E. R. Rajula, BScN, MBA, MPH, BBA (HCM), Lecturer, Community Health Thematic Unit, University of Nairobi P. O. Box 19676-00202, Nairobi, Kenya

OVERVIEW OF SERVICE ORIENTED ARCHITECTURE: DEFINITION, USE IN HEALTHCARE MANAGEMENT, CHALLENGES AND ETHICS

E. R. RAJULA

ABSTRACT

Objective: To provide an overview of use of service oriented architecture in Healthcare with focus on the pros and cons of its use as well as the challenges involved in its implementation.

Data Sources: The subject was broken down to specific areas of concern and literature search and enquiries done in a focused manner.

Data Extraction: Extensive literature provided ability to extract data related to architectural approaches, technologies adapted the required healthcare standards and challenges and potential solutions.

Data Synthesis: Extracted data were grouped into topics such as SOA use in Healthcare management, Ethical issues, Benefits, and Challenges. The benefits were found to outweigh the challenges. Potential service discovery was noted as fairly complicated, by the fact that organisations may have huge amounts of biomedical data which may be regarded as vast internet-accessible subroutine library, when deciding whether a service is appropriate for a specific task. This would require expert human intervention.

Conclusion:Service-oriented architecture can be described as an open agile, extensible, federated composite architecture comprised of autonomous, Quality of Service (QoS)-capable, vendor diverse, inter-operable, discoverable and potentially re-usable services, implemented as web services. Health data being sensitive, it is important to carry out extensive research on its security, particularly on storage of non-encrypted data in cloud, and security of access.

INTRODUCTION

A service-oriented architecture is essentially a collection of services. These services communicate with each other. The communication can involve either simple data passing or it could involve two or more services coordinating some activity. Some means of connecting services to each other is needed. A service-oriented architecture (SOA) is an architectural pattern in computer software design in which application components provide services to other components via a communications protocol, typically over a network. The principles of service-orientation are independent of any vendor, product or technology. It is simply defined as A loosely-coupled architecture designed to meet the business needs of the organisation (1). SOA is defined as "The policies, practices, frameworks that enable application functionality to be provided and consumed as sets of services published at a granularity relevant to the service consumer (6, 7). Services can be invoked, published and discovered, and are abstracted away from the implementation using a single, standards-based form of interface" (Figure 1 a and b, 4).

Service-orientation, on the other hand, is a way of thinking in terms of services and service-based development and the outcomes of services. A service, is a logical representation of a repeatable business activity that has a specified outcome, is self-contained,may be composed of other services,and can be referred to as a "black box" to consumers of the service (2)

By that definition, a service is an operation that may be discretely invoked. However, in the Web Services Description Language (WSDL), a service is an interface definition that may list several discrete services / operations. And elsewhere, the term service is used for a component that is encapsulated behind an interface.

Services can be combined to provide the functionality of a large software application. SOA makes it easier for software components on computers connected over a network to cooperate. Every computer can run any number of services, and each service is built in a way that ensures that the service can exchange information with any other service in the network without human interaction and without the need to make changes to the underlying programme

itself.

SOA USE IN HEALTHCARE MANAGEMENT

It is noted from the literature that the rapid rise in technology and its adoption into the healthcare field has caused healthcare organisations to collect an accumulation of non-interoperable systems that not only need to work together within the organisation, but are also accessed from outside. The burden of integration usually falls on the users of the system, who are forced often to access many different systems to complete one task. The use of a service oriented architecture (SOA), however, can improve the delivery of important information and make the sharing of data across a community of care practical in cost, security, and risk of deployment (4).

Increasingly, SOA is becoming not just a technology platform, but also a business platform. SOA represent a dramatic change in the relationship between business and IT. SOA makes technology a true business and empowers business and technology leaders alike (Figure 2 a and b).

