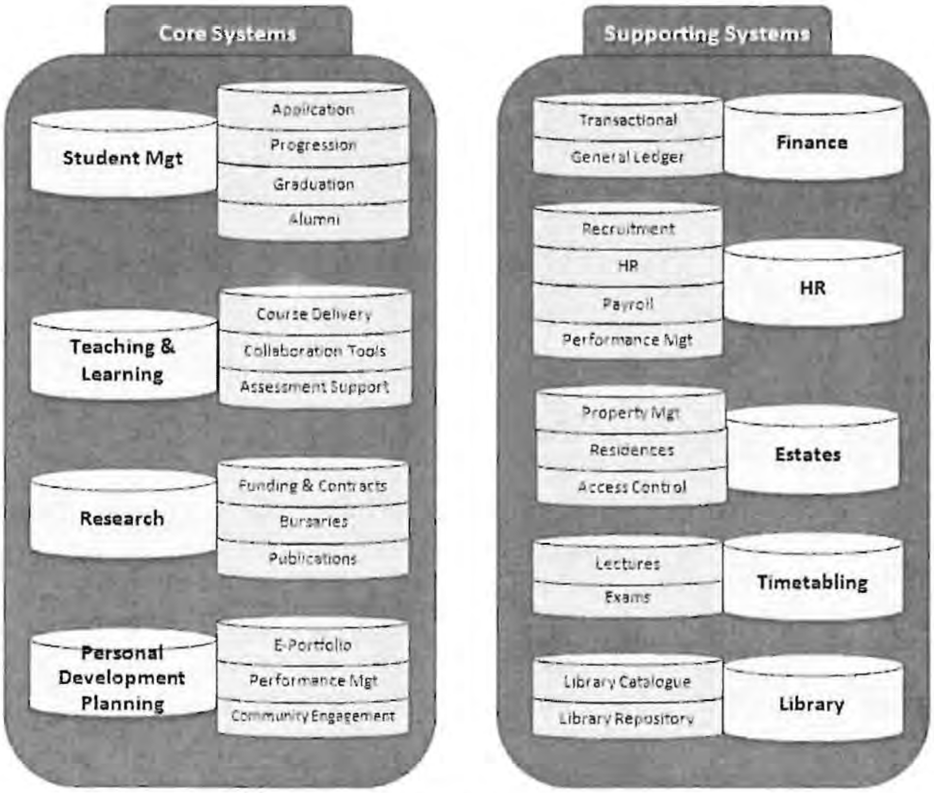


Figure 8.1: Core vs. Supporting Systems in an Institution

Core areas are defined as those which contribute to the personal growth of the student graduate, in both intellectual and social capacities. Based on our previous functionalities, these core systems are found in Student Management, Teaching & Learning, Research and Personal Development Planning.

Within each of these core systems, an institution may have one or a number of sub-systems that effectively enable the implementation of each of the core areas.

Student Application, Progression, Graduation and Alumni benefit graduates during and after their time at the institution. Course Delivery, Collaboration Tools and Assessment Support are tools that benefit students in Teaching & Learning. Research Funding & Contracts, Bursaries and Publications benefit students in their Research endeavours. E-portfolios, student Performance Management and Community Engagement initiatives directly benefit a graduate's Personal Development Planning in the institution.

Supporting areas are those which are necessary to support the administrative and core functions of the institution. These supporting systems are found in Finance, HR, Estates, Timetabling and Library.

Finance systems include Transactional systems and General Ledgers. HR systems may include Recruitment, Human Resources, Payroll and Performance Management systems for staff. Estates generally include Property Management, Residences and Access Control systems. Timetabling may include Lecture and Exam Timetabling systems. Library may include a Library Catalogue and a Library Repository.

Questions A.1.1.1 – A.1.1.3 enquire about the system product and supplier used in each of the functions and sub-functions (if they exist); whether or not the system was recently implemented; and whether or not the institution plans on replacing the system.

Question A.1.1.4, which was previously based on a matrix in the exploratory pilot study, is adapted to allow the respondent to indicate the integration approach used for each system and subsystem identified in the previous question. The integration approaches to choose from, as identified in previous chapters, are shown in Table 8.2.

Table 8.2: Integration Approaches

A.	Not Applicable	**F.**	Periodic Data Dumps (to centralized warehouse)
B.	Not Integrated	**G.**	Via Direct Data Adaptors (messages)
C.	Manual Re-Keying	**H.**	Via Universal Data Adaptors (central hub or bus)
D.	Portals/Screen Dumps	**I.**	Pre-integrated Suites
E.	Periodic Data Dumps (between systems)	**J.**	Other or Don't Know

Questions relating to attitudes to integration in Section A.1.2 are also drawn from the MUSIC study (JISC, 2007). Some questions were drawn directly, while others were adapted and additional ones that reflect the literature were included. The institution's attitude to systems integration and its current integration practices are documented, as well as its opinions on further integration practices and those involving service-oriented principles.

Questions A.1.2.1 – A.1.2.5 enquire about the institution's attitude to systems integration, including current integration practices, favoured integration approaches, and opinions on risks and barriers to integration.

Questions A.1.2.6 – A.1.2.10 are aimed at determining the institution's opinions about SOA, including whether or not they have implemented or will implement such an approach, as well as driving factors and barriers that may promote or inhibit their adoption of SOA.

Sections A.2 – A.7 explore the other factors affecting SOA adoption. Each of these sections is based on the theoretical framework of factors affecting SOA adoption as well as the corresponding literature in Chapter 7.

Section A.2 enquires about the institution's opinions on the acceptance of a new technological innovation such as SOA. Questions A.2.1 – A.2.3 enquire about whether or not the institution is prepared to embrace technological change; the extent of communication between the business and IT departments; and the perceived drivers or barriers to SOA acceptance.

Section A.3 is aimed at determining the efficiency and effectiveness of the institution's governance strategy. Questions A.3.1 – A.3.3 discern the existence of such a strategy; and if so, whether or not it effectively manages business rules and policies between departments; and how it is adjusted to incorporate future growth.

Section A.4 questions the characteristics and attributes of the institution's system data. Questions A.4.1 – A.4.4 investigate the flexibility and quality of data; the presence of inconsistencies in data sets; the location of business rules; and the institution's perceived important attributes of data.

Section A.5 determines development planning initiatives and strategies used in the institution with the adoption of new systems and technologies. Questions A.5.1 – A.5.4 determine whether or not business cases, transition plans and pilot projects are constructed to coordinate the adoption of new technologies; whether or not a relationship exists with vendors; and how new adoptions affect systems development in the institution.

Section A.6 identifies the various security strategies in place at the institution. Questions A.6.1 – A.6.4 determine the existence and use of identity management initiatives, software and data authentication policies and audit trails to monitor staff and student activities; and how security is ensured with each new technological adoption.

Section A.7 identifies system linkages to external organisations. Questions A.7.1 – A.7.3 determine whether or not any systems can connect externally; the institution's need for and support of such external integration; as well as factors that would promote the integration of their systems with other institutions or organisations.

8.2.2 Section B – Demographics

Section B enquires about the respondent's job title and other relevant identifying characteristics, as well as general information about the institution itself. This section is chosen as the last set of questions to be asked in order to ensure that the respondent is occupied with the most important questions of the survey first, thus supplying enthusiastic opinions and answers. The structure and layout of the section is outlined in Table 8.3.

Table 8.3: Section B

B.1	About You
B.2	About Your Institution

B.1 enquires about the respondent's job-related details. Questions B.1.1 – B.1.4 identify the respondent's job title; how long the respondent has been working in that position; which committee or position the respondent reports to; and in which area the respondent has managerial responsibilities.

B.2 requests basic information about the institution itself. B.2.1 determines whether or not the institution is a single or multi campus facility. B.2.2 determines whether or not the institution has merged with or taken over another higher education provider in the last ten years.

8.2.3 Survey Delivery

An interview with the systems expert of each institution is conducted at their office. Audio recording equipment and a copy of the questionnaire is used during the interview.

8.3 Conclusion

This chapter provides a detailed description of the design of the empirical study to be undertaken. The key factors of SOA adoption were identified in preceding chapters and categorised into 7 subsections (A.1 - A.7). These subsections all include questions based on previous literature and these were polled using a semi-structured survey instrument.

Chapter 9: Results of the Empirical Study

This chapter presents the results of the empirical study. The responses from the interviews with each institution are presented and discussed in detail with respect to the extent of systems integration in each institution; the respondents' attitudes to further integration; and an analysis of the other factors that affect SOA adoption. Detailed results are included in Appendix B.

9.1 Introduction

The empirical study involves a semi-structured survey that is distributed to four selected universities in two South African provinces. The survey used in the exploratory pilot study is modified and redesigned in Chapter 8.

This chapter presents the results of the empirical study. The selection process and the demographics of the respondent are presented and an exploration of the factors of SOA adoption is discussed.

Institution #1 was revisited after the exploratory study and the results were modified and updated to reflect the requirements of the final survey designed in Chapter 8.

9.2 Respondents

The survey was completed through semi-structured interviews with each of the four institutions. Requests to conduct the interviews were sent to each institution's presumed director of information, systems analysis, IT projects, etc. These directors either presented their interest in conducting the interview themselves, or referred a more suitable respondent. In the interviews, respondents were required to answer open-ended questions about the systems integration challenge at their institution and their attitudes to factors that affect SOA adoption. While respondents were encouraged to answer questions based on the structure of the survey, they were free to elaborate or further explain their institution's current systems integration issues.

An interview at each of the four institutions was conducted to provide a total of four different sets of interpretive results. The identities of the respondents, the institutions and where they are situated in South Africa are protected under a confidentiality agreement, but the results of the interviews are suitable for release.

9.3 Demographics

Section B of the survey (detailed in Appendix A) addresses the respondent's demographic details. These questions are designed to elicit information regarding the respondent's position at the institution and basic information about the institution itself. The following table illustrates the demographic data collected on the survey respondents.

Table 9.1: Respondent Demographics

	Institution #1	Institution #2	Institution #3	Institution #4
Job Title	Data Manager Data Management Unit	Dep. Director ICT Projects Office	Head of Administrative Computing Services	Director of IT Manager of Infrastructure
Years in Position	15 Years	3 Years	8 years	10 years 5 years
Report To	Registrar of Finance and Operations	ICT Director	Executive Director of ICTS	Senior Director of IT Director of IT
Managerial Responsibilities	Provision of business systems and general data sources	Provision of business systems and development projects	Provision of business, identity and access management systems	Provision of business and teaching & learning systems Provision of IT infrastructure
Institution's Campus	Single-Campus	Multi-Campus in SA	Single Campus	Multi-Campus in SA
Institution Mergers	Offsite campus removed	Three institutions merged	None	Six institutions merged

Each of the respondents is responsible in some way for the administrative and core business systems used at each institution. Most of these individuals have been in their respective positions for a number of years and report to senior members of the institution. Institution #1 reports to the Finance department, while the rest of the institutions report to a senior member of IT. Respondents are all responsible for the provision of business systems in their institutions. Other systems provided for include data sources, development projects, identity and access management systems and IT infrastructure.

Two of the four institutions are contained within a single campus, while the others are merged with a number of other institutions in the country.

Responses for Institution#4 were provided from both the IT director and the manager of infrastructure, boasting both business and technical perspectives of the institution's systems.

9.4 Results

Due to the interpretive nature of this study, in-depth responses to each of the interview questions are detailed in Appendix B. This section summarizes these results and presents them by case.

9.4.1 Institution #1

A.1 Systems Integration

A.1.1 Extent of Systems Integration

This institution uses Progress throughout Student Management, Research, Finance and Estates to integrate the various functions and their respective siloed applications.

Moodle is a tool used for Teaching & Learning purposes and is completely maintained by one department. The Research system is currently undergoing the pilot phase for replacement through a software package called RIMS InfoEd, which promises to improve integration between institutions.

The Alumni system Kidz and the Finance package Omnix are both modified by using Progress. HR recently replaced its HR Expert system with a pre-integrated suite, HR Premier and VIP Payroll.

Interestingly, Lecture Timetabling is developed completely in Turbo Pascal and then loaded every year into Progress. Increased size and venue allocation issues with this system make it clear that it is outdated and needs to be replaced.

The Library makes use of OPAC, the Millennium Library System for the SEALS libraries, which provide access to information resources for education and research in this particular province. Each institution transfers files via ftp to the base institution, where files are uploaded onto OPAC. This institution has no systems in place to support Personal Development Planning of students, nor do they have extensive Teaching & Learning systems or a Performance Management system for staff.

Figure 9.1 illustrates this institution's integration capabilities.

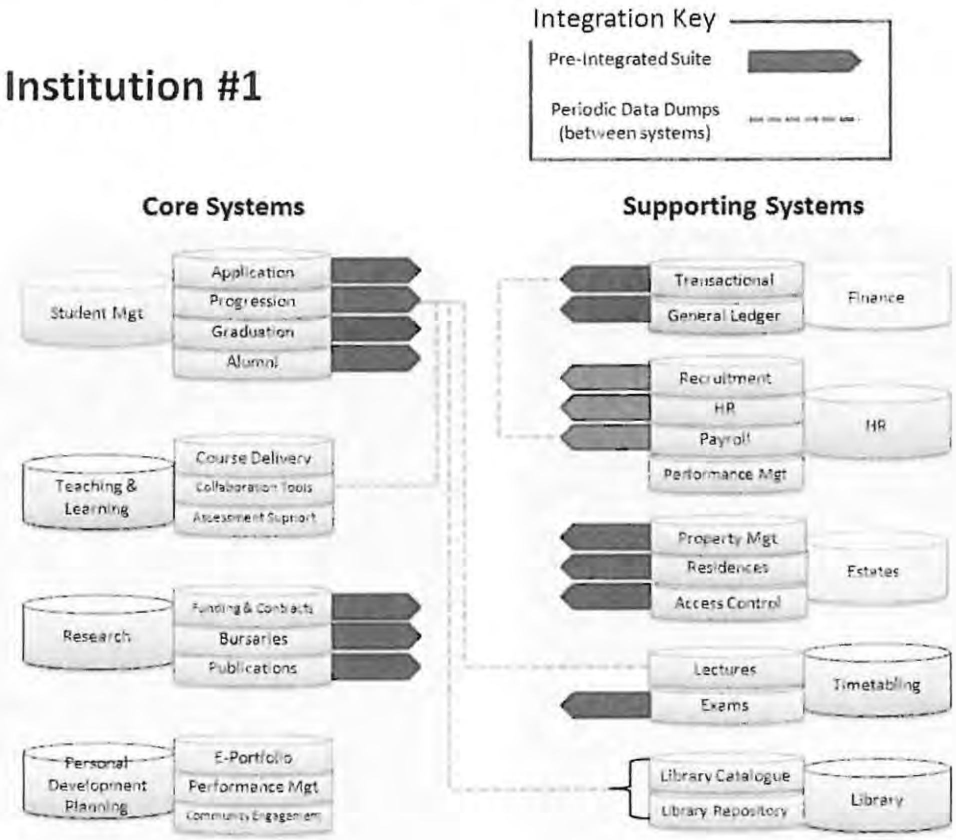


Figure 9.1: Institution #1 System Layout

This institution uses a pre-integrated suite to connect its Student Management, Research, Finance, Estates and Exam Timetabling systems.

Periodic data dumps are used to integrate Finance with HR; and Student Management with Teaching & Learning, Library and Lecture Timetabling.

The respondent notes that there are a number of systems which still require integration.

A.1.2 Attitude to Integration

The respondent believes that the goal of systems integration in this institution is having a single data entry point in order to be more business efficient and ensure less conflict with different data sets.

Initially the systems integration challenge was very difficult at this institution due to a lack of financial backing and acceptance and issues relating to data security.

This institution favours the use of data dumps since they are sometimes the only way to pass data between systems that are located on different platforms and written in different languages. Direct data adaptors are also not always available to communicate between the different systems and security and validation of data becomes an issue.

The respondent believes that business units do not take ownership of their role in the integration process. A lack of documentation and responsibility for certain business processes is evident. There are risks in using data dumps and strong relationships with business units are essential for efficient and secure data transfer.

Since each system is written on different platforms and owned by different vendors, technology itself becomes a barrier to better integration.

The concept of SOA has not been implemented in this institution, however it is hoped that the Student Management System will be better integrated through Web services. The current system used by students will be rewritten to use a Web service that will allow students to request data directly from the other core systems. The data management unit could manage the data, while the Web developers could manage the Web interface. This ensures a separation of concerns with regards to the implementation of the Web service and furthermore, allows the students to have access to the university facilities and data from wherever they are.

The institution wants to use SOA to streamline much of its business processes. They are at an advantage as they already have the tools available for a SOA implementation - Web Speed (part of the Progress package), which is used to help build Web services for business applications.

However, security issues inhibit the institution's adoption of SOA, as well as the fact that it involves a steep learning curve.

A.2 Acceptance

The institution is open to change and improvements in their systems integration strategy provided the new innovation streamlines users' processes and saves them time. The university boasts a good relationship between the systems experts and business people that would enable such technological improvements.

A.3 Governance

The university follows a strict governance strategy in which rules and policies about the institution's systems are set by the data management unit. The unit does, however, ensure the modification of such policies when new business process requests are made.

