Proposing A Delphi-Derived, Inter-Enterprise Service-Oriented Architecture Maturity Model

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Doctorate of Business Administration
2009

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WEB SERVICES TECHNOLOGY: ARCHITECTURE, BUSINESS STRATEGIES AND OPPORTUNITIES.

Is It Applicable And Of Any Value To The Cyprus Government Industry (Particularly, To The Cyprus Customs Information System Processes).

Document 1: Definition and Mapping of Research Questions

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Abstract

In the next phase of the Internet, called Act II, the World Wide Web (or simply, Web) becomes so sophisticated that information systems, located at different computer systems and run by different departments or organizations, will perform transactions and accomplish various tasks using the Web's infrastructure and without people intervention. It is the Web at your services and it is accomplished by a set of new technologies (in fact, "a standards-based approach to integration and interoperability") altogether called Web Services.

Web Services are modular business process applications based on Open Internet standards that are self-describing (in terms of their functionality), can be published and located, and dynamically interact with other Web Services over the Web. They provide a method for organizations to conduct dynamic e-Business across the Internet, even if the communicating/collaborating parties might be heterogeneous systems (implemented using different programming languages and running on different operating systems).

Web Services technology promises that it will deliver strategic business value to its adopters. Among others, Web Services technology promises to free up money by driving down costs of integration, reducing expensive functionality duplication, and providing new revenue streams from existing functionality or data.

The Government industry, an industry traditionally unwieldy, will also benefit from Web Services technology adoption.

Keywords: Internet, World Wide Web, Web Services, Open Internet standards, dynamic e-Business.

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Organization and Managerial Context

Web Services is a new generation of technology that utilizes a set of new, widely accepted standards (WSDL (to describe), UDDI (to publish and locate) and SOAP (to communicate)) that promise to add value to an organization both financially and strategically. "What the Web did for program-to-user interactions, Web Services are poised to do for program-to-program interactions. Web Services allow companies to reduce the cost of doing e-business, to deploy solutions faster and to open up new opportunities. The key to reaching this new horizon is a common program-to-program communications model, built on existing and emerging standards such as HTTP, Extensible Mark-up Language (XML), Simple Object Access Protocol (SOAP), Web Services Description Language (WSDL) and Universal Description, Discovery and Integration (UDDI)."(Kreger 2001)

In today's highly competitive economy, reduction of costs and organizational agility are very important requirements for business survival. Web Services are designed to address these issues enabling their adopters to create a flexible and agile IT foundation for the future, upon which business value and competitive advantage can be built.

Web Services technology, which is an implementation of Service Oriented Architecture (a new type of enterprise architecture), allows applications to be integrated more rapidly, easily and less expensively than ever before. Integration is based on messages and it is "centred more on service semantics and less on network protocol semantics."(Kreger 2001) This characteristic is ideal for connecting business functions across the Web—both between enterprises and within enterprises. Web Services is a technology for "deploying and providing access to business functions over the Web."(Kreger 2001)

Not only Web Services technology facilitates application integration, but it also promises to reduce costs within an organization by reducing expensive functionality duplication, and by providing new revenue streams from existing functionality and data. That is, existing applications and data are not "buried", but they are appropriately adjusted to become usable components of the new framework.

An industry sector that could benefit from Web Services adoption is the Government. Its complicated and bureaucratic processes (that require enormous integration effort, in case an Information System will be implemented) and the need to have Government agencies exchange real-time information/data one another, make the Web Services technology (due to its properties) a very attractive alternative/solution. In addition, due to the need to compete the corresponding agencies of the other countries, and due to the pressures experienced by the existence of similar services offered by the private sector organizations, the adoption of Web Services technology is becoming more emerging than ever before.

Academic Field

Since the development of the first electronic digital computer (mid 1940s), we have witnessed a tremendous evolution of both computer hardware and software. The evolution is even more radical with the advent of the Internet (the physical inter-networking infrastructure), Web (the graphical interface provided to users to access information on the Internet), and with the challenges that were created by their (Internet/Web) warm embracement (both by people and by organizations). Enterprises (in fact, the way they are performing business with their customers, suppliers, and partners; or even the way they –themselves- are operating internally) could not escape from this "wave".

In the past, computer systems were considered just as "tools" for supporting organizations' secondary operations, like office administration (word processing, emailing, etc) or filling. Now, the majority of organizations are using enterprise applications (Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), and Supply-Chain Management (SCM) systems) to support and manage basic processes of their businesses. This change in the degree of importance of computer systems for organizations, combined with the ever more rapidly moving dynamics of the business landscape, creates great challenges for effective IT (Information Technology) management. The administration and management of an organization's IT infrastructure "is a constant struggle to maintain and support aging legacy systems and implement new systems to meet emerging business needs, while also ensuring that the overall IT infrastructure is dynamic and flexible enough to enable rather inhibit changes in business direction and strategy." (Marks 2003, 1) These competing perspectives and the desire to keep the ideal balance between them (IT and business strategies) for the company's overall benefit, emerged the need to define an Enterprise Architecture.

The Enterprise Architecture defines the components that make up an organization's overall system infrastructure and its objectives are: (a) to provide all the necessary means/infrastructure for incorporating new functionality to the existing system while maintaining the system's integrity, (b) to optimise current IT investments, and (c) to have future IT investments aligned with company's strategic goals.
The Enterprise Architecture is realized by balancing the interactions, relationships, and dependencies of "organization's infrastructure and application architecture needs with business and information requirements," (Marks 2003, 2) as illustrated in Figure 1.

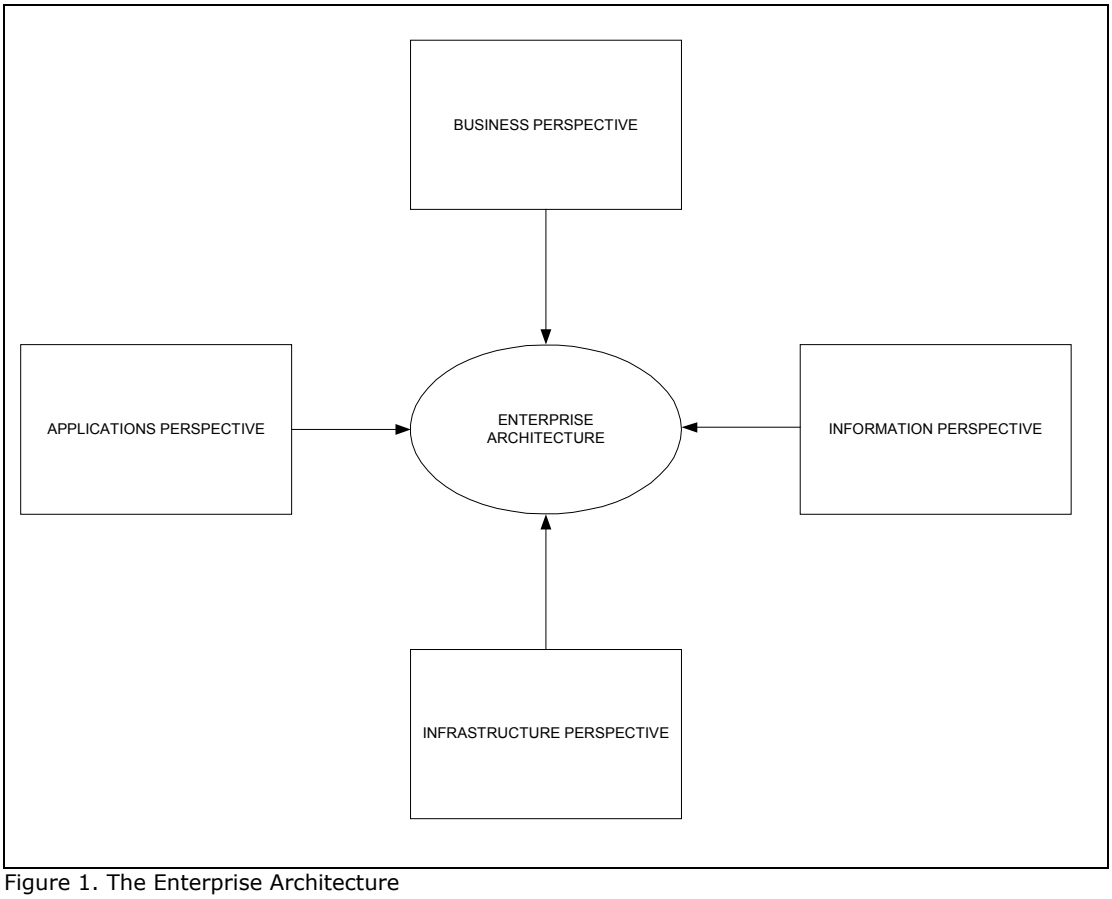

Figure 1. The Enterprise Architecture

If all these four (Infrastructure, Applications, Business, and Information) perspectives are kept in balance, then the organization can benefit the most, since it will reduce its expenditure in IT (through its wise IT policy) and it will have the current and future IT infrastructure "serve" the company's overall strategic goals and objectives.
So, the importance of enterprise architecture can be realized, if the enterprise architecture is used as a strategic tool which will lower costs, increase flexibility, improve time-to-market, and reduce complexity.

The role of an enterprise architecture is getting more important due to the fact that the enterprises' IT budgets are reduced, but at the same time the expectations (from the IT) remain high and the need/demand for integrating existing systems (in an attempt to reduce costs) with new ones in a highly heterogeneous environment is getting even more complex and expensive. So, the need for a new model that will support today's needs and serve long-term business goals is emerging. This model is the Service Oriented Architecture (SOA).

The Service Oriented Architecture(SOA) consists of three(3) components and there are three(3) major operations through which the SOA participants interact, as shown in Figure 2.

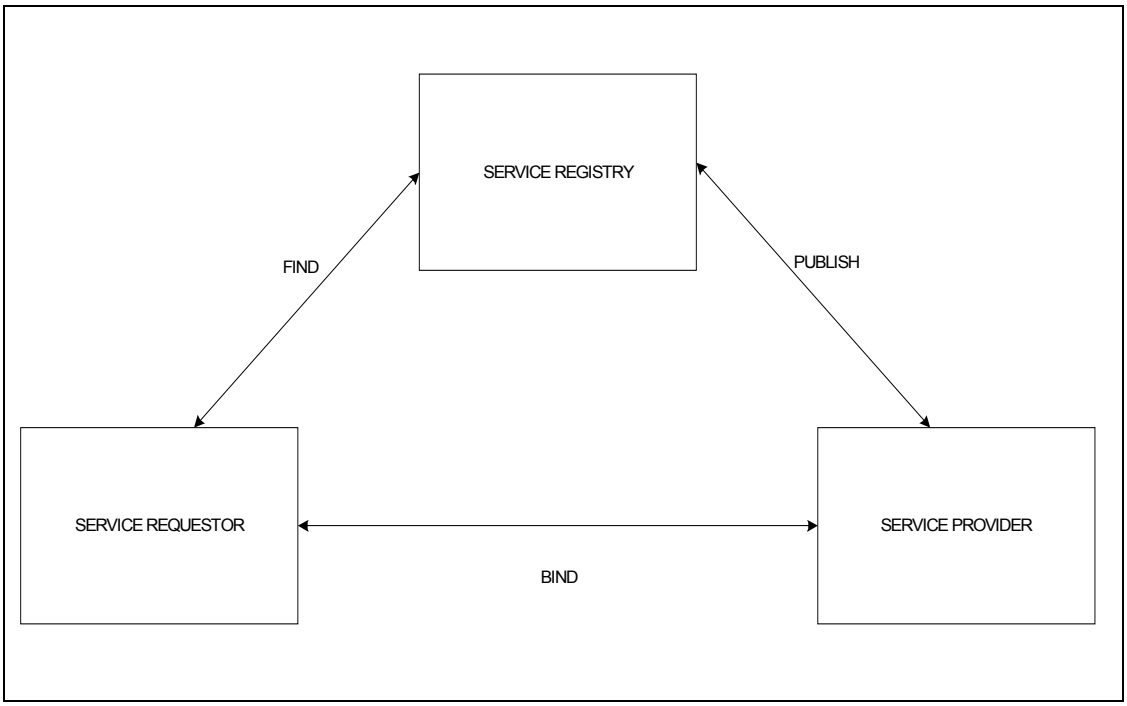

Figure 2. The Services-Oriented Architecture

The three (3) components of the SOA are:
(i) Service Provider. It is responsible for creating and publishing the services.

(ii) Service Broker. It registers and categorizes public services published by various providers and offers services to service requestors.

(iii) Service Requestor. This component is the user of the services. It discovers services by searching the registry/repository maintained by the service brokers and then invoke these services by communicating with the actual service providers.

The three (3) basic operations of the SOA components, through which they are interacting one another, are:
(a) Publish-ing. The service provider publishes its services to the service broker.

(b) Find-ing. The service requestor locates, searches, and discovers the services stored by the service broker.

(c) Bind-ing. The service requestor binds and use the service provided by the service provider (via the service broker).

Web Services is just an implementation of the SOA. "Web Services can be pictured as a relationship between a service provider and a service consumer, or publisher and subscriber. The service provided can be either functionality (all manner of calculations), or data access (providing a regulated view of any repository of data). The provider and consumer could well be within the same company, since Web Services potentially enable a rapid application development solution to integration problems. Alternatively, Web Services could be used to integrate systems between trusted partner companies.
Web Services are a way to drive down costs by reducing data and functionality duplication within an organization. Rather than having three departments running three different packages to do the same job because they're all using different systems, the functionality can be centralized and accessed as Web Services, regardless of the platform each department uses for its own needs. Web Services are also a way to drive up income, by allowing an organization to market their previously purely internal functionality to a wider audience. If part of your system does a good job of providing a certain type of valuable information in a timely manner, it could be a candidate for exposure as a Web Service so that it can be marketed as a service to other companies."(Clark 2002)

The simplest way, however, to view Web Services is as software that knows how to talk to other types of software over the network (either internally through an intranet; or, through the Internet if it needs to communicate with a remote application/software). "A Web Service can be nearly any type of application that has the ability to define to other applications what it does and can perform that action for authorized applications or parties."(Edwards 2002, 1) Specifically, a software component can be characterized as a Web Service if it satisfies the following criteria :

(1) It is able to expose and describe itself to other applications, allowing those applications to understand what the service does.

(2) It can be located by other applications via an online directory, if the service has been registered in the directory.

(3) It can be invoked by the originating application by using standard protocols.

A simple Web Service is characterized by the three (3) standards:

(i) SOAP (Simple Object Access Protocol),

(ii) UDDI (Universal Description, Discovery, and Integration), and,

(iii) WSDL (Web Services Description Language),

which taken together provide a basic "request and response" functionality. For an application to be able to communicate with other applications, it must have a set of interfaces defined in WSDL. Defining those interfaces is called publishing WSDL interfaces. To make the application locatable for the other applications, register it with the Web Services registry, the UDDI registry. Applications can invoke a Web Service by sending a request via SOAP and listening for the response. Figure 3 shows the Web Services architecture (which in fact, it is a Service Oriented Architecture implementation).

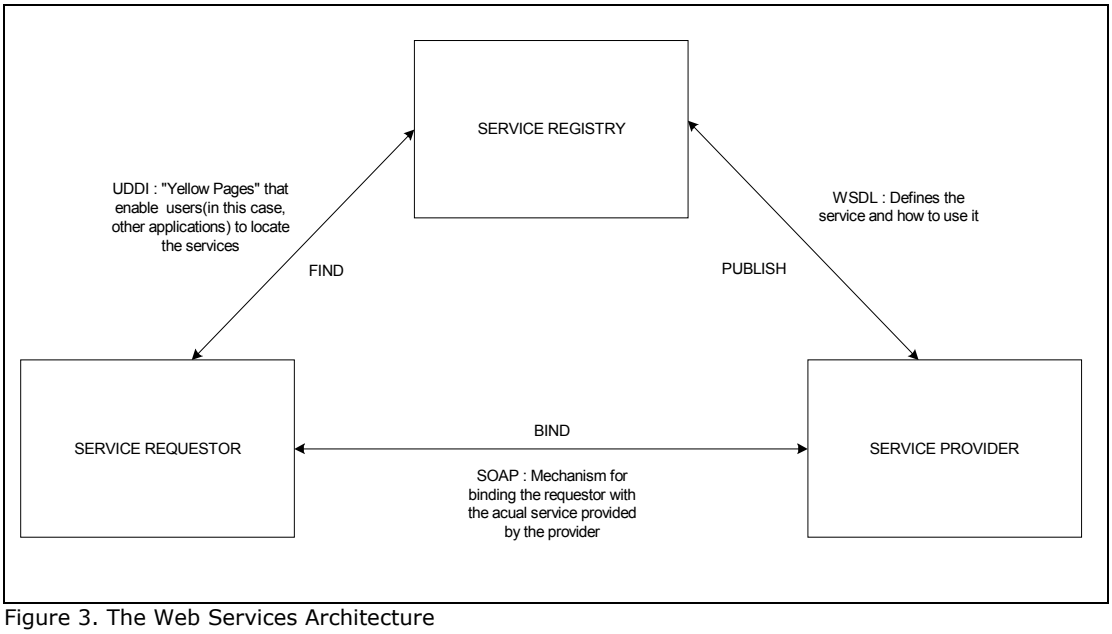

Figure 3. The Web Services Architecture

All these operations (Publish, Register, Locate/Find, Bind, etc) take place over a network (specifically, over the Internet/Web) in an automated way and without human intervention. Applications are "talking" one another (in a "request-and-response" mode, as described above) to complete a set of tasks that might altogether form a transaction. This means that with Web Services, we are moving from a human-centric Web to an "application-centric" Web. This does not necessarily means that humans are entirely out the picture. It just means that the exchange of data takes place (directly) between applications without the need (for a human) to provide input or any kind of instructions.

There are various areas where this "application-centric" model of Web Services might be useful. Industries or processes (within industries) that already benefit (or will

benefit from Web Services) are: credit card verification, package tracking, portfolio tracking, currency conversion, language translation, and in general all processes/transactions that need real-time exchange of data. "It will apply to any application where you need near-real-time exchange of data; where you need to exchange information across business partners"(Edwards 2002, 2), across departments or remote sites of the same organization, and when you need to exchange information/data with your suppliers and your customers.

Web Services technology is also warmly accepted in very complex inter-operating environments. "Web Services can dramatically ease business-to-business (B2B) integration and speed application development."(Edwards 2002, 2) Enterprise Application Integration (EAI) is one of the most challenging tasks businesses are facing today. The need to provide quality products/services at competitive prices in a short period of time is what all organizations are trying to achieve.
Enterprise Application Integration is a two-fold challenge: (a) integration of internal applications; that is, integration of the various applications that are used by the different departments (or by remote sites) of an organization, and (b) integration of organization's applications with the applications of its suppliers, business partners, and customers.
Applications within an organization are built in order to solve specific business problems. Most of the times, applications (for example, accounting system, payroll system, sales systems, etc) are built separated/isolated the one from the other in order to meet the objective intended to reach. Most of the times, it is desirable to have these (isolated developed) applications/systems communicate ("talk" or exchange data) one another. For this reason interfaces between these distinct applications/systems need to be developed which it is a highly challenging task but time-, effort- and capital- consuming. Even more costly is the task of integrating organization's applications/systems with those of its suppliers, business partners, and customers.

Hopefully, Web Services provide a solution. Built on existing Internet standard protocols (such as XML and HTTP), Web Services are designed to facilitate applications integration, reduce costs and boost productivity.
To illustrate how beneficial the adoption/use of Web Services might be to various industries, consider the following: In order for an airline company to be able to have its mainframe-based reservation system connected to a Windows-based (or to a UNIX-based) reservation systems of hotels and car-rental companies, it had to have its software engineers built custom connectors between its system and the systems of the

hotels and car-rental companies; a task highly challenging because the communicating systems are running on totally heterogeneous environments, and most probably built with different programming languages/packages.
Web Services technology makes things easier because it allows these totally heterogeneous environments easily integrated by means of exchanging "messages" in the way the "request and response" functionality of Service Oriented Architecture presented earlier in this document.
It is due to this nature ("request and response") that Web Services are applicable to (almost) all service-oriented businesses. "In many financial services organizations - as well as other service-oriented businesses – you see an immediate recognition of the relevance of that technology." (Gilpin 2001)

There are some other industries/processes where Web Services will be really beneficial. From my working experience, Web Services could be beneficial to all industries/processes where the service-oriented paradigm is observed. For almost six (6) years now, I am working in the IT (Information Technology) industry. For the first five (5) years, I was working with IBM Cyprus Ltd and I was given the opportunity to work in a Governmental agency project (the Information System of the Vehicles/Drivers Licensing Authority of Cyprus) and to various other projects in the Banking Industry (e-Banking, e-Alerts, and other e-Business projects/systems). After a quick (six (6) months) break being an Oracle Technical Consultant, the last six (6) months I am back to the "real work" (Application Integration) as the Architect/ Integrator of the Cyprus Customs Information System.
The Cyprus Customs Information System is composed of five (5) primary sub-systems (Import, Manifest, Tariff, Accounting, and Bonded Warehouses) integrated into what it is known as THESEAS system. The integration process of these five (5) sub-systems (and, of their constituents) was (and, continues to be) a complex activity, especially for the software engineers (analysts, programmers, the integrator, etc) who are responsible to design and implement interfaces between these sub-systems in order to have them inter-operate and collaborate. The software engineers are also responsible to build the interfaces for the Cyprus Customs Information System to be able to exchange data with other external systems (for example, of other Government agencies information systems) that might be (most of the cases) totally heterogeneous. Their (software engineers) task becomes even more frustrating when the business processes change (which happens very frequently). In this case, the interfaces need to change accordingly. That's why the adoption/use of Web Services sounds to be an ideal solution to these (integration) issues.

The two (2) governmental projects mentioned above (Cyprus Vehicles/Drivers Licensing Authority Information System, and primarily, the Cyprus Customs Information System) will be the main areas of my research work throughout Documents 3, 4, and 5.

A benefit (not so far clearly articulated) derived by Web Services adoption/use is the fact that Web Services do not "dictate" companies to discard their existing applications/system and invest to new systems or applications; but, the existing components, applications, or systems can be integrated in such a way that the business objectives are being met. You only need to modify the existing applications to contain a Web Services stack in order to handle the SOAP messages (that's the way communication between applications is taking place in Web Services technology). But even this, it is much less costly than having to buy (or build) a new system(s) that will meet your needs and (and forced to withdraw the existing one(s)). "Web Services are essentially an infrastructure layer between existing component models," says Timothy Blake, member of the Oracle9i JDeveloper (popular Integrated Development Environment for creating Java components) team.

This new model/technology (Web Services) promises to provide organizations some more benefits. For Rick Ross, of North Carolina-based JavaLobby, ROI hinges on integration and maintenance costs. "If an organization can extent the life span of existing solutions instead of having to write new ones and can also use average programmers instead of expensive consultants (who are otherwise needed), I think the ROI can grow pretty quickly," he said. (Edwards 2002, 2)

Positioning the adoption/acceptance of Web Services in the industry, we can say that we are in the early adoption territory (designated by the red arrow in Figure 4) of the life-cycle of this new model/paradigm/technology. Besides this fact, the benefits observed by Web Services adoption are great and the promises even more enthusiastic.
Web Services adoption will be accelerated when the first success stories (concerning their beneficiary aspects) will be announced/published. In addition to that, due to the fact that big IT companies (IBM, Microsoft, Sun Microsystems, etc) are investing great amounts of money in order to finalize and fine-tune this technology (Web Services) and due to the great effort that is also undertaken in academic communities, it is less risky to say that this (Web Services technology) will be the dominant technology in the near future.

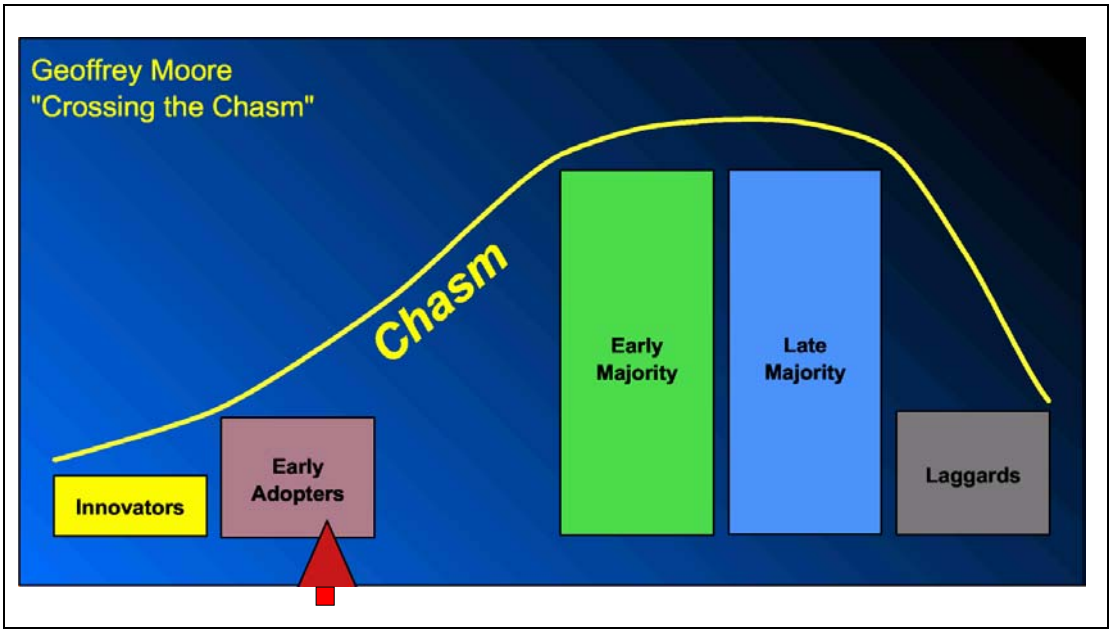

Figure 4. The Early Adopters Of Web Services

Strategically, as also previously mentioned, a well designed and implemented enterprise architecture is important if a company desires a competitive advantage over its competitors. "It's only through getting control of the architecture that you can hope to have a chance of being competitive in the long run."(Gilpin 2001) This new type of enterprise architecture, the Service Oriented Architecture (Web Services is just an implementation of it), mainly encompasses a competitive advantage that it is expressed as:

Reusability - Web Services architecture is an architecture that is based on reusable services. This has effort and cost savings implications, and,

Flexibility and Agility – Web Services architecture promise that it "is less fragile and more adaptive to ever-changing business pressures, either tactical or strategic" (Marks 2003, 3);

All these will require a thorough literature review in the areas of Web Services technology and architecture, Web Services business strategies and opportunities, integration, and collaboration.

The biggest IT companies in the world (IBM, Microsoft, Sun Microsystems, Oracle, HP, etc) along with the academic community are the major contributors of information in the area of Web Services technology and architecture. In order to provide a state-of-

the-art product to their customers, the IT companies are offering incredibly useful documentation (white papers, technical articles and journals, etc) on Web Services technology and architecture.

The pool of information offered by the IT companies is also the primary contributor of the Enterprise Application Integration (EAI) concept.

The online "libraries" of the IT companies are (again) the primary source of information concerning the business perspective of Web Services. This is not surprising since most of them (e.g. IBM, HP, etc) are transforming (themselves) into services-provider (for example, offering business transformation and re-engineering consulting services) companies.

One of the most influential source for this research work is the work done by a number of researchers/professionals whose work is assembled in a book titled: "Web Services Business Strategies and Architectures."

Another really useful source for this research work is the work done by Eric Marks and Mark Warrell found in their book titled: "Executive's Guide To Web Services."

And of course, the "classical" source for the Strategic point-of-view of Web Services is the "Out Of The Box : Strategies for Achieving Profits Today and Growth Tomorrow through Web Services." by John Hagel III.

The information concerning the Information Systems of the two (2) Government agencies (the Cyprus Customs and the Cyprus Vehicles/Drivers Licensing Authority), that will be the main area of study/research in Documents 3-5, will be provided by the companies (Bull Cyprus Ltd for the Cyprus Customs Information System and IBM Cyprus Ltd for the Cyprus Vehicles/Drivers Licensing Authority) that were in charge to implement and integrate the various sub-systems (modules or components) of the two (2) systems. In addition, information for these two (2) systems will be provided by the Government agencies themselves as well as by third-party agencies (for example, Department of Statistics) that are performing market and statistical researches and whose information might be valuable. Furthermore, a personal perspective will also be provided because I was an active member (in different positions) during the implementation and integration of both systems.

Problem and Issue Description

Web Services underlying technology, architecture and the business strategies and opportunities derived by this new kind of technology will be examined in respect to its applicability and value in the various Information Systems of the Cyprus Government agencies (ministries, departments, etc).

During the last ten (10) years, the Government of Cyprus is applying its strategic plan to streamline the procedures in the various governmental offices (ministries, departments, etc) by computerising the manual processes. This ambitious plan was having the primary goal to reduce costs, increase employee's productivity and provide better services to citizens.
From the early days of the adoption of Information Systems in various ministries or departments of the Government, the benefits were obvious. Among others, the various systems dramatically change the way businesses processes are performed, increase employees' productivity, decrease costs and facilitate customers (Cyprus citizens) service.

Today, Governments throughout the world face increased demands from citizens and businesses, pressures on basic service provisions, the challenge of developing new service delivery mechanisms, and forming the right ventures and alliances to meet service delivery demands. Citizens and businesses are accustomed to functioning in the 24x7 world of the e-Economy, and are now demanding the same responsiveness from their Government agencies. Towards meeting these needs, the Government of Cyprus is examining various technologies and architectures that will fulfil these expectations.
Web Services technology seems to be the right choice for the Cyprus Government because:
(a) It will reduce costs through reuse of functionality and data among the various information systems of the ministries and departments of the Cyprus Government. For example, there is no any need to store the personal information of a citizen in all the Information Systems of the various government agencies (ministries, departments, etc). It is only needed to store once the information in a central location (system) and have the other system locate the information needed from that repository/registry. Web Services, as presented in the previous section: Academic Field, are designed to centrally store services (which in this case will be the personal information of a citizen) in the Service Registry and

upon request (by the Service Requestor) to provide (to the Service Provider) the requested information/data.
Moreover, the reduction of costs can be realised by the fact that existing (outdated) systems are not "buried", but, they can become part of the new framework, if they are adjusted accordingly to contain a Web Services stack. That way, they will be able handle the SOAP messages (the way communication between applications is taking place in Web Services technology).
Another source of reduction in costs is the fact that the systems integration effort and time is considerably reduced. Most of the times (and, in the case of Information Systems of the Cyprus Government agencies) there is a need to integrate heterogeneous and completely different systems. In order to take care of this, there is a need to develop interfaces among the communicating parties. This is not always an easy task. With the advent of Web Services the integration process became much easier and less time-consuming;
(b) It will provide the flexibility and agility needed to a traditionally unwieldy organization/industry (Government). These characteristics (flexibility and agility) are now desired more than ever because the Cyprus Government has to compete the corresponding agencies of the rest of the EU countries and the agencies in the private sector that offer the same (or similar) services.
Thus, the Government of Cyprus needs to seriously take into consideration the Web Services technology too, both for the Information Systems that were already implemented, for the undergoing ones, and for the future ones, even though the technology is not mature enough (to allow possible adopters feel confident about it) and various important issues (security) need yet to be addressed.

Throughout my (current) research work, I am going to present two (2) information systems of the Cyprus Government agencies.
Specifically, in Document 3, I am going to present the Cyprus Customs Information System. It is an information system that is under construction, and it also has some phases that will be carried out in the future.

The Cyprus Customs Information System (CCIS) is composed of the following modules:

- The Import System (or, just Import)
- The Presentation to Customs (or, just Manifest)
- The National Tariff Management (or, just Tariff)
- The Accounting of Duties, Taxes and Fees (or, just Accounting)
- The Processing of Bonded Warehouses (or, just Bonded Warehouses)

The relationships and interfaces among the various components/modules of the Cyprus Customs Import System are shown in the Figure 5, below.