Currently, there is a challenge for Healthcare organizations to manage a growing portfolio of systems. There is rising cost of acquiring, integrating, and maintaining these systems, while the demands of system users are increasing. Organisations must therefore address evolving clinical requirements as well as support revenue cycle and administration business functions. Besides, demands are increasing for interoperability with other organisations to regionally support care delivery. Service oriented architecture offers system design and management principles that support reuse and sharing of system resources across the healthcare organisation. SOA does not require the re-engineering of existing systems. With SOA, existing processing can be combined with new capabilities to build a library of services that are used as a part of solutions. Using shared services that are aligned with business processes, SOA strengthens interoperability while reducing the need to synchronise data between isolated systems. Services may be made available, no matter their location, to create (5).

Currently, there is no single integrated healthcare resource planning application available in the market that can satisfy the needs of all departments. Yet this can be done easily when all these features and functions exist in a single software programme; however, that's not the case in hospitals. Usually, manual steps are required to complete the admissions workflow. And, if the organisation uses multiple software vendors for admissions, bed assignment, and insurance verification, for example, then the problem is even greater. The fact is there is no single integrated Healthcare Resource Planning (HRP) application available in the market today that can satisfy the needs of all departments (5). Healthcare systems have been developed around entities such as doctors, hospitals, insurance companies, and researchers. Each of these work in their own environment with minimal interaction.

ETHICAL ISSUES

Hardly of the Healthcare providers, such as Doctors, hospitals and insurance companies are usually willing to share information, mainly for ethical reasons, yet this sometimes may leads to the suffering of the consumer of the health service. Patients have to put up with several of these entities that might not have any similarity. Each has a different approach in controlling the information. The sensitive nature of the health information is very critical. If it is not protected well all of the health entities will be reluctant to use a widespread and connected health system (6). There are also issues of standards, especially when the service may be called from outside the organisation and must be interoperable with services designed by others. The issue of medical errors and adverse effects may occur because SOA services are not licensed practitioners, as been mentioned in some studies. The issue of commercialisation may arise, complicating patient billing and care quality.

BENEFITS OF SOA

IT enterprise infrastructure is heterogeneous across operating systems, applications, and system software and application infrastructure. Enterprises should quickly respond to business changes with agility; leverage existing investments in applications and application infrastructure to address newer business requirements; support new channels of interactions with customers, partners and suppliers, and feature an architecture that supports organic business. SOA with its loosely coupled nature allows enterprises to plug in new services or upgrade existing services in a granular fashion to address the new business requirements, provides the option to make the service consumable across different channels and expose the existing enterprise and legacy applications as services, thereby safeguarding existing IT infrastructure investments (Kodhali, 2005).

SOA offers the following advantages over traditional approaches to distributed computing:

In general, it reduces healthcare spending. Business service across platforms; provide location independence; completely loosely coupled approach; authentication and authorisation support at every level, and the search and connectivity to other services is dynamic.

The short-term benefits of implementation include enhanced reliability, reduced hardware acquisition costs, leveraging existing development

skills, and it accelerates movement to standards-based server and application consolidation.

SOA components allow the services to work and managed independently. Some of the management issues can be (7) the following:

Security: Authorise requests, encrypt and decrypt data as required, and validate information. Deployment: Allow the service to be moved around the network to maximise performance or eliminate redundancy to provide optimum availability.

Logging: Provide auditing and metering capabilities. Dynamic rerouting: Provide fail-over or load-balancing capabilities. Maintenance: Manage new versions of the service.

Its long-term benefits of implementation are that, it provides the ability to build composite applications; creates self-healing infrastructure that reduces management costs; provides truly real-time decision-making applications, and enables the compilation of unified taxonomy of information across the enterprise and its customer and partners. In an article by Sen (6), it has been reported that in the USA, there has been recommendation for creation of a non-proprietary "network of networks" to support the rapid acceleration of electronic connectivity that will enable the flow of information to support patient care. Service oriented architecture fits perfectly in such a scenario. There can be a common framework at national level comprising of standards for various information exchange, security and authorisations, data integrity built upon service-oriented paradigm. Using such architecture would help integrating various systems and services in secure manner without jeopardising patients and providers confidential data. Becoming Agile means to Reinvent, Repurpose, Reuse (8).