A.4 Data

The data used in the university's systems is generally trustworthy and flexible, but should inconsistencies arise, the data management unit is prepared to take action. Business rules are written entirely by individual departments and then integrated with other core systems within the central database. This ensures ownership of data and separates the concerns of implementation for the data management unit.

A.5 Development Planning

The institution does not appear to follow documented plans and standards with regards to new technological innovations, but treat each project individually and plan for the necessary transitions.

The university is under the firm belief that "IT must not drive business, but business must drive IT". The actual implementation of this statement is, however, difficult to attain. Services provided by IT must be dependable and in turn, support and ownership from business is required to ensure that business processes are efficiently integrated into the institution's systems.

A.6 Security

The university does not use a central repository of security roles, but rather provides access rights on a one-to-one basis with each new user. Transaction audit trails also limit the detection of fraud in the institution's systems as only successful transactions are logged. These limitations may cause security issues in the institution, but plans are underway to improve the current security packages in place.

A.7 External Opportunities

Since data can be easily dumped between systems, a need for external integration is not evident in the university. However, if external integration between universities proves useful, this institution will support the transition. Issues with different systems and business rules between institutions with their own individual competitive agendas make the idea seem improbable. Furthermore, since the adoption of new technologies involves a dependence on acceptance and not as much on technology, long term external integration goals will be inhibited.

9.4.2 Institution #2

A.1 Systems Integration

A.1.1 Extent of Systems Integration

This institution uses an ERP system (ITS) on an Oracle platform which pre-integrates most of its core business systems. Student Management, Research, Finance, HR and Estates systems are all managed through ITS.

Systems to support Teaching & Learning make use of Sharepoint and other Microsoft based tools to create web-based environments to allow teachers and students to collaborate. They are currently considering the implementation of Moodle for their Teaching & Learning initiatives.

The Research system, partly pre-integrated with ITS, makes use of RIMS InfoEd, in which research information is shared, transferred and archived. The department of Science and Technology sponsored the project and the implementation is facilitated through the National Research Foundation.

Performance management initiatives for staff are rolled out to all departments on an incremental basis and make use of Microsoft Word and Excel processing with no inherent integration with any business systems.

The institution uses an access control system, Keymaster, running off a SQL Server Database that extracts required information from ITS. This system is due to be replaced by a dual-running system called Salto.

The Timetabling system is supported by ITS Abacus (the sister company to ITS) and runs on a SQL Server platform.

Library Services uses SEALS which incorporates the OPAC system, externally integrating several institutions in the province as mentioned previously.

This institution has no systems in place to support Personal Development Planning of students.

Figure 9.2 illustrates this institution's integration capabilities.

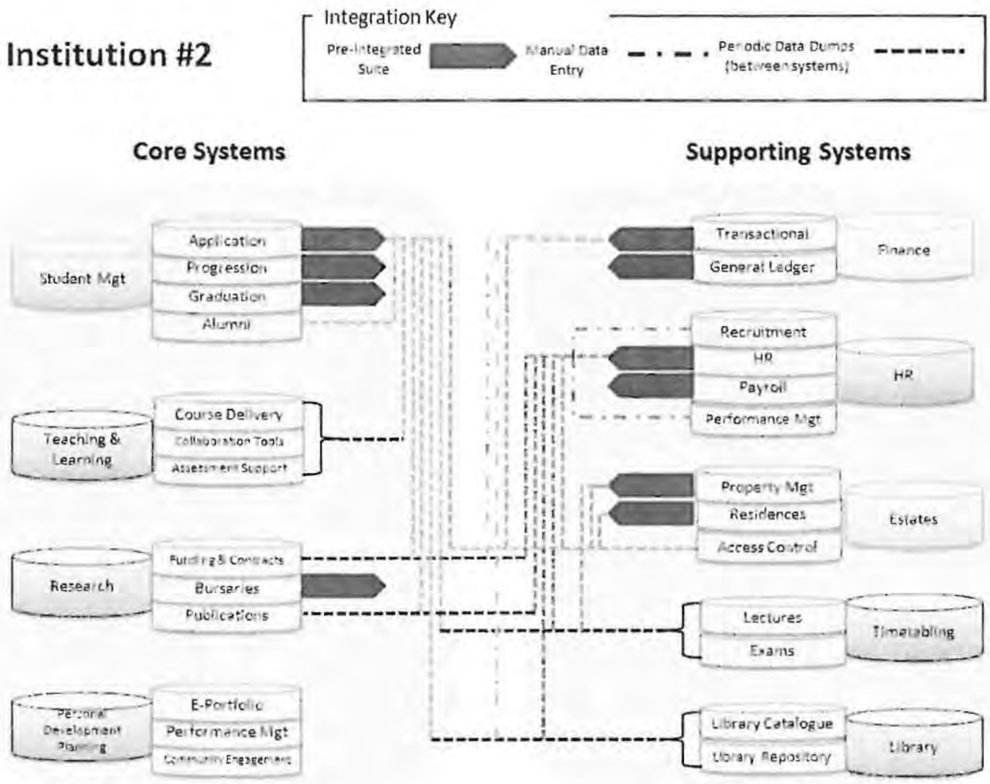


Figure 9.2: Institution #2 System Layout

This institution uses ITS as a pre-integrated suite to integrate its Student Management, Research, Finance, HR and Estates systems.

Student Management is also integrated with Alumni, Teaching & Learning, Research, Library and Timetabling via views through the ITS suite.

Finance is integrated with the Library and Research systems through manual data entry. Similarly with HR, performance management initiatives are done manually, as is the recruitment process, but plans are being made to develop an e-recruitment module using Web services. HR also integrates with Timetabling, Library and Research through periodic data dumps.

Access Control supplies security access to Student Management, Finance, HR, Timetabling and the rest of Estates through periodic data dumps and some manual data entry.

A.1.2 Attitude to Integration

This institution believes that a single version of truth is required in its systems. Systems integration has been difficult with separate systems on different platforms. For example, Teaching & Learning systems at this institution are based on Microsoft packages while the ERP suite is based on an Oracle platform. Differences between these technologies entail integration difficulties. The pre-integrated ERP suite is very useful as an integration approach as it provides a single point of truth for recording and accessing information.

The respondent notes that systems are becoming so large and it is difficult to have a single picture of how everything fits together. Often, the systems and how they work are not documented properly and this makes it difficult for new people to understand the systems and business processes they execute. Capacity in ICT resources and funding provide barriers to better systems integration.

An HR Web service is being developed where data is collected by various departments through Sharepoint services and InfoPath and transferred via the Web service into ITS.

However, there is a limited need for SOA with the ERP system in place but the promise of Web services is constantly being reviewed. Since Web services are not dependent on technology, the transfer of data between systems on different platforms ensures that the entire process is basically abstracted into the Web service.

Many of the institution's ERP developers are being trained in .NET to coordinate the integration between the systems on different platforms. Although the developers have the business knowledge, they require the time to develop the skills to embrace various new technologies adopted.

This institution believes that SOA could be considered an evolutionary approach to systems development but it is important to realise that one needs to think beyond the data. SOA provides a level of abstraction as it involves integrating business processes as opposed to the data within systems.

A.2 Acceptance

This institution believes that technology needs to be seen as an enabler of change and it should be embraced. A number of people are responsible for business analysis in the ICT sector with good working relationships between them. However, new technologies like SOA cannot be supported without efficient funding and organisational support.

A.3 Governance

The institution's governance strategy ensures that users regularly communicate, but in order to support future growth, rules and policies need to be enforced and enhanced to ensure operation at a strategic level.

A.4 Data

Since this institution makes use of a pre-packaged suite, change is evidently difficult and needs to be justified and checked with suppliers before action can be taken. The quality of data produced through the pre-packaged suite is, however, generally trustworthy. Business rules are again embedded within the source code of each system. This institution believes that data in systems should be consistent, accurate and presented in real-time.

A.5 Development Planning

This institution promotes the future plans and vision of ICT through presentations to management. New adoptions are controlled and implemented using transition plans, but developers are subject to steep learning curves with little time to train and learn new skills.

A.6 Security

Login security at this institution is based on two sets of login details: one to access the pc and another to access the ERP system. Data adaptors could integrate these logins but that functionality is currently unavailable. Different security software packages are used to connect the workstations and the network-level ERP system. Security is ensured by an IT security officer who monitors and controls the implications of new security adoptions.

A.7 External Opportunities

Data is currently integrated with external departments through data dumps. While further integration could improve the sharing of knowledge and efficient use of resources, it will only be supported if security of data is not compromised and each external department can retain its own competitive advantages.

9.4.3 Institution #3

A.1 Systems Integration

A.1.1 Extent of Systems Integration

This institution's Student Management system makes use of Oracle's Campus Solutions, while alumni and fundraising for students is managed through Kidz.

The institution uses SAKAI as an open source learning management system to support its Teaching & Learning initiatives. It has had much success with its VULA implementation as a collaborative system delivering learning materials and managing student collaboration and assessment. In addition, the institution is considering the implementation of an Early Warning System that may assist in the detection of students that are at risk of failing their courses.

The Research Funding & Contracts and Research Publications areas make use of University Office's IRMA package. However, pressure is being placed on the university to implement the country-wide RIMS InfoEd system, as identified previously.

The institution uses SAP to manage its Finance and HR functions. Staff Performance Management is currently supported through a paper-based system. However, the system needs to be reviewed due to increased pressure from the South African labour unions.

This institution has various estates systems. The Property Management systems are managed through MS Access, while Residences is managed by RMS. Access Control is managed with Impro, which is currently undergoing further upgrades. In addition, a 3rd

Party system is used to allow the capture of visitors who may need access to the institution's systems.

The Timetabling system is supported by Scientia's Syllabus+ for the institution's curriculum and exam timetables.

As one of the provinces in this study use SEAL's OPAC system to share institutional libraries, this particular province makes use of CALICO's ALEPH system to allow collaboration among its institutional libraries. This institution therefore makes use of this system for its Library Services.

In addition, another important system is used at this institution. Novell's ID Vault is an identity and access management system, which acts as the hub from which access is granted to other systems. An institutional planning system called HEDA extracts important enrolment and student data from the Student Management system into a data warehouse, which is then used in conjunction with data from HEMIS, the Department of Education's Higher Education Management Information System.

This institution has no systems in place to support Personal Development Planning of students, nor do they have a Recruitment or electronic Performance Management system for staff.

Figure 9.3 illustrates this institution's integration capabilities.

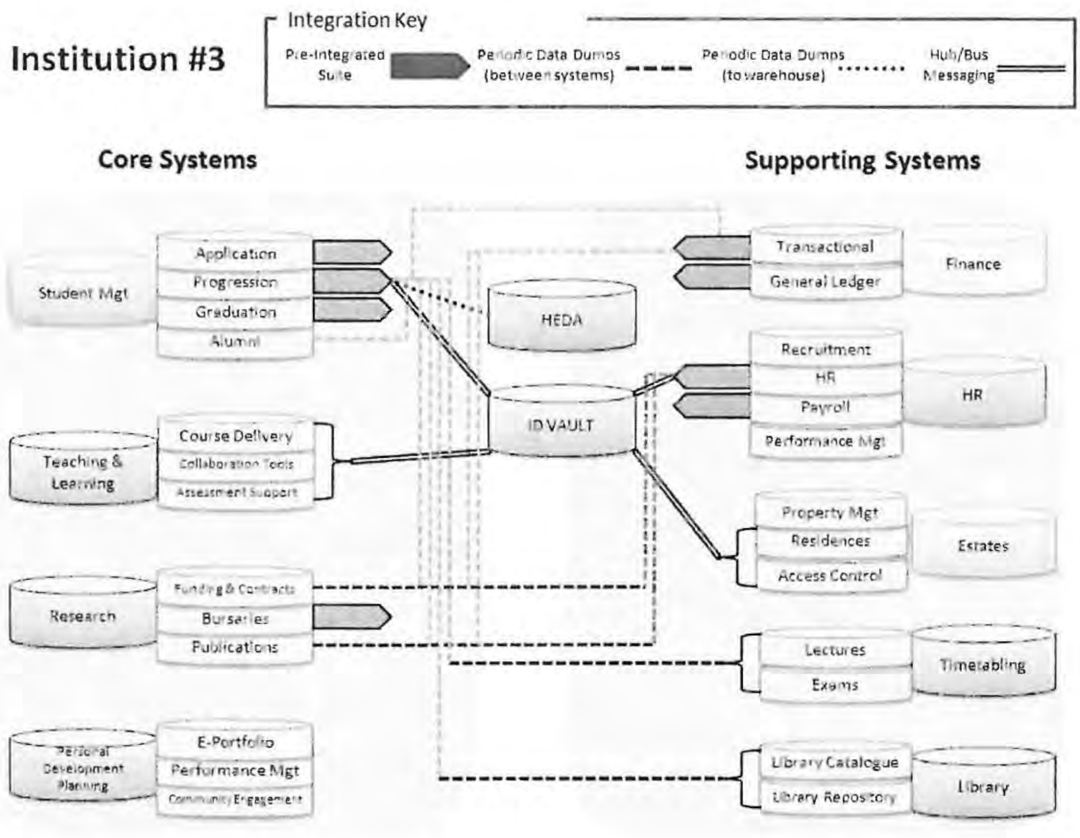


Figure 9.3: Institution #3 System Layout

Student Management, Teaching & Learning, HR and Estates are integrated with the access control system, ID Vault, through hub messaging.

Student Management and Research Bursaries are both pre-integrated in the Campus Solutions package, as are Finance and HR with the general ERP package, SAP.

Student Management is also integrated with Alumni, Finance, Research, Library and Timetabling through periodic data dumps. Student Management also makes periodic dumps to the data warehouse HEDA for the Department of Education's statistical needs.

In addition, both Finance and HR are integrated with Research Funding & Contracts and Research Publications through periodic data dumps.

A.1.2 Attitude to Integration

This institution believes that systems should be seamless with minimal user interaction required, tasks should be processed in real-time and systems should retain a high level of integrity and should always be secure. Integration is not particularly difficult provided a good architecture is in place and the entire process is very controlled and organised. This institution has tried to be consistent in their approach to integration across all departments. The institution favours the use of a central access control system that acts as middleware to ease the integration between disparate and heterogeneous systems further supporting the notion of a service-oriented approach. The institution is trying to avoid the use of data dumps between systems as it is risky and requires constant coordination to ensure data is up to date and not redundant. Resources and capacity for improvement are barriers to a better integration approach. The time and effort needed into researching and adopting a new technology are often too great to make the move feasible.

The principles of SOA, in terms of business process integration, have been implemented. An online student application system has recently been implemented in which students are able to apply to register at the institution remotely. This implementation hopes to streamline the application process considerably, ensuring that the admissions office can provide a far more efficient service to aspiring students. In addition, a payment gateway for fees payments does rely heavily on externally integrated Web services. This makes the integration relatively painless on the institution's side since there is little development required.

This institution wants to use as much of their legacy systems as possible and SOA provides a means of integrating older applications with newer systems. It also ensures that data integrity is preserved, productivity and maintainability is improved and the service-oriented approach is robust. However, in order to move beyond point-to-point integration, there is an awareness barrier and a greater learning curve to adopt new technologies.

A.2 Acceptance

In the last few years, this institution has had a number of highly successful initiatives and this positive track record proves that new ideas and innovations are actively embraced.

The Registrar of the institution, in particular, fully supports the use of the new online application system. However, communication issues between the IT department and other administrative functions are still evident.

A.3 Governance

There is not a formal governance strategy followed at this institution. This does pose a problem as it is easy to identify weak points in the system architecture of the institution without formal documentation. In most cases, most of the management information is prepared and analysed by individuals in spreadsheets. This is a high risk area because if an expert leaves, it is difficult to find someone to replace them who understands the system in the same way. However, being able to identify these weak points makes it possible for the institution to focus on areas with greater precedence. This approach makes people more open to change and able to accept new innovations because there are no set policies and procedures to follow.

A.4 Data

The flexibility and trustworthiness of data varies between systems. Generally the institution is very satisfied with the quality of data in their Student Management system since there are tight validation rules for each data set.

Business rules are generally embedded within the code itself and maintained within departments with business process documents developed to keep track of these rules. Data needs to be trustworthy, reliable and easily accessible.

A.5 Development Planning

The institution does develop business cases and transition plans with regular meetings to get approval from management. Pilot projects are also used to prove the general concept of the technology. The institution also makes an effort to keep up to date with new advances in technologies with their current vendors as well as with other institutions.

A.6 Security

The institution uses the ID Vault to control identity management. In principle, to access a particular system, a line manager must first approve access and then the person must receive training on that particular system before they are granted access. Auditing is done on student data like exam results and bank account details to track every change made to these critical attributes.

A.7 External Opportunities

The institution can connect to CALICO's Libraries externally and is considering the implementation of RIMS InfoEd which integrates externally with the NRF and DST. The MWEB payment gateway is also an example of an external system connection. The need to integrate externally is not yet extensive, but it is useful and will probably grow over the next decade or so. The respondent notes that several institutions have discussed the possibility of working together to integrate and share some of their systems.

9.4.4 Institution #4

A.1 Systems Integration

A.1.1 Extent of Systems Integration

This institution uses Sofware AG's Adabas to manage its Student Management function. Systems to support Teaching & Learning currently make use of Blackboard Vista, but this is soon to be replaced by either a newer version of the product or SAKAI or MOODLE as used in other institutions. The institution has also recently rolled out the implementation of the country-wide RIMS InfoEd for its research function.