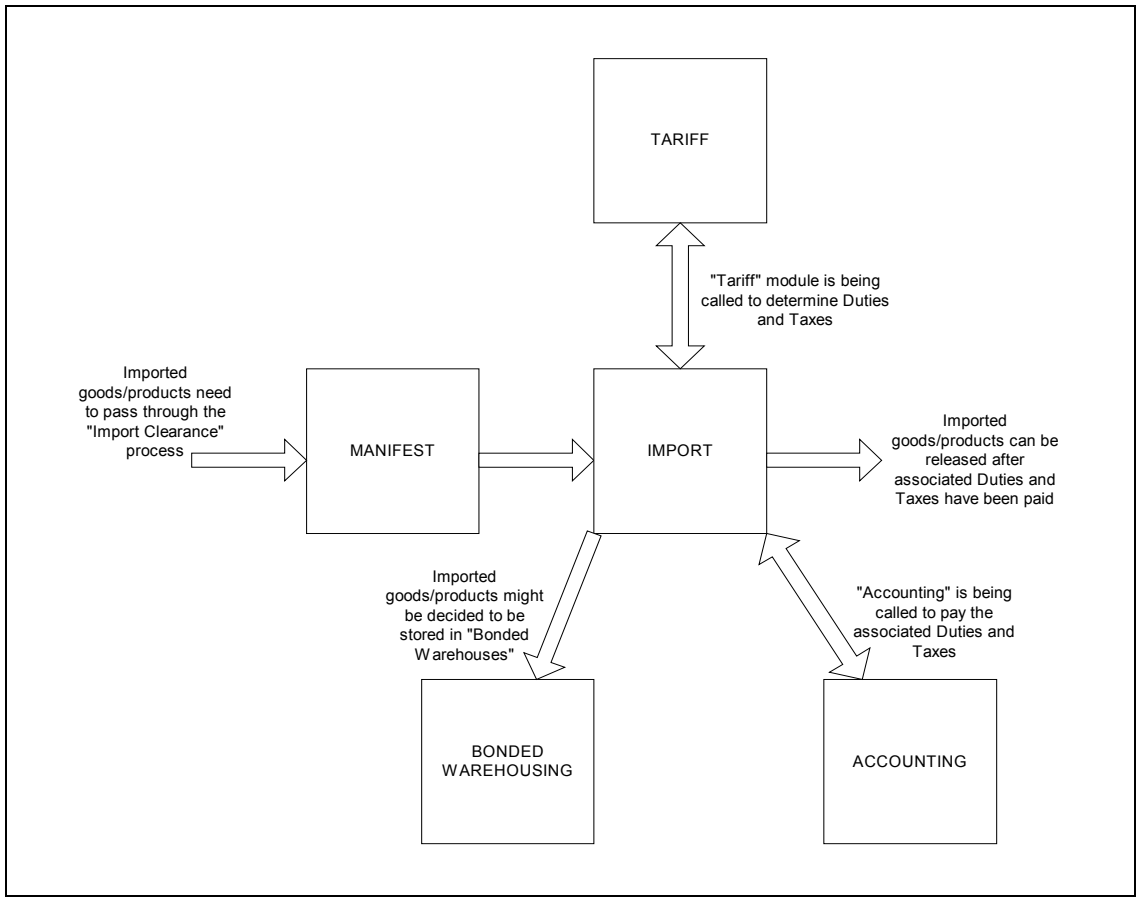

Figure 5. The "Import Clearance" process is a composite process where all the sub-systems (modules) take place.

The targets of the CCIS, as expressed by the responsible officials, will be to:

- Increase the speed of the clearance process (goods declaration is validated, accepted and paid),
- Ensure maximum security for the integrity of the data,
- Improve reliability of the clearance process,
- Enable immediate, complete application of up to date Customs regulations over the country, and
- Reduce paperwork requirements for both Customs and the trade community.

More specifically the main objective of the implementation of the CCIS system shall be to align the Cyprus Customs system with the European best-in-class systems in operation.

But, throughout the implementation and integration process (using less contemporary technologies than Web Services) of the individual modules of the whole system various challenges/problems are faced. These challenges are continually postpone the system delivery and its acceptance is becoming risky.
Throughout my exploration of the Cyprus Customs Information System I am going to present these major problems (challenges) faced during systems integration and how Web Services (if were applied) would have minimised the integration effort, costs, and risks. This also implies that Web Services could have secured a prompt delivery of the product/system (through integration effort minimization) and thus, minimising associated penalties imposed to the supplier. In addition, the product could have been highly competitive (through flexibility and agility) over the corresponding ones of the others EU countries (that were implemented with less contemporary technologies). This means that the European importers could have selected Cyprus Customs for clearing their imports originated from Asia, Africa, Oceania, or the Americas instead of any other point of entrance to the EU. This could be an important source of capital for the Cyprus Customs and subsequently Cyprus economy.
In Document 3, the various participants' (suppliers, partners, customers/citizens, IT staff, etc) perceptions towards (a) these challenges faced during integration, and (b) the possibility of deploying Web Services instead of the current technologies used, will also be presented.

In Document 4, the real value (benefits) of Web Services (if they were adopted by the Cyprus Customs) will be studied. Specifically, an attempt will be undertaken to construct a model/formula by which the Return On Investment (ROI) can be calculated if Web Services would have been used in the integration of the various modules (Import, Manifest, Tariff, Accounting, Bonded Warehouses) of the Cyprus Customs Information System.
The ROI model will take into account the following factors:
(1) Costs and Expenses. These will be based on parameters like:
    (a) Hardware Requirements
    (b) Software Requirements
    (c) Training Requirements
    (d) Network Bandwidth Requirements
    (e) Monitoring Tools
    (f) Operational Costs and Vendor Consulting
(2) Technical Benefits. They will be quantified by considering the following:
    (a) Software Development Automation
    (b) Streamlining of Middleware Technology

(c) Usage of Standards-Based Integration

(d) Integration with Applications and Business Process Management

(e) End of Duplication of Software Code Leading To Reusability

(3) Business Benefits. The following parameters will be taken into account:

(a) End-User Productivity

(b) Participation in Dynamic Business

(c) Collaborative Business Activities

(d) Better and Cheaper Customer Service

(e) Other Benefits, such as faster time to market, increased process efficiency, and increased efficiency through business process automation.

(4) Risks associated with adoption of Web Services. The following risks need to be considered in the ROI model or formula:

(a) New Technology

(b) Standards not Matured or Finalised

(c) Web Services Development Tools and Servers availability

(d) Quality of External Web Services

(e) Security

Thus, considering all those parameters, we can come up with the following model/formula concerning ROI that might be realised in the case Web Services technology would have been used for the implementation and integration of Cyprus Customs Information System:

$$ROI = \frac{\text{(Technical \& Business Benefits)-(Costs \& Expenses)-(Risks)}}{\text{(Technical \& Expenses)+(Risks)}} * 100$$

In Document 5, I am going to compare and contrast the already studied in the previous Documents (3 and 4) Cyprus Customs Information System with the Cyprus Vehicles/Drivers Licensing Authority Information System in respect to the business value that might be observed if Web Services were used for the implementation and integration of the two (2) systems.

Currently, the two (2) systems are not directly interfacing one another, but information related to the Import Clearance of vehicles are provided by the

Customs to the Vehicles/Drivers Licensing Authority. This piece of information is needed during the process of vehicles registration. That is, a vehicle can be registered and allowed to be in use by the Vehicles/Drivers Licensing Authority, only if it has been "cleared" by the Customs.

A proposition will be made such that these two (2) systems are directly interfacing one another by the adoption of Web Services. In this case the "indirectly" collaborated systems (in the process of vehicle registration, presented above) will be "directly" collaborated. This will have direct impact (that is, reduction) in the time needed to complete the process, and of course, in the associated costs (reduction) involved.

Moreover, the possibility of collaboration between any other processes of these two (2) systems (the Cyprus Customs Information System and the Cyprus Vehicles/Drivers Licensing Authority Information System), as well as between processes of these two systems and processes of other Governmental agencies' Information Systems (Police Department, Army, etc) will be examined in respect to the business value and opportunities derived by the adoption of Web Services in such collaborating environments.

Research Questions and Objectives

Research questions aim to reflect the issues/problems identified in the "Problems and Issue Description" section. A series of issues/questions need to be addressed:

In relation to "Web Services technology and Architecture, Business Strategies and Opportunities"

"The underlying technology of Web Services and what are their major characteristics" will be the first area of focus throughout this research work.

Subsequently, the business perspective of Web Services will be explored: today's organizations are facing high pressures through competition and they need to find ways to survive, and, if possible, to thrive in their workplaces. Towards covering this need, organizations are adopting a new practice/discipline, the Enterprise Architecture, to help them: (a) make the right decisions concerning their IT investments, (b) build competitive IT strategies/policies that will serve the organization's overall strategic goals, and (c) in the reduction of costs by efficiently utilising the existing IT resources and by choosing the right IT infrastructure, products, and tools.
Throughout this research work I am going to present the importance of an Enterprise Architecture for a company and how it can serve/facilitate (or inhibit) the company's strategic goals.

I am also going to explore the latest model of Enterprise Architecture, the Service Oriented Architecture, and how it relates to Web Services.

Subsequently, I am going to address the issues: "Based on Web Services' nature/characteristics, how can Web Services facilitate the complex task of Enterprise Application Integration?" and "In what industries (Banking, Government, etc) or processes within industries, is more likely the case that Web Services technology will play a strategically important role?"

Finally, due to the fact that Web Services technology is not yet mature enough and due to the fact that the underlying security specification has not yet been finalized, the consequent implications need to be addressed.

In relation to "Web Services technology and its Applicability and Value to the Government Industry"

Government agencies throughout the world face increased demands from citizens and businesses, pressures on basic service provisions, the challenge of developing new service delivery mechanisms, and forming the right ventures and alliances to meet service delivery demands.
It is due to this nature (services-centric) of Government agencies that Web Services technology seems to be applicable because Web Services technology was designed to facilitate and enhance (almost) all service-oriented businesses.

Further to Web Services applicability to Government agencies Information Systems, Web Services technology promises:

(a) To reduce costs through Reusability (and Collaboration) of components/applications, or even through utilization (and not replacement) of the existing IT infrastructure, and

(b) To enable the Government agencies have the agility and flexibility needed to compete corresponding agencies of other countries (e.g. Cyprus Customs against other EU countries' Customs in order to be the one that will collect imported goods' associated taxes and duties), or, compete the private sector that offers the same kind of services as you (Government).

Moreover, a model/formula for calculating ROI (on Web Services in Government industry) will be developed. Using this model/formula I am going to quantitatively justify/address the issue: "Is there any value out of adopting Web Services in the Government industry?"

Research Plan and Methods

The primary source of information will be the two (2) Government agencies (the Cyprus Customs and the Cyprus Vehicles/Drivers Licensing Authority) that will be the sample of my research work.

Another source of information will be the Bull Cyprus Ltd (the supplier of the Cyprus Customs Information System) and the IBM Cyprus Ltd (the supplier of Cyprus Vehicles/Drivers Licensing Authority Information System).
Bull Cyprus Ltd is the primary contractor in the consortium of companies that were gathered and assigned the responsibility to design, implement, and maintain the Cyprus Customs Information System.
IBM Cyprus Ltd is the company that was assigned the responsibility to design and implement the Cyprus Vehicles/Drivers Licensing Authority Information System. Moreover, IBM was also asked to provide the necessary advisory know-how for the proper application and effective operation of the system.

Statistical data (concerning various parameters of the two (2) Government agencies that will be used throughout research work) will be collected by the Department of Statistics, Ministry of Finance of the Government of Cyprus.

The data need to be collected will be gathered by conducting interviews, by observation, by performing statistical analysis of the processes of the system(s) and/or through surveys, depending on the approach of research required in the various Documents of the research work.

In Document 3, the Interpretative/Phenomenological approach of Research will be followed. This approach is an inductive approach: you let the investigation guide the construction of theory.
In my research work, an exploration of the Cyprus Customs Information System will be carried out and the challenges faced during the complex task of integration of the various modules (Import, Manifest, Tariff, Accounting, Bonded Warehouses) of the Cyprus Customs Information System (CCIS) will be presented.

I am also going to evaluate whether (or not) the targets:

- Increase the speed of the clearance process (goods declaration is validated, accepted and paid),

- Ensure maximum security for the integrity of the data,
- Improve reliability of the clearance process,
- Enable immediate, complete application of up to date Customs regulations over the country, and
- Reduce paperwork requirements for both Customs and the trade community,
- Align the Cyprus Customs system with the European best in class systems in operation,

set by the Cyprus Customs about their Information System, are being met.

Subsequently, I am going to present (and support it) why Web Services technology is applicable for this system (Cyprus Customs Information System), what would be the value of the Web Services technology to the integration challenges faced during the implementation of the system and why (and how) Web Services would have addressed better the targets set than the existing technology.
Data will be gathered by conducting interviews (of all participating parties: end users, Project Managers, Customer, Supplier, IT Architects, Software Engineers, etc) and through observation (e.g. personal experience).

The conclusions derived (in Document 3) will be based on data generated by the investigation carried out and not on some pre-existing theory.

In Document 4, the Positivist approach to research will be followed. This approach is a deductive approach: you start with a theory/hypothesis from the literature, you carry out the research, and at the end you confirm or refute the initial theory/hypothesis.
In my case, the theory/hypothesis that will be tested is: "Web Services technology is beneficial to the Cyprus Customs Information System (a Government agency Information System)."
Specifically, an evaluation (taking into consideration various parameters/variables) of the major processes of the modules (Import, Manifest, Tariff, Accounting, Bonded Warehouses) of the Cyprus Customs Information System will be carried out, if Web Services technology would have been used (instead of the current technology). Moreover, an attempt to construct a model/formula for calculating the Return On Investment (if Web Services were adopted/used) will be undertaken.

The ROI model/formula will take the form:

$$ROI = \frac{\text{(Technical and Business Benefits) - (Costs and Expenses) - (Risks)}}{\text{(Costs and Expenses) + (Risks)}} * 100$$

Due to the fact that many of the factors/parameters that need to be taken into account in the ROI model/formula cannot be quantified (since they are intangible), certain assumptions and approximations might be employed.

The information will be collected through statistical analysis of the Cyprus Customs Information System processes and/or through surveys. The findings of the analysis and/or survey will confirm or refute my initial hypothesis: "Web Services technology is beneficial to the Cyprus Customs Information System (a Government agency Information System)."

In Document 5, the Interpretative/Phenomenological approach of Research will be adopted. However, my research will take the form of: "comparing and contrasting" the (already studied in the previous Documents (3 and 4)) Cyprus Customs Information System with the Cyprus Vehicles/Drivers Licensing Authority Information System in respect to the business value that might be observed if Web Services were used for their implementation and integration.

Throughout the investigation of the two (2) systems' processes, I am going to come up to the conclusion as to whether Web Services technology is applicable to these two (2) systems and if there are any business benefits/opportunities that will be realised by adopting/using Web Services technology, instead of the current technology.
Throughout the process of investigation of the two (2) systems' processes and towards the attempt to come up to a conclusion, the possibility of collaboration between the two (2) systems' processes (and in what extent) will be examined.
An investigation will also be carried out in order to examine the possibility of collaboration of the Cyprus Customs Information System and the Cyprus Vehicles/Drivers Licensing Authority Information System processes with other Government agencies (Police Department, Army, etc) information system processes.
Data will be collected mainly through observation and if needed by conducting interviews.

Research Ethical Issues and Organizational Political Issues

This research is being undertaken on a self-sponsored basis and as such the potential to be bias is eliminated.

Another point need to be stressed is the nature of the industry (Government) into which the systems (under study) belong to. Government is a very specific industry and there is always the risk to be prohibited to reach documents (and data) that at some point of time will be "characterized" confidential. In addition, some governmental processes are getting so bureaucratic that "inhibit" research.

A note also need to be made to the fact that Web Services are available over the Internet and everyone might be able to access them. There is a need to have Web Services available only to trusted/authorised consumers/users.

Outcomes

The perceived outcomes of completion of the research are as follows:

The dissertation will be written from the viewpoint of an enthusiastic practitioner of applications integration. As previously stated, from my experience in the IT industry, I can ensure that the challenges faced throughout the integration process are really great. It is getting a very complex activity especially for the software engineers (analysts, programmers, integrators, etc) who have to design and implement the interfaces between the communicating parties (in this case, applications/systems) in order to have them inter-operate and collaborate.
Web Services promise to facilitate application integration, reduce costs and provide a competitive advantage to those adopt them.

At personal level the research will also provide an excellent opportunity to:

- Access research skills training
- Develop high level research skills by using a wide range of methodologies
- Build on a sound knowledge on Web Services technology, its architecture, Strategic Management, collaboration, application integration, etc
- Develop personal intellectual and academic abilities

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WEB SERVICES: TECHNOLOGY, BUSINESS STRATEGIES AND OPPORTUNITIES

Document 2: Critical Literature Review And Initial Conceptual Framework

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Contents

1. Introduction

Volatility is now a permanent feature of business life. Even though change is normal, the growing speed and unpredictability of change have pushed many enterprises to the very limits of manageability (Truex et al. 1999). Within this business landscape, contemporary organizations have to develop adaptive responses and innovative strategies in order to create value, no matter how unstable the market environment may be.

Agility, that is, the ability to detect and seize market opportunities with speed, is considered to be an important ingredient of the contemporary companies' repertoire of responses to the volatile and highly competitive business environment (Brown and Eisenhardt 1997; Christensen 1997; D'Aveni 1994; Goldman et al. 1995). The convergence of computing, communications, and content technologies offers firms significant opportunities for enhancing agility (Goldman et al. 1995; Moore 2000; Venkatraman and Henderson 1998).

But, it is frequent the case that the information systems developed with the intention to support organizations' business strategies, fail to serve their purpose. Information systems development projects are often given priority according to technical criteria rather than business imperatives and the information technology investments are unrelated to business strategy. Thus information technology vendors, consultants, and academics invented and sold planning techniques that aimed first at discovering a company's competitive strategy and second at suggesting an information systems portfolio to support it. Strategic alignment would then be assured (Bensaou and Earl 1998). That process is also called "enterprise architecture:" the systematic method of designing, implementing and maintaining information systems ensuring that the IT strategy is aligned with the organization's business goals and objectives.

Unfortunately, the goal of aligning IT strategy with the organization's business goals and objectives remains elusive. Business strategies are rarely as clear as expected; IT opportunities are poorly understood; the organization's parts have different priorities; and the IT strategies that are eventually drawn up often seem devoid of common sense (Bensaou and Earl 1998). Indicatively, the dominant scenario observed in most of the organizations in respect to their IT infrastructure and subsequently in their enterprise architecture is that the companies' information systems are proprietary, they bought or leased their own hardware, wrote or licensed their own applications, and hired big staffs to keep everything up and running. This approach has worked, but it has not worked well. It becomes hard, if not

impossible, to adapt quickly to changes in the marketplace, and strategic restructurings, through acquisitions, divestitures, and partnerships, become fiendishly difficult to pull off (Hagel and Brown 2001).

Moreover, since organizational change has become so important to organizational survival, IT systems must incorporate continuous change. This incorporation goes beyond adaptable systems, and includes creating support for organizations that wish to emerge. Continuous change implies replacement of traditional information systems' development values. These outmoded values include long IT system life spans, dependence on user acceptance, concise specifications, and complete systems analysis. Emergent IT organizations value continuous analysis, negotiated requirements, and a large portfolio of continuous maintenance activities (Truex et al. 1999).

Web Services is the new technology that aims to address most of the issues faced by the contemporary organizations enhancing agility and incorporating continuous change. Constructed on the Internet, Web Services technology is open rather than proprietary. Instead of building and maintaining unique internal systems, companies can rent the functionality they need -whether it's data storage, processing power, or specific applications- from outside service providers. Web Services enable applications to connect freely to other applications by means of XML-based protocols (SOAP, WSDL, UDDI, etc). That is, you no longer have to write customized code whenever communication with a new application is needed.
Instead, this takes the form of exchanging flexible, loosely coupled services that comply to universally agreed standards (Hagel and Brown 2001).

2. The New Business Landscape And The Emergence Of Agility

In the new competitive business landscape, firms face significant uncertainty, ambiguity and an increasing number of strategic discontinuities. This highly volatile environment produces almost perpetual disequilibrium in the firm. Firms have to create innovative products and services of high quality and at low prices to satisfy increasingly informed customers with distinct needs. Thus, managers are motivated to reduce the uncertainty by identifying new sources of competitive advantage (Hitt et al. 1998).

Managers now face the task of creating a balance between the stability necessary to allow development of strategic planning and decision processes and instability that allows continuous change and adaptation to a dynamic environment. Additionally, managers must recognize and cope with multiple states of coexisting stability and instability. They have to use vision and foresight during periods of destabilization to transform the organization into a new state of equilibrium. These conditions require agility that allows firms to reduce periods of instability by making rapid and effective changes.

Agility is the ability of a firm to continually sense and explore customer and marketplace enrichment opportunities and respond with the appropriate configurations of capabilities and capacities to exploit these opportunities with speed, surprise, and competitive success (Sambamurthy and Zmud 2004).
Agility encompasses the exploration and exploitation of opportunities for market arbitrage. Exploration is organizational experimentation with new alternatives and pursuit of knowledge about currently unknown opportunities for competitive action (March 1991). Exploitation is the use and development of things already known through refinement and extension of existing competencies, technologies, and knowledge (March 1991).

Furthermore, agility encompasses a firm's capabilities related to interactions with customers, orchestration of internal operations, and utilization of its ecosystem of external business partners (Cronin 2000; Tapscott et al. 2000; Treacy and Wiersema 1993; Sambamurthy and Zmud 2004).
In respect to customers, agility is the co-opting of customers in the exploration and exploitation of opportunities for innovation and competitive action moves. Nambisan (2002) argues that customers serve three valuable roles in stimulating firms' competitive actions: as a source of innovation ideas, as a co-creator in the

development and design of innovative products and services, and as a user in testing the product or in helping other users learn about the new product or service. Customer agility describes firms' ability to leverage the voice of the customer for gaining market intelligence and detecting competitive action opportunities (Kohli and Jaworski 1990). Information technologies provide opportunities for building and enhancing virtual customer communities and, thereby, customer agility (Holstrom 2001; Kambil et al. 1999; Nambisan 2002).

Partnering agility is the ability to leverage the assets, knowledge, and competencies of suppliers, distributors, contract manufacturers, and logistics providers through alliances, partnerships, and joint ventures (Venkatraman and Henderson 1998). Partnering agility enables firms to build a network of strategic, extended, or virtual partnerships to explore opportunities for innovation and competitive action (Choudhury and Xia 1999). Partnering agility also refers to the ability of firms to exploit opportunities through efficient sourcing and staging of manufacturing, logistics, or customer support assets and resources. It enables a firm to modify or adapt its extended enterprise network when it needs access to assets, competencies, or knowledge not currently resident in its networks (Dyer and Singh 1998). Zaheer and Zaheer (1997) found that firms with wide-ranging information networks were able to exhibit superior responsiveness and performance in turbulent business environments. Information technologies enable greater inter-firm collaboration through platforms such as portals, supply chain management, and visibility technologies. Web Services technology is also one of the most promising technologies that aims to facilitate and enhance collaboration between organizations that wish to co-operate.

Operational agility reflects the ability of firms' business processes to accomplish speed, accuracy, and cost economy in the exploitation of opportunities for innovation and competitive action. Operational agility ensures that firms can rapidly redesign existing processes and create new processes for exploiting dynamic marketplace conditions (Sambamurthy et al. 2003). Information technologies are driving the modularization and atomization of business processes and enabling their combination and recombination to create new business processes (Malone et al. 1999). Operational agility allows firms to reduce information asymmetries between buyers and sellers through rapid and up-to-date supply of comprehensive information, often through the use of electronic distribution channels. Firms can enhance their operational agility by leveraging the cheap interconnectivity of virtual markets and gaining faster and more informed decision-making (Amit and Zott 2001).

These three(3) perspectives -that is customer, partnering, and operational- collectively reflect agility. Sambamurthy et al. (2003) propose that firms that have developed all of these perspectives of agility should be in a better position to engage in more competitive action as well as complex action repertoires by bundling their customer, partnering, and operational agility. Moreover, Ferrier et al. (1999) argue that firms that possess a more complex base of resources and capabilities will be in an advantageous position to launch competitive actions.

3. IT Infrastructure As Enabler Of Agility

IT (and subsequently, IT infrastructure) can be an enabler of agility if it is properly used, if the right expectations are set, and if it helps a company meets its strategic objectives (Bensaou and Earl 1998).

IT infrastructure is everything that supports the flow and processing of information in an organization, including hardware, software, data, and network components. It consists of components, chosen and assembled in a manner that best suits the plan and therefore best enables the overarching business strategy (Hay and Munoz 1997). IT infrastructure in an organization is similar to the plumbing, wiring, and furnishings in a house. But, all these alone do not make a house. Rather these components must be assembled according to the blueprint to create a structure in which people can live. Similarly, hardware, software, data, and networks must be combined in a coherent pattern to have a viable infrastructure (Pearlson and Saunders 2004).

Moreover, the goal of a successful IT infrastructure is to support the organization's strategic objectives. In particular, Weill et al. (2002) argue that the IT infrastructure needs to support the organization's long-term, enterprise-wide strategies while being responsive to the demands of its various business unit strategies. In addition, Weill et al. (2002) conclude that implementing different types of electronically based business initiatives requires different high-capability IT infrastructures. Strategic agility requires time, money, leadership and focus — and an understanding of which distinct patterns of high-capability infrastructures are needed where. Getting the right balance is difficult. Under-investing reduces strategic agility and slows time-to-market. Also, infrastructure investments usually must be made before investments in business applications because doing both at the same time results in infrastructure fragmentation. But if the infrastructure is not used or is the wrong kind, a company is over-investing and wasting resources.

Investing in IT infrastructure is like buying an option (Amram and Kulatilaka 1998). If used successfully, infrastructure enables faster time-to-market; it not, it will prove an unnecessary cost. Successful enterprises get the infrastructure balance right because they make regular, systematic, modular and targeted investments in IT infrastructure on the basis of an overall strategic direction (Weill et al. 2002).

A different perspective of the role of IT as enabler of agility is taken by Sambamurthy et al.(2003). IT can be an enabler of agility on the grounds of the differences between digital economics and the (traditional) economics of physical components

(Arthur 1996; Grover and Ramanlal 1999; Shapiro and Varian 1999). According to Sambamurthy et al. (2003), some of these differences are:

- The fixed costs of production of information goods are dramatically higher due to the human costs of developing intellectual capital (rather than plant and equipment).
- The marginal costs rapidly approach zero, going down successively as new generations of technologies become available.
- The coordination costs are becoming extremely low, which not only allows ease of searching and product comparison, but also enhances the ability to combine digital products to create new value.
- Network effects create increasing returns for firms that can expand the size of their base of customers.

With the pervasiveness of digitization within organizational boundaries as well in the inter-organizational networks, these economics will influence the viability of firms' competitive actions. Evans and Wurster (2000) argue that firms have traditionally constructed their value chains and inter-organizational relationships by bundling information and physical products and services into integrated structures. Digital economics (e.g., lower coordination costs), however, enables firms to deconstruct their value chains and inter-organizational relationships by unbundling information from physical products and services. Not only does this create new options for information-based products and services, but it also facilitates the streamlining of work processes and building of inter-organizational relationships. Additionally, firms are able to move their information value chains to the forefront of competitive moves (Bradley and Nolan 1998; Hagel and Singer 1999).

All-in-all, according to Sambamurthy et al. (2003), these conceptual frameworks stimulate thinking about the role of IT as a platform for agility. Firms are integrating IT with key processes, knowledge, and relationships to nurture innovation in customer relationships, manufacturing, procurement, supply chains, and other key activities (Agarwal and Sambamurthy 2002; Barua and Mukhopadhyay 2000). Digitized platform of processes and knowledge permit firms to adapt to changing requirements more quickly by changing information-based value propositions, forging value-chain collaborations with partners that competitors cannot easily duplicate, and rapidly exploiting emerging and untapped market niches.

4. Enterprise Architecture: IT Policy And Business Strategy Alignment

Not only agility, but also the need to align business and IT strategies, constitutes an important factor for the success of an organization in its marketplace.
Today, that the majority of organizations are using all sorts of applications from enterprise applications (i.e., Enterprise Resource Planning –ERP-, Customer Relationship Management –CRM-, Supply Chain Management –SCM- systems, etc), to portals and desktop productivity packages (like MS-Office, etc), as well as industry-specific applications, it became extremely important to have in place an effective IT management policy.

The administration and management of an organization's IT infrastructure "is a constant struggle to maintain and support aging legacy systems and implement new systems to meet emerging business needs, while also ensuring that the overall IT infrastructure is dynamic and flexible enough to enable rather inhibit changes in business direction and strategy." (Marks 2003 p.160) The desire to keep an ideal equilibrium between IT policy and business strategy, for the organization's benefit, emerged the need to design, develop, and deploy an Enterprise Architecture.

Enterprise Architecture

The term "Architecture" has been used for many years within the IT community to refer to the framework that provides guidance to application developers to come up with a piece of software to address a new request or solve a given problem. The term is obviously a metaphor derived from the "Construction" industry. Just like builders who are not undertaking the construction of a building without a well-defined architecture (in the form of a series of blueprints), so do software developers; they are not undertaking the development of software systems without the existence of a detailed architecture.

In the mid-nineties, the term "Architecture" began to be used by business managers too, especially those involved in enterprise planning and in business process reengineering projects, to describe an overview of the business (Nadler et al. 1997).

Today, there is a growing trend among business and IT managers to use the term "Enterprise Architecture" to refer to the components that make up an organization's overall system infrastructure and to "a framework into which new applications can be incorporated while maintaining the integrity of the whole. The Enterprise Architecture

can be used to optimise current IT investments and ensure that future investments are aligned with the organization's business goals and objectives." (Marks 2003 p.161)

For a company to benefit the most, the creation of an Enterprise Architecture needs to be a joint effort between business and IT managers, because IT policy has to act as an enabler of company's overall business objectives. Enterprise Architecture should be achieved through balancing the interactions, relationships, and dependencies of organization's infrastructure and application architecture needs with business and information requirements (Figure 1).

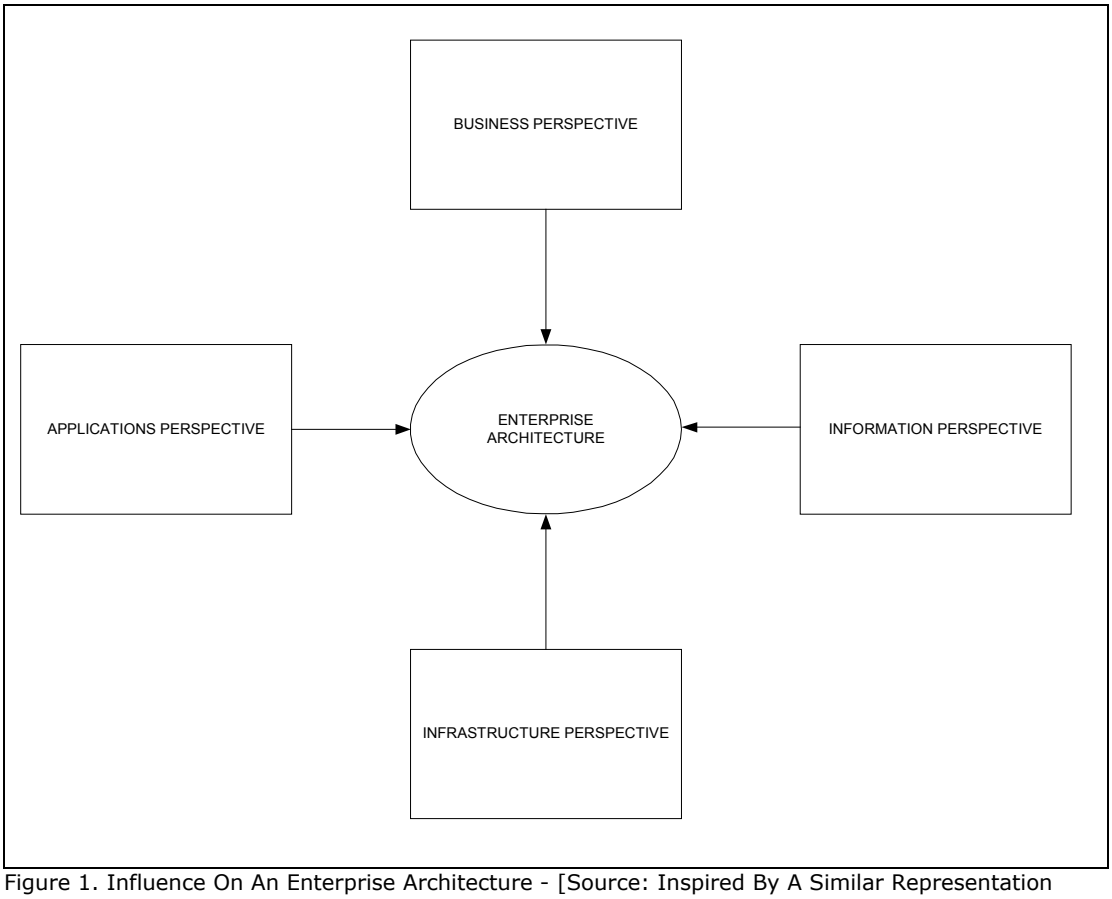

Figure 1. Influence On An Enterprise Architecture - [Source: Inspired By A Similar Representation Found In (Marks 2003)].

It is also urged that the Enterprise Architecture practice should be an ongoing process to assure that business processes and information systems remain aligned. In respect to this, Harmon(2003) suggests that an Enterprise Architecture Alignment Process (Figure 2) should be in place.