"...provide solutions that attract more patients and physicians...connect all parties so the organisation can provide stellar care, bill for services easily and optimise revenue collection... be clinically centered, not technology centered."

Shahid Shah, "The Healthcare IT Guy"

Among the most difficult challenges facing healthcare organisations making IT investments today comes from deciding whether to go "all-in" with any particular vendor, or whether to self-integrate components from multiple vendors. The tradeoff is that a multi-vendor solution offers best-of-breed options, and a SOA promotes the easy integration and alignment across suppliers into a cohesive architecture (Figure 3).

CHALLENGES A OF SOA IMPLEMENTATION

Service Oriented Architecture presents multiple challenges. On the one side, it must address software development and system implementation issues. On the other side, it has to deal with IT systems planning and governance issues. Development of SOA depends on implementation standards. However, despite its much-lauded flexibility, SOA has to face actual deployment issues within the enterprise. The following factors must be taken into account:

In situations involving change, business units influence IT departments.

The culture of IT departments is generally aligned along project priorities. Implementing service-oriented architecture requires a longer planning horizon that usually conflicts with the short-term issues inherent to a project orientation.

Relevant criteria must be created to divide an information system into services that consider both technical constraints and business requirements.

Diverse expertise and required skills must be coordinated to implement service oriented architecture projects.

Methods and techniques for governing service systems must be provided.

The challenge is therefore to be able to logically link the different analysis perspectives through a cornerstone approach that will allow models to be circulated between the different players within the organization. The role of Enterprise Architecture is to provide a common framework to conduct an enterprise's multidisciplinary analysis (Figure 5).

In conclusion, a digitalent organisation is one that di uses computers and information systems to perform or support its activities. (10) They further explain that a digital enterprise uses IT to accomplish one or more of three basic activities, that is: Reach and engage customers more effectively; Boost employee activity, and improve operating efficiency.

When emphasising the convergence of computing and telecommunications via the Internet the term digital economy is used. Digital economy is considered to refer to an economy based on digital technologies and where members are better informed and able to communicate because of IT (11).