As part of Personal Development Planning for students, a community interaction application is used to coordinate community outreach projects in the area. In addition, a CRM events management application that tracks and manages student short courses has also been developed in-house.

The Finance system also makes use of Adabas. It is, however, looking into replacing this system with Oracle's Finance package.

The HR function uses Oracle's HR & Payroll system. As part of this system, a training system has just been implemented; while a performance management system is due to go live in 2011.

Property management in Estates is managed through the newly implemented Cyberstream's Infor EAM, while the residence system is contained as part of the Student Management system. Access Control for meal bookings, photocopies, micro payments, etc, is developed in-house.

The Timetabling system makes use of Scientia's Syllabus+, while Library Services are managed using the provincial CALICO's ALEPH web-based system.

In addition, identity and access management makes use of a metadata directory system supported by Novell's eDirectory, Microsoft's Active Directory and Oracle's Internet Directory services. This allows the provision of security profiles and authentication between systems, ensuring a single sign-on portal that connects underlying systems. A Business Intelligence system that supplies statistical information to the Department of Education is also used through an Oracle Data Warehouse. The institution is currently considering the option of replacing the system's front-end with Microsoft's BI solutions.

Figure 9.4 illustrates this institution's integration capabilities.

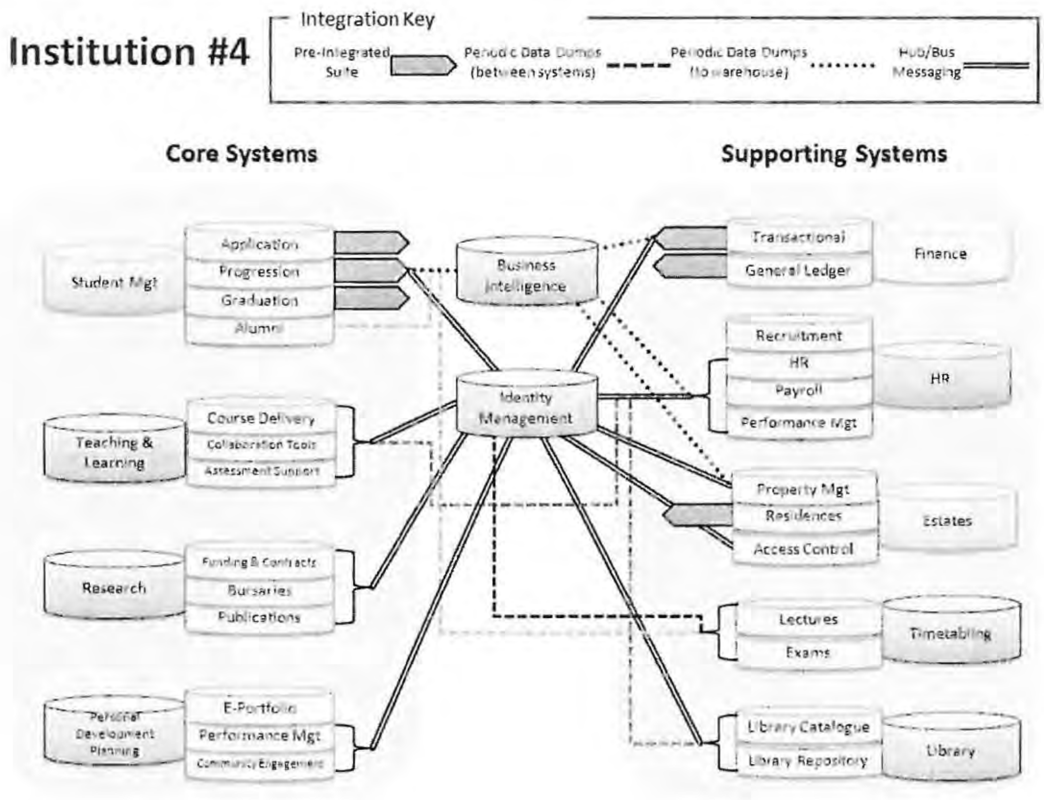


Figure 9.4: Institution #4 System Layout

Student Management, Finance and Residences are all pre-integrated in the Adabas package.

The Identity Management control system acts as a universal data adaptor integrating the Student Management, Teaching & Learning, Research, Personal Development Planning, Library, Estates, HR and Finance systems through hub messaging. Timetabling dumps periodic data to the Identity Management system when necessary.

Student Management, Finance, HR and Estates Property Management also all dump periodic data to the Business Intelligence warehouse used for the Department of Education's HEMIS data.

In addition, Student Management is integrated with Alumni and Timetabling through periodic data dumps, as is HR with the Teaching & Learning and Library systems.

A.1.2 Attitude to Integration

The aim of this institution is to integrate via a central hub. The buy-in for the central integration approach was difficult because it had to be proven that it was the best possible approach for the requirements of the institution. However, the concept itself sold and was generally well received. Since the institution has been on a single platform, it has proven very successful. The institution makes use of the central hub by allowing event-driven messaging between systems, which enhances data integrity and improves manageability, control and tracking of data. The institution has been fortunate in that its adoption of the hub and spoke model was relatively easy to achieve and get the institution to embrace. This has broken down many barriers for the institution.

The institution is using a services approach with some of its systems and is also trying to expose as many of its common functions as business services which will be used in future development. The trial implementation of a fully SOA-based system utilising only services with a Microsoft client technology layer is, however, not as successful as the institution would like due to governance, security and service visibility issues.

A separation of concerns between the presentation and business logic layers drives the adoption of services in the institution. Data integration and propagation have also driven the need for a service-oriented approach.

The number of skilled staff required for the implementation of SOA is an important consideration. In addition, people tend to remain in their comfort zone with regards to integration approaches and it is difficult to embrace the concept of services in improving integration. Users and management need to move from having a siloed mentality to thinking about their systems at the enterprise level. In order to expose services it is important to take security into account and to ensure that services are accessible, while still maintaining control over them.

A.2 Acceptance

The institution is generally resistant to change and communication between business and IT remains an issue since business departments are only concerned with Student and administrative systems and do not see the potential of improvements in other areas. There is an inherent need to involve the stakeholders, students and academics from teaching, research and community outreach. In order to adopt SOA, it is important that IT approach it in terms of business processes in a way that business departments can understand and relate to.

A.3 Governance

A change-control process is in place to enable the adoption of newer technologies and the integration of this with older legacy systems. There are inherent gaps in the policy but it is being continuously refined and improved. Each new technology poses new challenges and a governance strategy needs to change to reflect this. The adoption of services requires governance consideration across departments and technology divides which makes it even more of a challenge.

A.4 Data

The data at this institution is generally flexible and trustworthy. Although the integration is relatively sound, replication and corruption of data is still evident. The capturing and validation of data is enforced at a central level. Legacy applications do not necessarily allow the validation of data at a database level, which makes it generally more difficult to avoid redundancy. In addition, many students are foreign and do not have appropriate documentation validating their unique identification, thus causing redundancy issues when trying to enforce business rules that require these identifiers.

A.5 Development Planning

The institution is required to construct business cases for each new adoption. Transition plans are particularly important in the implementation of pilot projects. The institution communicates with vendors, analysts and other institutions about integration initiatives and needs. However, it is difficult to deliver more and more with each new development under the same budgets.

A.6 Security

The institution relies very strongly on its access control system and the use of hub messaging to authorise and allow access to certain systems. Access control policies are set in place to ensure security access and execution of systems. The Student and administrative systems do have some form of audit trail built in that successfully prevents potential malicious activities. Security does, however, remain the biggest challenge in any institution. Legacy applications tend to have a security layer built on top of them already, but it is the governance policy that needs to enforce security across systems.

A.7 External Opportunities

The institution can connect to CALICO's Libraries externally and makes use of RIMS InfoEd which integrates externally with the NRF and DST. The community outreach system allows portal access to members of the public, while the e-payment service enables interaction from international event managers that can access the institution's servers and process its financial data. The institution is looking into using Facebook and Mxit as clients for their registration applications. The barrier of sharing more data between institutions is the acceptance of federated identity, another security issue. An institution may not be able to confirm that another institution has been authenticated and can use their resources.

9.5 Conclusion

The use of semi-structured surveys proved useful in gathering information, opinions and experiences from respondents. Key to the exploration of SOA factors of adoption is the initial analysis of systems integration in terms of core and supporting systems at an institution. Each of the institutions express the importance of measuring and understanding the full complexity of systems integration before SOA and the other factors affecting its adoption can be considered. The four sets of responses are sufficient to provide for interpretive case study analysis. The results provide insight into the challenge of systems integration in higher education and the factors that affect SOA adoption. These receive further analysis in the following chapter.

Chapter 10: Analysis of the Results of the Empirical Study

This chapter analyses the results of the empirical study and discusses the impact that they have on the research and the theoretical framework. A comparative factor analysis is made of the systems integration challenge as well as each of the factors of SOA adoption. A holistic analysis of the results is also provided.

10.1 Introduction

Each of the previous chapters provides insight into the systems integration challenge and the factors that affect SOA adoption. The aim of this chapter is to expand and generalize the available theory by analyzing the results of the four interviews conducted at the selected South African universities. The data gathered from the interviews is used to develop conceptual categories or to illustrate, support or challenge theoretical assumptions held prior to data gathering.

This chapter presents an analysis of the participant demographics, followed by a comparative factor analysis of each of the factors of SOA adoption as described in the theoretical framework. This analysis is presented for each of the four cases, followed by a comparative summary of each of the factors under investigation. Finally, a holistic analysis of the factors for SOA adoption is discussed. It is concluded that an analysis of systems integration is pivotal in setting a foundation for the exploration of SOA factors of adoption.

10.2 Participant Demographics

No significant features regarding the demographic data of the participants were evident. Given that the sample chosen was purposive, the institutions were selected from the four largest higher education institutions in two provinces in South Africa. Due to a confidentiality agreement, the identity of these institutions and their provinces will remain anonymous.

An interesting feature is that while three of the four institutions' respondents report to senior members of IT, the respondent from Institution #1 reports directly to the Finance director of the institution. This may be attributed to the smaller size of the institution and its limited hierarchical structure when compared to the other larger institutions investigated in this sample.

The fact that two institutions are contained within a single campus while the other two consist of multiple campuses across South Africa bears no significance to the findings of the study.

10.3 Comparative Factor Analysis

As a sufficient starting point in the exploration of SOA factors of adoption, the systems integration challenge is first investigated in terms of the extent of systems integration and the respondents' attitudes to integration. The remaining six factors illustrate the other important considerations for the adoption of SOA.

10.3.1 Systems Integration

10.3.1.1 Extent of Systems Integration

Institution #1

The institution primarily makes use of Progress to integrate its institution's systems. The general approach to integration is identified as some form of 'best of breed' approach, either through pre-integrated databases or data dumps. Student, Research and administrative systems are integrated through the pre-integrated suite, while other systems are integrated through periodic data dumps. Many systems are currently not integrated but a need for this integration has been identified. This institution has limited integration in its Teaching & Learning system and no Personal Development Planning system for students whatsoever.

Institution #2

The institution makes use of ITS to integrate its Student and administrative systems. The approach to integration at this institution is again identified as 'best of breed' with a combination of a pre-integrated suite, data dumps and some manual data entry. Considerably many data dumps are evident from Student Management, HR and Estates to the various other systems. Again, this institution does not make use of Personal Development Planning systems for students.

Institution #3

This institution uses Campus Solutions to integrate its Student Management functions and SAP to integrate some of its administrative functions. The access control system acts as a hub through which Student Management, HR, Estates and Teaching & Learning can integrate. This institution also follows a "best of breed" approach in which a combination of pre-integrated suites, periodic data dumps and hub messaging is used to integrate various systems. This institution does also not have any systems in place for Personal Development Planning of students and is facing increased pressure to improve some of its systems, namely its paper-based Performance Management system for staff, as well as the nation-wide adoption of RIMS InfoEd as a common Research system among South African institutions.

Institution #4

This institution makes use of Adabas to integrate Student Management with some of its administrative systems. Again an access control system acts as a universal data adaptor connecting all other systems. The "best of breed" integration is again managed through a combination of pre-integrated suites, periodic data dumps and hub messaging. In contrast, this institution makes use of a community interaction application as well a CRM events management application to support Personal Development Planning of students.

Summary Analysis of the Extent of Systems Integration

Systems integration in each of the four institutions can be identified as some form of "best of breed" integration approach, in which a combination of pre-integrated suites, periodic data dumps, some manual data entry and hub messaging is used to integrate the various systems in each institution.

The general pattern for all institutions was comprised of two broad categories of systems:

- The administrative systems, including Finance, HR and Estates which were all tightly integrated with each other and with the Student Management system.
- The teaching and learning systems, including Teaching & Learning, Research, Personal Development Planning, Library and Timetabling which had limited integration between themselves, but were generally well integrated with the Student Management system.

The common element to both these groups is the Student Management system which clearly forms the central core system of the systems integration landscape in these institutions.

Student Management, along with the administrative supporting systems of Finance, HR and Estates controlled the greatest concentration of integration within institutions. Consequently, previously identified core systems in Teaching & Learning, Personal Development Planning and to a lesser extent, Research, were areas which governed very little integration with other systems.

Interestingly, the Research endeavours of each of the four institutions were fairly well integrated with the Student Management and other administrative systems. This may be attributed to the increased pressure from the National Research Foundation and the Department of Science and Technology to adopt and implement the country-wide RIMS InfoEd Research system.

10.3.1.2 Attitude to Integration

Institution #1

The goal of this institution is to ensure that its systems are business efficient with fewer conflicts between different data sets. The most significant barrier to achieving this integration is identified as technology itself with each system written on different platforms making it more difficult to communicate with other systems. Data dumps are often the most efficient way to pass and validate data between disparate systems running on different platforms. The emergent SOA approach is considered the destination and clear future direction of systems integration strategies at this institution. The interest in SOA and Web services suggest a decomposition of the current, internally focussed systems integration challenge and the emergence of a new set of issues concerned with security issues and knowledge about the new methodology.

Institution #2

The goal of this institution is having a single version of the truth to ensure that dynamic content is supported without different sources of data scattered across the organisation. A lack of ICT resources and funding may be preventing a better integration approach. A pre-integrated suite is favoured as it provides a single version of the truth for recording and accessing information. The institution has a limited need for SOA with the ERP package currently meeting its integration needs. However, Web services are being developed to streamline the integration between systems on different platforms. The adoption of SOA is limited as developers require the time to develop the skills to embrace this new methodology.

Institution #3

This institution believes that systems should be seamless with minimal user interaction required, tasks should be processed in real-time and systems should retain a high level of integrity and should always be secure. Integration is not particularly difficult provided a good architecture is in place and the entire process is very controlled and organised. The institution favours the use of a central access control system that acts as middleware to ease the integration between disparate and heterogenous systems. The time and effort needed into researching and adopting a new technology are often too great to make the move feasible. This institution wants to use as much of their legacy systems as possible and SOA provides a means of integrating older applications with newer systems, but an awareness barrier and a greater learning curve limit its adoption.

Institution #4

The aim of this institution is to integrate via a central hub by allowing event-driven messaging between systems, which enhances data integrity and improves manageability, control and tracking of data. The institution is using a services approach with some of its systems. However, skilled staff and being able to embrace change is an important consideration for the adoption of SOA.

Summary Analysis of the Attitude to Integration

The goals of these institutions correspond well with one another. Each institution aims to ensure that its systems provide a single version of the truth, are efficient and seamless, require minimal user interaction, and maintain a high level of integrity.

The challenge of integration is difficult in these institutions. Respondents note that a technology barrier and a lack of ICT resources, time, effort and funding prevent a better integration approach in their institutions.

While all institutions follow some form of "best of breed" integration approach, respondents from each institution identify the benefits of their preferred approach. While Institution #1 believes that sometimes data dumps are the most efficient way to pass and validate data between disparate systems, Institution #2 believes that a pre-integrated suite can provide a single version of the truth for recording and accessing information. However, both Institution #3 and Institution #4 favour the use of a central access control system that acts as a hub to allow event-driven messaging between disparate and heterogeneous systems.

SOA is generally considered the destination and clear future direction of systems integration in these institutions. The use of Web services, whether already implemented or still in development, suggests a decomposition of the current, internally focused silos and enables the seamless integration of older, legacy applications with newer systems on different platforms.

However, the adoption of SOA still requires a steep learning curve, efficient resources (staff, time, effort and funding), and the ability of the institution to embrace change.

10.3.2 Acceptance

Institution #1

The university boasts a good relationship between the systems experts and business people that would enable technological improvements.

Institution #2

This institution believes that technology needs to be seen as an enabler of change and it should be embraced. However, new technologies like SOA cannot be supported without efficient funding and organisational support.

Institution #3

New ideas and innovations are actively embraced, but communication between the IT department and other administrative functions is still an issue.

Institution #4

The institution is generally resistant to change and communication between business and IT remains an issue.

Summary Analysis of Acceptance

Each institution believes that technology needs to be seen as an enabler of change that streamlines user's processes and saves time. New technologies like SOA cannot be supported without organisational support. While new ideas and innovations are actively embraced, communication between business and IT departments remains an issue.

10.3.3 Governance

Institution #1

The university follows a strict governance strategy in which rules and policies are set by a specific unit.