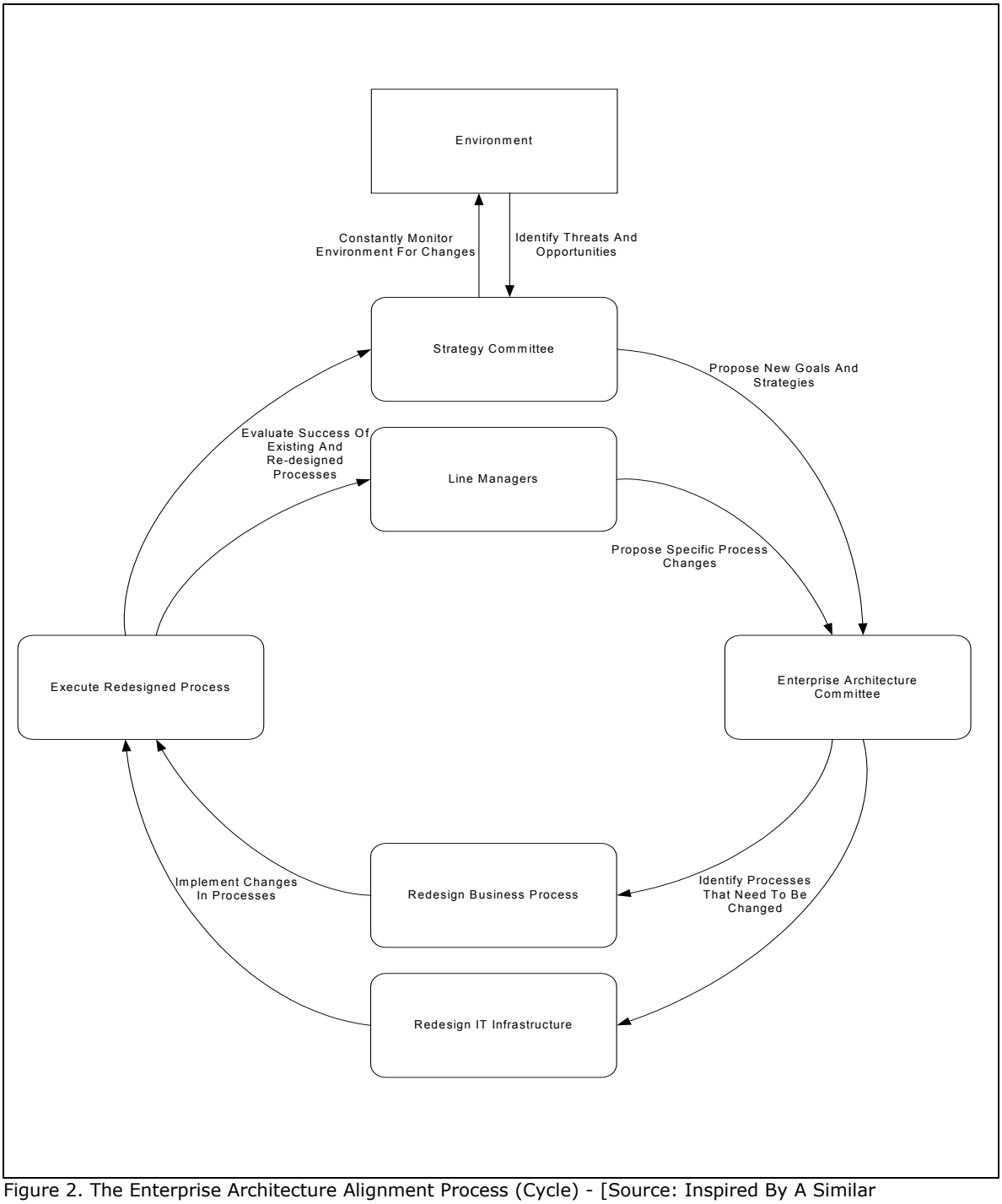

Figure 2. The Enterprise Architecture Alignment Process (Cycle) - [Source: Inspired By A Similar Representation Found In (Harmon 2003)]

Harmon(2003), in his model, proposes that the Enterprise Architecture Committee, a panel consisting of both business and IT executives, receives inputs from two groups:

(a) The Strategy Committee. When the Strategy Committee decides that the organization needs to set new strategies or change existing ones, it communicates its propositions to the Enterprise Architecture Committee, and,

(b) The Line Managers. The Enterprise Architecture Committee receives inputs from a variety of line managers when they decide that the processes they manage aren't performing the proper way.

This way, all changes that require significant business process redesign or software automation efforts must go through the Enterprise Architecture Committee. The committee, then, has to assure that the business processes and the IT infrastructure remain aligned.

Once a given process or set of processes are redesigned and implemented, the cycle returns to where it began. The Strategy Committee continues to watch for changes in the environment that suggest new strategies, and the line managers continue to look for opportunities to increase the productivity of existing operations.

The Enterprise Architecture will typically identify a current state, an anticipated future state, and a plan of coordinated activities to guide an organization from the current state to the desired future state. Ultimately, the value of the Enterprise Architecture is only realized by balancing the interactions, relationships, and dependencies of the four(4) perspectives (that is, infrastructure, applications, business, and information) of an organization (Figure 1). In order to find the appropriate balance between these perspectives, there must be a compromise and development of mutual understanding and respect between IT and business stakeholders. They all have to be advised, and if needed taught, of the necessity to work for and serve the company's overall strategic objectives, which will ultimately lead to their own benefit, too.

The need to formalize and conceptualise Enterprise Architecture's elements and their interactions has led to a series of models and methods, the widely known Enterprise Architecture Frameworks (Martin et al. 2004).

Enterprise Architecture Frameworks And Their Benefits

There are many different approaches to describing the elements of an Enterprise Architecture. One approach that has grown in popularity in the past few years is based on a framework developed by John Zachman, a distinguished IBM engineer. Zachman originally proposed his framework in 1987 in an article published in the *IBM Systems Journal* (Zachman 1987). The article created a relatively low interest when it was first published because it was too comprehensive for IT application developers. Over the years, however, as business managers have become

more concerned about the role of IT in their organizations, the Zachman framework has become the most popular approach to describing an Enterprise Architecture. Table 1 below depicts the current version of the Zachman framework.

The Zachman framework is arranged in rows. The rows at the top of the framework are the most abstract and are oriented toward very broad goals and plans of an organization. As you go down the table, things are becoming more concrete. In particular, the bottom layer refers to actual data, specific applications, all the physical structures, and the people that comprise the business.

	The Zachman Framework	DATA *What*	FUNCTION *How*	NETWORK *Where*	PEOPLE *Who*	TIME *When*	MOTIVATION *Why*
Business Managers	SCOPE (Contextual) *Planner*	List of Things Important to the Business	List of Processes the Business Performs	List of Locations in Which the Business Operates	List of Organizations Important to the Business	List of Events Significant to the Business	List of Business Goals/Strategies
	ENTERPRISE MODEL (Conceptual) *Owner*	Semantic Model	Business Process Model	Business Logistics System	Work Flow Model	Master Schedule	Business Plan
IT Managers and Developers	SYSTEM MODEL (Logical) *Designer*	Logical Data Model	Application Architecture	Distributed System Architecture	Human Interface Architecture	Processing Structure	Business Rule Model
	TECHNOLOGICAL MODEL (Physical) *Builder*	Physical Data Model	System Design	Technology Architecture	Presentation Architecture	Control Structure	Rule Design
	DETAILED REPRESENTATIONS (Out-of-Context) *Sub-Contractor*	Data Definition	Program	Network Architecture	Security Architecture	Timing Definition	Rule Specification
	FUNCTIONING ENTERPRISE	Actual Business Data	Actual Application Code	Actual Physical Networks	Actual Business Organization	Actual Business Schedule	Actual Business Strategy

Table 1. The Zachman Framework : An Enterprise Architecture Overview - [Source: (Zachman 1987)]

The top level of the Zachman framework, labelled "SCOPE," is focused on the concerns of senior executives. The second level focuses on the slightly more detailed concerns of business managers. Level three focuses on concerns that business and IT

managers often work on together. Levels four through six focus on details that IT managers and software developers are concerned with.

Zachman's framework is popular because it provides a comprehensive overview of the major components and processes of the enterprise and how they are interrelated. Moreover, each of the cells of the framework reveals the various kinds of specific architectures that Zachman includes within his overall framework. For instance, the cell that represents the intersection of "FUNCTION" and "SYSTEMS MODEL" describes the organization's Application Architecture. And, the cell that represents the intersection of the "NETWORK" and the "TECHNOLOGICAL MODEL" represents the Technology Architecture, which describes the hardware used and the links between the platforms. It is due to the Zachman's framework completeness that it serves as the primal reference for the various frameworks built by organizations as part of their "Enterprise Architectures."

Even though Zachman's framework is complete, it is, at the same time, complex and not so flexible to address ever-changing business requirements. There are instances where more condensed and flexible models are needed. Over the years, various other enterprise architecture frameworks have been conceived, built, and used. For instance, the "Information Technology Management Reform Act" of 1997 led to the US Government's "Federal Enterprise Architecture Framework," the FEAF, which "describes an approach, including models and definitions, for developing and documenting architecture descriptions" (U.S. GAO 2003). It is being deployed in all non-military agencies of the US Government.
Other enterprise architecture frameworks include the European pre-standard "ENV 40003:1990 Computer Integrated Manufacturing: Systems Architecture Framework for Modeling" (T.E.C.S. 1990), the ISO Standard 15288 "Systems Engineering-System Life Cycle Processes" (ISO 15288), and the US Defense Department's "C4ISR Architecture Framework" (DoD 1997).

Whether the frameworks address manufacturing operations, process control, information systems, or government bureaucracy, the artifacts produced to describe the enterprise comprise a valuable asset requiring its own distinct management. Managing and gaining full value from that asset is the reason enterprise architecture frameworks are developed (Martin et al. 2004).

The need for aligning organizations' IT policy with the business strategy (for the benefit of an organization) is also the primary research work of Henderson and Venkatraman (1993) who are proposing the Strategic Alignment Model shown in Figure 3.

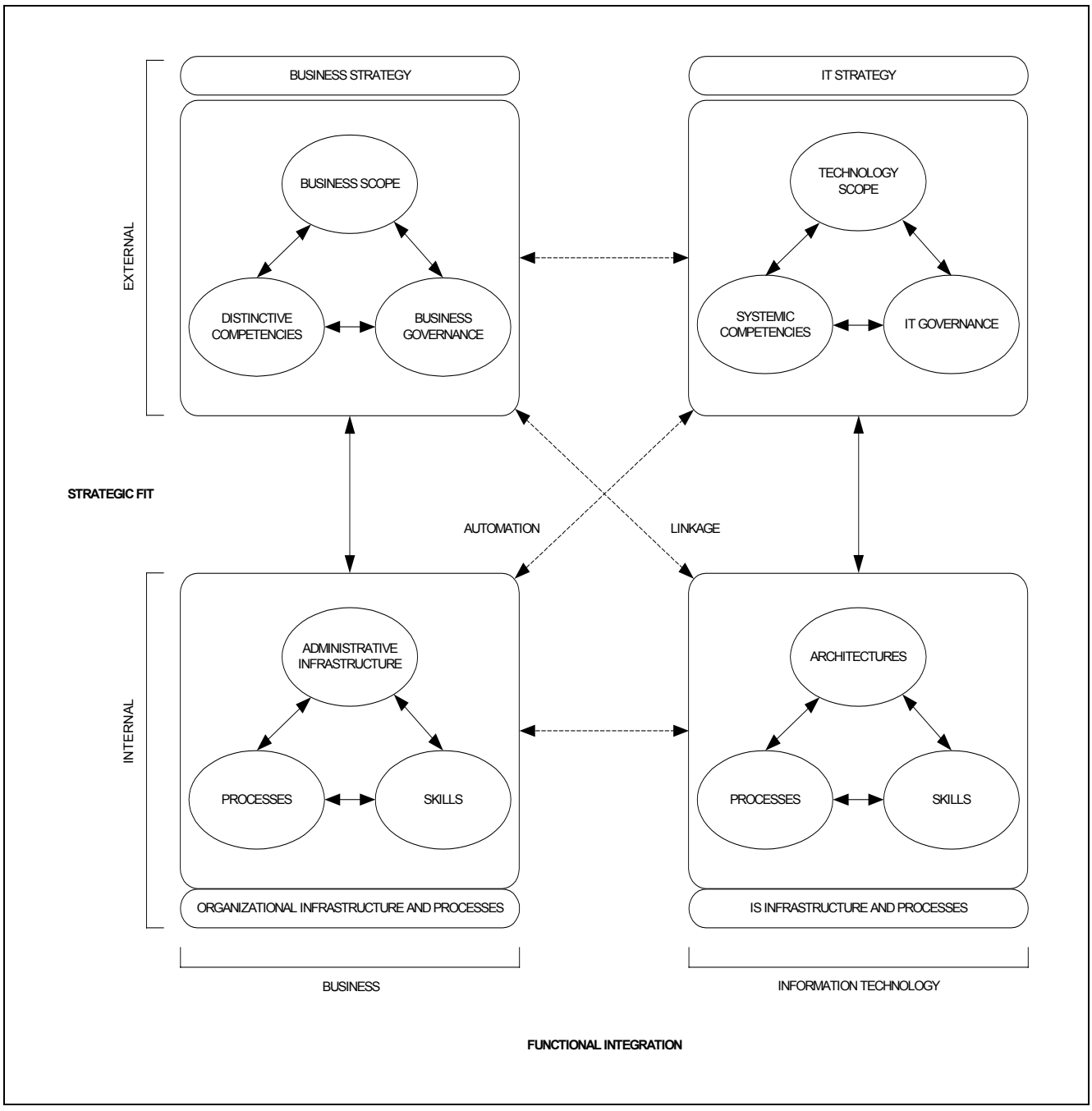

Figure 3. The Strategic Alignment Model - [Source: (Henderson and Venkatraman 1993)]

The Strategic Alignment Model (see Figure 3) identifies the need to specify two types of integration between business and IT domains. The first, termed *strategic integration,* is the link between business strategy and IT strategy

reflecting the external components. More specifically, it deals with the capability of IT functionality to both shape and support business strategy.

The second type, termed *operational integration,* deals with the corresponding internal domains, namely, the link between organizational infrastructure and processes and information systems (IS) infrastructure and processes. This type highlights the criticality of ensuring internal coherence between the organizational requirements and expectations and the delivery capability within the IS function.

The logic behind the Strategic Alignment Model, according to Henderson and Venkatraman (1993), lies on its third premise which states that effective management of IT requires a balance among the choices made across all four domains (that is, the business strategy, the IT strategy, the organizational infrastructure and processes, and the IT infrastructure and processes).

The simplest approach to conceptualize and achieve this alignment calls for considering all combinations of any two domains, a bivariate-fit perspective. If, for instance, the organizational and IS infrastructures can be reconfigured easily, then a strategic perspective that focused only on strategic integration, bivariate-fit between business and IT strategies, could suffice. That is, if the firm could easily adapt their internal process (both business and IT) to support any possible market positioning strategy, the executives could delegate this issue and spend their time understanding only the dynamics of markets. Unfortunately, there exists a significant possibility that internal inconsistencies (mutually conflicting directions) will occur. For instance, a bivariate-fit perspective that considered only external issues (business and IT strategies without any regard for the internal, organizational domains) could seriously underestimate the difficulty (risks) of redesigning key business processes. Alternatively, a bivariate-fit perspective that considered issues of business and IT strategic fit separately has been argued to be dysfunctional (King 1978; McLean and Soden 1977; Pyburn 1983; Henderson and Venkatraman 1993).

In contrast, the Strategic Alignment Model (Figure 3) calls for the recognition of multivariate relationships, or more precisely, cross-domain relationships (Henderson and Venkatraman 1993). Henderson and Venkatraman (1993) argue that there are four(4) dominant cross-domain alignment perspectives:

Perspective One: Strategy execution. This perspective is anchored on the notion that a business strategy has been articulated and is the driver of both organizational design choices and the design of IS infrastructure.

Perspective Two: Technology transformation. This alignment perspective involves the assessment of implementing the chosen business strategy through appropriate IT strategy and the articulation of the required IS infrastructure and processes.

Perspective Three: Competitive potential. This alignment perspective is concerned with the exploitation of emerging IT capabilities to impact new products and services (business scope), influence the key attributes of strategy (distinctive competencies), and develop new forms of relationships (business governance).

Perspective Four: Service level. This alignment perspective focuses on how to build a world-class IS service organization. This requires an understanding of the external dimensions of IT strategy with corresponding internal design of the IS infrastructure and processes.

Henderson and Venkatraman (1993) conclude that all four(4) dominant alignment perspectives are equally important. They urge managers not to consider IT as a panacea and consequently focus only on the *"Competitive potential"* and *"Service level"* perspectives that have the IT strategy as the starting point, nor do managers need to –always- have the business strategy as their starting point and thus adopt only the *"Strategy execution"* and *"Technology transformation"* perspectives on strategic alignment.

Summarising, an organization is more likely to benefit the most, if the right balance among the all four(4) domains of strategic choice (that is, the business strategy, the IT strategy, the organizational infrastructure and processes, and the IT infrastructure and processes) is achieved.

Enterprise Architecture (Frameworks) Benefits

The creation of all these enterprise architecture frameworks and models has a single objective: IT must mirror the organization's overall vision and goals, to deliver its highest value to the organization. IT no longer merely supports business. It is integrated into the business. It is no longer sufficient to merely

deliver individual projects on time and within budget. "Delivering on the larger business vision requires an approach to IT based on a holistic, overall business perspective. To reflect the characteristics of agility, speed and integration needed by all businesses today, a disciplined process –from planning to implementation– is required that focuses on the enterprise as a holistic system of systems." (METAGroup).

Marks (2003), further supporting METAGroup's arguments, claims that the creation and maintenance of an effective enterprise architecture can be a key enabler to achieving competitive advantage and will become an increasingly important requirement for organizational survival. Among others, the benefits that could be realised by the creation and deployment of an effective enterprise architecture are: (a) the reduction of costs by eliminating the need to re-produce the same functionality over and over again. A well-defined architecture can provide system modularity and reuse. Modularity and reuse are important attributes towards eliminating duplication and overlapping of technologies, information, and business applications. This also leads to decreasing of support and maintenance costs and reduction in delivery time; (b) the increased organizational flexibility. By defining and maintaining the way components of the overall architecture are interfaced to one another, it is possible to increase support for organizational growth and restructuring requirements (for example, mergers and acquisitions). A modular architecture can also be leveraged to increase organizational flexibility, and maintain a firm's options to build, buy, or outsource systems as needed; (c) the faster time-to-market for products and services. An enterprise architecture can be leveraged to support the rapid deployment of mission-critical business applications, achieving faster time-to-market for new products and services, and increased growth and profitability; (d) the reduction of complexity. The modularity of an enterprise architecture can reduce the complexities associated with the integration of information across disparate systems, maximizing the visibility and value of the organization's available assets. Moreover, it is becoming easier for the enterprise systems to communicate with the corresponding systems of external business partners.

5. Limitations of The Available Information Systems Frameworks To Respond To The Ever-Changing Business Environment

Methods for the building of information systems are clearly important elements in the information systems discipline. Yet there are gnawing problems about their practicability. Methods are often unsuitable for some individuals (Naur 1993) and settings (Baskerville et al. 1992). Similar methods in similar settings yield distinctly different results (Turner 1987). Developers may claim adherence to one method while ignoring this method in actual practice (Bansler and Bodker 1993). While development methods research has essentially reified methods, it offers little fundamental understanding of what it means to be methodical and how methods are actually applied in the field (Wynekoop and Russo 1993).

Besides information systems methods' unreliability --as articulated by Turner (1987), "similar methods in similar settings yield distinctly different results"-- and abstractness –-as expressed by Wynekoop and Russo (1993), "development methods research offers little fundamental understanding on how methods are actually applied in the field"-- issues, the ever-changing business environment makes the application of frameworks and methods for building information systems impossible.

The degree of organizational change is reaching a frenzied pace. Organizational change is currently driven by the rapid development of commercial technology, global markets and reengineered, quality-oriented organizations. This constant need to change gives rise to a recognition that human organizations in the current era are no longer stable, but are continuously adapting to their shifting environment. These organizations can be said to be in a state of constantly seeking stability, while never achieving it (Truex et al. 1999).

Trying to identify the drivers of this unprecedented organizational change (which at the same time are the pressures on the today's IT executives) it is concluded that these include the need to cut costs and make whatever needed with existing technology, while at the same time serve customers better, be more competitive, and respond to the organization's strategic priorities. Basically, executives must do more with less, not just right now, but also into the future as business needs change and new ones develop.

According to Bloomberg (2003), there are two(2) underlying themes behind all of these pressures: *"heterogeneity"* and *"change".* Most enterprises today do have a

range of different systems, applications, and architectures of different technologies. The investment done by enterprises on IT systems in the 1990s was all about "suites": buying a few large packages with several tightly integrated modules made more sense than going with the best products (applications or systems) in the market and then trying to integrate all these disparate products from multiple vendors.

Today, however, companies cannot afford to take a single-vendor approach to IT, because application suites are inflexible, which potentially leads to higher costs. IT executives are now having different criteria and priorities for their IT investment: they assemble just those products that best meet the needs of their enterprises. This way, the "embracement" of *heterogeneity* has become a common practice, because it is more affordable.

Change, the other theme behind the business pressures observed today, is an ever-present theme because competition between companies has become very fierce. Mainly, this is expressed in four(4) dimensions. First, products' life cycles are becoming shorter, as companies look to gain advantage over their competition in promoting and selling their products. Customer needs and requirements change more quickly which, in turn, leads to improvements in products and services, but at the same time "contributes" to the increased competition.
In addition, the broad economic forces including globalisation and e-business and the improvements in technology that continue to accelerate, feeding the increased pace of changing customer requirements, are further increasing the pace of change.

Ever since applications first started communicating with one another, companies have been struggling with how to integrate them. As business applications became more powerful and more complex, they required increasing levels of customisation. Finally, the over-investment in IT in the 1990s coupled with the tough economic environment of the 2000s is putting the IT executive in an exceptionally difficult position. IT executives are asked to find ways to make the organization's IT environment more flexible and responsive to changing business requirements, without spending a lot of money and at the same time to reduce the complexity of the organization's IT environment. They are also asked to get more value out of the existing data and make wise application purchasing decisions, without getting locked into a single vendor, and without spending "ages"(in terms of time) and "millions"(in terms of money) on customisation. Furthermore, the IT executives have to pull cost out of the IT budget, by reducing unnecessary expenses and create and follow the best

strategy for solving heterogeneity, provided that the organization's IT environment is heterogeneous and is going to stay that way (Bloomberg 2003).
All these constitute the portfolio of challenges that every IT executive has to deal with, in the highly heterogeneous and rapidly changing IT and business environments.

In such an ever-changing and demanding business environment, in which IT must succeed, it has to continually evolve and incorporate such attributes as agility and flexibility to help emergent organizations meet their strategic business objectives. But, there have always been limited means to match IS development to a rapidly changing organization. The available means include prototyping, end-user development, and open systems connectivity. But these are inadequate because they are not connected though a coherent framework that focuses on the emergent character of organizations. If emergence, rather than stability, is taken as the dominant character of organizations, at least in some periods, there is a need to radically rethink the way in which IS are developed. Rather than viewing information systems development (ISD) as a series of projects each having a clear beginning and end, emergence calls for a continuous redevelopment perspective. A continuous redevelopment perspective implies the creation of an ISD environment that is optimized for high maintenance rather than low maintenance (which is a characteristic of the systems derived by the available ISD methods). Within an organization where continual change is valued, low maintenance is evidence of an IT system that is inadaptable. These systems lead to *stable systems drag,* a condition in which the organization must adapt to both to its environment and its petrified IT systems. With stable systems drag the IS actually inhibit adaptation; so organizational emergence must necessarily "break" free from the IS constraints. IT systems that do not produce stable systems drag are designed to adapt with the organization, shifting the organization's essential adaptation constraints to the external environment and not its own rigid internal IT framework (Truex et al. 1999).

In addition, according to Bloomberg (2003 p.4), "Business is calling upon IT more than ever to respond quickly and efficiently to shifting requirements—but IT is still facing a plethora of issues". These include the fact that the integration technologies are still very expensive and inflexible and they present unacceptable risks of failure to the enterprise along with the limitations of business applications which are monolithic in that they require expensive customisation and maintenance to meet organization's needs.

Another issue that aggravates the situation is the fact that there is a limited ability to participate in value networks because the automation of business processes that involve suppliers or customers is complex, inflexible, and insecure.

These issues, on which IT is being called upon to find solutions, have given rise to a new approach to designing, developing and maintaining information systems, the Service Oriented Architecture.

6. Service Oriented Architecture: Web Services' Template

Into today's tough business environment, the reality is that the pressures do not become less, the demands do not stabilize, and the Enterprise Architecture is lost in the myriad of tactical initiatives. But, as also Paras and Zachman (1999), respectively argue: "The wild e-everything ride is over. Budgets are tighter and reality has set in. Executives tell us they must provide a solid, cost-effective IT foundation and simultaneously increase flexibility to respond to the increasingly diverse demands of the business. The effective use of information, technology, human resources, and investment capital must be balanced to achieve these goals. The solution is a portfolio focus, a return to disciplined, pragmatic approaches for strategy development and enterprise design, combined with robust processes for managing the enterprise portfolio of programs," (Paras) and "Enterprise Architecture requires actual work. We keep looking for the 'quick fix,' a technological solution, a tool, a package, a new processor, the perennial 'silver bullet.' We wish we could simply throw money at the problem and have the pain go away,"(Zachman 1999) an evolutionary, standards-based approach to (enterprise) architecting needs to be devised to address the business needs today and support the long-term business strategy of the contemporary organizations.

The Evolution Of Systems Architecture

Figure 4 illustrates the architectural paradigm shifts observed during the last few years. First, there is a tendency to more "loosely coupled" systems, and second, there is a trend towards more adaptable and flexible systems.

The mainframe systems of the 1960s were implemented as large blocks of functionality that ran on a single mainframe computer. On the contrary, services-oriented systems are implemented as discrete business services that are "loosely coupled" to other services running on a heterogeneous systems and platforms across the organization, or beyond them.

Orton and Weick (1990) argue that three(3) major definitions of "loosely coupling" are the dominant ones throughout the academic community. Glassman (1973) wrote that loose coupling is present when systems have either few variables in common or the variables they have in common are weak. Weick (1976) defined loose coupling as a situation in which elements are responsive, but retain evidence of separateness and identity. Later, he wrote that loose coupling is evident when elements affect each other "suddenly (rather than

continuously), occasionally (rather than constantly), negligibly (rather than significantly), indirectly (rather than directly), and eventually (rather than immediately)" (Weick 1982).

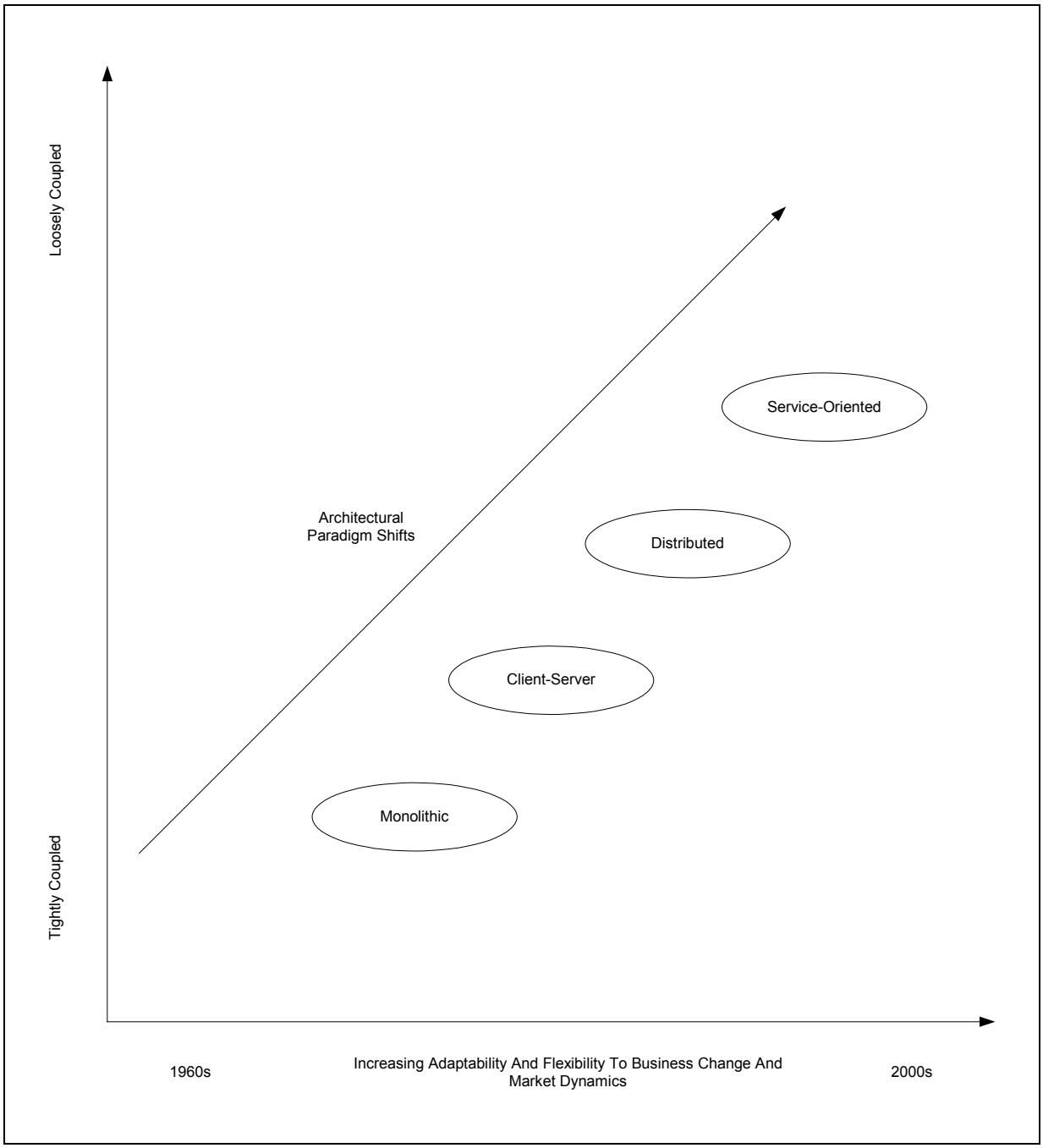

Figure 4. Evolution Of Systems Architecture - [Source: (Marks 2003)]

The concept of "loosely coupled" is widely practiced in computing architectures. It is the foundation for the design of massively parallel computing systems.

This concept is also widely talked about, but far less widely practiced, in the software world. In some respects, the movement to three tier software architectures was a small step in the direction of loose coupling, at least at the

level of standardizing interfaces across databases, application logic and presentation layers. In general, though, software has remained tightly coupled because of the inability of major vendors to agree on a universal set of standards to define interfaces across software modules. However, this appears to be in the process of changing. Web services technology is built upon a loosely coupled design philosophy (Hagel 2004).

Besides the tendency to more "loosely coupled", the other shift that is observed in architectural paradigm throughout the period of the last forty(40) years is the "migration" to more adaptable and flexible systems. Early mainframe systems used paper tape and punch cards to store data and programs. The use of mainframe processing time was strictly managed and allocated in sequential blocks or batches. On the contrary, services-oriented systems (implemented as discrete business services) are interconnected across an organization's computer network, where it is possible to locate and re-use services registered with a central registry of service.

Even though there were shifts in the architectural paradigm towards a more "loosely coupled", flexible and easily adaptable model over the last forty(40) years, the current state of the IT industry is not yet an "ideal" place for business, especially for the IT professionals (including the IT executives). For instance, today's IT executives have to deal with all sorts of technologies:

- *Business Applications* - From large suites like Enterprise Resource Planning(ERP), Supply Chain Management(SCM), and Customer Relationship Management(CRM) packages to Portals and desktop productivity packages (like MS-Office, etc), as well as industry-specific applications.
- *Distributed Computing Architectures* – Client-Server architectures for database-centric applications and N-tier architectures for Internet or intranet purposes, etc.
- *Middleware* - The glue that keeps systems "talking" to each other, including message-oriented middleware (like IBM's MQ-Series), Application Servers(like BEA Weblogic, or Oracle's Application Server, etc), Enterprise Application Integration(EAI) solutions, and transaction monitoring and processing systems.
- *Miscellaneous Systems* - Mainframes, mid-range computers, servers of all types and sizes, desktop systems(PCs), and any number of special-purpose systems, depending on industry.

Bloomberg (2003 p.5) argues that: "this plethora of technologies, while intended to *address* business issues, often *presents* issues that the IT executive must resolve. Most of these issues fall into three(3) broad categories: *complexity, inflexibility,* and *brittleness."*

Unfortunately, all this sort of technologies introduces unnecessary complexity. Today's enterprise IT environment contains many kinds of systems that work in many different ways. Enterprises must hire large, multi-skilled groups of workers to develop, deploy, and manage the heterogeneous collection of applications and systems needed.

In addition to complexity, the existence of the various kinds of technologies also introduces inflexibility, considering that almost all enterprises have existing business applications that are difficult to upgrade, difficult to interoperate with, and worst of all, impractical to replace. Furthermore, heterogeneous systems tend to be difficult to integrate, each exposing different interfaces with different rules. Integration is therefore an expensive, difficult process that yields inflexible distributed systems.

But, inflexible systems also encompass the risk of failure and are sources of instability and brittleness. Traditional approaches to building IT environments lead to a really messy approaches to integration. As a result, when business processes or requirements change, IT departments must either undertake expensive, risky upgrade projects, or simply drop the existing applications and systems since they are no longer meet the needs of business.

Of course, the problems of complexity, inflexibility, and brittleness are nothing new in the enterprise. The need for a new solution (or approach) that will address all these issues encountered in the IT landscape today, it seems to be, ever than before, an imperative matter. Today's IT executives need fresh approaches to dealing with heterogeneous environments and an increasing pace of change, in the face of tight budgets and a tough economy.