Companies utilising SOA are doing so to gain a competitive edge. Porter proposed three forces that influence competitive advantage in the market place which are, cost-leadership, differentiation and niche strategies (11). Porter also came up with fine competitive forces model, which has been used to develop strategies in businesses to give then a competitive edge. The fine major forces include: Threat of entry of new competitors; bargaining power of suppliers; bargaining power of customers or buyers; threat of substitute products or services, and rivalry among existing firms in the industry. Healthcare has become so competitive and almost every major health organisation is out on advertisement of their services to gain a competitive edge.
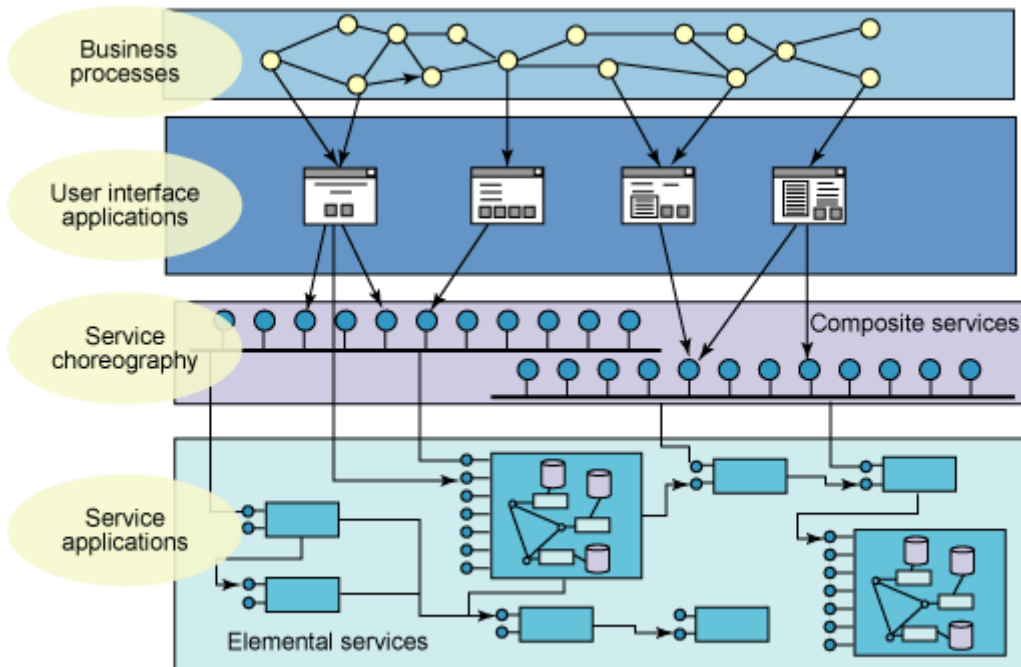
Figure 1
*Source google.co.ke/search/service+oriented+architecture
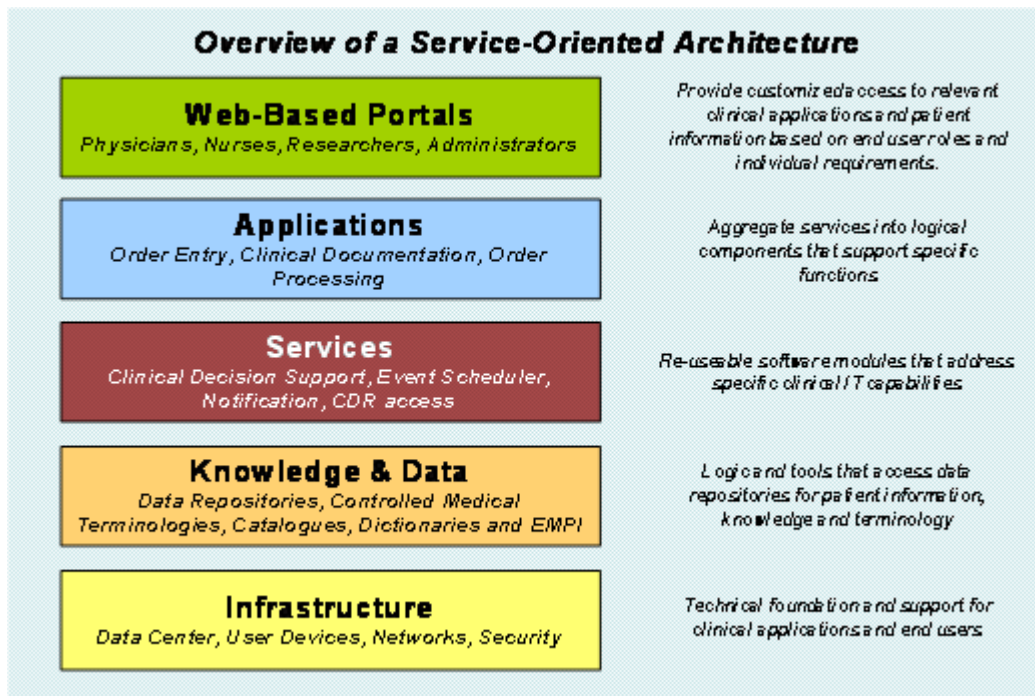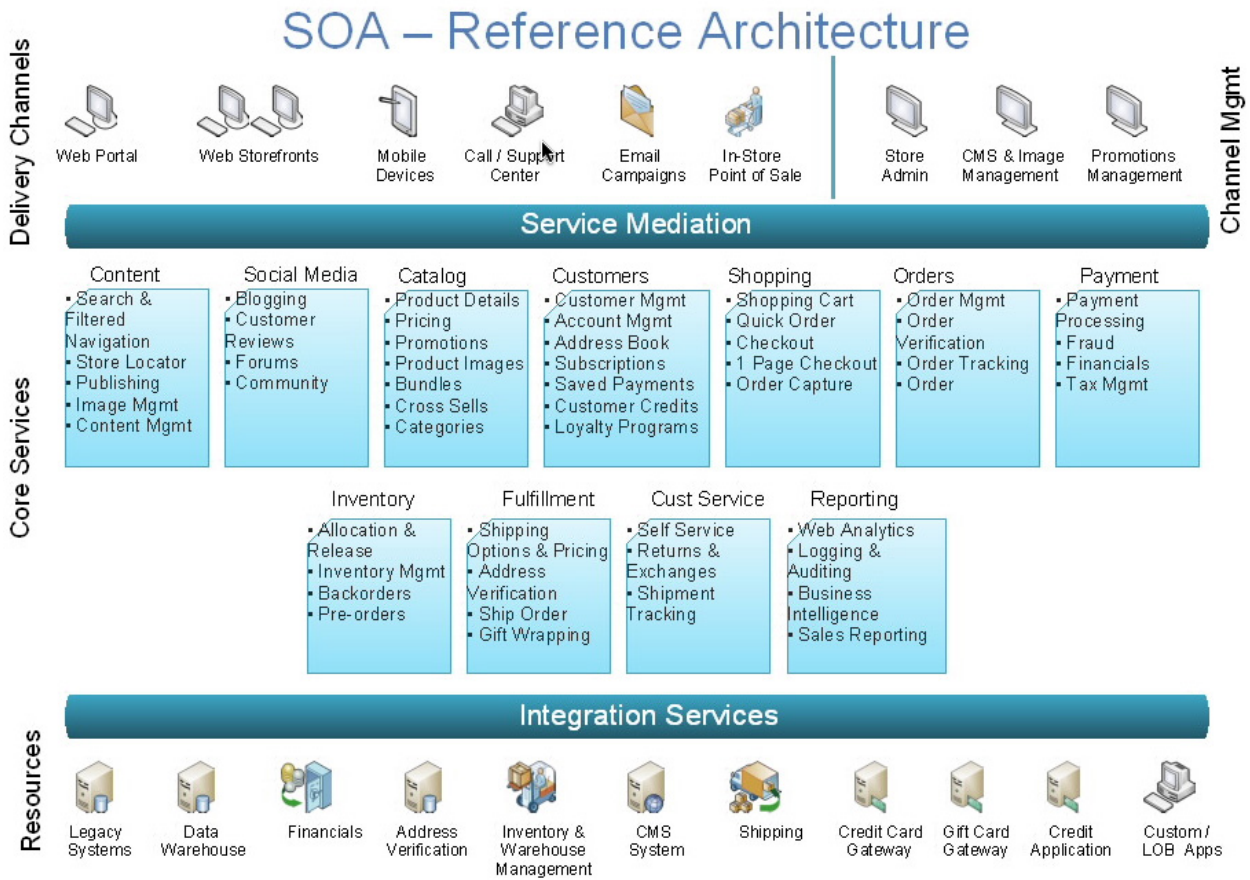+orientedarchiteture architecture*