Institution #2

For future growth, rules and policies need to be enforced and enhanced to ensure operation at a strategic level.

Institution #3

Because there are no set policies and procedures to follow, this institution is able to focus on weaker areas with greater precedence.

Institution #4

A change-control process is used to enable the adoption of newer technologies and the integration of this with older legacy systems, however this requires constant refinement of the governance policy.

Summary Analysis of Governance

Three of the four institutions follow governance strategies that generally ensure that users follow guidelines for development but future growth requires constant refinement and modification of the policy to ensure operation at a strategic level.

Interestingly, Institution #3 does not follow a formal governance strategy. The respondent notes that this lack of set policies and procedures enables the institution to identify weak areas a lot more easily, which, in turn, allows them to focus on these areas with greater precedence. It may be useful to note that this institution is internationally recognized as a leading university in the country.

10.3.4 Data

Institution #1

A unit is prepared to manage inconsistencies in the data set. Business rules are written by individual departments and integrated with central systems.

Institution #2

The quality of data is generally trustworthy with business rules embedded within the source code of each system.

Institution #3

The flexibility and trustworthiness of data varies between systems. Business rules are again generally embedded within the code itself and maintained within departments.

Institution #4

Although the integration of data is relatively sound, replication and corruption of data is still evident.

Summary Analysis of Data

Data in these institutions' systems is generally flexible and trustworthy with invariably some inconsistencies across data sets. Business rules are embedded within the code of each institution's systems. These are generally maintained within departments and tracked in business process documents. According to previous research, embedding business rules within system code may cause problems with inconsistency when changes need to be made.

10.3.5 Development Planning

Institution #1

Instead of following documented plans and standards, this institution treats each project individually and plans for the necessary transitions.

Institution #2

This institution promotes the future plans and vision of ICT through presentations to management. Barriers to new developments are evident with steep learning curves and limited time to spend on research and train staff.

Institution #3

In addition to developing business cases and transition plans, this institution makes an effort to keep up to date with new advances in technologies with vendors and other institutions.

Institution #4

This institution also communicates with vendors, analysts and other institutions about integration initiatives and needs.

Summary Analysis of Development Planning

Most institutions follow some form of plan to present new technologies and ensure successful transitions. Since Institution #1 is particularly smaller than the other institutions with a limited hierarchical structure, they treat each potential project individually and plan for the necessary transitions. All institutions also make an effort to communicate with vendors and other institutions to keep up to date with new advances in technologies. Institution #2 notes that developers are, however, subject to steep learning curves with little time to train and learn skills required for new technologies.

10.3.6 Security

Institution #1

The university provides access rights on a one-to-one basis with each new user.

Institution #2

Different security software packages are used to connect the workstations and the ERP system.

Institution #3

The institution uses the ID Vault to control identity management.

Institution #4

The institution also uses an access control system and hub messaging to authorise and allow access to certain systems.

Summary Analysis of Security

System security at Institution #1 and Institution #2 relies on different sets of login details using different security packages to grant access to its systems. Both Institution #3 and Institution #4 use a central access control system that acts as a hub using event-driven messaging to provide access to the various systems in each institution.

10.3.7 External Opportunities

Institution #1

Since data can be easily dumped between systems, a need for external integration is not evident in the university. However, if external integration between universities proves useful, this institution will support the transition.

Institution #2

While further integration could improve the sharing of knowledge and efficient use of resources, it will only be supported if security of data is not compromised.

Institution #3

The need to integrate externally is not yet extensive, but it is useful and will probably grow over the next decade or so.

Institution #4

This institution is actively seeking new ways to connect to external systems which will improve systems that contribute to the growth of the student.

Summary Analysis of External Opportunities

The need for external integration is not yet extensive in these institutions since data can be transferred easily enough between systems using current integration approaches. While this method presents issues with data integrity, some institutions believe that further integration will only be supported if security and individual competitive agendas are not compromised. Institutions are, however, supporting integration efforts through their respective online shared Library systems, as well as the increased adoption of RIMS InfoEd for their Research systems. In addition, Institution #4 is investigating new ways to externally integrate its application system through Facebook (an online social networking tool) and Mxit (a mobile social networking tool).

10.4 Holistic Analysis of the Results

10.4.1 Systems Integration

10.4.1.1 Extent of Systems Integration

The results based on measuring the extent of systems integration support the assumption in previous research in which administrative systems were likely to be more "tightly" integrated than other systems involved in teaching, learning and research.

However, this raises a concern. Administrative systems should support an institution's core systems, which should in turn, contribute to the growth of the student graduate. These core systems were identified in systems involved in teaching, learning and research. According to this study's findings, integration is greatest between the supporting administrative systems of the institution and not the core teaching, learning and research systems.

An institution which fails to focus its integration efforts on its core teaching, learning and research systems is not well prepared to adopt SOA to improve its integration.

10.4.1.2 Attitude to Integration

The challenge of integration is difficult in institutions with a distinct lack of ICT resources to promote the adoption of a better integration approach. Each institution follows its own ad-hoc integration approach using a combination of different strategies to integrate its most important systems.

While SOA is generally considered the destination and clear future direction of systems integration, it still requires a steep learning curve, efficient resources (staff, time, effort and funding), and the ability of the institution to embrace change. Without these considerations, an institution would not be able to successfully adopt SOA.

10.4.2 Acceptance

Before an institution is prepared to accept SOA, it needs to view technology as an enabler of change that streamlines user's processes and saves time. Communication and organisational support between business and IT departments is essential for the consideration of SOA adoption.

10.4.3 Governance

In order to adopt SOA, governance strategies require constant refinement and modification to ensure operation at a strategic level and to allow for technological growth. However, it is important that this strategy does not effectively inhibit collaboration between departments because of its stringent set of policies and procedures.

10.4.4 Data

Data in institutional systems should be flexible and trustworthy with minimal inconsistencies across data sets. The location and tracking of business rules is particularly important with the adoption of SOA in order to determine accurate representations of data and to ensure consistency across departments when changes need to be made.

10.4.5 Development Planning

Institutions considering the adoption of SOA should be using a strategy that makes use of business cases, transition plans and pilot projects with each new technological development. Communication with vendors and other institutions is also vital to ensure an institution is kept up to date with the latest technologies and is maintaining its systems appropriately.

10.4.6 Security

System security is another important consideration for the adoption of SOA. Institutional systems should be protected with identity management initiatives, software authentication policies and audit trails to track potential fraudulent or malicious activities.

10.4.7 External Opportunities

While the need for external integration is not extensive in higher education, it is important for institutions to consider new ways of sharing information and reusing existing technology with other institutions or organisations. Once an appreciation for external integration is evident, an institution may consider the use of services to integrate in new and efficient ways with other organisations, thus challenging the status quo and improving the institution's current integration approach.

10.5 Conclusion

Before an institution can successfully adopt and implement SOA, it needs to take into account the current extent of systems integration at the institution, its attitude to integration and SOA principles, as well as its general attitude to issues of acceptance, governance, data, development planning, security and external opportunities.

The institutions investigated in this study generally embrace the principles of SOA and believe it is the clear future direction of their integration efforts. However, concerns are evident in the concentration of integration in supporting administrative systems and not in the core teaching, learning and research systems. Institutions also require an appreciation for service-oriented principles and may need to rethink their approaches and attitudes to acceptance, governance, data, development planning, security and external opportunities before they can successfully adopt SOA.

The results of the empirical study and their analysis form the basis of reflections and enhancements in the structure of the theoretical framework.

Chapter 11: Revisions to the Theoretical Framework

Based on the results of the empirical study and their analysis in Chapters 9 and 10, this chapter details the revisions to the theoretical framework.

11.1 Introduction

An empirical investigation of the factors that affect SOA adoption in selected South African universities explores the applicability of the theoretical framework presented in Chapter 7. The empirical study was designed to further explore and verify the relevance and validity of this proposed framework. The study reveals the suitability and shortcomings of the theoretical framework which contributes to reflections and enhancements in the structure of the framework.

This chapter aims to revise the existing theoretical framework based on the results of the empirical study and their analysis in Chapters 9 and 10 respectively. A summary of revisions to the framework is presented for each factor of SOA adoption. A resulting framework is then illustrated and discussed. It is concluded that systems integration is the first and most important factor that requires analysis before the other factors of SOA adoption are considered. In addition, the application of the SOA Adoption Framework can provide for a comparative assessment of the requirements for SOA to support its adoption in higher education institutions.

11.2 Framework Revisions

The empirical study explores a framework of SOA factors of adoption in selected South African higher education institutions. The results of the empirical study are used to make revisions and adaptations to the theoretical framework.

Table 11.1 details the revisions made to the framework.

Table 11.1: Revisions to Framework

Proposed Framework	Empirical Study Results	Revised Framework
Factors of SOA Adoption Systems Integration	Systems Integration is investigated in detail before the other factors of adoption are considered. Systems Integration is classified according to the Extent of Systems Integration as well as Attitude to Integration. The Extent of Systems Integration is measured in terms of the institution's Core and Supporting Systems.	**Factors of SOA Adoption** Systems Integration The importance of systems integration and its priority is emphasised, before other factors of SOA adoption are considered.
Acceptance	Acceptance and organisational support is vital for the adoption of SOA.	Acceptance
Governance	A governance strategy needs to constantly change and be adapted when considering SOA.	Governance
Data	The quality, flexibility and trustworthiness of data in systems need to be reviewed when adopting SOA.	Data
Development Planning	An institution's existing approach to new developments and their ability to embrace new technologies should be reviewed before considering SOA.	Development Planning
Security	An analysis of system security is required to ensure that data security and access control is a priority before considering SOA.	Security
External Opportunities	Institutions need to be open to the sharing of information externally before they can adopt SOA.	External Opportunities

The framework for the adoption of SOA comprises seven (7) factors:

11.2.1 Systems Integration

Systems Integration was previously classified equally with the other factors and used as a starting point in analyzing the extent of systems integration before other factors of SOA adoption were considered.

After an analysis of the results from the empirical investigation, it is evident that the importance of systems integration should be stressed as a vital and fundamental issue that should be thoroughly investigated before the other factors of SOA adoption can be considered. It is thus represented in the final framework with greater importance than the other factors of SOA adoption. The systems integration challenge is classified according to the Extent of Systems Integration and Attitude to Integration.

Extent of Systems Integration

The extent of systems integration takes into account the types of systems used in each of the institutions as well as an indication as to how each of the systems are integrated with one another.

The types of systems in each institution are categorized into their respective functional areas of Student Management, Finance, Human Resources, Estates, Teaching & Learning, Research, Library, Timetabling and Personal Development Planning (PDP). These systems are further classified according to core or supporting systems based on further research introduced in Chapter 7. Core systems are identified as Student Management, Teaching & Learning, Research and Personal Development Planning; while supporting systems are identified as the administrative systems, Finance, Human Resources and Estates; as well as Timetabling and Library. Each of these functional areas may be made up of one or more subsystems. This standard layout is shown in Figure 11.1.

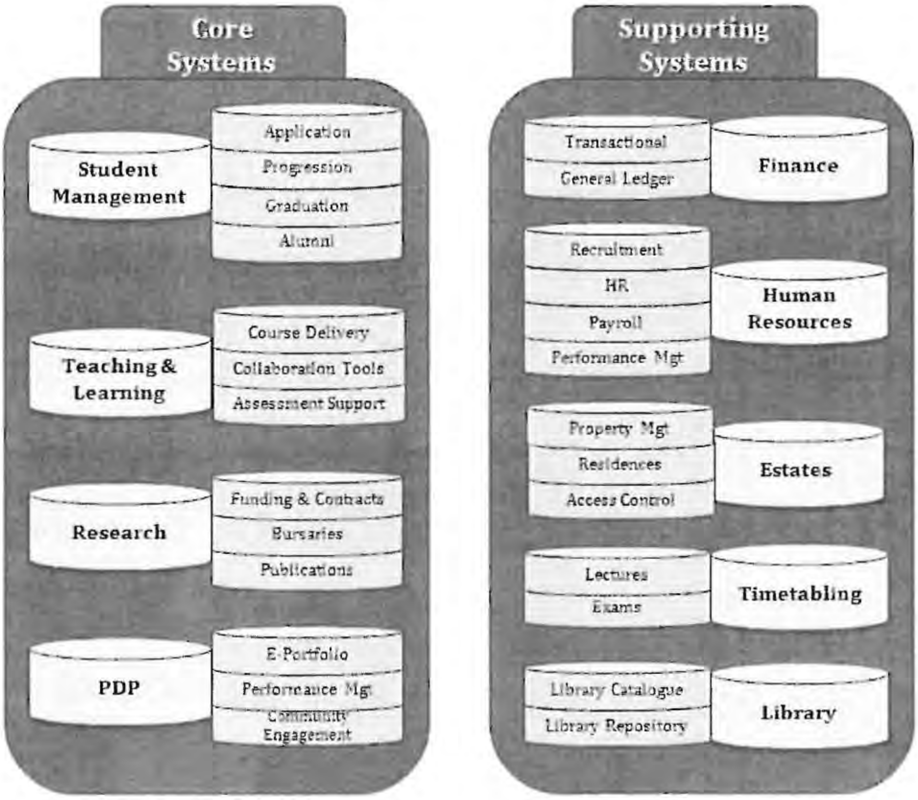


Figure 11.1: Core vs. Supporting Systems in an Institution

Once the systems in each institution have been identified and categorised, the method of integration between each of the systems is noted. This gives an indication as to where integration is concentrated between systems. Based on research of core competencies, integration should be greatest between the core systems of the institution. However, if integration is greatest between the administrative or supporting systems, the institution is not focusing its integration efforts on its main objective, which, in these South African institutions, is to develop the student graduate.

Attitude to Integration

The systems integration challenge also needs to identify the institution's attitude to systems integration. The interpretive opinions from the respondents about their integration goals, risks, barriers, preferred integration approaches and inclination towards SOA need to be analysed. Here, the institutions identify their relationship with the challenge of systems integration in higher education and their opinions about SOA in general and adopting service-oriented principles, whether they already have, or are still considering the adoption.

The findings of this study suggest that the Extent of Systems Integration and an institution's Attitude to Integration gives an indication of the current state of systems integration in their institution and whether or not they are in a position to consider SOA. If systems integration is discovered to be concentrated on supporting systems as opposed to core systems; and the institution does not have an open mind with regard to SOA and does not see it as the clear future direction of its integration efforts, it is not well prepared to adopt SOA to improve its integration approach. The institution's integration efforts should be concentrated on core systems; and the institution should actively seek to be innovative and adopt service-oriented principles.

A thorough investigation of the institution's systems integration challenge presents a foundation for the analysis of other factors that affect SOA adoption. Understanding the institution's systems, integration approaches and attitudes to integration is a prerequisite for the exploration of the way in which an institution accepts new systems; governs systems; handles system data; develops systems; ensures system security; and fosters external integration. The remaining factors are independent of one another and may be reviewed in any order.

11.2.2 Acceptance

Organisational wide acceptance, support and excellent communication between the business and IT units are required before SOA can be considered. Acceptance is classified according to Embracing Change and Communication.

11.2.3 Governance

Due to the fact that new technologies and innovations entail new risks and challenges, the institution needs to enable the constant change and refinement of the governance strategy to reflect the changes required for SOA. Governance is classified according to Strategy, Business Rules & Policies and Growth.

11.2.4 Data

The quality, flexibility and trustworthiness of data in systems need to be reviewed when adopting SOA. If business rules are embedded within the code of systems, the departments that maintain these rules need to ensure that they can be efficiently recorded and tracked so that data integrity is preserved. Data is classified according to Flexibility & Trustworthiness, Inconsistencies and Location of Business Rules.

11.2.5 Development Planning

An institution's existing approach to new developments and their ability to embrace new technologies that challenge the status quo should be reviewed before considering SOA. Development Planning is classified according to Business Cases, Transition Plans & Pilot Projects and Vendor Communication.

11.2.6 Security

An analysis of system security in terms of access control, application trustworthiness and audit tracking is required to ensure that access to data is a priority before considering SOA. Security is classified according to Identity Management, Software Authentication and Audit Trails.

11.2.7 External Opportunities

Institutions that are open to the sharing of information between themselves and other institutions and organisations are more likely to be successful in their adoption of SOA. External Opportunities is classified according to External Integrations, Integration Needs and Attitude to Shared Services.

11.2.8 The Graphical Framework

Figure 11.2 shows the proposed revisions to the SOA Adoption Framework.