As a response to that need, a new approach to architecting IT application functionality is gaining traction at enterprises across many industries. Known as *Service Oriented Architecture* (SOA), this new way of thinking about how to integrate IT resources and access application functionality in the enterprise aims to address most of the issues faced by enterprises today. "SOAs have the potential to rise to the challenges of brittle application infrastructures, inflexible technology, and high-risk, high-cost IT. Fundamentally, SOAs have the flexibility and responsiveness to

enable business priorities to finally drive technology decisions. On the other hand, building service-oriented infrastructures is not easy. It requires commitment and expertise. The long-term business benefits of SOAs, however, can justify such investments. Many enterprises have already implemented SOAs and achieved quantifiable benefits from their investment in this new architectural approach."(Bloomberg 2003 p.4)

The Service Oriented Architecture Components And Operations

The Service Oriented Architecture is an approach to enterprise business systems and applications that considers software resources as services available and discoverable on a network. Such services provide functionality to the business while hiding the underlying implementation details. The Service Oriented Architecture (SOA) consists of three(3) components and there are three(3) major operations through which the SOA participants interact, as shown in Figure 5, below.

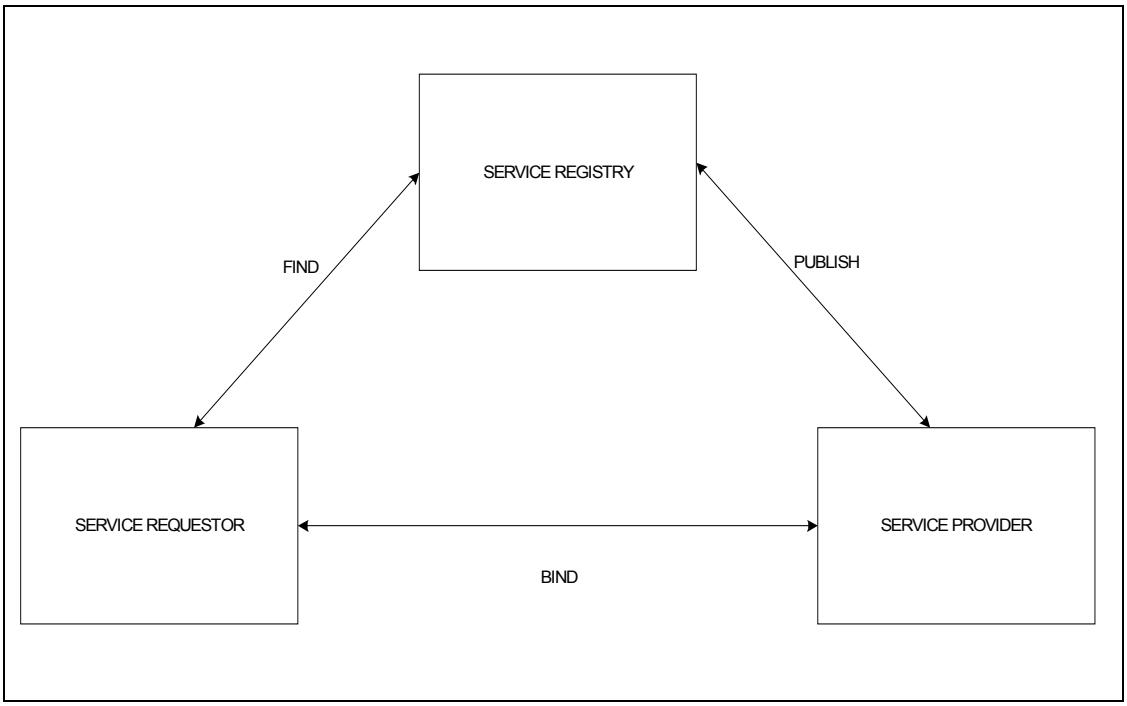

Figure 5. The Service Oriented Architecture - [Source: (Cutlip 2001)]

The "Service Provider" creates and publishes the services with the "Service Registry" which is responsible for registering and categorizing the (public) services. These services are being "consumed" by the "Service Requestor". The "Service Requestor" is the user of the services. It discovers the required services by searching the registry, maintained by the "Service Registry", and then it invokes these services by communicating with the actual "Service Provider".

The interaction between the major components of the SOA architecture is done via means of three (3) basic operations: *Publish* (the "Service Provider" publishes its services to the "Service Registry"), *Find* (the "Service Requestor" locates, searches, and discovers the services stored by the "Service Registry"), and *Bind* (the "Service Requestor" binds and use the service provided by the "Service Provider" (through the "Service Registry").

The Service Oriented Architecture Characteristics

SOA is primarily differentiated from previous architectural paradigms (Monolithic, Client-Server, and Distributed) due to the certain characteristics.

The fact that the exchange of information between the communicating parties ("Service Provider" and "Service Requestor") is realized using "Open" interface standards, as opposed to systems or vendor specific standards that the previous paradigms enforced, is one of the most differentiating attribute of SOA.

Other differentiating factor of SOA from the other architectures is that the applications based on previous architectural paradigms are exposing their interfaces (through which the communicating parties are "talking" one another) as fine-grained components (meaning that they implement low-level technical functions such as: "user login functions for security and authentication"). These components are then aggregated into larger, coarse-grained services that more closely resemble real business functions. Applications, though, that are based on the SOA paradigm are exposing their interfaces as services (which are coarse-grained and implement business level service such as "user administration" service).

The most decisive factor that distinguishes a SOA-based system from systems that are based on the other architectural paradigms, is its "loosely coupled" attribute. "Loosely coupled is an attribute of systems, referring to an approach to designing interfaces across modules to reduce the interdependencies across modules or components – in particular, reducing the risk that changes within one module will create unanticipated changes within other modules. This approach specifically seeks to increase flexibility in adding modules, replacing modules and changing operations within individual modules" (Hagel 2004). Indeed, traditional systems are tightly coupled (which means that the implementation of a "Service Provider" had to be closely tied to the implementation of the "Service Consumer" for the communicating parties to "talk" one another), as opposed to SOA-based

systems where the exchange of information between communicating parties takes the form of exchanging flexible, loosely tied services.

Finally, the other attribute that makes SOA distinct is the fact that in an SOA-based environment, services are published in the "Service Registry". Service Registry is a central repository, either within an organization or on the Web, which can be used to *dynamically discover* services at run-time, as opposed to "hard-wired" references observed in the traditional architectural paradigms.

Concluding, SOA is addressing the complexity, inflexibility, and brittleness issues of existing approaches to integration, while embracing heterogeneity. Well-known SOAs (the *Common Object Request Broker Architecture –CORBA-,* and Microsoft's *Distributed Component Object Model* –DCOM-) were around for few years now and they were providing this functionality. These approaches to service orientation, however, were: (a) *tightly coupled,* which means that the implementation of a "Service Provider" (the software that offered the service) had to be closely tied to the implementation of the "Service Consumer" (the software that accessed the service), and (b) *proprietary.* In spite of these issues, the concept of service orientation continued to make sense, provided that the problems of proprietary approaches, and tight coupling could be solved. It is within this architectural context that Web Services were first imagined. Web Services are an open standards-based way of creating and offering software services.

7. Web Services: An Implementation Of SOA

Web Services is an implementation of this promising architectural approach (SOA). A simple Web Service is mainly characterized by three(3) new standards: SOAP, UDDI, WSDL, which taken together provide a basic "request-and-response" functionality between communicating parties.

Web Services technology aims to address a series of issues faced by contemporary organizations. It aims to support application integration internally (within an organization) and externally (between an organization and its business partners), to provide easier business-to-business (B2B) collaboration between business partners, to reduce costs of software procurement, deployment, and integration, and to increase business and technology agility by deploying loosely coupled business applications versus monolithic enterprise applications.

Having all these attributes and properties, somebody would have expected that Web Services would have been the de-facto choice for all the business cases and applications. Building a Web Services-based solution in the enterprise, however, is not an easy task because it not only requires deep architectural expertise, but also Web services development and testing tools, integration brokers or message buses, systems management and Web services management capabilities, and finally an enterprise security infrastructure based on corporate security policies.
In addition, Web services are still in their infancy. The long-term success of Web Services mainly depends on the compliance to accepted standards. Currently, none of the web service technologies (that is, SOAP, UDDI, WSDL) has any official standing with standardization authorities.

So, Web Services technology does provide an alternative, and most of the cases a preferred, architectural paradigm implementation, but there are issues, like security and the lack of skills and expertise, that inhibit its immediate adoption. Consequently, the chosen approach (or technology) for a project or a business case, depends on the case requirements and on the project specifics.

Web Services can be pictured as a relationship between a service provider and a service consumer, or publisher and subscriber. The service provided can be either functionality (all manner of calculations), or data access (providing a regulated view of any repository of data). The provider and consumer could well be within the same company, since Web Services potentially enable a rapid application

development solution to integration problems. Alternatively, Web Services could be used to integrate systems between trusted partner companies.

In addition, "Web Services are a way to drive down costs by reducing data and functionality duplication within an organization. For instance, rather than having three departments running three different packages to do the same job because they're all using different systems, the functionality can be centralized and accessed as Web Services, regardless of the platform each department uses for its own needs. Web Services are also a way to drive up income, by allowing an organization to market their previously purely internal functionality to a wider audience. If part of your system does a good job of providing a certain type of valuable information in a timely manner, it could be a candidate for exposure as a Web Service so that it can be marketed as a service to other companies." (Clark 2002 p.2)

Web Services Technology

The simplest way, however, to view Web Services is as software that knows how to "talk" to other types of software over the network (either internally through an intranet; or, through the Internet if it needs to communicate with a remote application). "A Web Service can be nearly any type of application that has the ability to define to other applications what it does and can perform that action for authorized applications or parties." (Edwards 2002 p.68) Specifically, a software component can be characterized as a Web Service if it satisfies the following criteria :

(1) It is able to expose and describe itself to other applications, allowing those applications to understand what the service does.

(2) It can be located by other applications via an online directory, if the service has been registered in the directory.

(3) It can be invoked by the originating application by using standard protocols.

A simple Web Service is mainly characterized by the three (3) standards:

(i) SOAP (Simple Object Access Protocol),

(ii) UDDI (Universal Description, Discovery, and Integration), and,

(iii) WSDL (Web Services Description Language),

which taken together provide a basic "request and response" (service-oriented) functionality. For an application to be able to communicate with other applications, it must have a set of interfaces defined in WSDL. Defining those interfaces is called publishing WSDL interfaces. To make the application locatable for the other applications, register it with the Web Services registry, the UDDI registry. Applications can invoke a Web Service by sending a request via SOAP and listening for the

response. Figure 6 shows the Web Services architecture (which in fact, it is a Service Oriented Architecture implementation).

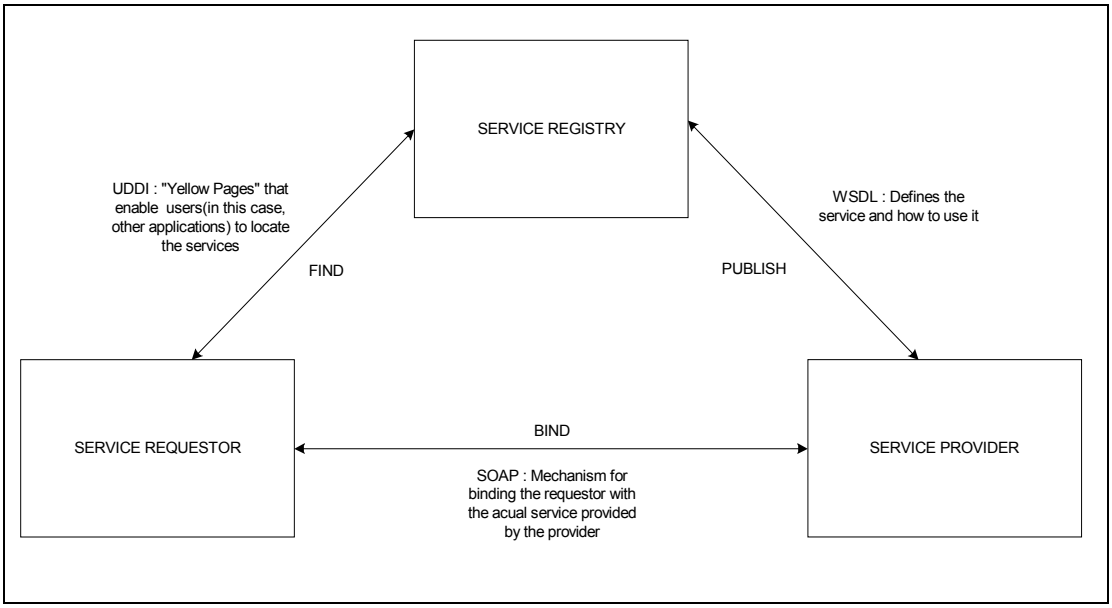

Figure 6. The Web Services Architecture - [Source: (Cutlip 2001)]

All these operations (Publish, Register, Locate, Bind, etc) take place over a network (specifically, over the Web) in an automated way and without human intervention. Applications are "talking" one another (in a "request-and-response" mode, as described above) to complete a set of tasks that might altogether form a transaction. This means that with Web Services, we are moving from a human-centric Web to an "application-centric" Web. This does not necessarily means that humans are entirely out the picture. It just means that the exchange of data takes place (directly) between applications without the need (for a human) to provide input or any kind of instructions.

Web Services are implemented by using a collection of standards (or protocols). These standards, when considered together, form what is widely referred to as the "Web Services Protocol Stack" (Figure 7).

The "Web Services Protocol Stack" is still evolving, but currently has four(4) main layers:

1. *Service Transport* - This layer is responsible for transporting messages between applications. Currently, this layer includes Hyper-Text Transfer Protocol (HTTP), Simple Mail Transfer Protocol (SMTP), File Transfer Protocol (FTP), and newer protocols, such as Blocks Extensible Exchange Protocol (BEEP).

HTTP is the most popular option for service transport. HTTP is simple, stable, and widely deployed. Furthermore, most firewalls allow HTTP traffic.

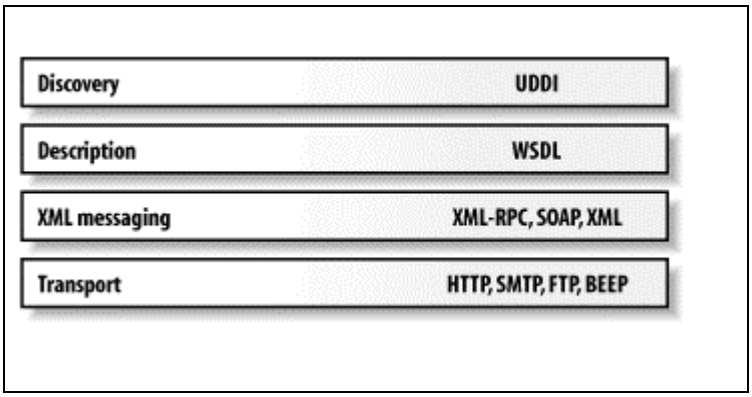

Figure 7. The Web Services Protocol Stack - [Source: (Cerami 2002)]

2. *XML Messaging* - This layer is responsible for encoding messages in a common XML format so that messages can be understood at either end. Currently, this layer includes XML-RPC and SOAP.
   XML-RPC is a simple protocol that uses XML messages to perform Remote Procedure Calls (RPCs). Requests are encoded in XML and sent via HTTP POST. XML responses are embedded in the body of the HTTP response.
   SOAP is an XML-based protocol for exchanging information between computers. Although SOAP can be used in a variety of messaging systems, and can be delivered via a variety of transport protocols, the main focus of SOAP is RPCs transported via HTTP.

3. *Service Description* - This layer is responsible for describing the public interface to a specific web service. Currently, service description is handled via the Web Service Description Language (WSDL).

4. *Service Discovery* - This layer is responsible for centralizing services into a common registry, and providing easy publish/find functionality. Currently, service discovery is handled via Universal Description, Discovery, and Integration (UDDI).
   The data captured within UDDI is divided into three main categories:
   a. White Pages - This category includes general information about a specific company; for example, business name, business description, and address.

b. Yellow Pages - This category includes general classification data for either the company or the service offered. For example, this data may include industry, product, or geographic codes based on standard taxonomies.

c. Green Pages - This category includes technical information about a web service (a pointer to an external specification and an address for invoking the web service).

Web Services Benefits

There are various areas where this "application-centric" model of Web Services might be useful. Transactions and processes that already benefit Web Services technology are: the credit card verification, the package tracking, the portfolio tracking, the currency conversion, the language translation, and in general all processes that need real-time exchange of data.

Web Services technology is applicable to any application where you need near-real-time exchange of data; where you need to exchange information across business partners, across departments or remote sites of the same organization, and where you need to exchange information with your suppliers and customers (Edwards 2002).

According to IT industry practitioners, enterprise application integration becomes easier and less expensive with Web services. For enterprises, integration is a continuous process. It is a never-ending struggle to 'get it all to work together' and, up until now, it has been a very expensive process. According to CapeClear (2003 p.1), an IT company specialized on IT systems integrations and one of the leaders in the Web Services arena, "a license for integration software can cost a company over $500,000, with Gartner Group estimating that the expense of installation and maintenance can lead to a total cost of set-up between $2m and $10m. Forrester estimates that less than 35% of integration projects are completed on time and on budget. IDC predicts the expenditure for enterprise integration will exceed $50 billion by 2003. Forrester calculates the average cost of an integration project for the Global 3,500 standing is $6.3m. Enterprise Application Integration, as it is currently implemented, is expensive; and money does not guarantee success. And, of course, the task is never complete - the costs remain continuous."

The advent of Web Services technology, according to CapeClear (2003 p.1), is proposed as the solution to this problem (i.e. the fact that integration is expensive and endless): "A new approach, Web Services, disrupts this status quo and makes integration pervasive and affordable. Web Services make integration the foundation of

any corporate IT strategy. This applies to both SMEs with limited resources through to Fortune 100 corporations."

Web Services technology allows applications to be integrated more rapidly, easily and less expensively than ever before. Integration is based on messages and it is "centred more on service semantics and less on network protocol semantics."(Kreger 2001 p.6) This characteristic is ideal for connecting business functions across the Web—both between enterprises and within enterprises. Web Services is a technology for "deploying and providing access to business functions over the Web." (Kreger 2001 p.6)

Web Services also addresses challenges in very complex inter-operating environments. "Web Services can dramatically ease business-to-business (B2B) integration and speed application development." (Edwards 2002 p.75) Enterprise Application Integration (EAI) is one of the most challenging tasks businesses are facing today. The need to provide quality products and services at competitive prices in a short period of time is what all organizations are trying to achieve.

Enterprise Application Integration is a two-fold challenge: (a) integration of internal applications; that is, integration of the various applications that are used by the different departments (or by remote sites) of an organization, and (b) integration of organization's applications with the applications of its suppliers, business partners, and customers.

Applications within an organization are built in order to solve specific business problems. Most of the times, applications (for example, Accounting system, Payroll system, Sales systems, etc) are built separated the one from the other in order to meet the objective intended to reach. Most of the times, it is desirable to have these (isolated developed) systems communicate with one another. For this reason interfaces between these disparate systems need to be developed: a highly challenging but costly task. Even more costly is the task of integrating organization's systems with those of its suppliers, business partners, and customers.

Hopefully, Web Services provide a solution. Built on existing Internet standard protocols (such as XML and HTTP), Web Services are designed to facilitate applications integration, reduce costs and boost productivity. It also makes things easier because it allows these totally heterogeneous environments easily integrated by means of exchanging "messages" in the way the "request and response" functionality of Service Oriented Architecture presented earlier in this document.

It is due to this nature ("request and response") that Web Services are applicable to (almost) all service-oriented businesses. "In many financial services organizations - as well as other service-oriented businesses – you see an immediate recognition of the relevance of that technology." (Gilpin 2001 p.29)

An attribute of Web services that falls within the "integration" realm but deserves a special reference is the fact that Web Services do not "dictate" companies to discard their existing systems and invest to new systems or applications; but, the existing components, applications, or systems can be integrated in such a way that the business objectives are being met. You only need to modify the existing applications to contain a Web Services stack in order to handle the SOAP messages (that's the way communication between applications is taking place in Web Services technology). But even this, it is much less costly than having to buy (or build) a new system that will meet your needs. "If an organization can extent the life span of existing solutions instead of having to write new ones and can also use average programmers instead of expensive consultants -who are otherwise needed-, I think the ROI can grow pretty quickly." (Edwards 2002 p.75)

No research work, academic or "industry-produced", has been encountered providing a formula or model for the exact estimation of Return-On-Investment (ROI), for an organization, from the adoption of Web Services.
Clark et al. (2002), however, provide great insights on how ROI, after Web Services adoption, could be quantified. Even though the proposed model contains abstract factors (which still makes the ROI calculation hard), it is a great attempt toward quantifying all those factors that affect ROI. The proposed ROI model takes into account the following factors:
(1) Costs and Expenses. These will be based on parameters like:

(a) Hardware Requirements
(b) Software Requirements
(c) Training Requirements
(d) Network Bandwidth Requirements
(e) Monitoring Tools
(f) Operational Costs and Vendor Consulting

(2) Technical Benefits. They will be quantified by considering the following:

(a) Software Development Automation
(b) Streamlining of Middleware Technology
(c) Usage of Standards-Based Integration

(d) Integration with Applications and Business Process Management

(e) End of Duplication of Software Code Leading To Reusability

(3) Business Benefits. The following parameters will be taken into account:

(a) End-User Productivity

(b) Participation in Dynamic Business, referring to the Web Services technology ability to participate in dynamic business relationships. Since the discovery, binding, invocation, and communication of Web Services are standards-based, companies can conduct business in a real-time mode rather than the traditional static mode.

(c) Collaborative Business Activities

(d) Better and Cheaper Customer Service

(e) Other Benefits, such as faster time to market, increased process efficiency, and increased efficiency through business process automation.

(4) Risks associated with adoption of Web Services. The following risks need to be considered in the ROI model or formula:

(a) New Technology

(b) Standards not Matured or Finalised

(c) Web Services Development Tools and Servers availability

(d) Quality of External Web Services

(e) Security

Thus, considering all those parameters, we can come up with the following model for calculating (or better, quantifying) ROI that might be realised if Web Services technology is adopted:

$$ROI = \frac{(\text{Technical + Business Benefits}) - (\text{Costs + Expenses}) - (\text{Risks})}{(\text{Costs + Expenses}) + (\text{Risks})} * 100$$

Not only Web Services technology facilitates application integration, but it also aims to reduce costs within an organization by reducing expensive functionality duplication, and by providing new revenue streams from existing functionality and data. That is, existing applications and data are not "buried", but they are appropriately adjusted to become usable components.

Moreover, Web Services architecture "is less fragile and more adaptive to ever-changing business pressures, either tactical or strategic" (Marks 2003 p.171). Web Services flexibility and agility is realized in two(2) perspectives: (a) because Web services are based on open standards, that most software vendors agree upon, it is possible to get software that interoperates out of the box, and, (b) Web services are designed to promote loosely coupled interactions between Web service providers and consumers. Such loose coupling means that provider and consumer applications can be developed independently of each other. These perspectives do have direct implications on the improvement of the time-to-market of any Web Services-based solution, which in turn, provides a considerable advantage over competitors.

Clearly, Web services technology supports more flexible collaboration, both among a company's own units and between a company and its business partners. When traditional information systems need to talk to each other, they do so through dedicated, point-to-point connections. The problem with such point-to-point connections is that they are fixed and inflexible and, as they proliferate, become nightmares to manage. With the Web services architecture, tight couplings will be replaced with loose couplings. Because everyone will share the same standards for data description and connection protocols, applications will be able to talk freely with other applications, without costly re-programming. This will make it much easier for companies to shift operations and partnerships in response to market or competitive stimuli. The loose-coupling approach of Web services also makes it an attractive option within an organization. Chief Information Officers (ClOs) can use the Web services architecture to more flexibly integrate the extraordinarily diverse set of applications and databases residing within most enterprises while at the same time making these resources available to business partners (Hagel and Brown 2001).

In addition, Web services architecture represents a much more efficient way to manage information technology. By allowing companies to purchase only the functionality they need when they need it, the new architecture can substantially reduce investments in IT assets. And by shifting responsibility for maintaining

systems to outside providers, it reduces the need for hiring numerous IT specialists, which itself has become a significant challenge for many companies. Using Web services also reduces the risk that companies will end up using obsolete technologies; third-party utilities and application providers will be required to offer the most up-to-date technologies in order to compete. Companies will no longer find themselves stuck with outdated or mediocre applications and hardware. The standardized, plug-and-play nature of such an architecture will also make it much easier for companies to outsource activities and processes whenever it makes economic sense (Hagel and Brown 2001).

Web Services Issues

Building Web services applications in the enterprise, however, is a difficult task, because there are many aspects of the underlying IT infrastructure that must be in place for the Web services applications to operate as promised. In particular, building and maintaining a Web services application requires great skills and expertise as well as the necessary infrastructure for designing, developing, maintaining, and managing such an application.

Security is very critical to Web Services. In particular, there are three(3) areas related to security that need to be addressed: confidentiality, authentication, and network security.

Confidentiality refers to the ability to ensure that the communication between the communicating parties (or systems) remains confidential, whereas authentication has to do with the mechanism of identifying a user (who requests to "consume" a service) and whether the user is authorized to "consume" the requested service.

As far as the network security is concerned, according to Schneier (2000), "SOAP is going to open up a whole new avenue for security vulnerabilities." Schneier's (2000) basic argument is that HTTP was made for document retrieval. Extending HTTP via SOAP enables remote clients to invoke commands and procedures, something that firewalls are (explicitly) designed to prevent. This means that firewalls need to provide additional capabilities (features) to address this new challenge. As a response to that, firewall vendors are currently developing tools explicitly designed to filter Web Service traffic.

Clearly, security is an area that needs further research and development. The Web services community has proposed numerous security frameworks and protocols, but as yet there is no any comprehensive security package.

Another important parameter, that needs to be considered by an organization before proceeding to Web services adoption, is the fact that they are still in their infancy. The most crucial elements to the long-term success of web services will be standardization and the coherency of accepted standards. Currently, none of the web service technologies has any official standing with the W3C or the IETF (standardization authorities).

8. Initial Conceptual Framework And Theory

A contemporary organization in the ever-changing business environment where it has to "live" and compete, it has to incorporate attributes like agility and flexibility. IT acts as an enabler of agility and fulfils its mission as "a competitive level that helps organization reaches its operational goals" (Bensaou and Earl 1998), if it is properly used, if the right expectations are set, and if the IT policy is aligned with the business strategy.

Towards that objective, that is to align organizations IT and business strategies, IT vendors, consultants, and academics invented and sold planning techniques that aimed first at discovering a company's competitive strategy and second at suggesting and information systems portfolio to support it. Strategic alignment would then be assured (Bensaou and Earl 1998). That process is called "Enterprise Architecture."

In an attempt to formalise the Enterprise Architecture's various elements and their interactions, various models have been developed, the Enterprise Architecture Frameworks.

Even though the Enterprise Architecture (along with the various frameworks) process is a structured, disciplined approach that tries to align IT and business strategies of an organization, according to some researchers (eg. Truex, Baskerville, etc), these models, methods, and frameworks --mainly because of their nature, that is, they are "stiff", "rigid" structures-- are not so flexible to address the ever-changing business requirements. The gap between business requirements and IT policy in place becomes even larger considering the pace through which organizational change is taking place.

The Service Oriented Architectural paradigm responding to most of the issues encountered in the business and IT landscape today, mainly because the services-oriented systems are implemented as discrete business services that are "loosely coupled" to other services running on a heterogeneous systems and platforms across the organization, or beyond them.
In addition, services-oriented systems (implemented as discrete business services) are interconnected across an organization's computer network, where it is possible to locate and re-use services registered with a central registry of service, enhancing flexibility and adaptability.

Web Services, an implementation of this architectural approach (SOA), aims to:

- Enhance agility and flexibility,
- Reduce IS integration complexity,
- Lower IT costs, and,
- Improve time-to-market.

All these will provide a strategic competitive advantage to an organization over the other players in the market.

This little theory described above is depicted in the "conceptual framework" below (Figure 8).

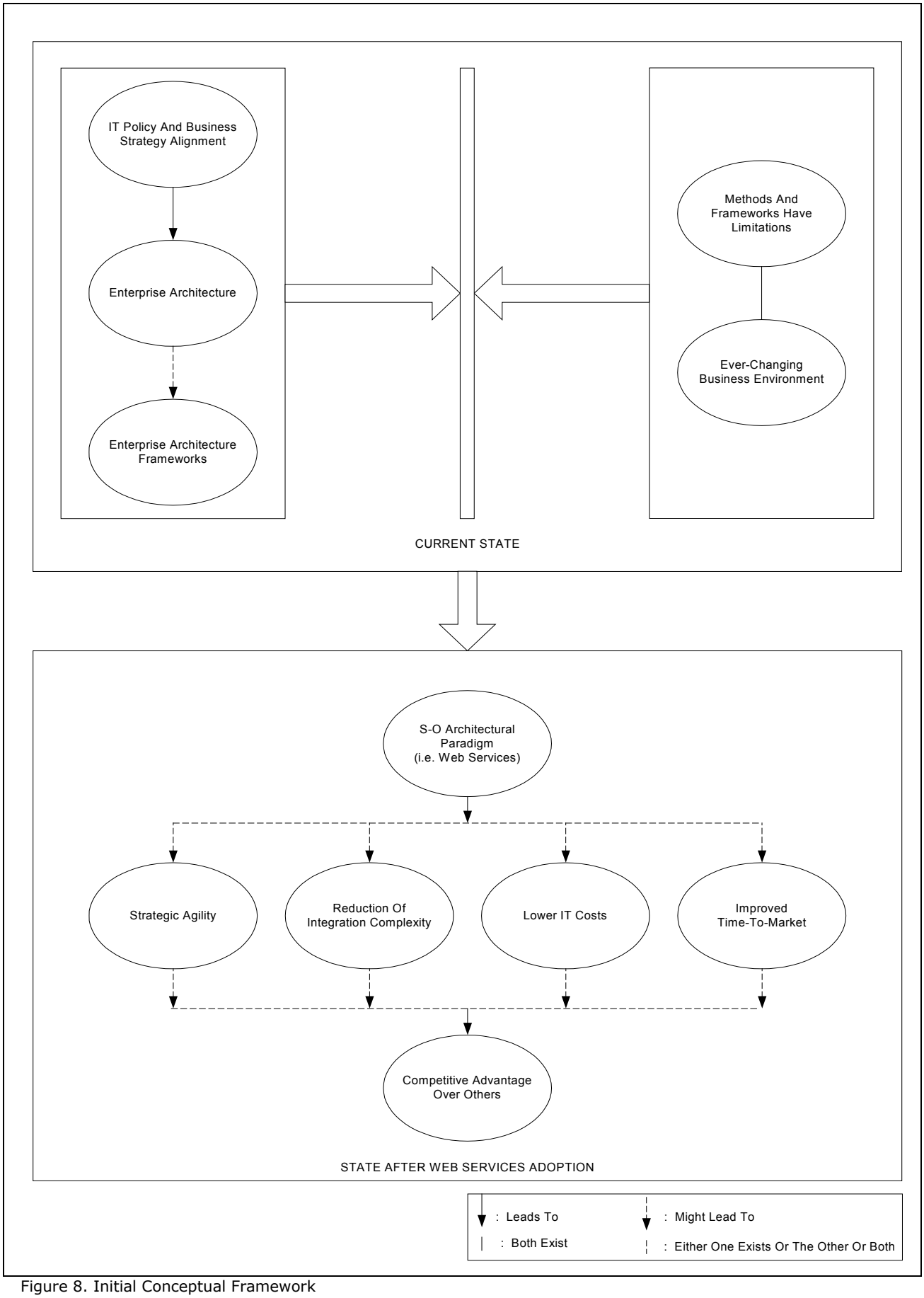

Figure 8. Initial Conceptual Framework

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Web Services Technology:
Architecture, Business Strategies And Opportunities

Document 3:
An Interpretative Report Using Case Study Research Method

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Contents

1. Introduction

Contemporary organizations in the ever-changing business environment where they have to operate, have to incorporate attributes like agility and flexibility, if they want to be competitive.

For years now, managers have been “advised” to invest on Information Technology (IT) with the promise that IT will be the vehicle for innovation, agility and flexibility and that it will significantly boost performance breakthroughs. As a consequence, companies’ executives had invested significant amounts of money and had waited long periods of time.

Throughout the years, though, the returns out of these investments were never (even) approached the expectations. This made the companies’ executives and those setting their strategic objectives very sceptical as to whether any further IT investments need to be made, when it is not clear whether there will be real and immediate returns on those investments.

The issue is more complex than it appears. IT acts as an enabler of agility and fulfils its mission as “a competitive lever that helps organization reaches its operational goals” (Bensaou and Earl 1998), if it is properly used, if the right expectations are set, and if the IT policy is aligned with the business strategy.