The core components which make up an SOA implementation

SOA Applications

Figure 2
Source google.co.ke/search/service+oriented+architecture

Phases in the decision-making process:
Source from: Lovonino and Turban (2010). *Information Technology for Management:*
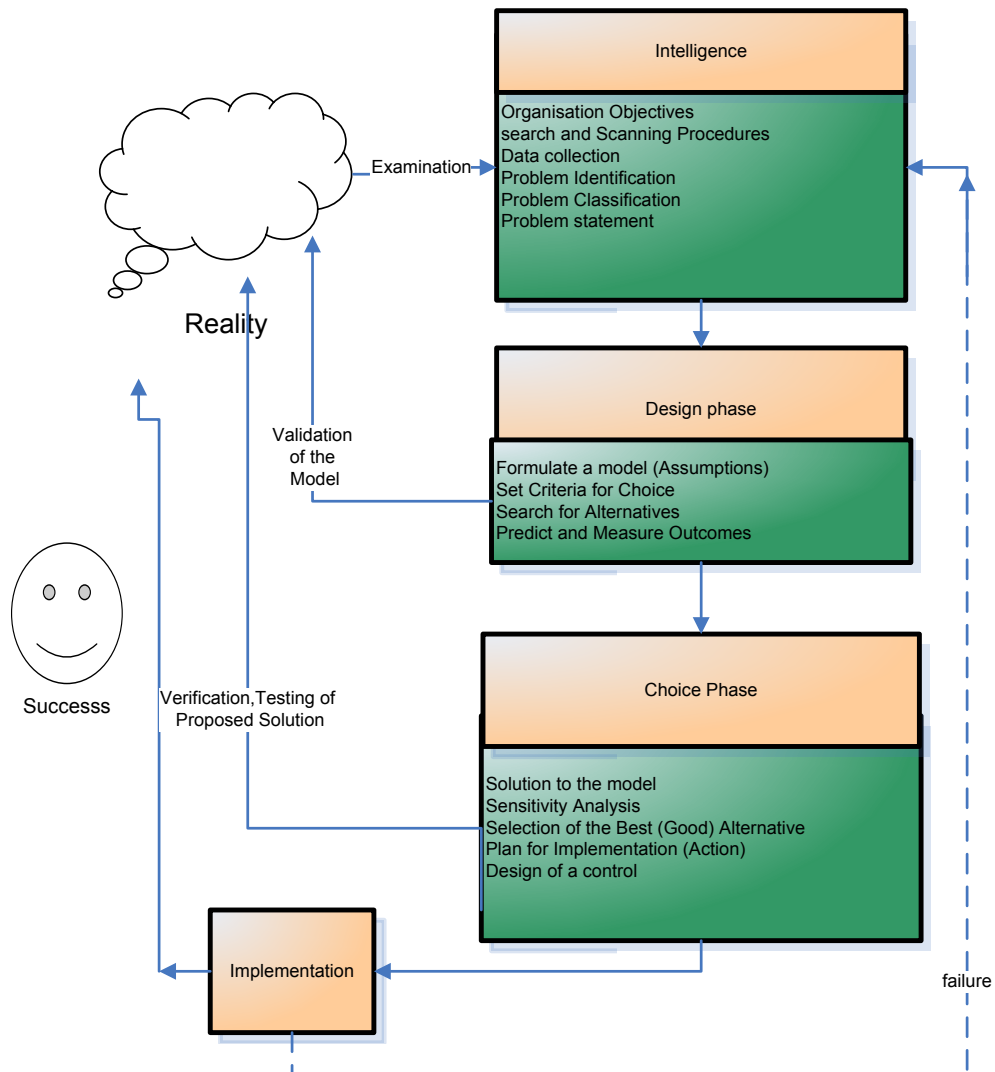Improving performance in the digital economy. 7thed.P. 469