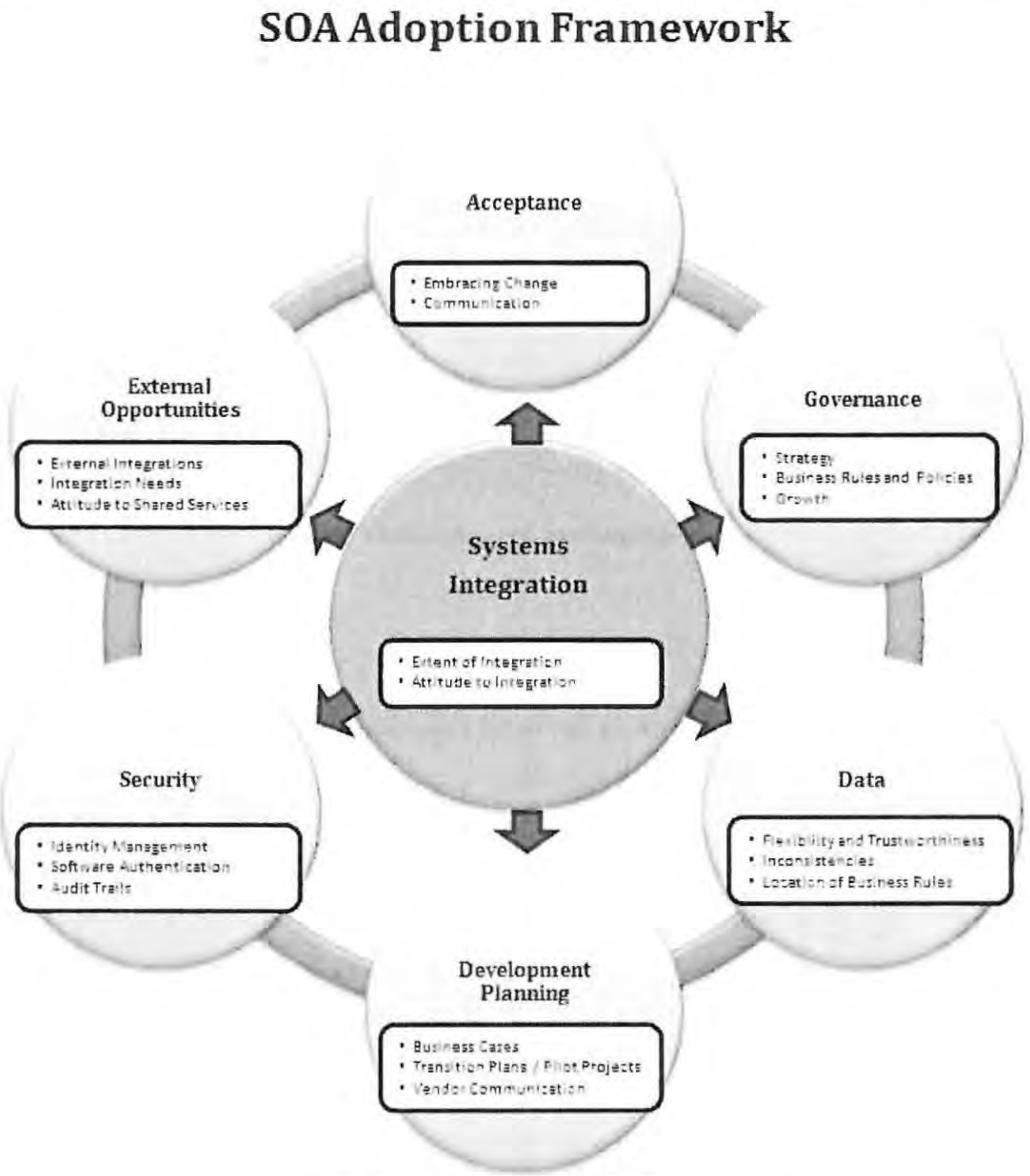


Figure 11.2: The Revised SOA Adoption Framework

Before an institution can consider its readiness to adopt SOA, it needs to conduct a thorough investigation of its systems integration challenge. This involves an analysis of the Extent of Systems Integration in terms of the core and supporting systems used at the institution; as well as an indication of the institution's Attitude to Integration. Understanding the institution's systems, integration approaches and attitudes to integration is a prerequisite for the exploration of the other factors of SOA adoption.

The remaining factors of SOA adoption may be considered independently of one another, but it is important for the institution to take into account each of these before they consider moving their integration approach towards SOA.

Acceptance involves an analysis of the institution's ability to Embrace Change and Communicate between departments. Governance involves an analysis of the institution's governance Strategy, how it manages Business Rules and Policies and enables Growth. Data involves an analysis of data Flexibility and Trustworthiness, Inconsistencies and the Location of Business Rules. Development Planning involves an analysis of the institution's use of Business Cases, Transition Plans and Pilot Projects and the institution's attitude to Vendor Communication. Security involves an analysis of Identity Management, Software Authentication and Audit Trail initiatives. Finally, External Opportunities involves an analysis of External Integrations, Integration Needs of the institution and its Attitude to Shared Services.

11.3 Conclusion

A comprehensive evaluation of SOA factors of adoption is essential before an institution can successfully choose to adopt SOA. The literature survey, the preliminary framework and the results of the exploratory pilot study led to the development of the theoretical SOA Adoption framework in Chapter 7. The empirical study was developed to test the important aspects of this framework. The interviews conducted with each of the institutions confirmed the seven (7) factors of SOA adoption. The resulting framework emphasises the importance and priority of an analysis of systems integration before the other factors of SOA adoption are considered. The overall structure of the framework is revised as a result of the increased significance of systems integration in analysing an institution's readiness to adopt SOA.

A general review of the framework indicates that the factors of SOA adoption were well explored and developed in relation to the previous literature. The resulting framework provides institutions with the facility to assess their readiness to adopt SOA with an emphasis on the systems integration challenge evident in higher education.

Chapter 12: Conclusion

This chapter concludes the research by identifying the most significant contributions of the research and by suggesting areas of future work.

12.1 Introduction

The demand for systems integration has become more and more significant in higher education as institutions need systems that provide coherent information with data that is up to date and not redundant and can seamlessly support the end user experience.

Universities traditionally operate as highly decentralized institutions, with faculty and business units allowed considerable autonomy in choosing their systems, business rules and operating practices. Each department supports a diverse array of computing platforms and applications, each with its own programming language, tools and training requirements. While this provides the institution with the flexibility to select the best software for each function as needed, it becomes very difficult to integrate.

In organisations, system developers and architects are finding different, innovative ways to eradicate the duplication of data and better integrate the silos of systems on different platforms.

SOA is an innovative approach to integrating existing systems involving the use of independent services based on business processes that can be accessed without knowledge of the underlying platform implementation. This emerging methodology is generally noted as an aspiration or destination rather than a currently existing strategy in many organisations.

However, the SOA initiative will not be success if it is not understood and used correctly by various applications and systems throughout the organisation. SOA applications are spread across many computers; composed of separately maintained parts; run on numerous platforms; and are subject to frequent change due to constantly changing business needs. These requirements introduce complexity and challenges in systems integration, acceptance, governance, data, development planning, security and external opportunities. If an organisation does not embrace or enable change in each of these areas, it is not ready for the adoption of SOA.

This chapter concludes the overall research investigation. The contributions of the research are presented, after which limitations are identified and areas for future research are proposed.

12.2 Contributions of the Research

This research investigated the systems integration challenge in selected South African universities in an attempt to determine whether or not the institutions were ready to adopt SOA.

By analysing the extent of systems integration in terms of the core and supporting systems in the institution, this research established that an institution is not prepared for the adoption of SOA and its inherent challenges if its systems integration strategy is not concentrated on the core systems that are meant to contribute to the perceived personal growth of the student graduate. In these institutions, it is evident that systems integration is more concentrated on the administrative supporting systems of the institution and not the core systems involved in teaching, learning and personal development planning. However, many of these institutions are beginning to focus integration initiatives on their Student Management and Research systems, which highlight a positive step towards the adoption of SOA.

In addition, institutions do believe that SOA is the clear future direction of their integration efforts and some are making active attempts to adopt an integration strategy that encourages the use of service-oriented principles.

After a thorough analysis of the systems integration challenge, institutions provide an indication of their outlook on other SOA adoption factors. This analysis emphasised the importance of being able to embrace change and innovation and modify strategies in order to reflect the constant changes required for the adoption of SOA.

The framework for the adoption of SOA comprises seven factors, of which Systems Integration is the most significant and represents an efficient starting point for institutions considering SOA adoption. Acceptance, Governance, Data, Development Planning, Security and External Opportunities are other factors of SOA adoption that require careful and thorough consideration before an institution can successfully adopt SOA.

12.3 Limitations and Future Research

Limitations of this Research include:

- Since this study's results are limited to an exploration of the systems integration challenge in four selected universities in two South African provinces, they cannot be generalised to higher education in South Africa.
- This research does not investigate why SOA is not being adopted in these institutions.
- This research identifies the core and supporting systems used at an institution based on the extraction of core competencies from an organisation's mission. The rules that apply to organisations may not necessarily apply to higher education.

Future research in this area includes:

- The replication of this research in other South African institutions in order to generalize the systems integration challenge and the adoption of SOA in higher education in South Africa.
- An investigation that focuses on the importance of distinguishing between core and supporting systems at both an institutional and organisational level.
- The investigation into the adoption of SOA for a central application in an institution and the impact that this adoption has on the extent of integration in the institution. This may involve a positivist approach into which the extent of integration is measured before and after the adoption and implementation of SOA.
- The investigation of the need for a governance strategy for the adoption of SOA. One of the institutions in this study states that its decision not to have a governance policy enables them to focus on weaker areas with much greater precedence. It may

be useful to investigate whether or not the governance strategy effectively inhibits innovation and growth in the institution.

12.4 Concluding Remarks

The strength of the SOA Adoption Framework involves the recognition of, and the emphasis on, the systems integration challenge and its importance among other SOA adoption criteria. A criticism of some of the approaches towards SOA implementation has been the failure to identify and clarify the extent of systems integration as well as the adoption criteria necessary to effectively implement SOA. The adoption of SOA can significantly improve the issues related to systems integration only once a careful and thorough analysis is made of the institution's current extent of systems integration; its attitude to systems integration; as well as the exploration of the way in which the institution accepts new systems; governs systems; handles system data; develops systems; ensures system security; and fosters external integration.

The investigation of the seven (7) factors affecting SOA adoption provides for a comprehensive coverage of the requirements for successful SOA. Furthermore, this framework provides the institution with the facility to assess their systems integration challenge in terms of core and supporting systems in order to determine their readiness for SOA.

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Appendices

Appendix A - Survey

Section A - Factors of SOA Adoption

A.1 Systems Integration

A.1.1 Extent of Systems Integration

The first set of questions enquires about your university's current systems in use and how they are integrated.

PLEASE ANSWER THE FOLLOWING QUESTIONS USING FLASHCARD A

FLASHCARD A			
Student Management	Application	**Finance**	Transactional
	Progression		General Ledger
	Graduation		
	Alumni	**HR**	Recruitment
			HR
Teaching & Learning	Course Delivery		Payroll
	Collaboration Tools		Performance Management
	Assessment Support		
		Estates	Property Management
Research	Funding & Contracts		Residences
	Bursaries		Access Control
	Publications		
		Timetabling	Lecture Timetabling
Personal Development Planning	E-Portfolio		Exam Timetabling
	Performance Management		
	Community Engagement	**Library**	Library Catalogue
			Library Repository

For each of the main areas of functionality and/or their subsystems (in FLASHCARD A):

A.1.1.1. Identify the system product and supplier.

A.1.1.2. When was this system first implemented?

A.1.1.3. Do you plan to replace this system in the near future?

PLEASE ANSWER THE FOLLOWING QUESTION USING FLASHCARDS B AND C

A.1.1.4. The purpose of this question is to allow you to give us some information on the means by which your information systems are integrated. This concerns only the main system or application which supports each area of functionality.

For each system identified in A.1.1.1, please indicate the integration approach used (in FLASHCARD B) to integrate that system with any of the other systems.

FLASHCARD B			
A.	**Not Applicable** (not necessary to integrate)	**F.**	**Periodic Data Dumps** (to centralised warehouse)
B.	**Not Integrated** (but could/should be)	**G.**	**Via Direct Data Adaptors** (messages)
C.	**Manual Re-keying** (manual data entry)	**H.**	**Via Universal Data Adaptors** (central hub or bus)
D.	**Portals/Screen Dumps**	**I.**	**Pre-integrated Suites**
E.	**Periodic Data Dumps** (between systems)	**J.**	**Other or Don't Know**

A.1.2 Attitude to Integration

The next set of questions enquires about the university's attitude to integration and to service-oriented principles.

PLEASE ANSWER THE FOLLOWING QUESTIONS TO THE BEST OF YOUR ABILITY

A.1.2.1. In your opinion, what are the essential goals of systems integration in your institution?

A.1.2.2. Has systems integration proved to be difficult in your institution?

A.1.2.3. Why would you favour a particular integration approach over any other approach?

A.1.2.4. In your opinion, what are some of the risks of systems integration in your institution?

A.1.2.5. In your opinion, what are the main barriers to systems integration in your institution?

PLEASE REFER TO FLASHCARD C FOR AN INTRODUCTION TO SOA

FLASHCARD C
In Service-Oriented Architecture (SOA), services are built on existing business processes and used as a mechanism for passing information between systems and applications that may be built on a multitude of different and disparate platforms. These services can be shared by multiple people, departments or even organisations and are not tightly bound or limited to any specific application. SOA encapsulates the service-oriented design principles of abstraction, autonomy, composability, discoverability, interoperability, loose coupling, reusability and statelessness, thus building on previous integration approaches as a means of avoiding problems associated with silo-based systems development.

A.1.2.6. Has SOA been implemented in some part of your institution?

IF YOU ANSWERED NO TO A.1.2.6 PLEASE SKIP AHEAD TO A.1.2.7

A.1.2.6.1. Which part/s of your institution has/have been implemented?

A.1.2.6.2. Has this implementation been successful?

A.1.2.6.3. How long has this project taken from concept to closure?

A.1.2.6.4. What discoveries have you made from this implementation?

A.1.2.7. Are you considering implementing SOA in some part of your institution?

IF YOU ANSWERED NO TO A.1.2.7 PLEASE SKIP AHEAD TO A.1.2.8

A.1.2.7.1. In which part/s of your institution do you want to implement SOA?

A.1.2.7.2. Why are you considering implementing SOA in your institution?

A.1.2.8. In your opinion, what are the driving factors that influence your adoption of SOA?

A.1.2.9. In your opinion, what are the barriers that inhibit your adoption of SOA?

A.1.2.10. Do you consider the concept of SOA an evolutionary approach to systems development in your institution?

A.2 - Acceptance

PLEASE ANSWER THE FOLLOWING QUESTIONS TO THE BEST OF YOUR ABILITY

A.2.1. How well is your institution prepared to embrace technological change?

A.2.2. Explain the extent of communication between the business and information technology departments at your institution.

A.2.3. In your opinion, what drives/prevents the *acceptance* of SOA in your institution?

A.3 - Governance

A.3.1. Does your institution follow some sort of governance strategy to bridge different integration approaches and different business rules across departments?

IF YOU ANSWERED NO TO A.3.1 PLEASE SKIP AHEAD TO A.4

A.3.2. Does your governance strategy effectively manage business rules and policies between departments?

A.3.3. How do you adjust your governance strategy to incorporate future growth?

A.4 - Data

A.4.1. Is your institution's data generally flexible and trustworthy?

A.4.2. Do you often find inconsistencies in data sets that are spread across silos in the institution?

A.4.3. Where are your business rules located?

A.4.4. In your opinion, what are the most important characteristics of data for your institution?

A.5 - Development Planning

A.5.1. Do you construct business cases to promote the adoption of new technologies?

A.5.2. Do you use transition plans and pilot projects to coordinate the controlled adoption of new technologies?

A.5.3. Do you communicate with and analyse various known and unknown vendors for your institution's integration and implementation needs?

A.5.4. In your opinion, how does the adoption of a new technology affect systems development in your institution?

A.6 - Security

A.6.1. Do you use identity management initiatives to identify individual users in your institution and govern their access rights?

A.6.2. Do you have software or data authentication policies that ensure only trusted applications are executed?

A.6.3. Do you use audit trails to regularly monitor staff or students to ensure that potential fraudulent activities are prevented?

A.6.4. How is system security ensured with the adoption of new technologies in your institution?

A.7 - External Opportunities

A.7.1. Can any of your institution's systems connect to external departments and organisations?

A.7.2. Do you find the need to integrate your institution's systems with external departments and organisations?

A.7.3. Do you support the possibility of integrating your institution's systems with another institution?

Section B - Demographics

The final set of questions enquires about you and the university itself.

B.1 - About You

B.1.1. What is your job title?

B.1.2. How long have you been working in this position?

B.1.3. Which committee or position do you report to?

B.1.4. In which of the following areas do you have personal managerial responsibilities?

A. Provision of IT infrastructure
B. Provision of business systems
C. Provision of library and information resources systems

D. Provision of learning and teaching systems
E. Provision of IT systems to support research
F. Other, please specify

B.2 – About Your Institution

B.2.1. Which of the following best describes your institution?

A. Single Campus
B. Multi-Campus in SA
C. Multi-Campus including overseas campus
D. Other, please specify

B.2.2. Has your institution merged with or taken over another Higher Education provider in the last 10 years?

Appendix B - Detailed Empirical Results

The results presented below follow the chronological order of questions presented in the survey in Appendix A.

Institution #1

A.1 Systems Integration

A.1.1 Extent of Systems Integration

For each of the main areas of functionality:

A.1.1.1. Identify the system product and supplier.