Traditionally, the challenge for IT has been to allow the organizations to respond to change in a timely, economical, and reliable manner without compromising organizational flexibility. Flexible IT systems are those that are malleable enough to deal with uncertainties in an unstable environment. They can rapidly respond to internal and external stimuli (Moitra and Ganesh 2004). One such technology is Web Services. Web Services are not just Web sites that help to connect people with technology and information. Web Services technology is a set of standards and protocols (namely, SOAP, UDDI, WSDL) designed to automate connections across applications and databases. These technologies are built upon a core standard known as eXtensible Markup Language(XML). All major Information Technology vendors (IBM, BEA, Oracle, Sun, Microsoft, etc) have embraced these standards and protocols.

This universal adoption makes these standards and protocols especially valuable in supporting connections across diverse technology platforms.

The primary value of Web Services technology is not to lower IT costs but actually lower operating costs provided the inefficiencies of most of the current Web-based systems (that otherwise seem to be streamlined) knowing that “behind the scenes people are often manually taking information from one application and entering it into another" (Hagel and Brown 2001).
These inefficiencies are increasingly concentrated at the edge of the enterprise, in functions like procurement and sales channel management that have to frequently interact with a large number of business partners. As difficult as it is to connect the diverse applications within the enterprise, the complexity escalates when the connections have to extend to multiple business partners. This results in significant operating expenses and inefficiencies that might lead to accumulation of inventory.
By implementing Web Services technology, companies can quickly deliver significant near-term operating expenses and asset savings to the bottom line, because Web Services technology, rather than requiring us to rip out the current systems and replace them with new ones, it serves as an overlay, operating on top of existing technologies to provide a much more low cost and flexible way of connecting these technology platforms. This way, businesses can generate more economic value from their underlying systems while attacking a lot of the operating inefficiencies.

The opportunity for savings will drive the early adoption of Web Services technology. The most substantial economic value, however, will surface over the longer term, as companies begin to realize the potential of the technology to support more accelerated growth. Mergers and acquisitions confront a significant challenge in terms of post-merger systems integration. Web Services can help to overcome this hurdle. More broadly, the opportunity to drive leveraged growth will create opportunities to accelerate growth by accessing resources of other companies through Web Services-enabled connections.

Web Services technology does not require significant changes in the way business currently gets done. It simply enables businesses to operate more efficiently - doing the same things they have always done, but doing them faster and cheaper. By making automated connections easier, less costly, and more flexible, Web Services technology creates many different options for business. For instance, it not only makes it much more feasible to outsource key business activities, but it also allows businesses to take world-class capabilities of their own and to make them available to other companies as a service, creating a new revenue (Hagel and Brown 2001).

Moreover, Web Services technology enables leveraged growth strategies, helping companies to access and mobilize resources of business partners in order to add more value to their customers.

Even though Web Services technology provides all these opportunities, promises profits and growth and enhances flexibility and agility, there is still a lot of resistance from business executives toward this new technology. Mainly, this is because they have been “burned” by technology investments in the past that were proved to be not so reliable, in terms of their returns.
In addition, business executives are also concerned about the early stage of development of the Web Services technology. The technology is still limited in terms of delivering the reliability, robustness, and security required for certain kinds of mission-critical business activities.

This paper attempts to investigate the attitude of business executives in Cyprus toward Web Services technology. In particular, we aim to address the issues:

- Does Web Services technology:
  - enhance business processes agility and flexibility?
  - improve the time-to-market of products or services?
  - reduce the information systems integration complexity?
  - eliminate inefficiencies, otherwise observed between communicating integrated information systems?

- create new business opportunities through collaboration, outsourcing, and by enabling global presence for the goods and services?
- accelerate growth by facilitating the integration of systems of acquired companies?

- Are there any limitations or constraints prohibiting the adoption of Web Services technology?

2. Overview of Qualitative Research

Research methods can either be qualitative or quantitative. Quantitative research methods were originally developed in the natural sciences (physics, chemistry, etc) to study natural phenomena. Throughout the years, however, quantitative methods are also appreciated more and more in the social sciences. Examples include the survey methods and the laboratory experiments.

Qualitative research methods were developed in the social sciences to enable researchers to study social and cultural phenomena. Examples of qualitative methods are the action research, the case study research and the ethnography.

The qualitative method used (that is, whether it is an action research, a case study research, or an ethnography) for the phenomenon under research is what will determine the way the data will be gathered. This can take the form of a participant observation, a series of interviews and questionnaires, a collection of documents and texts, or the researcher's impressions and reactions from the interaction with the issue under study.

The motivation for doing qualitative research, as opposed to quantitative research, comes from the observation that, if there is one thing that distinguishes humans from the natural world, it is our ability to talk. Qualitative research methods are designed to help researchers understand people and the social and cultural contexts within which they live.

For instance, Kaplan and Maxwell (1994) argue that the goal of understanding a phenomenon from the point of view of the participants and its particular social and institutional context is largely lost when textual data are quantified.

3. Philosophical Perspectives

All research (whether quantitative or qualitative) is based on some underlying assumptions about what constitutes valid research and which research methods are appropriate in each case or phenomenon under investigation. In order to conduct a qualitative research, it is therefore important to know what these assumptions are.

The most pertinent philosophical assumptions are those that relate to the underlying epistemology that guides the research. Epistemology refers to the assumptions about knowledge and how it can be obtained (Hirschheim 1992).

Guba and Lincoln (1994) suggest four(4) underlying "paradigms" for qualitative research: positivism, post-positivism, critical theory, and constructivism. Orlikowski and Baroudi (1991) work, a widely accepted research work, suggests three(3) categories for qualitative research, based on the underlying research epistemology: positivist, interpretive and critical (Figure 1).

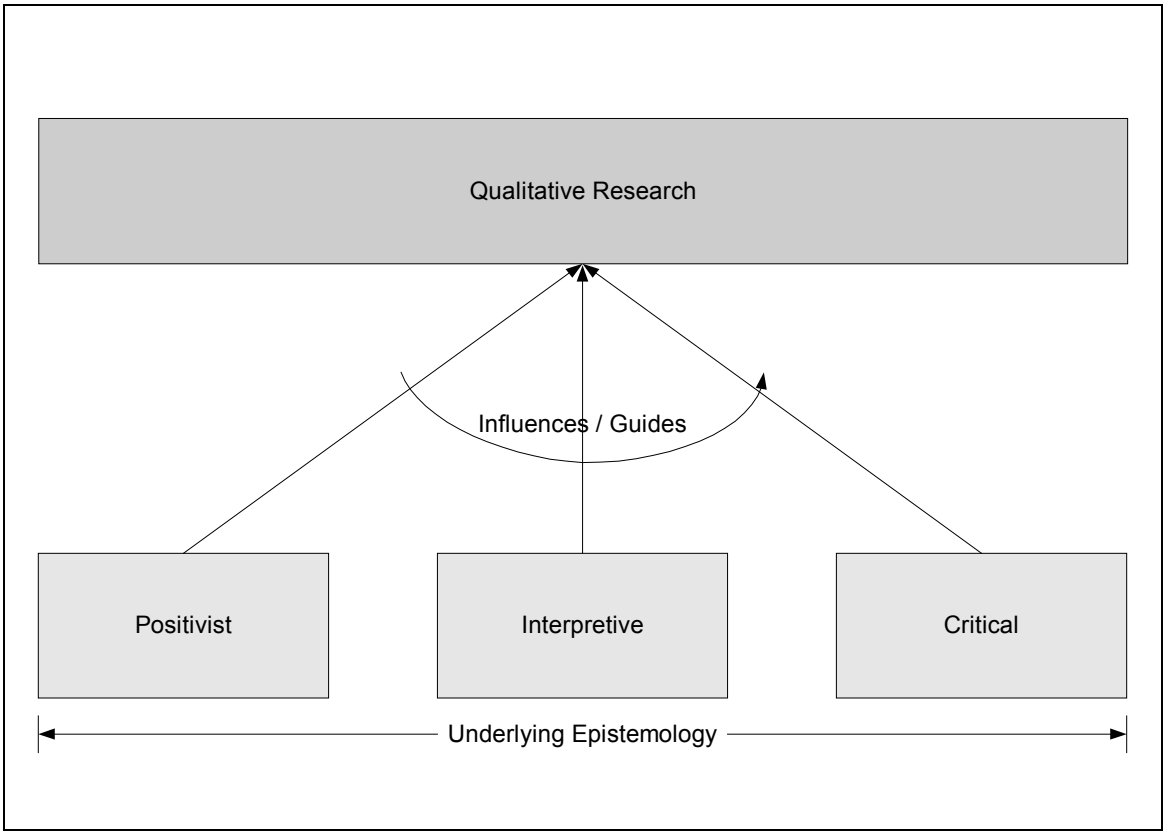

Figure 1. Underlying Philosophical Assumptions Of Qualitative Research
(Source: Orlikowski and Baroudi, 1991)

Positivists generally assume that reality is objectively given and can be described by measurable properties that are independent of the observer (researcher) and his or her instruments. Positivist studies generally attempt to test theory, in an attempt to increase the predictive understanding of phenomena. In line with this, Orlikowski and Baroudi (1991) classified Information Systems research as positivist if there was evidence of formal propositions, quantifiable measures of variables, hypothesis testing, and the drawing of inferences about a phenomenon from the sample to a stated population.
Examples of a positivist approach to qualitative research include Yin's (2002) and Benbasat et al's (1987) work on case study research.

Interpretive researchers start out with the assumption that access to reality (given or socially constructed) is only through social constructions such as language, consciousness and shared meanings. The philosophical base of interpretive research is hermeneutics and phenomenology (Boland 1985). Interpretive studies generally attempt to understand phenomena through the meanings that people assign to them and interpretive methods of research in Information Systems are "aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context" (Walsham 1993). Interpretive research does not predefine dependent and independent variables, but focuses on the full complexity of human which starts making sense as the situation emerges (Kaplan and Maxwell 1994).
Examples of an interpretive approach to qualitative research include Boland's (1991) and Walsham's (1993) work. Klein and Myers' (1999) paper suggests a set of principles for the conduct and evaluation of interpretive research.

Critical researchers assume that social reality is historically constituted and that it is produced and reproduced by people. Although people can consciously act to change their social and economic circumstances, critical researchers recognize that their ability to do so is constrained by various

forms of social, cultural and political domination. Critical research focuses on the oppositions, conflicts and contradictions in contemporary society.

Examples of a critical approach to qualitative research include Ngwenyama and Lee's (1997) and Hirschheim and Klein's (1994) work.

4. Qualitative Research Methods

The philosophical perspective (Positivist, Interpretive, Critical) adopted for conducting the qualitative research does not determine the qualitative research method (action research, case study research, ethnography) that will be used throughout the research work.

A research method is a strategy of inquiry which moves from the underlying philosophical assumptions to research design and data collection. The choice of research method influences the way in which the researcher collects data. Specific research methods also imply different skills, assumptions and research practices (Figure 2).

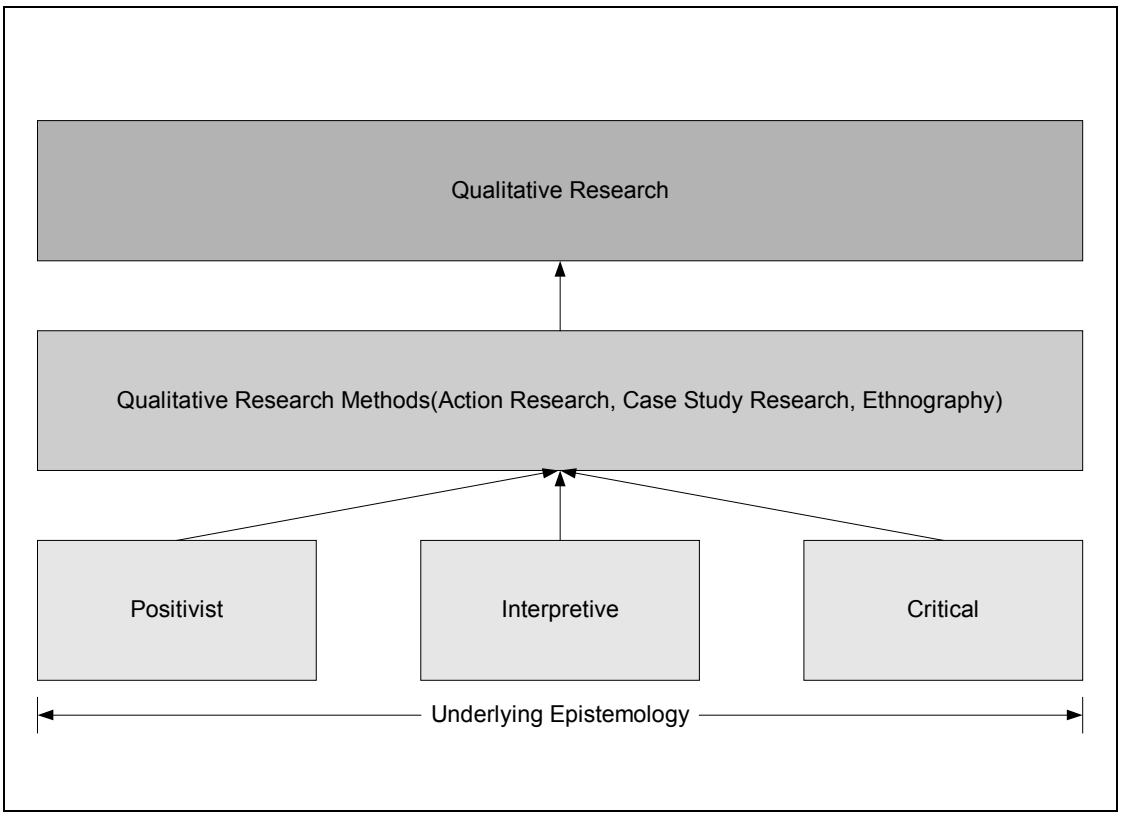

Figure 2. Underlying Philosophical Assumptions And Research Methods Adopted For Conducting A Qualitative Research

Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework (Rapoport 1970).

This definition draws attention to the collaborative aspect of action research and to possible ethical dilemmas that arise from its use. It also makes clear, as Clark(1972) emphasizes, that action research is concerned to enlarge the stock of knowledge of the social science community. It is this aspect of action research that distinguishes it from applied social science, where the goal is simply to apply social scientific knowledge but not to add to the body of knowledge.

In Information Systems, action research was for a long time largely ignored. Checkland's (1991) work was the notable exceptions to this rule. More recently, there seems to be increasing interest in action research. A brief overview of action research is the article by Susman and Evered (1978). The article by Baskerville and Wood-Harper (1996) provides a good introduction to how action research might be used by Information Systems researchers. An empirical example of action research is the article by Ytterstad et al. (1996).

The term "case study" has multiple meanings. It can be used to describe a unit of analysis (e.g. a case study of a particular organisation) or to describe a research method. The discussion here concerns the use of the case study as a research method.
Case study research is the most common qualitative method used in Information Systems (Orlikowski and Baroudi 1991; Alavi and Carlson 1992). Although there are numerous definitions, Yin (2002) defines the scope of a case study as follows: "A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident."

Clearly, the case study research method is particularly well-suited to Information Systems research, since the object of Information Systems discipline is their (Information Systems) study in organizations, and because "interest has shifted to organizational rather than technical issues" (Benbasat et al. 1987).

Case study research can be positivist, interpretive, or critical, depending upon the underlying philosophical assumptions of the researcher. Yin (2002) and (Benbasat et al. 1987) are advocates of positivist case study research, whereas Walsham (1993) is an advocate of interpretive in-depth case study research.

Ethnographic research comes from the discipline of social and cultural anthropology where an ethnographer is required to spend a significant amount of time in the field. Ethnographers immerse themselves in the lives of the people they study (Lewis 1985) and seek to place the phenomena studied in their social and cultural context.

After early ground-breaking work by Wynn (1979), Suchman (1987) and Zuboff (1988), ethnography has now become more widely used in the study of Information Systems in organizations, from the study of the development of Information Systems (Hughes et al. 1992; Orlikowski 1991; Preston 1991) to the study of aspects of Information Technology management (Davies 1991; Davies and Nielsen 1992). Ethnography has also been discussed as a method whereby multiple perspectives can be incorporated in systems design (Holzblatt and Beyer 1993) and as a general approach to the wide range of possible studies relating to the investigation of information systems (Pettigrew 1985).

In the area of the design and evaluation of Information Systems, some very interesting work is taking place in a collaborative fashion between ethnographers on the one hand, and designers, Information Systems professionals, computer scientists and engineers on the other. This collaborative work is especially strong in the United Kingdom and Europe and is growing in the United States.

An overview article by Myers (1999) is one of the most notable works done in the field (Information Systems investigation using ethnography). According to Myers' (1999) work, ethnographic research is one of the most in-depth research methods possible. Because the researcher is there for a reasonable amount of time - and sees what people are doing as well as what they say they are doing – an ethnographer obtains a deep understanding of the people,

the organization, and the broader context within which they work. Ethnographic research is thus well suited to providing information systems researchers with rich insights into the human, social and organizational aspects of information systems.

5. Qualitative Techniques for Data Collection

One or more techniques can be used for collecting data towards a research work that uses any of the known research methods (Positivist, Interpretive, Critical). These techniques range from interviews, observational techniques such as participant observation and fieldwork, through to archival research. Written data sources can include published and unpublished documents, company reports, memos, letters, email messages, faxes, newspaper articles, etc (Figure 3).

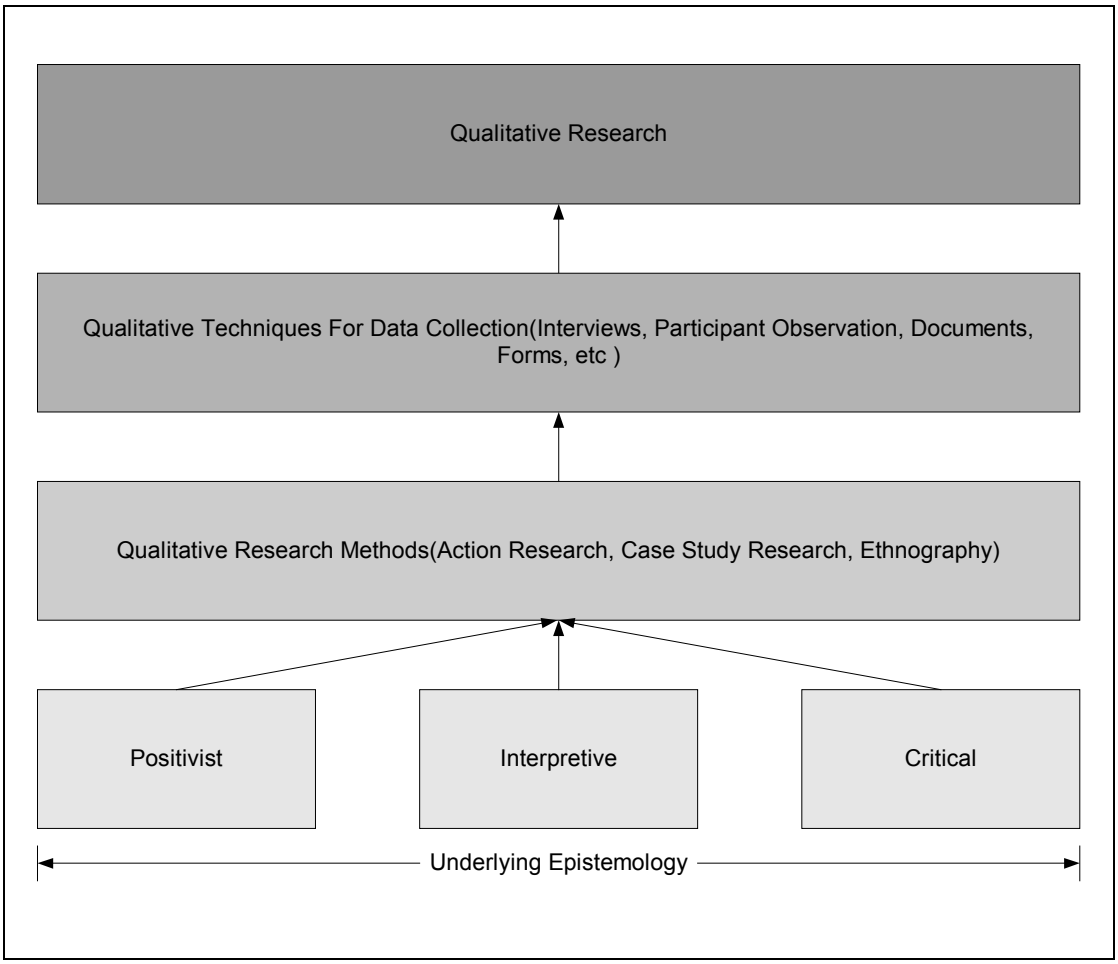

Figure 3. Underlying Philosophical Assumptions, Research Methods And Data Collection Techniques Adopted For Conducting A Qualitative Research

Typically, a case study researcher uses interviews and documentary materials first and foremost, without using participant observation.

The distinguishing feature of ethnography in respect to the case study research, however, is that the researcher spends a significant amount of time

in the field. The fieldwork notes and the experience of living there become an important addition to any other data gathering techniques that may be used.

The interview is one of the major sources of data collection. Interview's aim is to guide the interviewee as little as possible (Kvale 1983) and the evolving discussion throughout an interview session should be guided -mainly- by the interviewee. In this process the role of the researcher (who conducts the interview) is to follow what the other person says, and only when needed does the researcher clarify questions and comments to keep the discussion going. The researcher tries to avoid taking a particularly active role and to be the listening partner as much as possible. The researcher also tries to avoid expressing his (her) opinion.
Moreover, the researcher should not assume that he(she) understands right away what the interviewee means. Instead the researcher must be aware of making an interpretation of the thoughts of others, and also be aware that these interpretations may be biased. The researcher must therefore test the trustworthiness of his (her) interpretation during the interview session (or by follow-up meetings or phone calls). The testing can be performed by raising clarifying questions to the interviewee. These questions should be based on the interpretation the researcher has made. The reactions of the interviewee give a clue as to whether the researcher is on the right track.

6. Approach Adopted For The Current Research Work

An interpretive philosophical perspective using the case study research method is adopted throughout this research work. The data used for the extraction of conclusions was collected mainly through semi-structured interviews using an open-ended questionnaire.

In addition, a reference to secondary data sources, such as press reports, company releases, and analyst reports was made.

The reason for the choice of interpretive case study research is based on the knowledge that case studies are the most appropriate for examining the processes by which events unfold, as well as for exploring causal relationships (Yin 2002) and also for providing a holistic understanding of the phenomena (Kitay and Callus 1998). The scientific benefit of the case study method lies on its ability to open the way for discoveries (Shaughnessy and Zechmeister 1990). It can easily serve as the breeding ground for insights and even hypotheses that may be pursued in subsequent studies. Stake (1994) points out that case studies are undertaken when a researcher wants to understand better a particular case or to provide insight into some issue and to refine some theoretical explanation.

Jones (1985) comments that the main reason for conducting qualitative interviews is to understand "how individuals construct the reality of their situation formed from the complex personal framework of beliefs and values, which they have developed over their lives in order to help explain and predict events in their world." Researchers must therefore be able to conduct interviews so that the opportunity is present for these insights to be gained (Jones 1985).

The use of interviews throughout this work will help "generate data which give an authentic insight into people's experiences" (Silverman 1993). Things, however, are not so simple to Denzin (1991) who notes that "the subject is more than can be contained in a text, and a text is only a reproduction of what the subject has told us. What the subject tells us is itself something that has been shared by prior cultural understandings. Most important, language,

which is our window into the subject's world, plays tricks. It displaces the very thing it is supposed to represent, so that what is always given is a trace of other things, not the thing – lived experience – itself."

It must also be stressed out that, although interviewing is often claimed to be "the best" method of gathering information, its complexity can sometimes be under-estimated. It is time consuming to undertake interviews properly. But, its main advantage is that it is quickly responsive to the investigator's decisions to move from more to less focused types of questions. Face-to-face interviews induce an appreciation of the people being studied, while permitting a relatively wide range of issues and questions to emerge (Van Maanen et al., 1982).

In this research work, emphasis will be placed on the context of the information system, the process whereby the information system influences and is influenced by its context, and the linkage between context and process (Walsham 1993). This approach is adopted throughout this work considering that the Web Services technology is one of the software architectures that could be used for building, maintaining, and integrating information systems.

According to Walsham (1993), context is concerned with the multi-level identification of the various systems and structures within which the information system is embedded. This can include such obvious elements as the organizational department within which the information system is being used (or it will be used), the organization as a whole, and the various sectoral, national and international contexts within which the organization is located. A more subtle set of contexts for an information system are the various social structures which are present in the minds of the human participants involved with the system, including designers, users and any of those affected by the system. Their interpretation of reality, their shared and contested sense of the world, create complex interacting contexts within which the information system, as a human artefact, is drawn on and used to create or reinforce meaning.

Moreover, Walsham (1993) believes that the concept of context has a static flavour whereas human affairs are in a constant flux and change and as such

a second strand of analysis of information systems needs to be taken into consideration. This dynamic aspect of humans' interaction with the information systems is addressed by seriously taking in consideration the processes of transformation and change which take place over the time. Human actors draw on elements of context, such as resources or perceived authority, to carry out actions, and this activity can reinforce existing systems of resource distribution or power, or can create new systems of authority or meaning. Thus human action draws on context or structure and, in so doing, reinforces existing structures or contexts, or creates new contexts. An investigation of this dynamic process of action/context interweaving is fundamental to an understanding of the process of organizational change within which the information system is one element. The information system itself is not static, neither in the obvious physical sense of changing hardware, software, systems and data, nor in the changing human perceptions of the output of the various systems and the system itself.
Finally, Walsham(1993) claims that the linkage between context and process is a crucial aspect of the analysis. Processes are viewed as both constrained by structures and involved in shaping structures, either by maintaining them or altering them.

A valuable approach to the study of context in the domain of information systems is provided by the work on "web models" (Kling and Scacchi 1982; Kling 1987). Web models draw broad boundaries around the focal computer system and examine how its use depends upon a social context of complex social actions. The models define this social context by taking into account the social relations between the set of participants concerned with the information system, the infrastructure available for its support, and the previous history within the organization of commitments made in developing and operating related computer-based technologies.

Web models have been used as an example of a rich analysis of context in information systems. It is less easy, though, to find good models of process in the information systems literature. Works by Boland and Day (1989), Zuboff

(1988) and Markus (1983) all contain elements of processual analysis, but the detail is normally limited and we see only a sketch of processual highlights. Walsham (1993) proposes models of process that can be linked to the cultural and political metaphors of organization that they both emphasize the process of creation and re-creation taking place in the organizational context. Culture is viewed as an active, living and changing phenomenon and the exercise of power and the taking of political action are seen an endemic and continuous process.

Even though the web models of context and the cultural and political models of process are valuable “tools” for understanding information systems within organizations, the linkage of context and process is a crucial aspect for the analysis and understanding of the impact of computer-based information systems in organizations, which are both constrained by the context in which they are developed and, in turn, are a factor in maintaining or altering that context. The contextualist analysis proposed by Pettigrew (1985) noted the importance of the linkage between context and process for the understanding of organizations (and organizational change) with respect to information systems.

The sociological model of structuration theory is the theortical approach to conceptualising the linkage between context and process in social systems. Structuration theory, the work of the British sociologist Giddens (1979, 1984), aims to resolve the debate between those social theories which place their emphasis at the level of human agents and human action, and alternative theories which focus on the structure of social systems. This agency/structure debate is resolved by Giddens (1979, 1984) into a duality of structure, whereby agents and structures are not two independently given sets of phenomena, but represent a duality whereby structure is drawn on in human interactions but, in so doing, social structures are produced and reproduced. A theoretical view of computer-based information systems in contemporary organizations which arises from structuration theory, is that they embody interpretative schemes, provide co-ordination and control facilities, and encapsulate norms. They are thus deeply implicated in the modalities that link

social action and structure, and are drawn on in interaction, thus reinforcing or changing social structures of signification, domination, and legitimation (Walsham 1993).

All these theoretical approaches concerning context, process, and the linkage between context and process of ("Web Services-based") information systems in respect to organizations (and organizational change) into which they are operating into, are pulled together into a model (Table 1) that will guide this research work to produce an understanding of the attitude of members of the management teams (executives, strategists, IT architects, etc) of various organizations with operations in Cyprus towards Web Services technology. In particular, an investigation is made on how these people (and consequently their respective organizations) perceive Web Services technology in respect to: business processes agility and flexibility, time-to-market of their products or services, information systems integration complexity, inefficiencies between communicating integrated information systems, business opportunities through outsourcing and global presence of their goods or services, growth through mergers or acquisitions, and possible limitations or constraints that could prohibit the adoption of Web Services technology.

Key Components Of The Model	**Associated Conceptual Elements**
Content	▪ Organisation (products, processes, system) ▪ "Web Services-based" Information Systems (hardware, software, systems)
Context	▪ Web models (social relations, infrastructure, history)

Process	▪ Culture (subcultures, multiple meanings) ▪ Politics (control and autonomy, morality)
Context/Process Linkage	▪ Structuration Theory (action and structure duality) ▪ "Web Services-based" Information Systems and modalities (embody interpretative schemes, provide co-ordination and control facilities, encapsulate norms)

Table 1. Model Used For The Analysis Of Organizations (And Organizational Change) In Respect To ("Web Services-based") Information Systems (Source: Walsham 1993)

The key components along with the associated conceptual elements of the model were derived by the theoretical approaches discussed above and are based on Walsham's work (1993). Its major components are:

- The content, in respect to the organization, involves changes to products/services, processes and systems. In respect to "Web Services-based" information systems, the content involves computer hardware, software, operating systems, and related technologies. "Web Services-based" information systems are the systems (that will be) created, maintained, or integrated using the Web Services technology. This is the particular category of information systems that we are interested in.
- The context, which will be investigated using the concept of web models which is a way of identifying and tracing the social context of an information system. Elements of this approach include the social relations between participants concerned with the "Web Services-based" information system, the infrastructure available or necessary for its support, and the history of previous commitments made in connection with "Web Services-based" information systems.

- The process, which involves taking both a cultural and a political perspective on the organization (and organizational change) associated with an information system. The first of these emphasizes how the “Web Services-based” information system is related to the maintenance and change of subcultures, the interaction at the boundaries between subcultures, and the multiple meanings ascribed by different groups to the same events and actions. The political perspective on the organization (and organizational change process) emphasizes the “Web Services-based” information system as involved in the processes of control and domination, as being implicated in moral issues such as the quality of work life, and having a part to play in the dynamics of the management of the balance between autonomy and control in organizations.
- The linkage between context and process, which uses the structuration theory as a sophisticated conceptual approach where the “Web Services-based” information systems are deeply involved in the modalities which link context and process in contemporary organizations. “Web Services-based” information systems embody interpretative schemes, provide co-ordination and control facilities, and encapsulate norms. They are draw on in the processes which take place in organizations, and in so doing, structures are reinforced or changed.

As it turned out, though, due to the fact that none of the organizations examined (and, none in Cyprus, for the time being) is currently using “Web Services-based” information systems, the context/process model was applied in respect to companies/organizations that could have implemented and deployed “Web Services-based” information systems, but they have not yet proceeded with such solutions.

7. Conceptual Framework

In the ever-changing business environment where contemporary organizations have to operate, they need to incorporate attributes like agility and flexibility, if they want to survive. For many years now, IT acts as an enabler of agility and fulfils its mission as “a competitive lever that helps organization reaches its operational goals” (Bensaou and Earl 1998), if it is properly used, if the right expectations are set, and if the IT policy is aligned with the business strategy.

Towards that objective, that is, to align organizations IT and business strategies, IT vendors, consultants, and academics invented and commercialised planning techniques that aimed first at discovering companies’ competitive strategies and second at suggesting the appropriate information systems portfolios to support them. Strategic alignment, the so-called “Enterprise Architecture,” would then be assured (Bensaou and Earl 1998).

Moreover, in an attempt to formalise the Enterprise Architecture’s various elements and their interactions, various models have been developed, the Enterprise Architecture Frameworks.

Even though the Enterprise Architecture (along with the various frameworks) process is a structured, disciplined approach that tries to align IT and business strategies of an organization, according to some researchers (eg. Truex, Baskerville, etc), these models, methods, and frameworks --mainly because of their nature, that is, they are “stiff”, “rigid” structures-- are not so flexible to address the ever-changing business requirements. The gap between business requirements and IT policy in place becomes even larger considering the pace through which organizational change is taking place.

Web Services technology --an implementation of Service-Oriented Architectural paradigm where services-oriented systems are implemented as discrete business services that are “loosely coupled” to other services (that could be) running on heterogeneous systems and platforms across the

organization, or beyond-- responding to challenges faced in the business and IT landscape, aims at facilitating organizations:

- enhancing agility and flexibility, which are important ingredients for organizations that wish to survive in the “tough” business environment of our times;
- improving their products’ or services’ time-to-market;
- reducing information systems integration complexity, an otherwise very challenging task;
- by eliminating inefficiencies (through lowering operating costs);
- creating new business opportunities through collaboration, outsourcing, and by enabling global presence for their goods and services;
- accelerating growth by facilitating the integration of systems of acquired companies.

These features (offered by Web Services technology), altogether or merely, can provide real profits to organizations that adopt this technology. The adoption of the Web Services technology, though, is constrained by the fact that the technology is currently immature, there is a lack of skills for the implementation and deployment of “Web Services-based” information systems, and there are still security issues on the technology(Figure 4).