Figure 3

Figure 4

Conceptual model of DDS and its components

Source from: Lovonino and Turban (2010). *Information Technology for Management:*
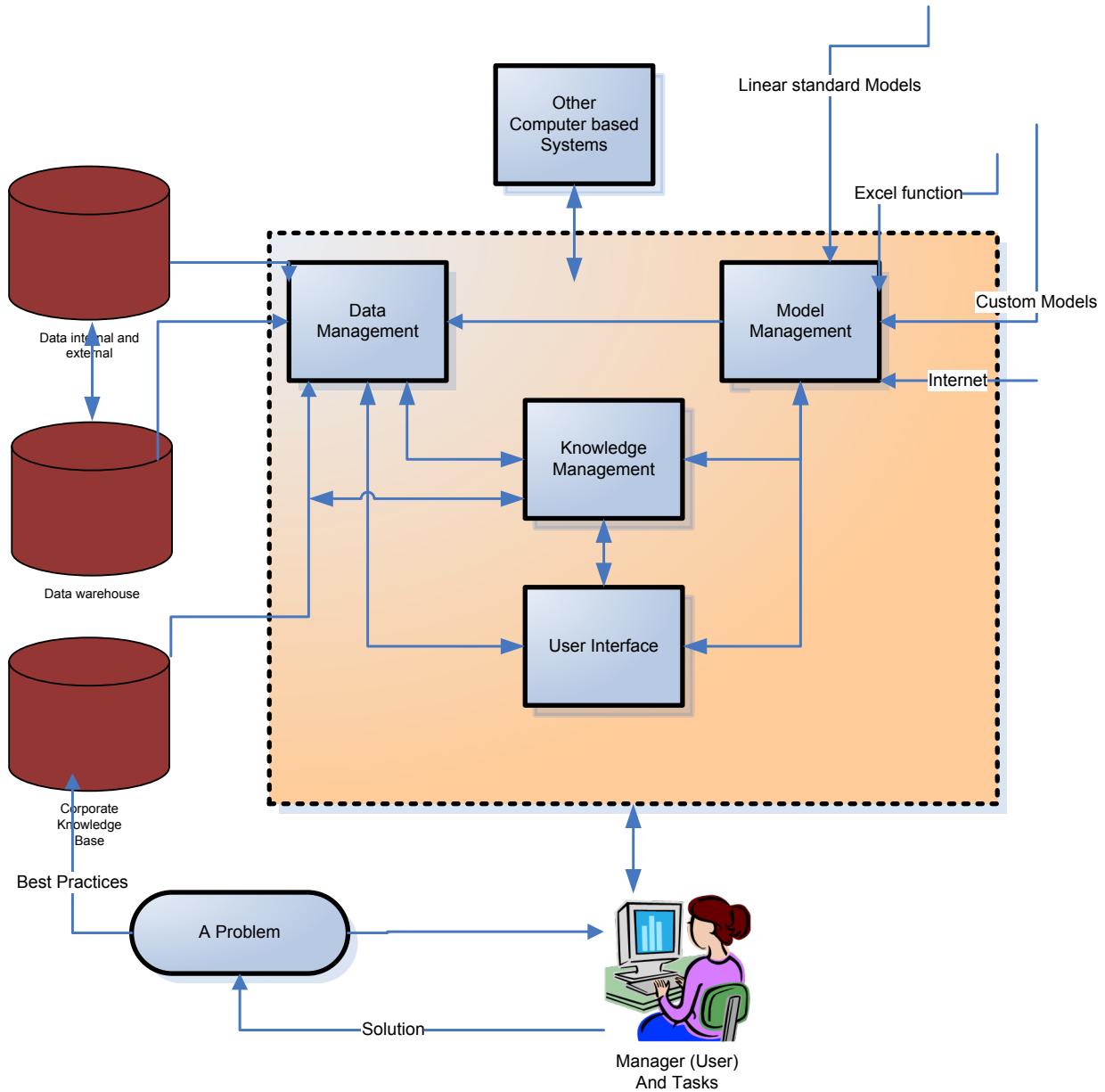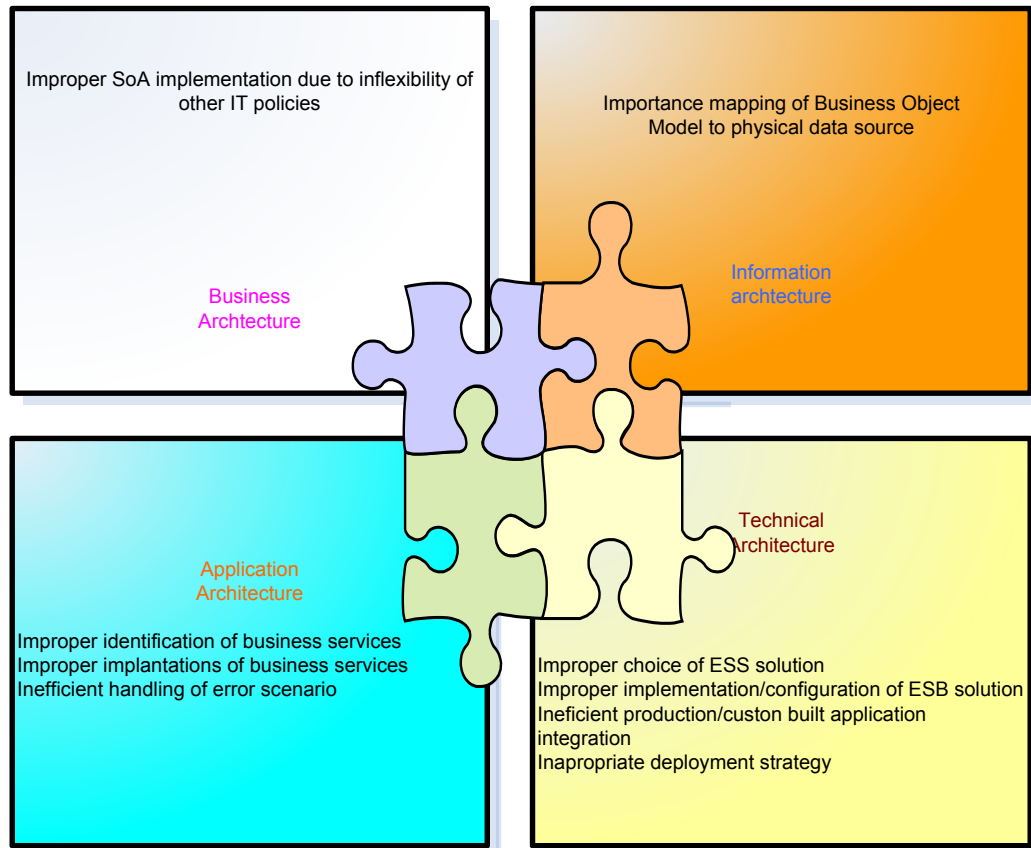Improving performance in the digital economy. 7th ed. P. 474