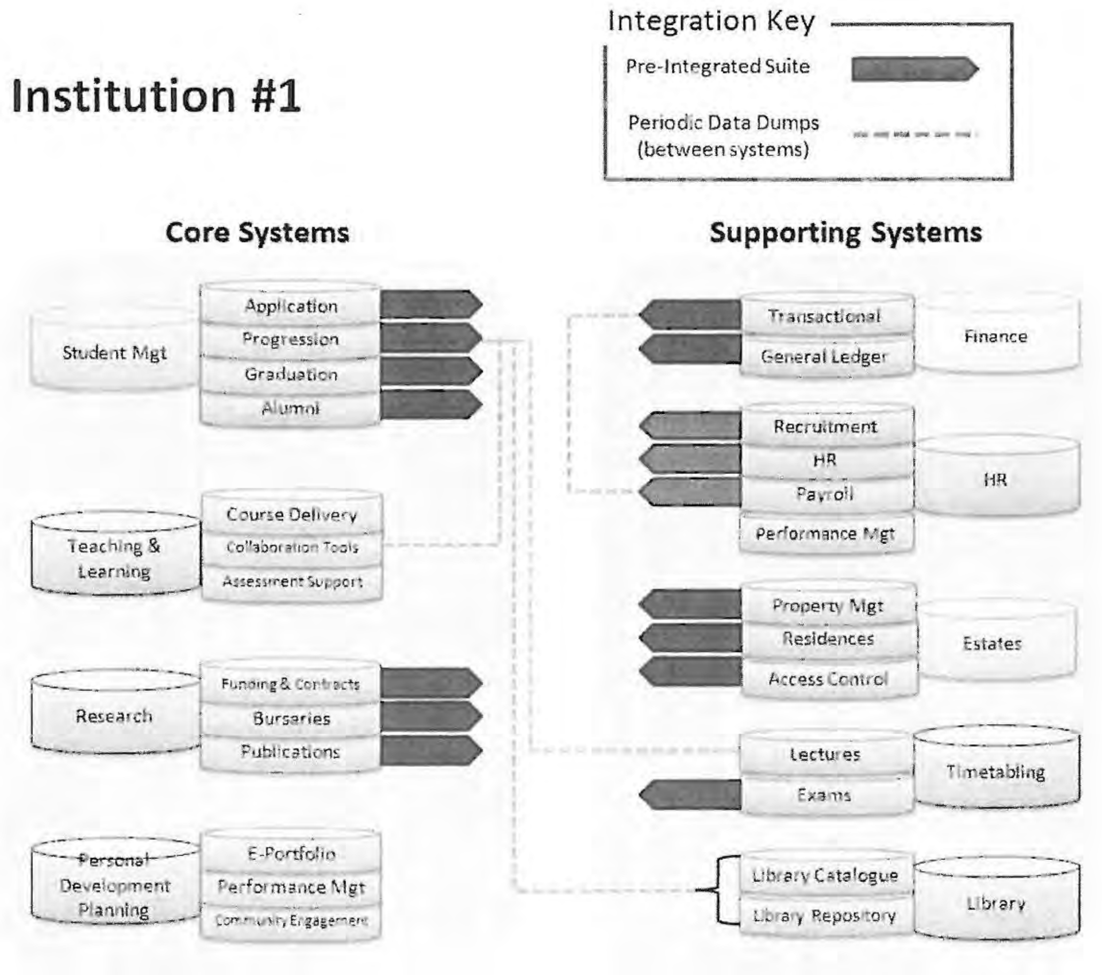
A.1.1.2. When was this system first implemented?

A.1.1.3. Do you plan to replace this system in the near future?

Function	Sub-Section	System Used	First Implemented?	Replaceable?
Student Management	**Application**	Progress	1996	No
	Progression	Progress	1996	No
	Graduation	Progress	1996	No
	Alumni	Progress/Kidz	1996	No
Teaching & Learning	**Course Delivery**	*none*	-	-
	Collaboration Tools	Moodle	2005	No
	Assessment Support	*none*	-	-
Research	**Funding & Contracts**	Progress	2005	Yes
	Bursaries	Progress	2005	Yes
	Publications	Progress	2005	Yes
Personal Development Planning	**E-Portfolio**	*none*	-	-
	Performance Management	*none*	-	-
	Community Engagement	*none*	-	-
Finance	**Transactional**	Progress/Omnix	1996	No
	General Ledger	Progress/Omnix	1996	No
HR	**Recruitment**	HR Premier	2010	No
	HR	HR Premier	2010	No
	Payroll	VIP Payroll	2010	No
	Performance Management	*none*	-	-

Estates	**Property Management**	Progress	2000	No
	Residences	Progress	2005	No
	Access Control	Progress	2000	No
Timetabling	**Lecture Timetabling**	Turbo Pascal	2000	Yes
	Exam Timetabling	ITS	2000	Yes
Library	**Library Catalogue**	SEAL's OPAC	2007	No
	Library Repository	SEAL's OPAC	2007	No

A.1.1.4. *For each system, please indicate which of the broad integration approaches best captures your institution's current approach.*



Student Management, Research, Finance, Estates and Exam Timetabling are all integrated through the pre-integrated suite Progress. These all share a common database from which required information is extracted.

In addition, Student Management is integrated with Collaboration Tools, Library and Lecture Timetabling through periodic data dumps from one system to the other.

Finance is integrated with HR's Payroll through periodic data dumps, which in turn is integrated with the rest of the HR system through the pre-integrated suite HR Premier.

The respondent notes that systems which are currently not integrated but could or should be integrated are HR with Estates, Library and Research; Finance with Library; Estates with Research; Timetabling with Teaching & Learning; and Library with Research.

A.1.2 Attitude to Integration

A.1.2.1. In your opinion, what are the essential goals of systems integration in your institution?

One goal of systems integration at this institution is having a single data entry point in order to be more business efficient and ensure less conflict with different data sets. The institution aims to ensure that information from one side of the university is easily accessible from any other part of the university, through the use of business processes and the Progress software package. A Data Management Policy is set in place in order to ensure that anyone who wishes to create a new database, must speak to the Data Manager first to ensure that the database is useful and if so, that it can be integrated efficiently.

A.1.2.2. Has systems integration proved to be difficult in your institution?

Initially the systems integration challenge was very difficult at this institution with a lot of animosity regarding the new databases and systems in place. It took a long time to convince the university that the data management unit can provide the systems, but they required financial backing and acceptance. Further conflicts about security between the data management unit, the IT department and the Information Systems departments need to constantly be improved and resolved.

A.1.2.3. Why would you favour a particular integration approach over any other approach?

Sometimes data dumps are the only way to pass data between systems that are located on different platforms and written in different languages. Direct data adaptors are also not always available to communicate between the different systems. Security and validation of data is also another issue when choosing an integration approach. Data received is often inconsistent and that is why data dumps are useful because the data can be validated before it gets integrated into the system.

A.1.2.4. In your opinion, what are some of the risks of systems integration in your institution?

Business owners do not appear to take ownership of their role in the integration process with a lack of documentation and responsibility for certain business processes.

Risks are also evident with the use of data dumps if the data is located on different servers for security reasons. Once information is dumped, there is no control over what is done with the information. Strong relationships between these departments are essential for efficient and secure dumping of data.

A.1.2.5. In your opinion, what are the main barriers to systems integration in your institution?

The technology barriers are the greatest with regards to integration. Each system is written on different platforms and owned by different vendors. Ensuring that the systems can communicate with these barriers is not easy.

A.1.2.6. Has SOA been implemented in some part of your institution? If so, please explain.

No.

A.1.2.7. Are you considering implementing SOA in some part of your institution?

A.1.2.7.1. In which part/s of your institution do you want to implement SOA?

It is hoped that the Student Management System will be better integrated through Web services. The current system used by students will be rewritten to use a Web service that will allow students to request data directly from the other core systems.

A.1.2.7.2. Why are you considering implementing SOA in your institution?

The data management unit could manage the data, while the Web developers could manage the Web interface. This ensures a separation of concerns with regards to the implementation of the Web service and furthermore, allows the students to have access to the university facilities and data from wherever they are.

A.1.2.8. In your opinion, what are the driving factors that influence your adoption of SOA?

The institution wants to use SOA to streamline much of its business processes. They are at an advantage as they already have the tools available for a SOA implementation – Web Speed (part of the Progress package), which is used to help build Web services for business applications.

A.1.2.9. In your opinion, what are the barriers that inhibit your adoption of SOA?

Security issues inhibit the institution's adoption of SOA, as well as the fact that it involves a steep learning curve.

A.1.2.10. Do you consider the concept of SOA an evolutionary approach to systems development in your institution?

SOA is definitely considered the next evolutionary approach to systems development.

A.2 Acceptance

A.2.1. How well is your institution prepared to embrace technological change?

The institution is sufficiently prepared. The IT department challenge the data management unit all the time, which are open to change and improvements in their strategy.

A.2.2. Explain the extent of communication between the business and information technology departments at your institution.

The communication between IT and business are very good. IT offers better ways of doing things and business readily enquires about them.

A.2.3. In your opinion, what drives/prevents the acceptance of SOA in your institution?

If a new technology streamlines users' processes and saves them time, then the institution is willing to accept it.

A.3 Governance

A.3.1. Does your institution follow some sort of governance strategy to bridge different integration approaches and different business rules across departments?

Yes, it is a centralised database management policy.

A.3.2. Does your governance strategy effectively manage business rules and policies between departments?

The governance strategy ensures that the data management unit can connect all the systems and know which rules and procedures to follow.

A.3.3. How do you adjust your governance strategy to incorporate future growth?

The strategy ensures that rules and policies are followed but if a new request is made, either the strategy or the request is modified to suit both parties.

A.4 Data

A.4.1. Is your institution's data generally flexible and trustworthy?

The data on the main database (Progress) is very flexible. However, there are areas where data quality may be compromised.

A.4.2. Do you often find inconsistencies in data sets that are spread across silos in the institution?

The institution doesn't often find inconsistencies but the data management unit is available for the purposes of detecting these inconsistencies and to put procedures in place to prevent them - as with the rollout of the integration between the HR and payroll systems.

A.4.3. Where are your business rules located?

All the business rules that integrate the core systems are written in Progress. Each department is responsible for writing their own system's business rules, which the data management unit helps to integrate.

A.4.4. In your opinion, what are the most important characteristics of data for your institution?

The data of a new innovation is mostly influenced by poor front-end software with no validation business logic. The data needs to be validated with ownership of the data allocated to respective users.

A.5 Development Planning

A.5.1. Do you construct business cases to promote the adoption of new technologies?

There is not really a need to create business cases, but seminars are held with various departments to promote the adoption of a new idea.

A.5.2. Do you use transition plans and pilot projects to coordinate the controlled adoption of new technologies?

It is absolutely vital to have plans to ensure the smooth transition from one technology to the next. These are generally written in a document which defines the processes involved.

A.5.3. Do you communicate with and analyse various known and unknown vendors for your institution's integration and implementation needs?

Before the implementation of the current centralised database on Progress, a committee discussion was held in which the tool's features and abilities to meet the needs of the university were assessed.

A.5.4. In your opinion, how does the adoption of a new technology affect systems development in your institution?

Cost influences the adoption of new technologies. Since it is a small institution, they are limited by what they can afford.

A.6 Security

A.6.1. Do you use identity management initiatives to identify individual users in your institution and govern their access rights?

The security for users is relatively limited. The IT department handles access on individual PCs, while the data management unit handles login accounts on a one-to-one basis. There is no central repository of information with read or write access roles.

A.6.2. Do you have software or data authentication policies that ensure only trusted applications are executed?

IT mostly manages the back-end integration processes and keys.

A.6.3. Do you use audit trails to regularly monitor staff or students to ensure that potential fraudulent activities are prevented?

Transaction audit trails are currently used. This can be used on the database but one cannot be sure of the impact it will have and so it is never used. Currently only successful transactions are logged.

A.6.4. How is system security ensured with the adoption of new technologies in your institution?

Having untrained people in the IT unit who do not know what they are doing could jeopardize the importance of the security of a new adoption.

A.7 External Opportunities

A.7.1. Can any of your institution's systems connect to external departments and organisations?

The institution can connect to Seals Libraries externally and is considering the implementation of RIMS InfoEd which integrates externally with the NRF and DST.

A.7.2. Do you find the need to integrate your institution's systems with external departments and organisations?

If external integration is of any use to the institution it will be considered.

A.7.3. Do you support the possibility of integrating your institution's systems with another institution?

If it is of any use to the institution, it will be supported. The problem is that every university uses different systems, but if a centralised system was available and was flexible enough to allow each institution to make changes, it may be useful, but we are still very far from this ideal. Each institution has such different requirements which give them their own edge and competitive advantage.

Institution #2

A.1 Systems Integration

A.1.1 Extent of Systems Integration

For each of the main areas of functionality:

A.1.1.1. Identify the system product and supplier.

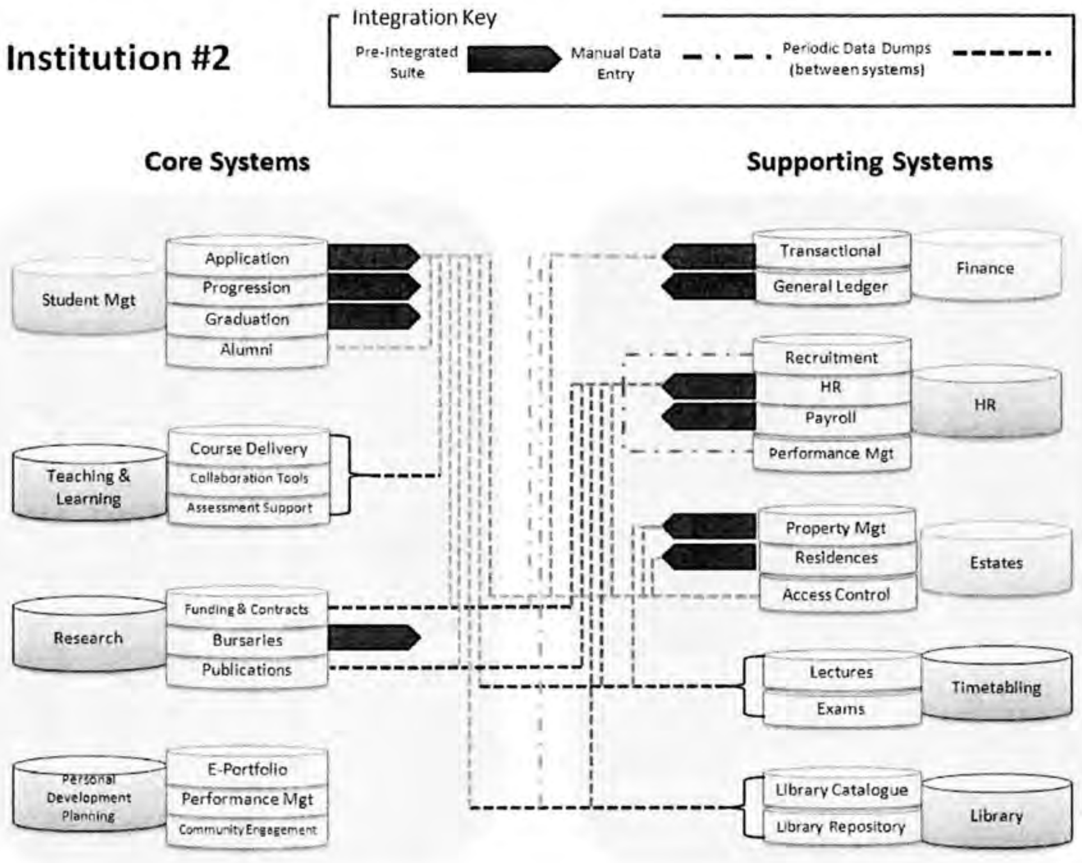
A.1.1.2. When was this system first implemented?

A.1.1.3. Do you plan to replace this system in the near future?

Function	Sub-Section	System Used	First Implemented?	Replaceable?
Student Management	**Application**	ITS	2006	No
	Progression	ITS	2006	No
	Graduation	ITS	2006	No
	Alumni	Kidz	2006	No
Teaching & Learning	**Course Delivery**	MS Sharepoint/Moodle	2006	No
	Collaboration Tools	MS Sharepoint/Moodle	2006	No
	Assessment Support	MS Sharepoint/Moodle	2006	No
Research	**Funding & Contracts**	ITS/RIMS InfoEd	2009	No
	Bursaries	ITS	2009	No
	Publications	RIMS InfoEd	2009	No
Personal Development Planning	**E-Portfolio**	*none*	-	-
	Performance Management	*none*	-	-
	Community Engagement	*none*	-	-
Finance	**Transactional**	ITS	2006	No
	General Ledger	ITS	2006	No
HR	**Recruitment**	In-house Development	2006	No
	HR	ITS	2006	No
	Payroll	ITS	2006	No
	Performance Management	MS Word, Excel	2006	No
Estates	**Property Management**	ITS	2006	No
	Residences	ITS	2006	No
	Access Control	Keymaster	2006	Yes
Timetabling	**Lecture Timetabling**	ITS Abacus	2008	No
	Exam Timetabling	ITS Abacus	2008	No

Library	**Library Catalogue**	SEAL's OPAC	2006	No
	Library Repository	SEAL's OPAC	2006	No

A.1.1.4. For each system, please indicate which of the broad integration approaches best captures your institution's current approach.



With the exception of Alumni, Recruitment, Performance Management and Access Control, the institution uses ITS to completely integrate its Student Management, Research Bursaries, Finance, HR and Estates systems through its pre-integrated ERP suite.

Student Management is also integrated with Alumni, Teaching & Learning, Research Funding & Contracts, Research Publications, Library and Timetabling via views (which are referred to as periodic data dumps here) through the ITS suite.