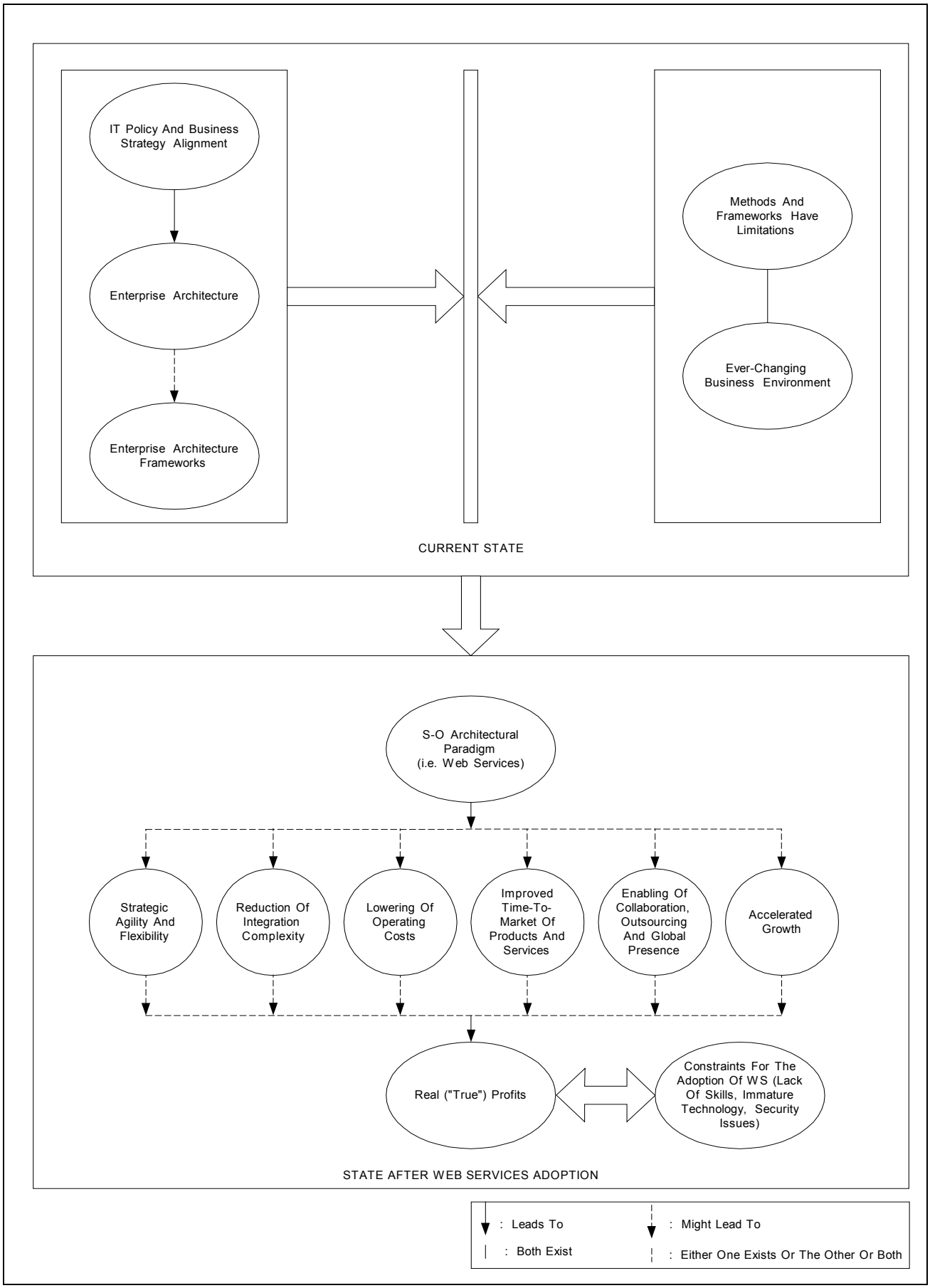

Figure 4. Adjusted Conceptual Framework (In Respect To The One Presented In Document 2)

8. Application Of Research Methodology: Findings And Analysis

The findings of this research work were derived by a series of interviews taken by executives, strategists, IT architects, and other employees (preferably, members of the management team) of the following four(4) groups of companies:

(i) Big international IT companies with operations in Cyprus. Five(5) interviews were conducted within the representative company of this group, IBM Cyprus.

(ii) Local IT companies. Again, five(5) interviews were conducted within the representative company of this group, NetU Consultants.

(iii) Financial Services (Banking) industry companies. People working for commercial banks were selected for the purposes of this research because Web Services technology seems to be ideal in cases (environments) were real-time transactions processing is desired. Banks could benefit from Web Services technology because of the constantly great demand for processing a huge number of real-time transactions.

Five(5) interviewees were selected within the representative company of this group, Bank of Cyprus.

(iv) Public Services industry departments/organizations. In particular, people working at the Department of Information Technology Services(DITS). Interviewees from this department (DITS), which acts as the IT department for the rest of the governmental authorities/departments, are people who were involved in the implementation and deployment of information systems in certain governmental authorities/departments.

The Cyprus government's master plan, concerning the automation/computerisation of the various processes of its authorities/departments, "directs" that all the departments' processes will be computerised in such a way that all the relevant information systems' services be available on the Web for the citizens' facilitation. Moreover, at some point in time all these information systems need to be integrated in order to avoid duplication of data, to enable sharing of information, and to eliminate unnecessary bureaucracy.

So, the input from people who worked in governmental departments' projects (with great exposure to integration activities) is considered to be very important for this research work.
Five(5) interviews were conducted within the representative department/organization of this group, DITS.

The sample "population" selected for this research work constitutes a representative sample of the IT, banking, and public services sectors of Cyprus' economy: an economy highly dependable on services.

Initially, the interviewees were sent a document with a brief overview of the Web Services technology (can be found as Appendix A at the end of this document), along with the superb paper on the area by Hagel and Brown titled: "Your Next IT Strategy" (Hagel and Brown 2001).

The purpose of the interviews was to produce an understanding of the attitude of members of the management teams (executives, strategists, IT architects, etc) of various organizations with operations in Cyprus towards Web Services technology. In particular, an investigation was made on how these people (and consequently their respective organizations) perceive Web Services technology in respect to: business processes agility and flexibility, time-to-market of their products or services, information systems integration complexity, inefficiencies between communicating integrated information systems, business opportunities through outsourcing and global presence of their goods or services, growth through mergers or acquisitions, and possible limitations or constraints that could prohibit the adoption of Web Services technology.
Table2 provides the questionnaire used for conducting the semi-structured interviews.

1. What do you think about Web Services technology; does it offer flexibility and agility for the enterprise to address business uncertainties? If so, how?
2. How does Web Services technology improve time-to-market of products or services of an enterprise?
3. How does Web Services technology help reducing information systems integration complexity?
4. Helping to reduce information systems integration complexity, do you think that Web Services technology also contributes to the elimination of inefficiencies that are frequently observed on the borderlines of the communicating (integrated) systems. Do you see any benefits that could be realised, if the Web Services technology does indeed help reducing inefficiencies?
5. How do Web Services facilitate inter and intra organizational business collaboration?
6. Do you see how the Web Services technology could create new business opportunities for enterprise through outsourcing?
7. Do you think that Web Services technology could be the “vehicle” that enables the global presence of an enterprise? If so, how this could be realised?
8. Do you think that Web Services could be an accelerator for the growth of an enterprise?
9. Do you see any limitations or constraints prohibiting the adoption of Web Services technology?

Table 2. Interview Questionnaire

In addition to the formal interviews, several informal discussions with technical experts engaged in Web Services consulting, analysts, industry experts were carried out.

The interviews were conducted using the questionnaire shown on Table 2. Throughout the interview session an attempt was made firstly to have the interviewees address the questions (Table 2), and secondly, to obtain the

necessary information for the context/process model, within, of course, the limited time frames available for contacting this research.

It is also important to note (again) that in this research work a slightly different approach of the context/process model was followed. Since none of the organizations examined (and, none in Cyprus, for the time being) is currently using "Web Services-based" information systems, the context/process model was applied in respect to companies/organizations that could have implemented and deployed "Web Services-based" information systems, but they have not yet proceeded implementing and deploying such solutions.

Interview Group 1. Representative Company: IBM Cyprus

Interviewees:

- Managing Director,
- Consulting Services Manager,
- Sales Specialist,
- IT Architect, and
- IT Specialist.

The interviews were taken by the company's Managing Director, the Consulting Services Manager, a Sales Specialist, an IT Architect, and an IT Specialist.

Their feedback was really useful for this work and it is summarised below, firstly, by presenting the elements of the (adjusted) context/process model, and then, their replies to the questions raised.

Key Components Of The Model (Associated Conceptual Elements)	**Findings**

Content	
▪ Organisation (products, processes, system)	➢ IBM Cyprus is the local branch of the well-known international company IBM. The local branch employs around fourty(40) people. IBM, with a local presence for over than fifty(50) years, used to be the company of choice for purchasing mainframes and PCs. Now, that the company is transforming itself into a Services Provider, the "Hardware" unit is outsourced to business partners. In particular, in Cyprus, three(3) business partner are in charge of offering IBM hardware. IBM itself has "Sales" and "Consultants" workforce who are mainly involved in obtaining (the Sales people) and implementing/maintaining (the Consultants) projects, mainly, in the Governmental and Financial Services industries. IBM Cyprus diagnosed that these industry sectors, the Government and the Financial Services, are the "Cash-Cows" and all their efforts are (now) focused in obtaining and maintaining customers from these areas. Internally, IBM Cyprus has to obey to the procedures, processes and standards imposed by the "mother" company, in respect to operations related to Procurement, Accounting, and Sales. The same applies to procedures and standards that need to be followed for the consulting services (which take the form of software development, delivery of training courses, etc) provided by the local team.
▪ "Web Services-based" Information	➢ IBM Cyprus is not currently using the Web Services technology in the local offices, if we are referring to the strict meaning of the term (Web Services) as known by its

Systems (hardware, software, systems)	underlying protocols (SOAP, UDDI, WSDL). They are utilizing, though, the Web for almost every activity within the company and for activities with their business partners, as the IBM Cyprus Managing Director said: “There are services out there implemented on (and utilizing the potential of) the Web.” In particular, through their intranet, they are utilizing the “mother” company’s resources (for example, the Procurement, Accounting, and Sales systems, the e-mailing services system, etc) and through their extranet they are also collaborating with their business partners in order to effectively respond to their customers’ requests. As far as their customers is concerned, in respect to the Web Services technology, the interviewees said that their customers started having queries and requests on this new IT architectural paradigm. Even, the first RFPs (Requests For Proposals) were out by proposed customers who were requiring solutions based on the Web Services technology. This made the management of the company invest on the education of its workforce on the area (Web Services).

Context ▪ Web models (social relations, infrastructure, history)	➢ Both the Managing Director and the Consulting Services Manager of the company seemed to be highly involved to the daily operations, trying to sustain in any way and at any cost the company's leading position in the market. According to them, this is achieved if the procedures, processes, and (quality) standards imposed by the "mother" company are followed, and if the workforce is continuously educated. "That's what we are doing, and we are observing great success," the Managing Director of the company admitted. As far as the Web Services technology is concerned, all the interviewees were (more-or-less) informed about the technology, but their knowledge was limited to the high-level concepts.

Process ▪ Culture (subcultures, multiple meanings)	➢ The impression taken by the interviews is that there is one and unique culture within the company and everybody who is being employed in the company needs to be "educated" accordingly. This helps the various teams within the company have common understandings (and provide the same meanings) for the various concepts/issues that might be encountered during their tasks/projects. This, in turn, secures the successful completion of projects (including "Web Services-based") that need to be delivered to customers within the budget, within the very strict time frames, and within the pre-defined scope. Sometimes, though, this one and unique culture within IBM makes the company very "close" and the impression might one create after discussing with these people is that they are behaving as if they were the only ones who know the technology. No one else.
▪ Politics (control and autonomy, morality)	➢ Management showed to understand the need for autonomy/control balance within the company. It was also concluded by the interviews conducted that the management wanted to impose the "message" to the rest of the employees that conflicts should be avoided at any cost. This will secure a healthy and productive environment for all the employees. The same applies to ("Web Services-based") projects taken by IBM Cyprus. The avoidance of conflicts, and the autonomy/control balance culture embedded secures their successful completion.

Context/Process Linkage	
▪ Structuration Theory (action and structure duality) ▪ "Web Services-based" Information Systems and modalities	➢ Legitimation of the need to adopt a "Web-Services based" information systems by appeal to norms of sustaining the leading position in the market, and achieving high profitability and growth, but only if the "mother" company also switched to that technology. This demonstrated the constraints in actions imposed by the "mother" company that could have created new structures for IBM Cyprus. At the same time, though, these constraints imposed by the "mother" company are those that secure procedures, processes, and standards of high quality. So, the "action" of constraints produces the "structure" of products/services of high quality within IBM Cyprus.

Questions Raised	**Replies**
1. What do you think about Web Services technology; does it offer flexibility and agility for the enterprise to address business uncertainties? If so, how?	"Services Oriented Architecture-based" systems (Web Services is an implementation of this software architecture) are the systems where the exchange of information between communicating parties takes the form of exchanging flexible, loosely tied services. These systems are also referred to as loosely-coupled systems. This particular type of systems (loosely-coupled) is applicable for firms operating in environments

	characterized by a high degree of change. Loose coupling may not sound attractive for firms operating in stable environments, where the need to adapt rapidly is not a priority. Tight coupling of applications is recommended for firms operating in predictable environments, as it is more economical and faster to execute. As the business processes are tightly coupled, it is difficult for the organization to adapt quickly, as any change made on one process would have an effect on many others. As the need for adaptation increases, there is a corresponding need for enterprise systems to change and hence the need for loosely coupled techniques. Thus, loose coupling would tend to remain the preferred technique for service firms as well as for organizational processes that are customer/partner oriented, such as Customer Relationship Management (CRM), Supplier Relationship Management (SRM), Supply Chain Management (SCM), etc. Tighter coupling would be the preferred option for processes such as Accounting, Human Resources etc.

2. How does Web Services technology improve time-to-market of products or services of an enterprise?	Due to the fact that Web Services are based on “open” software standards and they are made available for use from publicly accessible repositories in the form of ready-to-use functionalities/services, it is possible to acquire and “consume” a service instantaneously and avoid the effort and time needed to create the desired functionality from scratch. Moreover, even if the functionality/service required by an enterprise is not available in the repository where Web Services are stored and there is a need to develop that functionality from scratch, “provider” and “consumer” applications can be developed independently of each other and in parallel (as opposed to traditional tightly-coupled system, where things need to done sequentially). Again, this has direct implications on the improvement of the time-to-market of a product/service.
3. How does Web Services technology help reducing information systems integration complexity?	The feedback given by the interviewees on this request/point, based on the investments made by big IT companies (IBM, Oracle, Sun, BEA, Microsoft, etc) on this technology (Web Services) and based on what they are hearing and on what they are reading in technical articles

	or books, is that Web Services is not just another “buzzword”, but a “real” technology that will facilitate mainly the systems integration “discipline” because heterogeneous systems built on different hardware platforms can now communicate each other via means of XML-based (Web Services) protocols. Earlier, before the Web Services technology advent, when you wanted to have such information systems integrated, you had to build special interfaces around the systems to achieve their communication. And, that was a very complex and demanding task.
4. Helping to reduce information systems integration complexity, do you think that Web Services technology also contributes to the elimination of inefficiencies that are frequently observed on the borderlines of the communicating (integrated) systems. Do you see any benefits that could be realised, if the Web Services technology does indeed help reducing inefficiencies?	During the interview sessions, it was admitted by some of the IBM Cyprus interviewees that: “most of the current Web-based systems are highly inefficient, especially those communicating with systems of business partners.” They said that: “The normal operation of such systems would be to interact without human intervention. In reality, though, people are often manually taking information from one application and entering it into another. This, in turn, results in significant operating expenses for the company.”

5. How do Web Services facilitate inter and intra organizational business collaboration?	"The collaboration between IBM offices in various countries and between IBM Cyprus and its business partners would have been more productive, if we used the Web Services technology. That's a very important factor (collaboration) for success in a highly competitive arena (IT). To realize how important is collaboration for IBM, bear in mind that our motto is based on the three-fold pillar: WIN-EXECUTE-TEAM. So, due to the fact that Web Services technology is, by nature, a technology that enhances business-to-business collaboration, its application (implementation) within IBM seems to be emergent," emphatically pointed out by the company's Managing Director. The rest of the interviewees provided similar replies.
6. Do you see how the Web Services technology could create new business opportunities for enterprise through outsourcing?	Out of the interviews conducted, it was concluded that the fact that Web Services-based solutions enable "plug-in-and-play" capabilities, making it much easier for organizations to outsource specific activities or processes (or even, all the organization's activities or processes), makes the technology very appealing, if it is also financially beneficial to do so. That's what the "mother" IBM (along

	with some other big international IT companies) has done. Many of its operations are outsourced to India and China where the cost for qualified workforce is much lower than that of the home country's (USA).
7. Do you think that Web Services technology could be the "vehicle" that enables the global presence of an enterprise? If so, how this could be realised?	It is due to the Web Services technology attributes (loosely-coupled, etc) that any acquisitions or mergers are no longer a "headache" for the IT people because the integration of the merged companies' IT systems has become much easier than what was happening before the Web Services advent. "Let me tell you that there were cases that proposed acquisitions/mergers were postponed or even, cancelled due to the obstacles encountered during the integration of the IT systems of the merged companies," the Consulting Services Manager of the company added.
8. Do you think that Web Services could be an accelerator for the growth of an enterprise?	"Certainly, yes," enthusiastically pointed out, the Managing Director of the company. And, he added: "Don't you see that the Web Services technology is transforming the current IT landscape? Using Web Services our transactions with our suppliers and customers will be much more than it is right now and they will be executed efficiently and faster."

	The other interviewees also stressed out the “catalytic” role of Web Services technology for the company growth.
9. Do you see any limitations or constraints prohibiting the adoption of Web Services technology?	From the responses obtained, it was obvious that there were reservations for adopting the Web Services technology right now, mainly because the technology is still immature. Security features of the Web Services technology are still under investigation and there were doubts as of the readiness of the technology. Another point raised throughout the interviews is the fact that there is a shortage of skilful employees on Web Services which also constitutes a constraint for the adoption of the technology.

Interview Group 2. Representative Company: NetU Consultants

Interviewees:

- Managing Director,
- Sales Manager,
- Training Center Coordinator,
- Pre-Sales Consultant, and
- IT Architect.

The interviews were taken by the company's: Managing Director, Sales Manager, Training Center Coordinator, a Pre-Sales Consultant, and an IT Architect. They were relatively young people with a considerable experience in the Cyprus Market.

As in the case of IBM Cyprus, the feedback taken by the interviewees who come from NetU, is summarised below, firstly, by presenting the elements of the (adjusted) context/process model, and then, their replies to the questions raised.

Key Components Of The Model (Associated Conceptual Elements)	**Findings**

Content	
▪ Organisation (products, processes, system)	➢ NetU is a local IT company offering IT consulting services. It is also the distributor of other IT (international) company's products. In addition, NetU also tries to establish itself as the training center of choice for IT-related subjects. It can be said that they are doing well on this. NetU is around fifteen(15) years old company and it employs twenty(20) people, most of them, of course, IT Consultants. Lately, NetU demonstrated great growth because of their success to win big governmental projects. NetU has internal procedures and standards set (imposed by the quality management policy of the company) that "secure" the high quality of deliverables.
▪ "Web Services-based" Information Systems (hardware, software, systems)	➢ Like IBM Cyprus, NetU is not currently using the Web Services technology, but they are using the Web infrastructure for some of their daily activities. The interviewees who come from NetU, though, admitted that the Web could have been utilized even more both for the intra and inter organizational transactions/activities. As far as their customers is concerned, in respect to the Web Services technology, they started having the first requests by customers. This, in turn, triggered the interest of the management team of the company to get educated, but also invest on the education of the rest of the employees.

Context ▪ Web models (social relations, infrastructure, history)	➢ As it happens with most of the small IT companies in Cyprus, most of the employees are involved in various (most of the times irrelevant the one from the other) tasks/activities, at various departments within the company. So, due to the fact that an employee is collaborating with many other colleagues throughout a day, it is important for him/her to sustain good social relations with his/her colleagues (for the company's benefit, too). And, this was something that was easily observed within NetU. At least, that's what was realised during the interviews we had with the company's employees. As concluded by the interviews conducted both within NetU and elsewhere, even though the interviewees were highly educated and most of the times they come from the IT discipline, their knowledge about Web Services technology was limited only to the very-very high-level concepts of the technology.

Process ▪ Culture (subcultures, multiple meanings)	➢ Within NetU, a very friendly culture was cultivated. This is mainly, due to the fact that the company as a subset of the broader Cyprus society inherited the characteristics of that society's culture. And, of course, due to the fact that the employees are involved into various tasks/activities at various departments during the day (as also earlier mentioned). This friendly environment has a direct impact on the company's success and growth. And, of course, to the successful implementation and deployment of ("Web Services-based") information systems both internally and to customers' sites.
▪ Politics (control and autonomy, morality)	➢ Another implication of the fact that the company's employees are dividing their time into various tasks/activities covering numerous positions/needs, is that the company's employees are not focusing on a specific area and they are not becoming experts on that. This, in turn, means that none of the employees can collect uncontrollable power (by becoming master in his/her area). But, at the same time, though, the company's employees are not becoming experts/specialists on their area. In respect to Web Services technology, this does not guarantee the successful completion of "Web Services-based" information systems since the skills and expertise needed imply sole devotion to the technology (at least, at the early stages of "getting-to- know" the technology).

Context/Process Linkage	
▪ Structuration Theory (action and structure duality) ▪ "Web Services-based" Information Systems and modalities	➢ The adoption of "Web-Services based" information systems by appeal to norms of continuing growth seems to be a "panacea" for NetU. The lack of skills, though, does not permit immediate switch to the Web Services technology. The education (initially) of the core team of employees on the technology is the "action" that would produce the new "Web-Services based" information systems, the "structure", which in turn would cause new "actions" (further education, information systems maintenance, new information systems, the rest of the employees are getting educated, etc).

Questions Raised	**Replies**
1. What do you think about Web Services technology; does it offer flexibility and agility for the enterprise to address business uncertainties? If so, how?	According to the NetU interviewees, Web Services technology is the "vehicle" that drives enterprises in the era of global economy. And, this is due to the fact that it enables enterprises rapidly adapting themselves in an attempt to address the ever-changing customer needs. Web Services technology provides high degree of customization of the integrated systems, allowing enterprises a tremendous opportunity to rapidly wrap around applications and data in various combinations addressing every time a different need.

2. How does Web Services technology improve time-to-market of products or services of an enterprise?	"Web Services technology improves the time-to-market of a product or service because the "functionality" that might be needed is timely available and can be used upon demand. That's considerably faster than having to create the "functionality" from scratch," the IT Architect of NetU stressed out. On the same lines were the replies of the rest of the interviewees of the company.
3. How does Web Services technology help reducing information systems integration complexity?	"That's the most prominent promise of the Web Services technology, isn't it?" the Managing Director of the company replied with a question to our question. And, he added "Web Services technology is there to play the role of "easy-and-quicky" glue of heterogeneous systems built on different hardware platforms; and, as far as I know this is achieved via means of XML-based (Web Services) protocols, right?" The feedback provided by the rest of the interviewees was very similar to that of the Managing Director of NetU: Web Services technology is here, mainly, to facilitate information systems integration using Web Services protocols (SOAP, UDDI, and WSDL).

4. Helping to reduce information systems integration complexity, do you think that Web Services technology also contributes to the elimination of inefficiencies that are frequently observed on the borderlines of the communicating (integrated) systems. Do you see any benefits that could be realised, if the Web Services technology does indeed help reducing inefficiencies?	The replies to this question resembled the ones that come from IBM's interviewees. The interviewees admitted that: "the current Web-based systems are not so efficient because they require human intervention. The use of Web Services technology will eliminate those inefficiencies, significantly reducing company expenses."
5. How do Web Services facilitate inter and intra organizational business collaboration?	This tuned out to be very important point for NetU since it is distributing other companies' products and services in the Cyprus market. Thus, the need for efficiently communicating with its providers is very important. In particular, within NetU, they are considering that both the Supply Chain Management (SCM) and the Customer Relationship Management (CRM) systems of the company need to be implemented using the Web Services technology allowing them to efficiently collaborate (that is, share common transactions, etc) with their providers and their customers.
6. Do you see how the Web Services technology could create new business opportunities for enterprise through outsourcing?	Web Services technology is viewed by the NetU interviewees as the technology of option for the outsourcing of their training courses delivery process to IT companies of countries with lower workforce compensation rates.

7. Do you think that Web Services technology could be the “vehicle” that enables the global presence of an enterprise? If so, how this could be realised?	The interviewees said that the Web Services technology’s capability to facilitate the integration of heterogeneous systems will prove to be a deciding factor for the global presence of the company because it will enhance synergies with other companies (or their acquisition).
8. Do you think that Web Services could be an accelerator for the growth of an enterprise?	“As earlier mentioned,” the company’s Sales Manager replied, “here in NetU, we see the Web Services technology as the means through which our sales will increase because Web Services will facilitate the outsourcing of critical operations (training, procurement, accounting, etc), and because we can reach our customers and partner more effectively,” he added. The replies of the rest of the interviewees were similar to that of the Sales Manager of the company.
9. Do you see any limitations or constraints prohibiting the adoption of Web Services technology?	As it turns out, the responses of the NetU interviewees were very similar to those of IBM’s. Immature technology, lack of skills, and security issues are the points that make NetU interviewees hesitant to immediately adoption Web Services technology.

Interview Group 3. Representative Company: Bank of Cyprus

Interviewees:

Five(5) people from the company's IT department, including the Software Development Manager.

As in the case of IBM Cyprus and NetU, the feedback provided by the Bank of Cyprus interviewees, is summarised below, firstly, by presenting the elements of the (adjusted) context/process model, and then, their replies to the questions raised.

Key Components Of The Model (Associated Conceptual Elements)	**Findings**

Content	
▪ Organisation (products, processes, system)	➢ Bank of Cyprus is the largest financial organization in Cyprus. Bank of Cyprus has offices all around Cyprus and it is doing business both with enterprises and individuals. Lately, it expanded its operations to mainland Greece, Australia, England, and USA (that is, everywhere Greek Cypriots can be found). The IT department of the company, which amounts to around seventy(70) people, "runs" (that is, implements, maintains, and supports) the IT infrastructure of the company. The company's IT department follows the same processes and procedures as the rest of the company's departments do. There is an employees appraisal system (that "secures" that the employees are motivated) and a quality management policy that governs the company's procedures and assures high quality of service delivery (to the company's customers).
▪ "Web Services-based" Information Systems (hardware, software, systems)	➢ The company is using all sorts of hardware architectures, operating systems, software, etc for the various disparate systems (the core banking, the loan, etc) within the company. The Web is the "vehicle" for the most of the internal and external (that is, customers' transactions with the company) operations of the company. Web Services technology, though, has not yet "penetrated" the company. Bank of Cyprus looks like as an ideal environment for the implementation and deployment of "Web Services-based"

	systems. All the systems built with different technologies and running on dissimilar platforms could be (easily) integrated and communicate one another (with obvious benefits: the sharing of information and the elimination repetition of the same data, among others).
Context ▪ Web models (social relations, infrastructure, history)	➢ Traditionally, IT people who are employed in the IT departments of Cyprus banks (including the Bank of Cyprus) are considered to be very "privileged" and "secured". This, in turn, though, has direct implications to the attitude of these people toward their colleagues and toward their job. There are cases where people are gathering great power and they are behaving like "barons" to colleagues (both to their supervisors and subordinates). Or, they fell so "secure" that their tasks/activities are always in progress (they never come to an end). As concluded by the interviews conducted, there is a basic knowledge on Web Services technology, but not to the extent required for implementing a solution using this technology.

Process ▪ Culture (subcultures, multiple meanings) ▪ Politics (control and autonomy, morality)	➢ As earlier noted, there is a culture (of "barons" and "secured" employees) that prohibits the effective communication between the employees of the IT department of the company. This, of course, affects the teamwork effort needed for the implementation and deployment of IT projects (and, "Web Services-based" projects) within the company. ➢ There are employees that collected uncontrollable power and this has implications on the effective execution of projects (including "Web Services-based") and the daily activities.
Context/Process Linkage ▪ Structuration Theory (action and structure duality) ▪ "Web Services-based" Information Systems and modalities	➢ The recognition that the current environment within the company with all sorts of hardware, operating system, and software is not the most efficient it could be, triggered the need for considering a new IT architecture. Service Oriented Architecture (Web Services technology is an implementation of this IT architectural paradigm) is one of the most promising perspectives. Certain initiatives (self-education, attendance into training courses, deployment of pilot systems, etc) were taken toward obtaining the set of skills needed to implement and deploy "Web-Services based" information systems within the company. These initiatives constitute the "actions" taken for creating new "structures" ("Web Services-based" information systems).

Questions Raised	Replies
1. What do you think about Web Services technology; does it offer flexibility and agility for the enterprise to address business uncertainties? If so, how?	Throughout the interviews conducted, it was observed that everybody perceived Web Services technology as the means for addressing changing customer needs and requirements and effectively compete the other players in the market.
2. How does Web Services technology improve time-to-market of products or services of an enterprise?	"The fact that a functionality could be rented and used right away makes the Web Services technology very appealing. Imagine the time needed to go through the whole development life-cycle to come up with the functionality we want! Web Services technology is a "life-saver", I could say," one of the interviewees admitted, regarding the Web Services technology capability to improve time-to-market of a product/service. The replies come from the other interviewees also pointed out the "catalytic" role of Web Services technology for the improvement of time-to-market of products/services.
3. How does Web Services technology help reducing information systems integration complexity?	The interviewees agreed on the fact that Web Services technology considerably facilitates the information systems integration. "Here, in the bank, we see Web Services technology's main contribution in its capability to

	efficiently integrate the various (most of the times, heterogeneous) systems/platforms we are having. In order to support all sorts of operations in the bank, there are many different systems run on dissimilar platforms (zOS, AS400, AIX, Windows, etc). There is a need, though, to eliminate operating costs, and where possible to have the various systems share information and/or functionalities. That's what exactly Web Services technology is doing, right?" the Software Development Manager of the company pointed out.
4. Helping to reduce information systems integration complexity, do you think that Web Services technology also contributes to the elimination of inefficiencies that are frequently observed on the borderlines of the communicating (integrated) systems. Do you see any benefits that could be realised, if the Web Services technology does indeed help reducing inefficiencies?	The replies that came from the Bank of Cyprus interviewees were expressing the need for a progressive deployment of "Web Services-based" information systems in order to tackle with the current inefficiencies observed. In particular, they pinpointed the need for the consolidation of the customers' data (which is spread throughout the various systems) and thus eliminating data repetition.
5. How do Web Services facilitate inter and intra organizational business collaboration?	Web Services technology will facilitate the exchange of information between systems that need to "talk" (located within the company and beyond). For instance, there are cases where information about the credibility of a

	proposed customer needs to be confirmed against the information held by the other banks' information systems. This can be easily and effectively done if a "Web Services-based" information system is in place (enabling the rapid and accurate exchange of information between information systems of different banks).
6. Do you see how the Web Services technology could create new business opportunities for enterprise through outsourcing?	Interviewees pointed out that the Web Services technology can help reducing operating costs if certain operations are outsourced to teams that are qualified, but their costs are much less than the native costs. "If the big international companies recognised (and start having) benefits by outsourcing some of their operations, why we shouldn't do it?" one of the interviewees at the Bank of Cyprus, admitted.
7. Do you think that Web Services technology could be the "vehicle" that enables the global presence of an enterprise? If so, how this could be realised?	Bank of Cyprus is doing business wherever Greek Cypriots are located (Cyprus, mainland Greece, England, Australia, and USA). Most of the times, all these offices spread out the world are each having its own information systems performing the exact same operations/transactions as their corresponding in the other locations. That is, the Bank of Cyprus has bought five(5) times (one at every

	location: Cyprus, mainland Greece, England, Australia, and USA) the same information systems, instead of just once (and having their functionality spread out the world) mainly due to the limitations in the technology existed at the time the "go-live" of new offices occurred. The interviewees noted that the Web Services technology could help the Bank of Cyprus spread its operations even more, at a lower cost because of its capability to effectively integrate information systems, eliminating the repetition of the same piece of information and functionality, too.
8. Do you think that Web Services could be an accelerator for the growth of an enterprise?	According to the interviewees, for the Bank of Cyprus, mainly, growth means further expansion to other geographic areas. Web Services technology is viewed as the most cost-effective "vehicle" for the penetration to other locations, too.
9. Do you see any limitations or constraints prohibiting the adoption of Web Services technology?	"Number one constraint for the adoption of Web Services technology by the bank is the security issues associated with the technology," was the reply of a "key" employee of the bank's IT department. "The piece of information kept by banks is very sensitive and we need to be very cautious on that," he added. The replies of the other interviewees

	also noted the security issues of the technology, but they also added the immaturity of the technology, and the lack of relevant skills as the other factors constraining the Web Services adoption by the Bank of Cyprus.