Figure 5

Risks in SOA implementation:
Extracted from: Mazumder, S. (2006). *SOA: A perspective on Implementation Risks.*
Infosys-viewpoint magazine

REFERENCE

1. Linthicum, D. service Oriented Architecture: SOA in the Real World. Msdn.microsoft.com. (2014)
2. The Open Group. Service Oriented Architecture. www.opengrou.org. Visited 2013 – 08-19
3. Anthony, V. T. Cloud Computing: A Practical Approach. McGraw Hill. ISBN 978-0-07-162694-1. 2010.
4. Jumenja, *et al*. Improving Performance of Health Systems with Service Oriented Architecture. Ifoq. 2008.
5. Kandelwal, A. Building foundation for Service Oriented Architecture. 2011.
6. Sen, H. Service Oriented Architectures. (SOA) and their application and use in healthcare: CSE300: Topics in Biomedical Informatics. 2013.
7. Sprott, D., Wilkens, L. Understanding Service Oriented Architecture. Microsoft Architect Journal; 2004.
8. Leader, E. A new Approach to Expanding SOA in Healthcare. Carefx. 2010
9. Object Management Group. The Practical Guide for SOA in Healthcare: A real Word approach to Planning, Designing and Developing SOA. Version 1.0. Healthcare Services Specification Project (HSSP). 2008.
10. Rodrigez, L. S. *et al*. Service Oriented Architecture for Clinical Decision Support: A systematic review and future directions. *J Med. Systems* (2014) 38:140.
11. Turban, E., Avolonino, L. (2010). Information Technology 78 Management Transforming Organisatons in the digital age. 7thed. John Wiley rsons (Asia)pte Ltd.