Finance is integrated with the Library and Research Funding & Contracts through manual data entry. Similarly with HR, performance management initiatives are done manually, as is the recruitment process, but plans are being made to develop an e-recruitment module using Web services. HR also integrates with Timetabling, Library, Research Funding & Contracts and Research Publications through periodic data dumps.

Access Control supplies security access to Student Management, Finance, HR and the rest of Estates through periodic data dumps and some manual data entry.

A.1.2 Attitude to Integration

A.1.2.1. In your opinion, what are the essential goals of systems integration in your institution?

This institution believes that a single version of truth is required in its system. Systems integration is regarded as extremely important in a higher education institution as there are a variety of systems that need to talk to one another. A blur between ERP and Web-based systems is becoming evident. More and more applications require dynamic content to be supported via the Web and this makes systems integration even more important. Different sources of data scattered across systems imply that there is no longer a single version of the truth.

A.1.2.2. Has systems integration proved to be difficult in your institution?

The respondent notes that systems integration has been difficult where there are separate systems on different platforms. For example, Teaching & Learning systems at this institution are based on Microsoft packages while the ERP suite is based on an Oracle platform. Differences between these technologies entail integration difficulties. There are indeed data adaptors that can simplify the integration possibilities but theory is very different from reality and the actual implementation provides a challenge.

A.1.2.3. Why would you favour a particular integration approach over any other approach?

The pre-integrated ERP suite is very useful as it provides a single point of truth for recording and accessing information.

A.1.2.4. In your opinion, what are some of the risks of systems integration in your institution?

Systems are becoming so large and it is difficult to have a single picture of how everything fits together. It works when the same people understand the systems, but often people leave and new people come in and have to learn everything about the dynamics of the institution's systems. In addition, often the systems and how they work are not documented properly and this makes it difficult for new people to understand the systems and business processes they execute.

A.1.2.5. In your opinion, what are the main barriers to systems integration in your institution?

Capacity in ICT resources and funding provide barriers to systems integration. Users only notice when systems break and not when they are automating tasks in the background. If a system does not meet the needs of the user, then the system needs to be fixed. A lack of ICT resources and funding may hinder this process.

A.1.2.6. Has SOA been implemented in some part of your institution? If so, please explain.

Still in development.

A.1.2.7. Are you considering implementing SOA in some part of your institution?

A.1.2.7.1. In which part/s of your institution do you want to implement SOA?

An HR Web service is being developed where data is collected by various departments through Sharepoint services and InfoPath and transferred via the Web service into ITS.

A.1.2.7.2. Why are you considering implementing SOA in your institution?

There is a limited need for SOA with the ERP system in place but the promise of Web services is constantly being reviewed. Web services are not dependent on technology so it allows the extraction of data from MS Sharepoint services created in a .NET environment and the population of data into the Oracle ERP system. This entire process is basically abstracted into the Web service.

A.1.2.8. In your opinion, what are the driving factors that influence your adoption of SOA?

Abstraction, technology independence and a faster process of development would drive this institution's adoption of SOA.

A.1.2.9. In your opinion, what are the barriers that inhibit your adoption of SOA?

Many of the institution's ERP developers are being trained in .NET to coordinate the integration between the systems on different platforms. Although the developers have the business knowledge, they require the time to develop the skills to embrace various new technologies adopted.

A.1.2.10. Do you consider the concept of SOA an evolutionary approach to systems development in your institution?

This institution thinks that SOA could be considered an evolutionary approach to systems development but it is important to realise that one needs to think beyond the data. SOA provides a level of abstraction as it involves integrating business processes as opposed to the data within systems.

A.2 Acceptance

A.2.1. How well is your institution prepared to embrace technological change?

In order to deliver services to higher education students, technology has to be seen as an enabler.

A.2.2. Explain the extent of communication between the business and information technology departments at your institution.

Within ICT, three people are responsible for business analysis in the Finance, Students and HR sectors. These people have developed good working relationships with one another to ensure that ICT is involved with each department. An ICT committee drives the adoption of ICTs in the institution. In addition, a Web technology committee is involved in discussing Web development.

A.2.3. In your opinion, what drives/prevents the acceptance of SOA in your institution?

ICT promotes the adoption of new technologies, but without efficient funding it cannot support such technologies. Technology can be used to enhance teaching, but in an institutional environment, resistance to change is often evident.

A.3 Governance

A.3.1. Does your institution follow some sort of governance strategy to bridge different integration approaches and different business rules across departments?

Yes, it is governed by varying committees that approve rules and procedures.

A.3.2. Does your governance strategy effectively manage business rules and policies between departments?

The strategy can be improved but the mere fact that users can talk to each other on a regular basis is in itself an achievement.

A.3.3. How do you adjust your governance strategy to incorporate future growth?

If the institution did grow tremendously, governance would have to be approached in a different way. The structure of rules and policies would become a lot more stringent. A newly appointed CIO at the institution hopes to enhance governance and the visibility of ICT within senior management to ensure operation at a strategic level.

A.4 Data

A.4.1. Is your institution's data generally flexible and trustworthy?

Since the institution uses a pre-packaged ERP system, change is difficult and the process takes time. Any changes required need to be justified and submitted to the suppliers before action can be taken. The trustworthiness of data has improved in some sectors, but there are still others that can improve. The quality of information is noticeably better with the integrated ERP system.

A.4.2. Do you often find inconsistencies in data sets that are spread across silos in the institution?

Inconsistencies are limited due to the use of the ERP system.

A.4.3. Where are your business rules located?

The business rules are mostly embedded within the source code of the ERP system.

A.4.4. In your opinion, what are the most important characteristics of data for your institution?

Data elements should represent a single business entity and business rules should not conflict. Data should be consistent, accurate and presented in real-time.

A.5 Development Planning

A.5.1. Do you construct business cases to promote the adoption of new technologies?

Presentations to management are made to promote the future plans and vision of ICT.

A.5.2. Do you use transition plans and pilot projects to coordinate the controlled adoption of new technologies?

If adopting new technology, a transitional plan is used to implement and control the move from the older version to the new.

A.5.3. Do you communicate with and analyse various known and unknown vendors for your institution's integration and implementation needs?

Where necessary, communication has been made with vendors.

A.5.4. In your opinion, how does the adoption of a new technology affect systems development in your institution?

The adoption of new technologies create great strain on persons responsible for development due to the steep learning curve and the time required to train and learn skills for a new technology.

A.6 Security

A.6.1. Do you use identity management initiatives to identify individual users in your institution and govern their access rights?

Login security at this institution is dependent on a number of systems. One login system is used for PC and network access, while another is used for the ERP system. Integration between the two is possible through a data adaptor but it is currently limited.

A.6.2. Do you have software or data authentication policies that ensure only trusted applications are executed?

Microsoft security is used to protect the workstations, while the ERP system has its own network-level security.

A.6.3. Do you use audit trails to regularly monitor staff or students to ensure that potential fraudulent activities are prevented?

Yes.

A.6.4. How is system security ensured with the adoption of new technologies in your institution?

An IT security officer is used to monitor and control the implications of new technological adoptions.

A.7 External Opportunities

A.7.1. Can any of your institution's systems connect to external departments and organisations?

The institution can connect to Seals Libraries externally and makes use of RIMS InfoEd which integrates externally with the NRF and DST. Student and staff data are also dumped annually to the Department of Education's HEMIS system for statistical purposes.

A.7.2. Do you find the need to integrate your institution's systems with external departments and organisations?

Data dumps between internal and external systems are useful. Further integration may be required in the future.

A.7.3. Do you support the possibility of integrating your institution's systems with another institution?

Support will always be provided to the Department of Education for the access of information. A single integrated provincial or national system will only be supported if its security is not compromised. One institution should not be able to access the other institution's data and vice versa. Each institution prides itself on its own competitive advantages and inefficient security could result in industrial espionage.

Institution #3

A.1 Systems Integration

A.1.1 Extent of Systems Integration

For each of the main areas of functionality:

A.1.1.1. Identify the system product and supplier.

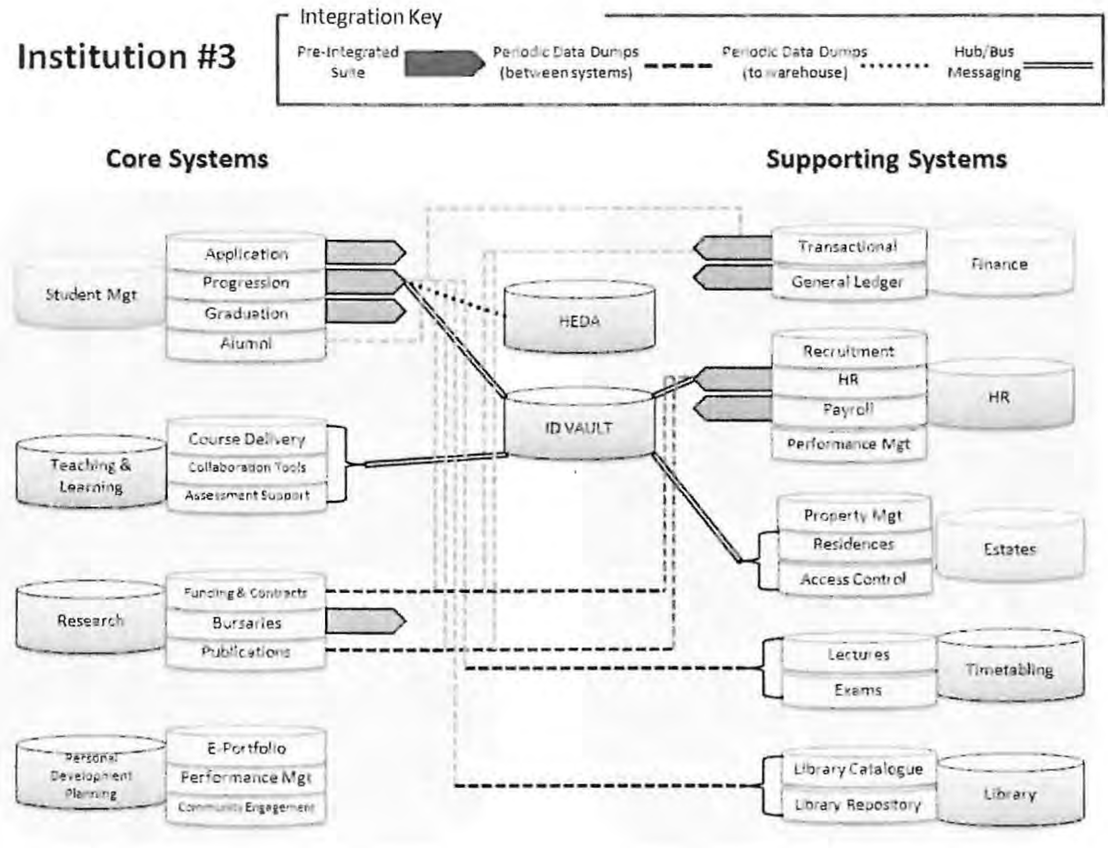
A.1.1.2. When was this system first implemented?

A.1.1.3. Do you plan to replace this system in the near future?

Function	Sub-Section	System Used	First Implemented?	Replaceable?
Student Management	**Application**	Campus Solutions	2006	No
	Progression	Campus Solutions	2006	No
	Graduation	Campus Solutions	2006	No
	Alumni	Kidz	2005	No
Teaching & Learning	**Course Delivery**	SAKAI	2007	No
	Collaboration Tools	SAKAI	2007	No
	Assessment Support	SAKAI	2007	No
Research	**Funding & Contracts**	IRMA	2001	No
	Bursaries	Campus Solutions	2006	No
	Publications	IRMA	2001	No
Personal Development Planning	**E-Portfolio**	*none*	-	-
	Performance Management	*none*	-	-
	Community Engagement	*none*	-	-
Finance	**Transactional**	SAP	1997	No
	General Ledger	SAP	1997	No
HR	**Recruitment**	*none*	-	-
	HR	SAP	1997	No
	Payroll	SAP	1997	No
	Performance Management	Paper-based	1997	No
Estates	**Property Management**	MS Access	2000	No
	Residences	RMS	2004	No
	Access Control	Impro/3rd Party	2000	No
Timetabling	**Lecture Timetabling**	Syllabus+	2003	No
	Exam Timetabling	Syllabus+	2003	No

Library	**Library Catalogue**	CALICO's ALEPH	2000	No
	Library Repository	CALICO's ALEPH	2000	No
Other	**Identity Management**	ID Vault (eDirectory)		No
	HEDA	HEMIS Data Warehouse		No

A.1.1.4. For each system, please indicate which of the broad integration approaches best captures your institution's current approach.



Student Management, Teaching & Learning, HR and Estates are integrated with the access control system, ID Vault, through hub messaging.

Student Management and Research Bursaries are both pre-integrated in the Campus Solutions package, as are Finance and HR with the general ERP package, SAP.

Student Management is also integrated with Alumni, Finance, Research Funding & Contracts, Research Publications, Library and Timetabling through periodic data dumps. Student

Management also makes periodic dumps to the data warehouse HEDA for the Department of Education's statistical needs.

In addition, both Finance and HR are integrated with Research Funding & Contracts and Research Publications through periodic data dumps.

A.1.2 Attitude to Integration

A.1.2.1. In your opinion, what are the essential goals of systems integration in your institution?

Systems should be seamless with minimal user interaction required, tasks should be processed in real-time and systems should retain a high level of integrity and should always be secure.

A.1.2.2. Has systems integration proved to be difficult in your institution?

Integration is not particularly difficult provided a good architecture is in place and the entire process is very controlled and organised. This institution has tried to be consistent in their approach to integration across all departments.

A.1.2.3. Why would you favour a particular integration approach over any other approach?

This institution favours the use of a central access control system that acts as middleware to ease the integration between disparate and heterogenous systems further supporting the notion of a service-oriented approach.

A.1.2.4. In your opinion, what are some of the risks of systems integration in your institution?

The institution is trying to avoid the use of data dumps between systems as it is risky and requires constant coordination to ensure data is up to date and not redundant. More frequent updates of smaller chunks of data are desirable. A security risk is also evident as data could be tampered with before it is dumped between systems. Timing, loss of data and integrity issues are also factors to consider.

A.1.2.5. In your opinion, what are the main barriers to systems integration in your institution?

Resources and capacity for improvement are barriers to a better integration approach. The time and effort needed into researching and adopting a new technology are often too great to make the move feasible.

A.1.2.6. Has SOA been implemented in some part of your institution? If so, please explain.

The principles of SOA, in terms of business process integration, have been implemented. An online student application system has recently been implemented in which students are able to apply to register at the institution remotely. This implementation hopes to streamline the application process considerably, ensuring that the admissions office can provide a far more efficient service to aspiring students.

The standards based approach of SOA may not necessarily be used in the online application system in terms of concrete services, but the concept is at the same level. In addition, a payment gateway for fees payments used at this institution does rely heavily on externally integrated Web services. The use of Web services in the payment gateway requires communication between the institution's fee accounts and the external credit panel without the user knowing that they are making use of different systems on different servers. This makes the integration relatively painless on the institution's side since there is little development required.

A.1.2.7. Are you considering implementing SOA in some part of your institution?

There are no further SOA implementations evident at this time.

A.1.2.8. In your opinion, what are the driving factors that influence your adoption of SOA?

This institution wants to use as much of their old technology as possible and SOA provides a means of integrating older legacy applications with newer systems. It also ensures that data integrity is preserved, productivity and maintainability is improved and the service-oriented approach is robust.

A.1.2.9. In your opinion, what are the barriers that inhibit your adoption of SOA?

In order to move to the next level of services as opposed to the current point-to-point integration, there is an awareness barrier and a greater learning curve to adopt new technologies.

A.1.2.10. Do you consider the concept of SOA an evolutionary approach to systems development in your institution?

It is definitely evolutionary. Being in the industry for so long makes one familiar with the design principles of abstraction, loose coupling, reusability, etc and the new innovations and advances with technology make the improvement of integration still based on these principles even more exciting.

A.2 Acceptance

A.2.1. How well is your institution prepared to embrace technological change?

In the last few years, this institution has had a number of highly successful initiatives and this positive track record proves that new ideas and innovations are actively embraced.

A.2.2. Explain the extent of communication between the business and information technology departments at your institution.

The registrar of the institution is the business owner of the new online application system and he has fully supported the institution's efforts to implement the system. Regular meetings are held to discuss the systems with an open line of communication at all times. However, communication with Finance and HR is less than ideal. HR recently opted to support their own systems internally which has not been much of a success, but have now once again requested support from the IT department. The major underlying problem with Finance is the lack of SAP support staff but communication remains positive.

A.2.3. In your opinion, what drives/prevents the acceptance of SOA in your institution?

The progression rules in the institution's policy documentation have to be embedded into the system and this may make it more difficult to adopt newer technologies that can efficiently make use of these business rules. Another issue involves knowing where to spend funds in the department, whether on systems, integration, or networking technology.

As mentioned, Finance and the Registrar's office are positive about using services to improve the integration of the institution's systems. However, there is a slight concern with the security of data dumps between systems.

A.3 Governance

A.3.1. Does your institution follow some sort of governance strategy to bridge different integration approaches and different business rules across departments?