Interview Group 4. Representative Company: Department of Information Technology Services (DITS)

Interviewees:

Five(5) people from the department (DITS) that acts as the IT department of the various departments of the Cyprus Government, providing IT consulting to the projects that it is involved into.

As in the case of the other three(3) groups that were presented earlier in this research work, the feedback provided by the DITS interviewees, is summarised below, firstly, by presenting the elements of the (adjusted) context/process model, and then, their replies to the questions raised.

Key Components Of The Model (Associated Conceptual Elements)	**Findings**

Content	
▪ Organisation (products, processes, system)	➢ DITS is the governmental department that provides consulting services (including, project management) to the various other governmental ministries and departments where information systems are implemented and deployed (most of the times by local IT companies). In particular, interviewees are people who were involved in the implementation and deployment of the "Cyprus Road Transport Department" and the "Cyprus Customs" information systems. "Cyprus Road Transport Department" information system is a client-server solution that is used for the issuance of both a driver's licence and a vehicle's licence. The technology used is an Oracle Relational Database Management (RDBMS) system at the back-end for storing the data (the server) which is accessed by the "thick-clients" that are running on every user's PC. "Cyprus Customs" information system is a Web-based solution used when importing goods from abroad. The solution is based on an Oracle RDBMS, a WebLogic Application Server, and "thin-clients" running web browsers. Through their browsers, the users "hit" a specific URL (Universal Recourse Locator) that corresponds to the system's main site. From that point on, a series of menus and an intuitive user interface allows the users to complete their transactions.
▪ "Web Services-based" Information Systems (hardware, software,	➢ Web Services technology is not used at any of the governmental information systems implemented and deployed. Throughout the interviewees, though, the opinion that the Web Services technology could be ideal for the governmental projects, stood out.

systems)	This is due to the fact that the citizens' personal information could be located at a central repository and shared by all the governmental information systems. This, in turn, would have direct implications to the (reduction of) operating costs of the governmental information systems because of the considerable reductions in disk space required.
Context ▪ Web models (social relations, infrastructure, history)	➢ As in the case of banks (operating in Cyprus), IT people working for DITS are considered "privileged" and "secured". This gives birth to undesired phenomena: the creation of "barons", that is, people with great and uncontrollable power, and the fact that tasks/activities that need to be completed are never converging. This of course affects not only the company, but the rest of the employees (personally) as well. Even though the need for deploying "Web Services-based" within the Government was identified, it was observed that none of the interviewees has taken any initiative to start learning the technology. The lack of motivation is one of the major characteristics of people who feel "secure" about their jobs. The interviewees from DITS really do feel that.

Process ▪ Culture (subcultures, multiple meanings)	➢ The culture of "barons" and "secured" employees that characterizes the employees working for the DITS, prohibits the effective communication of the employees within the department, their communication with the employees at the various governmental departments where information systems are deployed, and their communication with the various IT companies that are delivering the solutions. The lack of effective communication affects the teamwork effort needed for the implementation and deployment of IT (and, "Web Services-based") projects.
▪ Politics (control and autonomy, morality)	➢ As already stated, the majority of the DITS' employees collected uncontrollable power that prohibits the effective execution of projects (including "Web Services-based" ones) and the daily activities. Conflicts are unavoidable and they are occurred very frequently.
Context/Process Linkage ▪ Structuration Theory (action and structure duality) ▪ "Web Services-based" Information Systems and modalities	➢ Throughout the interviews, it was obvious that the Government would benefit the most if a "Web Services-based" solution was adopted because all the governmental information systems would have been integrated. Through integration, the costs will be eliminated (through the elimination of data redundancies) and the citizens will be satisfied by the services provided. The immediate implementation and deployment of "Web Services-based" information systems, on a pilot basis, in any (at least two, in order to realise the beneficial implications of the Web Services technology)

	governmental departments (the “action”) could lead to new “structures” (“Web Services-based” information systems throughout the whole government).

Questions Raised	**Replies**
1. What do you think about Web Services technology; does it offer flexibility and agility for the enterprise to address business uncertainties? If so, how?	Throughout the interviews conducted, very few interviewees were able to really capture the meaning and necessity of flexibility and agility for their organization. It was not surprising to us because all the governmental departments/organizations are not facing (at least, for the time being) any kind of internal or external competition.
2. How does Web Services technology improve time-to-market of products or services of an enterprise?	As in the previous question addressed to the interviewees who come from DITS, the time-to-market feature is not of great importance to them. Again, this attitude is the expected one due to the lack of direct competition. The services offered by the various governmental departments are only available through them; no any other company/organization is (allowed to be) in place to provide the same services/products.
3. How does Web Services technology help reducing information systems integration complexity?	The interviewees pointed out that “Web Services-based” information systems would be beneficial to the

	government mainly because: (i) the citizens' personal information could be located at a central repository and shared by all the governmental information systems (and thus reducing the operating costs through the reduction of disk space required), and, (ii) the various departments' heterogeneous systems could be efficiently integrated.
4. Helping to reduce information systems integration complexity, do you think that Web Services technology also contributes to the elimination of inefficiencies that are frequently observed on the borderlines of the communicating (integrated) systems. Do you see any benefits that could be realised, if the Web Services technology does indeed help reducing inefficiencies?	"Currently, when we would like to load data from one system to the other, we have to do it manually, because the process that is in place does not guarantee that the data is loaded. And, if this happens, though, we are not sure if it was loaded only once," was the reply of one of the interviewees who admitted the inefficiencies observed in the ways – currently- information systems are integrated. This is also the feedback provided by the other interviewees who participated in these interview sessions. Web Services technology, though, guarantees the correct (only once) delivery of data from one system to the other in an efficient way.
5. How do Web Services facilitate inter and intra organizational business collaboration?	The interviewees noted that the Web Services technology will facilitate the exchange of information between the

	various governmental departments' information systems with the obvious benefits (as stated in the previous questions/replies). The new piece of information (provided by the interviewees) is the fact that the governmental departments' information systems could exchange information with external information systems (for instance, the information systems of corresponding departments/agencies in other countries, or with the information systems of credit card processing companies allowing the citizens to complete transactions through the WWW).
6. Do you see how the Web Services technology could create new business opportunities for enterprise through outsourcing?	DITS' interviewees were worried about the option of outsourcing because they thought that their "secured" positions were at risk. After we had assured them that this scenario is a bit distant, they admitted that Web Services technology could help reducing operating costs if certain operations were outsourced to qualified teams.
7. Do you think that Web Services technology could be the "vehicle" that enables the global presence of an enterprise? If so, how this could be realised?	The global presence of services provided by the (Cyprus) governmental departments will not benefit anyone outside Cyprus, nor the government itself will be benefited in any way.

	The governmental departments' information systems could exchange information with corresponding departments' information systems of other countries (for instance, the Police department when investigating an international fraud case, the Road Transport Department for the international road transport exchanges, etc).
8. Do you think that Web Services could be an accelerator for the growth of an enterprise?	Again, this question seemed "not-so-applicable" to DITS' interviewees. But, if the interviewees regarded the Government as a money-collector too, their views would have been different.
9. Do you see any limitations or constraints prohibiting the adoption of Web Services technology?	According to DITS' interviewees, the major constraint for the adoption of Web Services technology for the implementation and deployment of the various governmental departments' information systems, is the lack of skills on the technology, the fact that the technology is not yet mature enough, and the security issues associated with it.

9. Conclusions

This paper attempted to investigate the attitude of business executives in Cyprus toward Web Services technology in respect to the following points:

- Does Web Services technology:
  - enhance business processes agility and flexibility?
  - improve the time-to-market of products or services of the enterprises examined?
  - reduce the information systems integration complexity?
  - eliminate inefficiencies, otherwise observed between communicating integrated information systems?
  - create new business opportunities through collaboration, outsourcing, and by enabling global presence for the goods and services of the enterprises examined?
  - accelerate growth by facilitating the integration of systems of acquired companies?
- Are there any limitations or constraints prohibiting the adoption of Web Services technology?

Throughout the investigation a variation of the context/process model was –also- adopted. This model is composed of the theoretical approaches concerning context, process, and the linkage between context and process of ("Web Services-based") information systems in respect to organizations (and organizational change) into which they are operating.

In our case a slightly different approach was followed. Since none of the organizations examined (and, none in Cyprus, for the time being) is currently using "Web Services-based" information systems, the context/process model was applied in respect to companies/organizations that could have implemented and deployed "Web Services-based" information systems, but they have not yet proceeded to do so.

Summarizing the findings of the interview sessions conducted, the majority of the interviewees admitted that Web Services technology can enhance business processes agility and flexibility because the Web Services

technology provides high degree of customization of the integrated systems, allowing enterprises a tremendous opportunity to rapidly wrap around applications and data in various combinations addressing every time a different need and request.

Web Services technology can also improve the time-to-market of products or services because it enables the “consumption” of services that are timely available on centrally located repositories avoiding the effort and time needed to create the desired functionality from scratch.

Of pivotal importance is the contribution of Web Services technology toward the reduction of information systems integration complexity (characterised as the major challenge in the IT industry, frequently ending up to be complex, time-consuming, and expensive activity) and the elimination of inefficiencies (otherwise observed between communicating integrated information systems).

Moreover, it was pointed out through the interviews conducted that the Web Services technology could create new business opportunities through collaboration, outsourcing, and by enabling global presence, and also accelerate growth by facilitating the integration of systems of acquired companies (or, companies that are merged).

On the contrary, though, there were reservations for the immediate adoption of the Web Services technology, mainly because the technology is still immature, especially in terms of security.

Another prohibiting factor (as revealed by the interviews) for the adoption of the Web Services technology is that there is a very limited expertise on this technology.

Some other interesting points were also derived from the interview sessions conducted:

- IT people are more risk-averse than the other employees, in terms of the adoption of new technologies;
- A fear was expressed by some interviewees of the possibility that might end up losing their jobs if the Web Services technology is adopted;
- The emergence of Web Services technology will shift the balance of power

between IT departments and business units because the new “Web Services-based” applications can be easily built by business process specialists, not strictly by IT people. This is an ethical issue that needs to be considered by all those IT companies that are “pushing” towards the adoption of the Web Services technology;

- International companies (especially, the IT ones), that are having operations in Cyprus, too, are the leaders in technology expertise (and, innovation);
- The competition between commercial banks in Cyprus makes them invest huge amounts on IT, considering it as a “panacea” for all their issues/problems;
- Employees are much more motivated if they do not feel “secure” at their positions;
- The uncontrollable collection of power by employees, most of the times, has negative impact on the normal operations within (and, outside) a company;

The findings of this research work, fully comply with the available literature on the topic. For instance, Hagel and Brown (2001) and Hagel (2002) also advocate about the people reluctance to immediately adopt Web Services technology (mainly, because of its limitations in respect to security features). The surprising feature of this finding is the fact that IT people are more risk-averse than the other employees, as also pointed out by Hagel and Brown (2001).

The current research work is also, in line with Checkland’s (1991) notable work on “human” factors that need to be considered when investigating information systems (or information systems-related technologies, including Web Services technology).

Following this document (in Document 4), an attempt will be undertaken to foresee, using the Delphi Method, how things will be in five(5) years, as far as the Web Services technology is concerned. For instance, an attempt will be made to address queries like:

- Will Web Services technology become the technology of choice in 2010? Or, will it remain as is now?

- Will Web Services technology fulfill the expectations as a means for reducing operating costs and thus contributing to profits?

- Will Web Services technology provide all those features necessary to be used for secure transactions?

This piece of information will be derived by a series of questionnaires sent to IT experts. In particular, throughout that research work, the Delphi method will be used.

The objective of most Delphi applications is the reliable and creative exploration of ideas or the production of suitable information for decision-making. The Delphi Method is based on a structured process for collecting and distilling knowledge from a group of experts by means of a series of questionnaires interspersed with controlled opinion feedback (Adler and Ziglio 1996). According to Helmer(1977), Delphi represents a useful communication device among a group of experts and thus facilitates the formation of a group judgement. Wissema(1982) underlines the importance of the Delphi Method as a mono-variable exploration technique for technology forecasting. He further states that the Delphi method has been developed in order to make discussion between experts possible without permitting a certain social interactive behaviour as happens during a normal group discussion and hampers opinion forming. Baldwin(1975) asserts that lacking full scientific knowledge, decision-makers have to rely on their own intuition or on expert opinion. The Delphi method has been widely used to generate forecasts in technology, education, and other fields(Cornish 1977).

In Document 5, a tool will be prepared that will be deciding on the “readiness” of an organization to adopt the Web Services technology. If not, a recommendation for the corrective actions need to be taken will be provided.

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11. Appendices

Appendix A (Web Services Brief Overview)

Introduction

Like 19th century's Industrial Revolution that landmarked the human history with massive social, economic, and technological change leading into huge productivity gains, Service-Oriented software paradigm, the software industrial revolution, is a paradigm that changes the IT landscape. It is, nowadays, the architecture of choice for building cheaper, more flexible IT systems.

Over the past fourty(40) years, four(4) distinct architectural paradigms were emerged (Figure 1). The "monolithic" approach of the mainframe systems of the 1960s (where systems were implemented as large blocks of functionality that ran on a single mainframe computer) was succeeded by IT architectures (Client-Server, Distributed Computing, Service-Oriented) that introduced more "loosely coupled," flexible and adaptable systems in a "desperate" attempt to address the ever-changing business requirements.

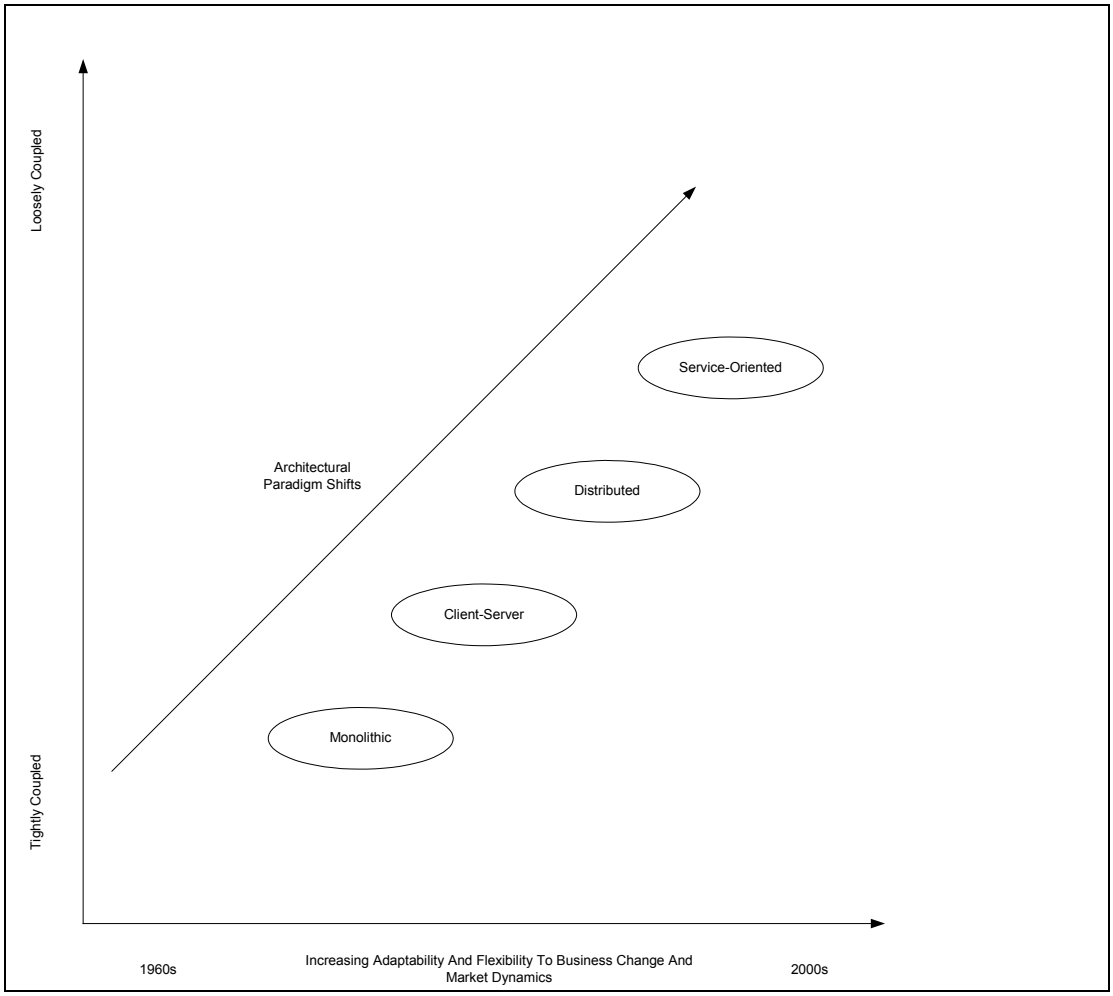

Figure 1. Evolution Of Systems Architecture

The Problem

The forces driving change can be seen in every company: information systems that are rigid, inflexible and costly to change, IT officers under pressure to do more with less. And, a typical scenario in most of these companies: all sort of information systems (**E**nterprise **R**esource **P**lanning systems, **C**ustomer **R**elationship **M**anagement systems, **S**upply **C**hain **M**anagement systems, in-house developed and customized systems, and a host of other software packages designed to speed the work) accumulated over the years are isolated and the need to build bridges between these "islands of automation" (primarily in order to avoid repetition of the same piece of information within all the systems and to share their functionalities) is becoming emergent. A task that is both time-consuming and expensive.

The Solution

That's where the Service-Oriented paradigm is called in. Service-Oriented Architecture systems are implemented as discrete business services that are "loosely coupled" to other services that can be running on heterogeneous systems and platforms across the organization, or beyond them. Each of these services has standard interfaces (wrapped in a layer of XML, an industry standard system of tags and labels that can be understood by any computer system, provided that there is shared meaning of the tags and labels used) that can be "consumed" by all the other systems within the company and by all the authorized systems of collaborating business partners and customers.

The implications from the adoption of this new software paradigm (Service-Oriented Architecture) by enterprises are highly beneficial:

(i) The complex and expensive task of systems integration is getting fastest and easier;

(ii) Software services (performing well-defined tasks) can be bought or rented. There are cases where it is much cheaper to buy or rent a "functionality" than creating it from scratch. This enhances agility and flexibility: necessary ingredients in the rapidly changing business landscape. This, in turn, improves time-to-market of companies' products or services;

(iii) "True" collaboration is realized between a company and its business partners through the "exposure" and "consumption" of the requested functionalities/services.

All these benefits can be the driving force for acquiring competitive advantage over competition and realize great revenues.

Big companies like **Merrill Lynch**, **Citibank**, **General Motors**, and **Dell** that were some of the early adopters of this new software paradigm (Service-Oriented software) transformed their "bravery" into real benefits.

The software industry has been quick to sense the opportunity. Big software companies such as BEA Systems, IBM, Oracle (all implementing **Java2 EE Web Services**) and Microsoft (implementing **.NET Web Services**) jumped seriously on the bandwagon during the last couple of years.

Web Services technology, which is an implementation of the Service-Oriented Architecture, can be described by a set of emerging standards/protocols:

(i) SOAP (Simple Object Access Protocol),
(ii) UDDI (Universal Description, Discovery, and Integration), and,
(iii) WSDL (Web Services Description Language),

which taken together provide a basic "request-and-response" (Service-Oriented) functionality.

For a system to communicate with another system, a set of interfaces is defined using WSDL. Defining interfaces is also referred to as publishing the WSDL interfaces or services. To make the services locatable for the other systems, you need to register them with the Web Services repository, the UDDI registry. Systems can invoke a Web Service by sending a request via SOAP and listening for a response. Figure 2 illustrates this "request-and-response" functionality of the components of the Web Services framework.

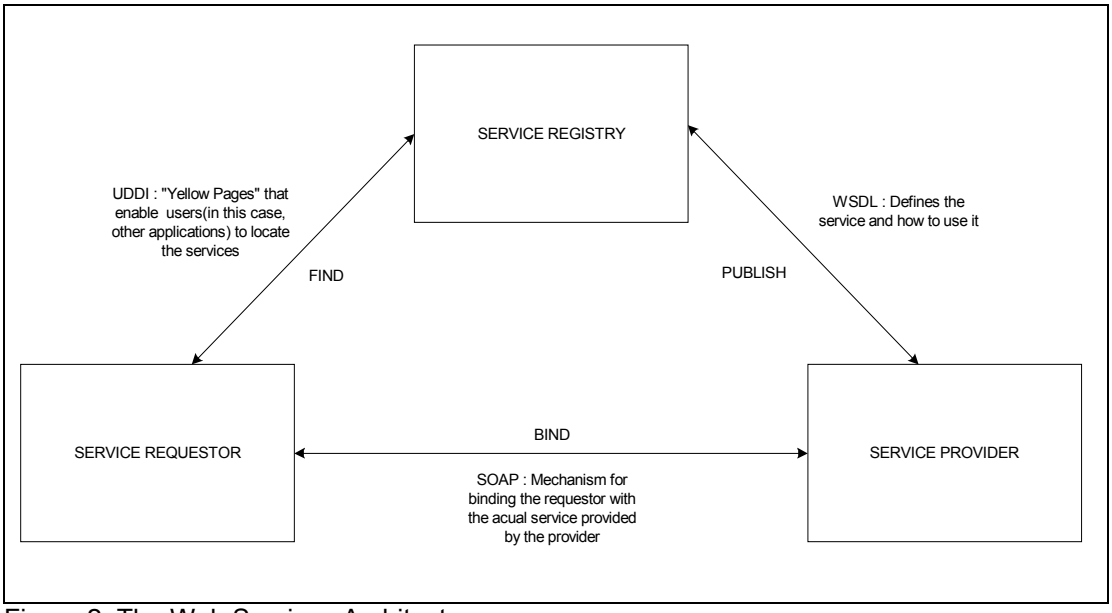

Figure 2. The Web Services Architecture

Web Services Technology:
Architecture, Business Strategies And Opportunities

Document 4: A Structured Research Report Using The Delphi Technique

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Contents

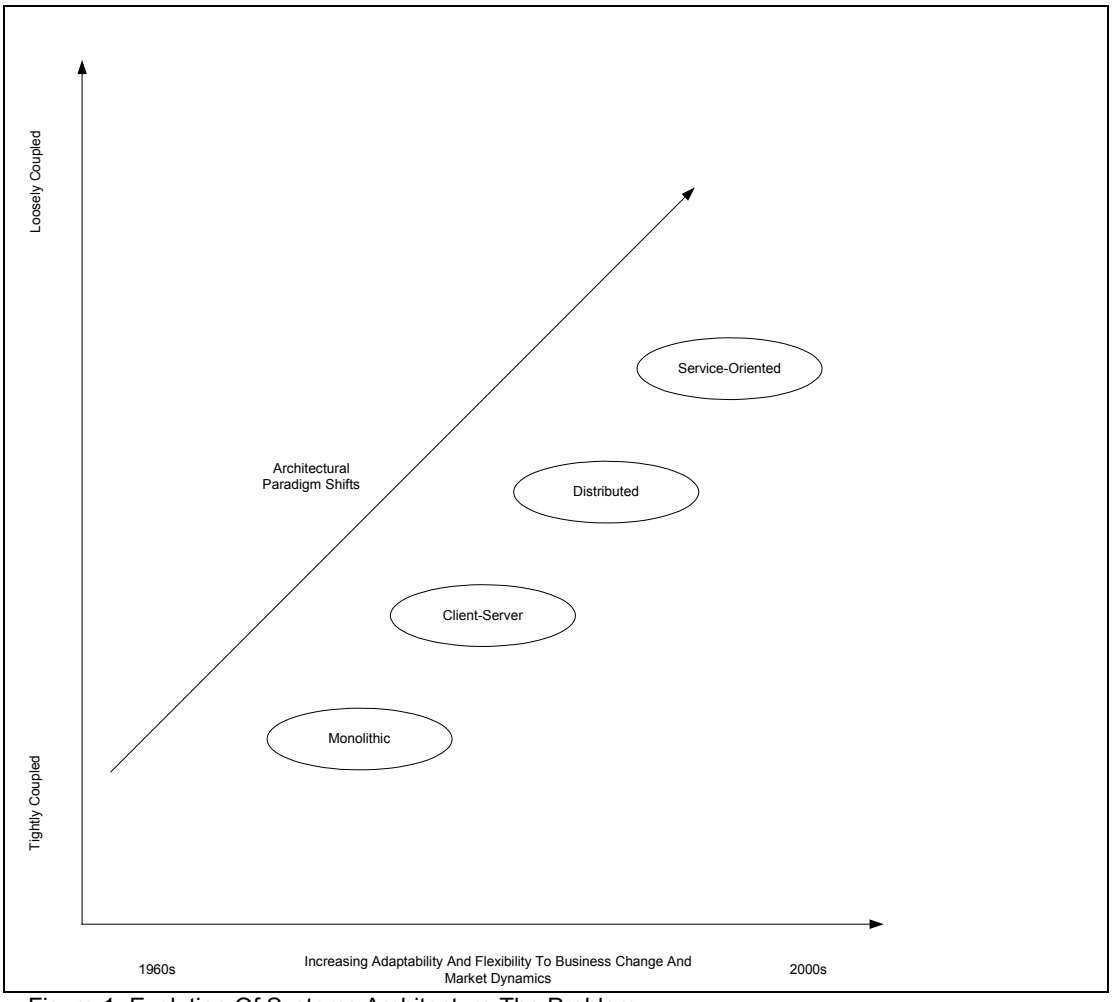
1. Introduction

1.1. SOA And Web Services Overview

Like 19th century's Industrial Revolution that land-marked the human history with massive social, economic, and technological change leading into huge productivity gains, Service-Oriented software paradigm, the software industrial revolution, is a paradigm that changes the IT landscape. It is, nowadays, the architecture of choice for building cheaper, more flexible IT systems.

Over the past fourty(40) years, four(4) distinct architectural paradigms were emerged (Figure 1). The "monolithic" approach of the mainframe systems of the 1960s (where systems were implemented as large blocks of functionality that ran on a single mainframe computer) was succeeded by IT architectures (Client-Server, Distributed Computing, Service-Oriented) that introduced more "loosely coupled," flexible and adaptable systems in a "desperate" attempt to address the ever-changing business requirements.

The forces driving change can be seen in every company: information systems that are rigid, inflexible and costly to change, IT officers under pressure to do more with less. And, a typical scenario in most of these companies: all sort of information systems (Enterprise Resource Planning systems, Customer Relationship Management systems, Supply Chain Management systems, in-house developed and customized systems, and a host of other software packages designed to speed the work) accumulated over the years are isolated and the need to build bridges between these "islands of automation" (primarily in order to avoid repetition of the same piece of information within all the systems and to share their functionalities) is becoming emergent. A task that is both time-consuming and expensive.



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That's where the Service-Oriented paradigm is called in. Service-Oriented Architecture (hereafter referred to as SOA) systems are implemented as discrete business services that are "loosely coupled" to other services that can be running on heterogeneous systems and platforms across the organization, or beyond them. Each of these services has standard interfaces (wrapped in a layer of XML, an industry standard system of tags and labels that can be understood by any computer system, provided that there is shared meaning of the tags and labels used) that can be "consumed" by all the other systems within the company and by all the authorized systems of collaborating business partners and customers.

The implications from the adoption of this new software paradigm (SOA) by enterprises are highly beneficial:

- The complex and expensive task of systems integration is getting fastest and easier;
- Software services (performing well-defined tasks) can be bought or rented. There are cases where it is much cheaper to buy or rent a "functionality" than creating it from scratch. This enhances agility and flexibility: necessary ingredients in the rapidly changing business landscape. This, in turn, improves time-to-market of companies' products or services;
- "True" collaboration is realized between a company and its business partners through the "exposure" and "consumption" of the requested functionalities/services.

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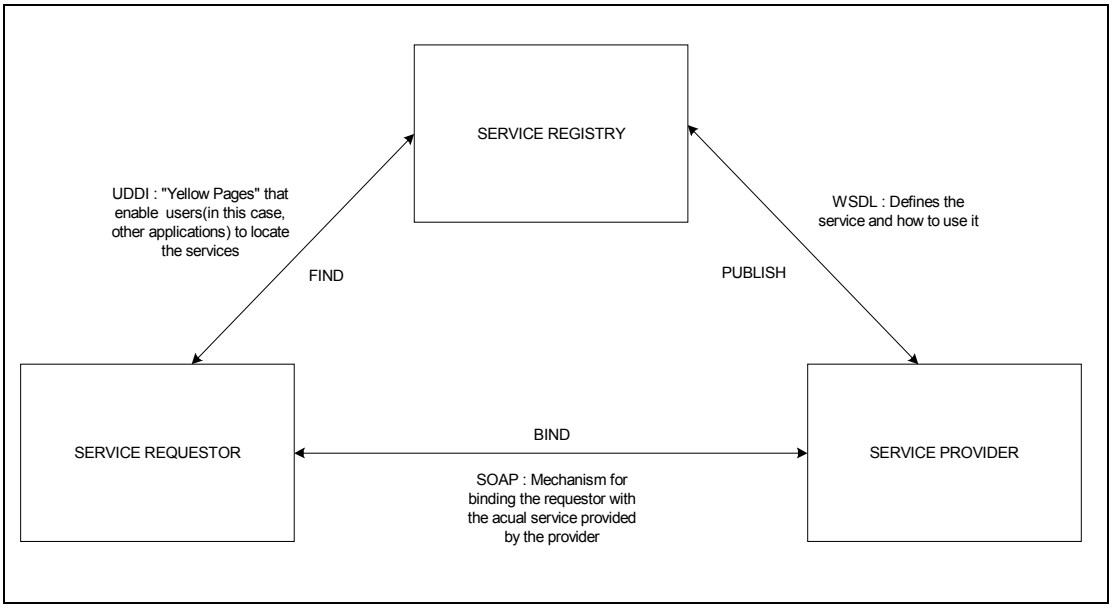

Figure 2. The Web Services Architecture

1.2. SOA From The "Delphi" Perspective

The advent and application of this new software paradigm (SOA) in organizations has been very promising (as observed in the cases of the pioneers -Merrill Lynch, Citibank, General Motors, Dell, etc- which adopted it) and it aims at facilitating organizations:

- enhancing agility and flexibility, which are important ingredients for organizations that wish to survive in the "tough" business environment of our times;
- improving their products' or services' time-to-market;
- reducing information systems integration complexity, an otherwise very challenging task;
- by eliminating inefficiencies (through lowering operating costs);
- creating new business opportunities through collaboration, outsourcing, and by enabling global presence for their goods and services;
- accelerating growth by facilitating the integration of systems of acquired companies.

The adoption of the Web Services technology, though, is constrained by the fact that the technology is currently immature, there is a lack of skills for the implementation and deployment of "Web Services-based" information systems, and there are still security issues on the technology (Figure 3).

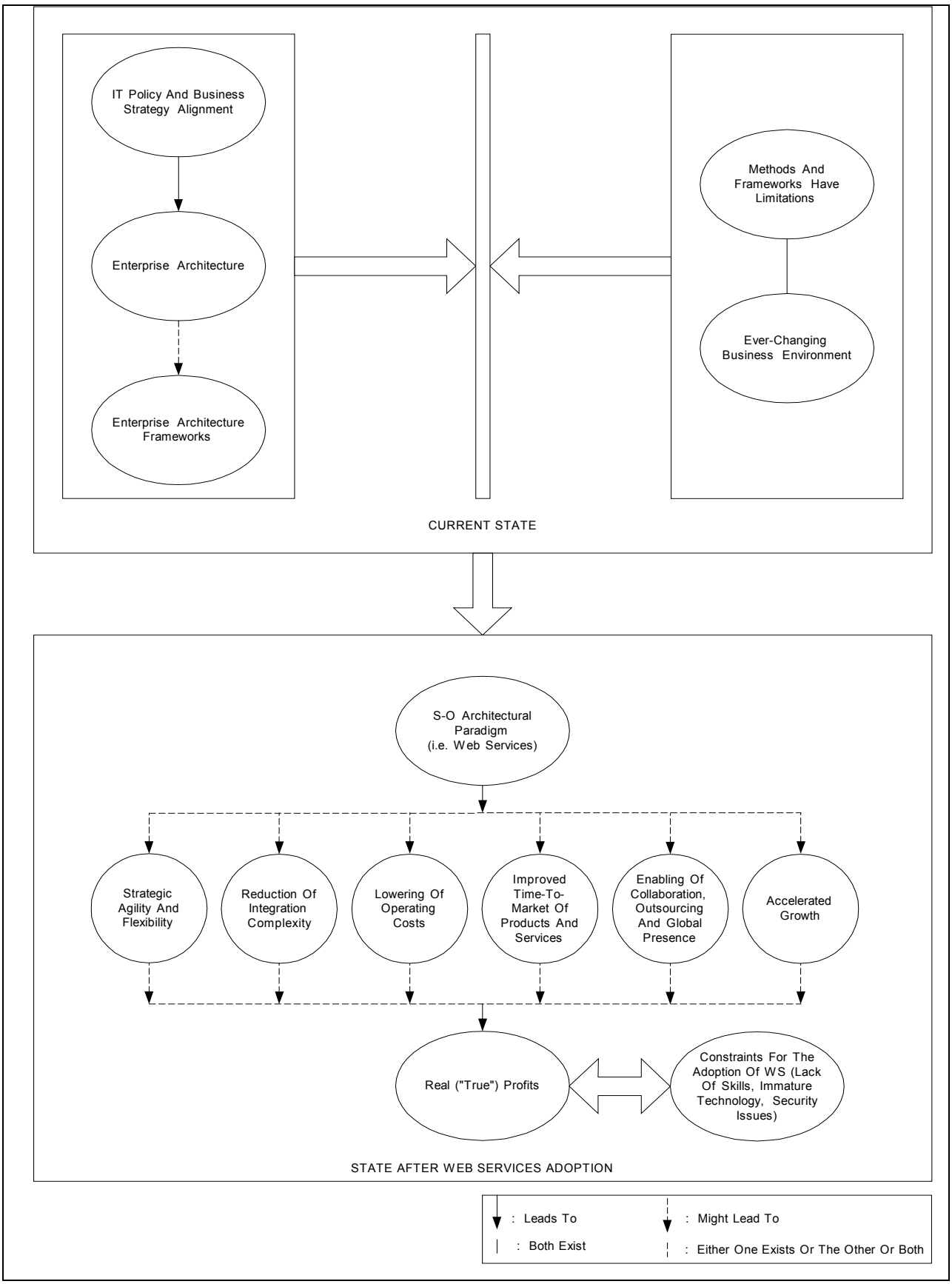

Figure 3. Web Services Technology Benefits And The Constraints Of Its Adoption (Conceptual Framework)

In this document (Document 4), key issues associated with the SOA (and, the Web Services) are explored using the Delphi technique. Of particular interest is the notion of “agility”, how important constituent it is for an enterprise, if it wishes to possess a competitive advantage over the other players in the market and how the IT infrastructure (including the software paradigm –SOA is one of them- adopted by an organization) can be an enabler of agility.