There is not a formal governance strategy followed at this institution. This does pose a problem as it is easy to identify weak points in the system architecture of the institution without formal documentation. In most cases, most of the management information is prepared and analysed by individuals in spreadsheets. This is a high risk area because if an expert leaves, it is difficult to find someone to replace them who understands the system in the same way. However, being able to identify these weak points makes it possible for the institution to focus on areas with greater precedence. This approach makes people more open to change and able to accept new innovations because there are no set policies and procedures to follow.

A.4 Data

A.4.1. Is your institution's data generally flexible and trustworthy?

The institution is generally satisfied with the flexibility of data, however pockets of inconsistencies occur. The data flexibility and trustworthiness varies between systems. Generally the institution is very satisfied with the quality of data in their Student Management system since there are tight validation rules for each data set.

A.4.2. Do you often find inconsistencies in data sets that are spread across silos in the institution?

In Finance, classifying the right account code for purchases is not done very consistently and this is an area that requires consideration. The minute data is extracted from systems and spreadsheets, inconsistencies are bound to spread.

A.4.3. Where are your business rules located?

Business rules are generally embedded within the code itself and maintained within departments. Business process documents are developed to keep track of these rules.

A.4.4. In your opinion, what are the most important characteristics of data for your institution?

Data integrity, trustworthiness and reliability are all important qualities of data. Access to data is also an important consideration as people need to be able to see information from different systems in order to draw up an analysis.

A.5 Development Planning

A.5.1. Do you construct business cases to promote the adoption of new technologies?

The institution does develop business cases with regular meetings to get approval from management. A formal project management approach is used and delivered to a very high level project implementation committee to manage the funds and overall progress, as well as a project management committee involved in the delivery and maintenance of the project.

A.5.2. Do you use transition plans and pilot projects to coordinate the controlled adoption of new technologies?

Transition plans are also used and managed by the afore-mentioned committees. Pilot projects are used to prove the general concept of the technology.

A.5.3. Do you communicate with and analyse various known and unknown vendors for your institution's integration and implementation needs?

The institution makes an effort to keep up to date with new advances in technologies with their current known vendors as well as with what other institutions are doing to improve their systems.

A.5.4. In your opinion, how does the adoption of a new technology affect systems development in your institution?

It is quite difficult to radically change the systems development process. However, most of the institution's systems are pre-packaged and very little development is required anymore.

A.6 Security

A.6.1. Do you use identity management initiatives to identify individual users in your institution and govern their access rights?

The ID Vault is an example of the identity management control initiatives used in the institution. A UCT role model on the department's website identifies the roles and access rights of each staff member, student or outside third party visitor.

A.6.2. Do you have software or data authentication policies that ensure only trusted applications are executed?

In principle, to access a particular system, a line manager must first approve access and then the person must receive training on that particular system before they are granted access.

A.6.3. Do you use audit trails to regularly monitor staff or students to ensure that potential fraudulent activities are prevented?

Auditing is done on student data like exam results and bank account details to identify every change made to these critical attributes.

A.6.4. How is system security ensured with the adoption of new technologies in your institution?

The same principles are followed with each new technology in terms of access rights and user profiles.

A.7 External Opportunities

A.7.1. Can any of your institution's systems connect to external departments and organisations?

The institution can connect to Calico's Libraries externally and is considering the implementation of RIMS InfoEd which integrates externally with the NRF and DST. The MWEB payment gateway is also an example of an external system connection.

A.7.2. Do you find the need to integrate your institution's systems with external departments and organisations?

The need to integrate externally is not yet extensive, but it is useful and will probably grow over the next decade or so.

A.7.3. Do you support the possibility of integrating your institution's systems with another institution?

Several institutions have discussed the possibility of working together to integrate and share some of their systems.

Institution #4

A.1 Systems Integration

A.1.1 Extent of Systems Integration

For each of the main areas of functionality:

A.1.1.1. Identify the system product and supplier.

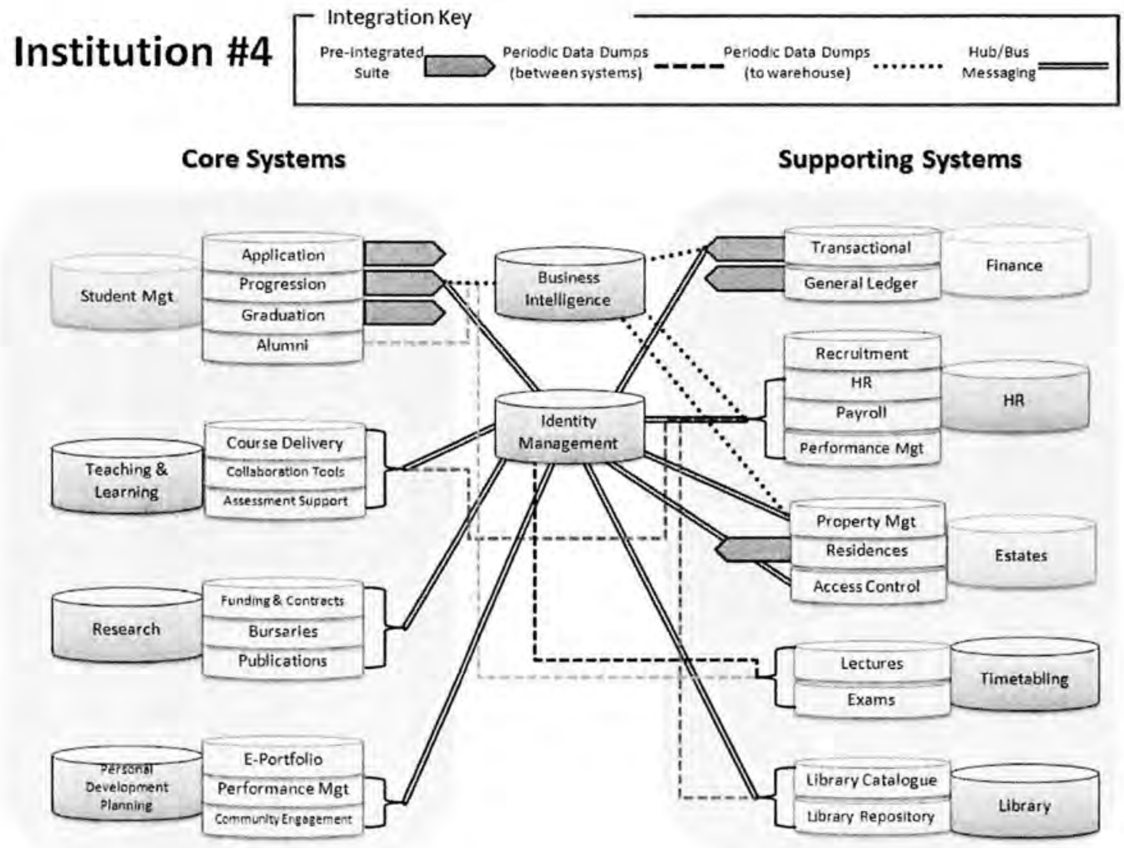
A.1.1.2. When was this system first implemented?

A.1.1.3. Do you plan to replace this system in the near future?

Function	Sub-Section	System Used	First Implemented?	Replaceable?
Student Management	**Application**	Adabas	1992	No
	Progression	Adabas	1992	No
	Graduation	Adabas	1992	No
	Alumni	Kidz	1992	No
Teaching & Learning	**Course Delivery**	Blackboard Vista	2000	Yes
	Collaboration Tools	Blackboard Vista	2000	Yes
	Assessment Support	Blackboard Vista	2000	Yes
Research	**Funding & Contracts**	RIMS InfoEd	2010	No
	Bursaries	RIMS InfoEd	2010	No
	Publications	RIMS InfoEd	2010	No
Personal Development Planning	**E-Portfolio**	*none*	-	-
	Performance Management	CRM Events Management	2010	No
	Community Engagement	In-house development	2008	No
Finance	**Transactional**	Adabas	1992	Yes
	General Ledger	Adabas	1992	Yes
HR	**Recruitment**	*none*	-	-
	HR	HRMS	2005	No
	Payroll	HRMS	2005	No
	Performance Management	HRMS	Expected 2011	No
Estates	**Property Management**	Infor EAM	2010	No
	Residences	Adabas	1992	No
	Access Control	In-house development	1990	No
Timetabling	**Lecture Timetabling**	Syllabus+	2008	No
	Exam Timetabling	Syllabus+	2008	No

Library	**Library Catalogue**	CALICO's ALEPH	1997	No
	Library Repository	CALICO's ALEPH	1997	No
Other	**Identity Management**	Directory/Sign-on	1993/2002	No
	Business Intelligence	Oracle Data Warehouse	2005	Yes

A.1.1.4. For each system, please indicate which of the broad integration approaches best captures your institution's current approach.



Student Management, Finance and Residences are all pre-integrated in the Adabas package.

As seen here, the Identity Management control system acts as a universal data adaptor integrating the Student Management, Teaching & Learning, Research, Personal Development Planning, Library, Estates, HR and Finance systems through hub messaging. Timetabling dumps periodic data to the Identity Management system when necessary.

Student Management, Finance, HR and Estates Property Management also all dump periodic data to the Business Intelligence warehouse used for the Department of Education's HEMIS data.

In addition, Student Management is integrated with Alumni and Timetabling through periodic data dumps, as is HR with the Teaching & Learning and Library systems.

A.1.2 Attitude to Integration

A.1.2.1. In your opinion, what are the essential goals of systems integration in your institution?

The aim of this institution is to integrate via a central hub so that any system that needs to communicate with another system can integrate through a central system.

A.1.2.2. Has systems integration proved to be difficult in your institution?

The buy-in for the central integration approach was difficult because it had to be proven that it was the best possible approach for the requirements of the institution. However, the concept itself sold and was generally well received. Since the institution has been on a single platform, it has proven very successful.

A.1.2.3. Why would you favour a particular integration approach over any other approach?

SU makes use of the central hub by allowing event-driven messaging between systems. This enhances data integrity and improves manageability, control and tracking of data.

A.1.2.4. In your opinion, what are some of the risks of systems integration in your institution?

Ensuring that the systems efficiently send messages is a concern, but it is possible to put the necessary controls in to prevent that risk. Ensuring the flow of information and data ownership is also an important consideration.

A.1.2.5. In your opinion, what are the main barriers to systems integration in your institution?

The institution has been fortunate in that its adoption of the hub and spoke model was relatively easy to achieve and get the institution to embrace and this has thus broken down many barriers for the institution. The possible barrier to such adoption could be the methodology followed as it is very important to be able to explain why a certain methodology should be adopted over something that is already working for the institution.

A.1.2.6. Has SOA been implemented in some part of your institution? If so, please explain.

The institution is using a services approach with some of its systems. Services are being developed and used to execute business processes more efficiently.

An example of a service created is in the e-payments section. The process itself involves the extraction and manipulation of data from a number of different systems to streamline the process of electronic payments.

A.1.2.7. Are you considering implementing SOA in some part of your institution?

A.1.2.7.1. In which part/s of your institution do you want to implement SOA?

The institution is trying to expose as many of its common functions as business services which will be used in future development.

The trial implementation of a fully SOA-based system utilising only services with a Microsoft client technology layer is, however, not as successful as the institution would like due to governance, security and service visibility issues.

A.1.2.7.2. Why are you considering implementing SOA in your institution?

Building applications that are based on services is easier once the business logic has been already built. One can focus on developing the service and the front end concurrently. However, the institution requires more skilled experts to deal with the presentation layer to enable the services to be reused and orchestrated among applications.

A.1.2.8. In your opinion, what are the driving factors that influence your adoption of SOA?

A separation of concerns between the presentation and business logic layers drives the adoption of services in the institution. Data integration and propagation have also driven the need for a service-oriented approach.

A.1.2.9. In your opinion, what are the barriers that inhibit your adoption of SOA?

The number of skilled staff required for the implementation of SOA is an important consideration. In addition, people tend to remain in their comfort zone with regards to integration approaches and it is difficult to embrace the concept of services in improving integration. Users and management need to move from having a siloed mentality to thinking about their systems at the enterprise level.

In order to expose services it is important to take security into account and to ensure that services are accessible, while still maintaining control over them.

A.1.2.10. Do you consider the concept of SOA an evolutionary approach to systems development in your institution?

From a technical point of view the concept of services has always been around through the use of modular programming. SOA allows a very gradual shift to a services-based approach over time and has become an evolutionary approach from a business perspective. IT departments act as an agent for change and should promote the technology wherever possible.

A.2 Acceptance

A.2.1. How well is your institution prepared to embrace technological change?

As mentioned, the institution has a mindset of siloes that is difficult to change. Developers are also not at the required level as they find it difficult to get out of their comfort zone. They are resistant to change and only accept a new technology if it is forced on the institution. The department is also short on staff to do valuable research into new innovations.

A.2.2. Explain the extent of communication between the business and information technology departments at your institution.

Communication between business and IT is an issue since business departments are only concerned with Student and administrative systems and do not see the potential of improvements in other areas. Current communication structures are not geared towards reaching the integration goals of the institution. There is a need to involve the stakeholders, students and academics from teaching, research and community outreach.

A.2.3. In your opinion, what drives/prevents the acceptance of SOA in your institution?

The lack of communication between the IT and business departments causes problems with SOA acceptance. However, it is important that IT removes all the technical jargon of SOA and approach it in terms of business processes in a way that business departments can understand and relate to.

A.3 Governance

A.3.1. Does your institution follow some sort of governance strategy to bridge different integration approaches and different business rules across departments?

A change-control process is in place to enable the adoption of newer technologies and the integration of this with older legacy systems.

A.3.2. Does your governance strategy effectively manage business rules and policies between departments?

There are inherent gaps in the policy but it is being continuously refined and improved. Formulating the policy is one accomplishment but actually enforcing it and ensuring compliance is another.

A.3.3. How do you adjust your governance strategy to incorporate future growth?

Each new technology poses new challenges and a governance strategy needs to change to reflect this. The adoption of services requires governance consideration across departments and technology divides which makes it even more of a challenge.

A.4 Data

A.4.1. Is your institution's data generally flexible and trustworthy?

The data is generally flexible and trustworthy. Although the integration is relatively sound, replication and corruption of data is still evident, but limited. The capturing and validation of data is enforced at a central level. The institution has experienced situations where data is overwritten or updated without the necessary controls to mitigate the risk. This, however, is a governance issue that needs to be addressed.

A.4.2. Do you often find inconsistencies in data sets that are spread across silos in the institution?

Legacy applications do not necessarily allow the validation of data at a database level, which makes it generally more difficult to avoid redundancy. Preventing duplication is a concern when unique identification is required. Many students are foreign and do not have appropriate documentation validating their unique identification, thus causing difficulties when trying to enforce business rules that require unique identifiers.

A.4.3. Where are your business rules located?

Business rules are generally embedded within the code. However, there are some instances where business rules are evident in the presentation layer where they should not be.

A.4.4. In your opinion, what are the most important characteristics of data for your institution?

Ensuring a primary source and unique identifier of data is important, as is preventing duplication, ensuring consistent business rules across department, accountability and responsibility of data.

A.5 Development Planning

A.5.1. Do you construct business cases to promote the adoption of new technologies?

The institution is required to construct business cases for each new adoption.

A.5.2. Do you use transition plans and pilot projects to coordinate the controlled adoption of new technologies?

Transition plans are particularly important in the implementation of pilot projects.

A.5.3. Do you communicate with and analyse various known and unknown vendors for your institution's integration and implementation needs?

The institution communicates with vendors, analysts and other institutions about integration initiatives and needs.

A.5.4. In your opinion, how does the adoption of a new technology affect systems development in your institution?

New technologies follow a hype cycle, deferring resistance and resulting in acceptance. In addition, it is difficult to deliver more and more with each new development under the same budgets.

A.6 Security

A.6.1. Do you use identity management initiatives to identify individual users in your institution and govern their access rights?

The institution relies very strongly on its access control system and the use of hub messaging to authorise and allow access to certain systems.

A.6.2. Do you have software or data authentication policies that ensure only trusted applications are executed?

Access control policies are set in place to ensure security access and execution of systems.

A.6.3. Do you use audit trails to regularly monitor staff or students to ensure that potential fraudulent activities are prevented?

The Student and administrative systems do have some form of audit trail built in that successfully prevents potential malicious activities.

A.6.4. How is system security ensured with the adoption of new technologies in your institution?

Security is the biggest challenge in any institution and is filtered through from an HR level. Legacy applications tend to have a security layer built on top of them already. It is the governance policy that needs to enforce security across systems.

A.7 External Opportunities

A.7.1. Can any of your institution's systems connect to external departments and organisations?

The institution can connect to Calico's Libraries externally and makes use of RIMS InfoEd which integrates externally with the NRF and DST. In addition, the community outreach system allows portal access to members of the public.

The e-payment service enables interaction from international event managers that can access the institution's servers and process its financial data.

A.7.2. Do you find the need to integrate your institution's systems with external departments and organisations?

The institution is looking into using Facebook and Mxit as clients for their registration applications.

A.7.3. Do you support the possibility of integrating your institution's systems with another institution?

The barrier of sharing more data between institutions is the acceptance of federated identity, another security issue. An institution may not be able to confirm that another institution has been authenticated and can use their resources.

However, the institution does support the possibility of this integration. A number of students recently developed a service for other students and approached the department to provide functions that would facilitate the display of timetables and results on their own platform. The project has been funded and adopted and appears to be running successfully.