As discussed in Document 2 (Critical Literature Review And Initial Conceptual Framework), volatility is now a permanent feature of business life. Even though change is normal, the growing speed and unpredictability of change have pushed many enterprises to the very limits of manageability (Truex et al. 1999). Within this business landscape, contemporary organizations have to develop adaptive responses and innovative strategies in order to create value, no matter how unstable the market environment may be.

Agility, that is, the ability to detect and seize market opportunities with speed, is considered to be an important ingredient of the contemporary companies’ repertoire of responses to the volatile and highly competitive business environment (Brown and Eisenhardt 1997; Christensen 1997; D'Aveni 1994; Goldman et al. 1995).

Web Services (and subsequently SOA) is the new technology that aims to address most of the issues faced by the contemporary organizations enhancing agility and incorporating continuous change. Constructed on the Internet, Web Services technology is open rather than proprietary. Instead of building and maintaining unique internal systems, companies can rent the functionality they need -whether it's data storage, processing power, or specific applications- from outside service providers. Web Services enable applications to connect freely to other applications by means of XML-based protocols (SOAP, WSDL, UDDI, etc). That is, you no longer have to write customized code whenever communication with a new application is needed. Instead, this takes the form of exchanging

flexible, loosely coupled services that comply to universally agreed standards (Hagel and Brown 2001).

These dimensions associated with the SOA (SOA and agility, SOA contribution toward competitive advantage for enterprises –through agility-, etc) along with a forecast on how things will be (in respect to SOA adoption by local organizations) five(5) years from now, were investigated with a group of IT experts in the local market. In particular, the following points were asked:

- How Agile is Your Organization?
- What's the value of being an Agile Enterprise?
- How do you build a more Agile Enterprise?
- Are organizations adopting SOA seeking for agility and flexibility?
- Which are the biggest drivers of potential shift to SOA (Service-Oriented Architecture)?
- Which are the primary concerns towards adopting SOA?
- How will the IT and business landscape be in terms of SOA penetration and contribution in resolving key business issues in five(5) years time from now?
- Will SOA's current constraints be addressed in five(5) years time from now?

The objective of most Delphi applications is the reliable and creative exploration of ideas or the production of suitable information for decision-making. The Delphi Method is based on a structured process for collecting and distilling knowledge from a group of experts by means of a series of questionnaires interspersed with controlled opinion feedback (Adler and Ziglio 1996). According to Helmer(1977), Delphi represents a useful communication device among a group of experts and thus facilitates the formation of a group judgement. Wissema(1982) underlines the importance of the Delphi Method as a mono-variable exploration technique for technology forecasting. He further states that the Delphi method has been developed in order to make discussion between experts possible without permitting a certain social interactive behaviour as happens during a normal

group discussion and hampers opinion forming. Baldwin(1975) asserts that lacking full scientific knowledge, decision-makers have to rely on their own intuition or on expert opinion. The Delphi method has been widely used to generate forecasts in technology, education, and other fields(Cornish 1977).

2. Research Methodology Used: Delphi Technique

2.1. Delphi: Introduction

Named after the Greek oracle at Delphi to whom the Greeks visited for information about their future, the Delphi technique is the best known qualitative, structured and indirect interaction futures method in use today (Woudenberg 1991). Created by Olaf Helmer and Norman Dalkey in 1953 at the RAND corporation to address a future military issue, the technique became popular when it was applied a decade later to large scale technological forecasting and corporate planning (Helmer 1983). From a number of RAND reports (Dalkey and Helmer 1962, Dalkey 1967, Brown 1968, Rescher 1969, Helmer 1967), the technique has gone on to become the subject of numerous books and journal articles (Armstrong 1985). Similarly its use has been broadly spread throughout many parts of the world, but especially in the US, eastern and western Europe and Japan (Masini 1993). It seems few methodologies have captured the imagination of planners and forecasters the way Delphi has.

Essentially, Delphi is the name given to a set of procedures for eliciting and refining the opinions of a group - usually a panel of experts (Dalkey 1967, Brown 1968). It is a way whereby a consensus and position of a group of experts is reached after eliciting their opinions on a defined issue and it relies on the "informed intuitive opinions of specialists" (Helmer 1983). This collective judgment of experts, although made up of subjective opinions, is considered to be more reliable than individual statements and is thus more objective in its outcomes (Johnson and King 1988, Masini 1993). As Linstone and Turoff (1975) write, "Delphi may be characterized as a method for structuring a group communication process, so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem."

2.2. Delphi: Methodology Development

The development of the Delphi technique had its main genesis in earlier work to overcome the shortcomings of human judgment for planning purposes. Douglas MacGregor, for example, undertook a study in 1936 and formulated what came to be known as the `MacGregor effect'. This refers to his finding that predictions made by a group of people are more likely to be right than predictions made by the same individuals working alone (Loye 1978). It had also been well established by this time that face-to-face meetings had several problems such as being dominated by one or a few individuals(Preble 1983, Riggs 1983).

The first experiment using a Delphi style technique was carried out in 1948 in the hope of improving betting scores at horse races (Woudenberg 1991, Preble 1983). However, it was Helmer and Dalkey at the RAND corporation in the 1950's, who really advanced the technique to increase the accuracy of forecasts.
From this beginning, the Delphi technique found its way into private corporations, think tanks, government, education and academia. With such proliferation of use, the technique also came to be modified to the point where we now have a family of `Delphi-inspired techniques' in a broad range of applications (Martino 1973, van Dijk 1990-2). These are: (1) the Conventional Delphi; (2) the Policy Delphi; and (3) the Decision Delphi (Woudenberg 1991, van Dijk 1990-1).
The Conventional Delphi has two main functions. That is forecasting and estimating unknown parameters and is typical of Delphi as it was originally conceived. It is used to determine consensus on forecasting dates and developments in many areas - but particularly in the area of long-term change in the fields of science and technology. By estimating unknown parameters, respondents make their own estimates regarding the expected levels of an activity relative to present levels. The Policy Delphi on the other hand, does not aim for consensus but seeks to generate the strongest possible opposing views on the resolution of an issue and to table as many opinions as possible. The objective is for it to act as a forum for ideas and to expose the range of positions advocated and the pros and cons of each position (Bjil 1992). And finally the Decision Delphi is utilized to reach decisions amongst a diverse group of people

with different investments in the solution. The subject of the decision, for which the Delphi is used as a resolution mechanism, is usually harshly contested and complex and thus the structured group communication process is deemed effective. Helmer (1994) has more recently written on the potential for Delphi to also be used to assist in the process of decision making to resolve adversarial situations such as physical planning, budgeting and abortion.

2.3. Delphi: Description

Although there are a range of Delphi techniques now in use and adapted for various needs, it is still possible to talk of a broad procedural outline that they follow. Firstly, the subject of the study is circulated to the participants in an unstructured manner to enable them to comment on the issues in question. This material is then synthesized by the monitoring team (one or more people co-ordinating the study) and distributed to the participants in a questionnaire format. It needs to be mentioned here also that this first round is very often circumvented by the issue being explored comprehensively by the monitoring team which gathers the information and uses it to frame the questions to the respondents. Secondly, a questionnaire is drawn up to ascertain the opinions of the experts and to try and begin to elicit points of convergence and divergence. Thirdly, the questionnaires are distributed repeatedly, each time with the information from previous questionnaires that has been interpreted and reformulated by the coordinating team. The feedback often provides textual and statistical material to participants with the groups response as well as their own and asks them to reconsider their response or if their response is radically different from the group to justify it. The aim is to repeat this process until finally a certain level of consensus or stability is reached. A final report, pulling the responses together, is then prepared by the coordinating team (Masini 1993).

Supplementing this broad outline, the many derivatives of the Delphi technique have developed different processes to suit each application. For example, some studies have interspersed the rounds with personal interviews with panel members, sometimes panel members have been brought together in a meeting format to discuss the results of the Delphi survey and to come to a final

conclusion. Others use structured group conferences such the nominal group technique (NGT) and computer conferencing and communication (Amara 1975, Webler et al 1991). The number of rounds can vary from two to ten. And as mentioned above, the first round of questionnaires to the panel can be presented as an inventory or it can be prepared by the monitoring team (researching, interviewing key people, pre-testing the questionnaire etc) (Woudenberg 1991). The use of technology has also found its way into Delphi procedures enabling it to be automated and thus streamlined (Helmer 1983, Cundiff 1988, Cho et al 1991).

2.4. Delphi: Characteristics

The Delphi was designed to optimize the use of group opinion whilst minimizing the adverse qualities of interacting groups. As such, it has four basic features: structured questioning, iteration, controlled feedback and anonymity of responses. Structured questioning is achieved through the use of questionnaires. This keeps a clear focus on the study and enables the moderators to control the process and channel it into a compact product. Iteration is the process by which the questionnaire is presented over a number of rounds to enable participants to reconsider their responses. Controlled feedback is achieved by feeding back to the panel members the responses of the whole group as well as their own response for their reconsideration. This means that all the responses of the panel are taken into account. Anonymity is achieved through the questionnaires ideally giving group members the freedom to express their opinions without feeling pressured by the wider group. In many Delphi studies, statistical aggregation of the group response is also a common feature. This means that where consensus is required at the end of the process, it is taken to be the median response of the panel (Rowe et al 1991). Another version of gaining consensus is for the respondents to make a self-appraisal as to their competence in giving their responses. The answers from those who grade their competency level high are then used as the median, rather than the group as a whole. Helmer (1983) explains the rationale for this, arguing that it has been found that these experts achieve a result closer to the actual outcome than the rest of the group.

The respondents and the coordinating team are advised to be inter-disciplinarian with at least one person on the monitoring team having a working knowledge of the issue in question. By having as diverse a panel as possible, biases are minimized (Masini 1993, Webler et al 1991). Where consensus is required, questionnaires need to be designed so that answers are not too long for consensus to be impossible or too short so that the consensus is superficial (Masini 1993). The monitor, in preparing the feedback, also needs to cull superfluous information to keep the group focused.

2.5. Delphi: Rationale

Saaty and Boone (1990) argue that there are four defensible ways of forecasting the future. One is by consensus, the second is by extrapolating on trends, the third is by historical analysis and analogy and the fourth is the systematic generation of alternative paths to the future. Delphi is considered the most prominent of the consensus methodologies (Jones 1980). Quantitative forecasting can be used when there is information about the past, when this information can be expressed as data and when there is an assumption that the future will be a continuation of the past and the present (Bijl 1992). If you don't believe this is how change occurs and data is not available, you need to turn to qualitative methods. Delphi is one of the best known qualitative methods and is one of the four opinion capturing techniques used by planners and futurists (Nelms and Porter 1985).

Another rationale for the creation and use of this technique is the speed and magnitude of change (Helmer 1983, Preble 1983). If change was not occurring at the pace it is, it would be feasible to make policy and other decisions based on an assessment of past and present failings. However, this is no longer the case and futures methodologies, such as Delphi, provide a mechanism whereby opinions and expectations of the future can be considered. Indeed, the realization that we have no formal theory about the future, necessitates us to consider tools that elicit the opinion of experts and others.

Linstone and Turoff (1975) provide a comprehensive list of situations where it would be best to employ the Delphi technique. These are:

- "The problem does not lend itself to precise analytical techniques but can benefit from subjective judgments on a collective basis;
- The individuals needed to contribute to the examination of a broad or complex problem have no history of adequate communication and may represent diverse backgrounds with respect to experience or expertise;
- More individuals are needed than can effectively interact in a face-to-face exchange;
- Time and cost make frequent group meetings infeasible;
- The efficiency of face to face meeting can be increased by a supplemental groups communication process;
- Disagreements among individuals are so severe or politically unpalatable that the communication process must be refereed and/or anonymity assured;
- The heterogeneity for the participants must be preserved to assure validity of the results i.e. avoidance of domination by quantity or by strength of personality (`bandwagon effect'). "

Similarly, Martino (1973) argues that the technique is best suited to making forecasts in fields that are poorly structured; in fields that are too new to have adequate historical data for the use of other methods; in fields where progress may be more dependent on external social and economic factors than on the technological factors intrinsic to the field; and in fields where ethical or moral considerations may weigh heavily. Using the Delphi to obtain data as part of environmental scanning or for information to feed into scenario planning, is also valid. Likewise in situations where obtaining the required objective data would prove highly costly, the Delphi method provides a valuable alternative (Masini 1993, Rowe et al 1991).

2.6. Delphi: Applications

Therefore, the Delphi technique, due to its flexibility, is best suited to the exploration of issues that involve a mixture of scientific evidence and social values (Webler et al 1991). Mohapatra et al (1984) suggest that a Delphi study is usually directed to four broad categories of issues. These are:

- "Normative issues such as ‘goal setting’;
- Narrative issues such as ‘problem statements’;
- Predictive issues such as:
    - forecasting occurrence of new events, and,
    - forecasting point values and trends of key parameters;
- Suggestive issues such as:
    - developing causal models, and,
    - formulating new policies."

Some examples of the subject areas in which Delphi studies have been undertaken include: economic trends and societal change, (Cicarelli 1984, Masser and Foley 1987), issues in the agriculture area (Waissbluth and Gortari 1990, Mohapatra et al 1984), educational developments (Kruus 1983), regulatory processes (Benaire 1988), medical developments (Smith and Johnson 1976, Adams et al 1992), determining future issues in grievance arbitration (Adams 1980), developing family therapy models (Fish and Osborn 1992), future need for affirmative action programs (Fry 1980), determining policy options (Sviden 1988, Setty et al 1987) and evaluating budget allocations (Linstone 1978). Similarly, Toffler (as cited in Rieger 1986) envisages computerized, normative Delphi-like exercises on a large scale involving many participants as a normal functioning part of societies of the future - in line with his concept of anticipatory democracy.

2.7. Delphi: Evaluation

It is very difficult to evaluate the accuracy and reliability of a judgment method such as the Delphi, because the technique is based on determining the opinion of panel members and the findings thus become person and situation specific. Therefore, each application of the methodology will be different, preventing comparison and measurement to be carried out. The only way Woudenberg (1991) argues you can evaluate its accuracy is to compare it with other judgment methods in the same situation and many of the previous evaluations of Delphi have not done this. In addition, much of the work undertaken to evaluate the Delphi technique has been done with university students asking almanac-type questions. This raises questions about the applicability and validity of results when trying to evaluate the technique for its effectiveness in generating alternative futures (Amara 1975).

Dalkey wrote two articles in 1968 and 1969 summing up most of the negative aspects of Delphi, including the strong response of the group to conform with the statistical feedback of the panel. However, it was Sackman in 1974 who provided the major critique of the Delphi attacking it on the grounds that it was unscientific and its application was highly questionable. His view was that the method lacked the necessary rigor to be taken seriously as a scientific methodology. Rieger (1986) argues that the Delphi drew this response from Sackman because the creation of the method was an attempt to move beyond the conventional research paradigm of which Sackman was a member. It has also been argued that Sackman's critique was based on studies that had used the technique sloppily, thus causing his evidence to be selective.

Linstone and Turoff (1975) responded to Sackman by agreeing with Coates (as cited in Rowe et al 1991) that the Delphi method must be considered as one of last resort - to deal with extremely complex problems for which there are no other models. "...one should expect very little of it compared to applicable analytical techniques. One should expect a great deal of it as a technique of last resort in laying bare some crucial issues on a subject for which a last resort technique is required...If one believes that the Delphi is of value not in the search for individual knowledge but in the search for public wisdom; not in the search for

individual data but in the search for deliberative judgment, one can only conclude that Sackman missed the point"(Linstone and Turoff 1975). Hughes (1985) concurs, arguing that the Delphi technique is more about opinion gathering than explanations of causality and thus its use is not a retreat from objectivity. Judgment and informed opinion have always played a crucial role in human enterprises and will continue to be useful so long as the structure of an investigation is made subject to some of the safeguards that are commonly used to assure objectivity in any scientific inquiry (Brown 1968).

Other criticisms that have been leveled at Delphi are:

- It has not been shown consistently that the results this method produces are any better than those achieved through other structured judgmental techniques (Rowe et al 1991);
- A Delphi study is at the mercy of the world view and biases of the coordinating or monitor team, who choose the respondents, interpret the returned information and structure the questions. There is a great deal of debate therefore over whether this coordinating group should be chosen from within or outside the organization initiating the study and whether they should be experienced in the subject area of the study in question (Masini 1993);
- The way the process and questionnaire is structured can lead to a bias (like IQ tests), which assume a certain cultural background. People may give responses they think the monitoring group wants to hear, or they may not respond at all. Thus, the cultural background of respondents will impact upon the results (Linstone 1978);
- Simmonds (1977) argues that one of the key weakness in using the Delphi technique is that certain questions do not get asked as they do not seem important when the study begins. However, once it is underway new questions cannot be added, which in turn can weaken the study considerably;
- The process of choosing the panelists is often not considered seriously enough. Yet, it is the caliber of the panelists which determines the quality of the outcomes of the study;

- In the process of achieving consensus, extreme points of views run the risk of being suppressed, when in fact they may provide important new information or insights, and,
- The flexibility of the technique means it can be adapted to a whole range of situations which in turn can make it vulnerable to misrepresentation and sloppy execution (Amara 1975).

Masini (1993) argues that these reasons are why developing countries have rarely used the methodology and when they have, it has been on narrow subjects. Reliance on experts in such countries has made potential users wary of the Delphi technique.

Linstone and Turoff (1975) also outline some of the common reasons for failure of the Delphi. These are:

- "Imposing monitor views and preconceptions of a problem upon the respondent group by over-specifying the structure of the Delphi and not allowing for the contribution of other perspectives related to the problem;
- Assuming that Delphi can be a surrogate for all other human communications in a given situation;
- Poor techniques of summarizing and presenting the group response and ensuring common interpretations of the evaluation scales utilized in the exercises;
- Ignoring and not exploring disagreements, so that discouraged dissenters drop out and an artificial consensus is generated;
- Under-estimating the demanding nature of a Delphi and the fact that the respondents should be recognized consultants and properly compensated for their time if the Delphi is not an integral part of their job function."

In terms of its positive contribution to futures methodologies, Ono and Wedemeyer (1994) argue that the accuracy of the technique in short range-forecasting has been proved fairly conclusively. Similarly, in their own study carried out in 1976 and evaluated in 1994, they show how the technique is also valid in long range forecasting, Ascher and Overholt (1983) likewise show from

their own experience that Delphi studies have an excellent record of forecasting, among others, in computer capability advances.

It is due to this acknowledgement that Delphi was selected as the preferred method for executing the current research work.

3. Application Of Research Methodology: Findings And Analysis

The application of Delphi technique life-cycle started by distributing to the selected group of IT experts an overview of the SOA (Web-Services) technology and SOA-related (Web Services-related) issues under investigation (as shown in paragraph 3.2., SOA-Related Issues To Be Explored).

3.1. Challenges In Selection Of The Panel Of IT Experts

In general, the questions arising around the formation of a Delphi panel are typical for selection and formation of any group – committee, task force, panel, or study group. Thus, while panel member selection is a problem that should be addressed, it is by no means unique to Delphi studies.

The selection criteria that would qualify an individual to participate on the Delphi panel include the context, scope and aims of the particular study. In particular, Adler and Ziglio (1996) argue that the following criteria are of decisive importance for the selection of any Delphi panel:

- Knowledge and practical engagement with the issue under investigation;
- Capacity and willingness to contribute to the exploration of a particular problem;
- Assurance that sufficient time will be dedicated to the Delphi exercise;
- Good written communication skills;
- Experts' skills and knowledge need not necessarily be accompanied by standard academic qualifications or degrees;

Since the Delphi method relies on repeated questionnaires to the same initially selected sample of participants, the method requires a continued commitment from the panelists and is heavily dependant on the time and continued involvement on the part of the study participants.

For this study, the following criteria were utilized to qualify experts in the local Information Technology(IT) industry for inclusion in the panel:

(a) IT professionals with more than ten(10) years of practical engagement in the local IT industry. This criterion assures that those selected are having sufficient knowledge of the peculiarities of the local market;
(b) IT experts working for those big global IT companies that are leading the industry (and they are pioneers in the SOA paradigm) and that are having local presence (for instance, Microsoft, IBM, Oracle, etc);
(c) IT professionals who have won any kind of technical award or certification on Web-related technologies (including SOA and Web Services) within the last five(5) calendar years;
(d) Leaders in local IT companies or organizations who emphasize continuous improvement and exercise best-of-breed technologies and practices;
(e) Experts possessing more than one of the aforementioned criteria.

Based on these criteria, only about eighty(80) IT experts qualified for participation in the panel. Finally, a quarter (that is, twenty-20-) of the qualified individuals confirmed their willingness to serve on the panel.

3.2. SOA-Related (Web Services-Related) Issues To Be Explored

The issues to to be investigated by the panel of IT experts are shown below and a two(2)-round questionnaire was utilized to achieve the desired convergence of opinions on these points.

- How Agile is Your Organization?
- What's the value of being an Agile Enterprise?
- How do you build a more Agile Enterprise?
- Are organizations adopting SOA seeking for agility and flexibility?
- Which are the biggest drivers of potential shift to SOA (Service-Oriented Architecture)?
- Which are the primary concerns towards adopting SOA?
- How will the IT and business landscape be in terms of SOA penetration and contribution in resolving key business issues in five(5) years time from now?

- Will SOA's current constraints be addressed in five(5) years time from now?

The questionnaires were designed in such a way that at the end of this procedure, the maximum degree of convergence (on the points under research) to be achieved.

3.3. Delphi Technique Applied – First-Round Questionnaire And Its Findings

Initially, the members of the panel were circulated a description of the subject under study along with a set of open-ended questions (derived from the issues stated in paragraph 3.2., SOA-Related Issues To Be Explored).

The choice of open-ended questions was stimulated from the fact that at that stage of the Delphi procedure not only the respondents' opinion was desired, but also an attempt had to be made to encourage them elaborate, justify, or expand on that opinion. This open-ended approach follows recommended procedures for Delphi that do not impose researcher bias through instrumentation. The directions encouraged respondents to list their ideas, to rephrase the questions to suit their perceptions, or even to add their own questions.

Upon receipt of IT experts' feedback (in an unstructured and informal format) on the questions circulated, the first-round questionnaire was formulated (shown in **Appendix A**, **Delphi Technique Applied – First-Round Questionnaire**). The questionnaire was designed (of course, based on the collected IT experts' opinions, and) in such a way that the desired degree of convergence would be achieved. That is, the open-ended questions, initially distributed to the panel members, are now structured in such a way that not only the whole spectrum of replies are available, but also these replies constitute a discrete and finite number of states which assures the accountability needed for extracting measurable results.

The panel members were initially given three(3) weeks to address the first-round questionnaire' points, but it was only after the fifth(5^{th}) week that all respondents provided their final feedback. Throughout this period of five(5) weeks, the panel

members and the researcher (who was the moderator for this Delphi technique application/implementation) were having frequent (2-3 times per week) conversations (mostly, via phone) on the questionnaire points. Where needed, clarifications and other supporting technical documentation was provided by the researcher.

The findings of the first-round questionnaire (shown in **Appendix B: Delphi Technique Applied – First-Round Questionnaire Findings**) started providing initial points of convergence to the various issues this research was trying to investigate. In particular, it is clear that IT is not fast enough toward meeting changing business needs and pressures. Only 5 percent of respondents believe that their IT could keep up with business demand to change processes without any difficulties. Worse, some 70 percent report their company's IT departments are having either "significant difficulties" (50 percent) or "can't keep up at all" (20 percent).

It is also obvious that business is no longer merely dependent on technology, but, business is now embodied in the technology. Even more and more operations (of enterprises) are solely dependent on the IT. It is indicative that 85 percent of the respondents to the first-round questionnaire admitted that the IT is either "vital and essential" (50 percent) or "significant contributors" (35 percent) toward assisting the lines of business in meeting their quarterly objectives and deliverables.

Even though IT has become an important constituent of contemporary organizations, the "lack of time and technical resources" (at 50 percent) and the "lack of budget" (at 40 percent) were found to be prohibitory factors to IT's ability to rapidly fix or improve important business practices.

Moreover, it is accepted by the majority of respondents(50 percent) that a great percentage (40 to 60) of their companies' core business processes require an IT fix.

Another thing that has been revealed from the responses to the first-round questionnaire handed-out to those selected IT experts who participated in this research work, is the fact that the IT does not only have a crucial role for the streamlining of the internal processes and procedures, but its contribution is also very important in creating market differentiation for the companies, their products and services. Particularly, 95 percent of the respondents believe that the IT's role is either "More important than ever" (60 percent) or "Important" (35 percent).

In addition, the strategic role of IT has been explored in the current research work. Specifically, the strategic priorities the IT should have within the contemporary organizations. The "quicker business agility and responsiveness" was the reply dominated the preferences of the respondents (50 percent). "Application integration" and "Integration of disparate business functions and processes" both with 15 percent followed, and the "more efficient service delivery" and the "reduced time and costs to develop new applications" were the options that each took the 10 percent of the respondents' preferences.
It is also interesting to stress out the fact that these strategic priorities are "somewhat" (at 50 percent) mapped to actual activities within companies.

Another finding that come out of the first-round questionnaire is the fact that the IT organizations in the various enterprises "have difficulties" (at 50 percent) to demonstrate business value and ROI (Return On Investment) from their resources, activities and expenditures.

"Quick, flexible and responsive in application delivery" was the dominant reply (with 40 percent) to the essential qualities and disciplines the IT experts would like to see in their IT organizations. Also, with equal preferences (at 10 percent) were the replies "makes business case for technology investment", "performance-driven, outcome-oriented", "understands strategic business needs", "meets deadlines and deliverables", "quality and process minded" and "budget and deadline driven" to this specific point of interest (essential qualities and disciplines the IT experts would like to see in their IT organizations).

Another weak point (concerning the contemporary enterprises) that come out from this research work is the fact that 50 percent of the respondents believe that their company is “ineffective” in creating new value from existing IT investments and infrastructure.

The agility and flexibility of an organization is very much associated with the adoption of Service-Oriented Architecture (and Web Services). 75 percent of the respondents believe that the adoption of SOA is either “very important” (25 percent) or “important” (50 percent) in helping companies become agile enterprises. With similar percentages the IT experts believe the exact same things for their own enterprises, too.

Trying to figure out the degree to which the IT expects’ organizations embraced SOA (and Web Services), we come across the following findings: 50 percent of the respondents’ organizations are “in the early stages”, 25 percent are doing “some planning & discussions”. At the same degree (25 percent), respondents’ organizations are having “no plans” in respect to SOA adoption.

Moreover, the top three(3) factors that are facilitating the “penetration” of SOA within their organizations are: “SOA enhances agility and flexibility; important ingredients for our organization” (50 percent), “SOA reduces information systems integration complexity” (20 percent), and with equal preferences among respondents at 10 percent, the following: “SOA eliminates inefficiencies by lowering operating costs”, “SOA creates new business opportunities through collaboration, outsourcing, and by enabling global presence for our goods and services”, and “SOA accelerates growth by facilitating the integration of systems of acquired companies”.

On the contrary, the prohibitory factors for the adoption of SOA (and Web Services) within organizations were found to be: “There is a lack of skills for the implementation and deployment of SOA-based Information Systems” (40 percent), “the technology is still immature”, “lack of anticipated ROI”, and “lack of funding” all at 20 percent of respondents’ preference.

Trying also to establish a clearer idea of which exactly aspects of SOA are considered immature by the IT experts, the research revealed that 65 percent to 80 percent of the respondents believe that all both aspects associated with SOA (and Web Services): “development tools”, “enterprise service bus”, “repository/registry”, “monitoring and management”, “security”, “migration/legacy adapter tools” and “underlying protocols” are still evolving.

It was also interesting to figure out what those IT expects thought of SOA (and Web Services) “penetration” would be in five(5) years time from now, both in the broader business landscape and within their organizations. 50 percent of them admitted that “there will be a considerable (to great) increase in the adoption of SOA (and Web Services)”. And, as the top facilitators (toward that adoption) were considered the “greater business flexibility and agility” (33.3 percent), the “lowering of costs of integrating existing applications and systems” (33.3 percent), and the fact that “there will be proven success stories associated with the application of SOA-based systems in highly demanding environments indicating the inherent benefits of the technology” (20 percent).
On the contrary, the prohibitory factors for the adoption of SOA-based systems, even in five(5) years time from now, are considered to be: “the skills needed to implement and use the technology will be very limited in respect to the capacity required by the technology” (40 percent), “the ROI will never be encouraging enough”, “the technology will fail to prove itself when it will be implemented and deployed in systems where high security features are mandated”, and “the Big supporters of the technology –Big IT companies like Microsoft, IBM, Oracle, etc- will abandon the technology and they will look for more profitable technologies/solutions”, all three(3) with 20 percent of preferences.

The first-round questionnaire was distributed to IT experts (IT Managers: 50 percent, IT Executives: 25%, and CIOs: 25%) mainly from the “Information Technology” industry sector (50 percent of participants), “Banking and Finance” (35 percent), “Telecommunications” (10 percent) and “Utilities” (5 percent).

3.4. Delphi Technique Applied – Second-Round Questionnaire And Its Findings

The findings of the first-round questionnaire were used for the preparation of the second-round questionnaire (**Appendix C: Delphi Technique Applied - Second-Round Questionnaire**) where the questions were reformulated in such a way so that the desired convergence of points and views is realized.

In particular, the findings of the first-round questionnaire were communicated to the panel members initially through a teleconferencing and later through a series of one-to-one personal meetings. In those interactions with the panel members, they were provided an insight on how and why the rest of the panel members concluded to the replies they provided and what were the replies of the most influential members of the panel. That was unavoidable because the panel members were originated from different companies and there would be no consensus without the intervention by the moderator. As it turned out, that was also the most crucial point for the success of this study because it leaded the research (without biases at all) to the desired degree of convergence to extract secure conclusions.

This time, the panel members were given five(5) weeks to address the questionnaire' points. Throughout this period of five(5) weeks, the panel members and the researcher were –again- having frequent (1-2 times per week) conversations (either over the phone or personally) to clarify or provide feedback on questionnaire points. At the end of five(5) weeks all replies were collected and their processing was initiated. The findings of the second-round questionnaire provided the desired degree of convergence to the various points this research was trying to investigate. Particularly, the following outcomes and conclusions were derived:

- IT is not fast enough toward meeting changing business needs and pressures;
- IT is not only slow in meeting changing business needs and pressures, but it is also facing significant difficulties to cope with the business demand to change processes;

- IT is becoming an even more necessary ingredient of the contemporary organizations both for assisting the lines of business in meeting their quarterly objectives and deliverables, and for creating market differentiation for the companies, their products and services;
- Even though it is admitted that enterprises' core business processes require an IT fix, the "lack of time and technical resources" and the "lack of budget" are the prohibitory factors to IT's ability to rapidly fix or improve important business practices;
- IT's strategic priorities should be the "quicker business agility and responsiveness" and the "integration of disparate business functions and processes";
- The IT organizations in the various enterprises "have difficulties" to demonstrate business value and ROI from their resources, activities and expenditures and their essential qualities and disciplines should be "quick, flexible and responsive in application delivery";
- Most of the contemporary organizations are "ineffective" in creating new value from existing IT investments and infrastructure;
- The agility and flexibility of an organization is very much associated with the adoption of Service-Oriented Architecture (and Web Services); Organizations, though, are "in the early stages" in respect to SOA adoption;
- Regardless of the fact that SOA (and Web Services) is at the early stages of being adopted by organizations, the facts that:
    - "SOA enhances agility and flexibility",
    - "SOA reduces information systems integration complexity",
    - "SOA eliminates inefficiencies by lowering operating costs",

are considered to be the most important "facilitators" for the adoption of SOA by organizations;

- On the contrary, the most important prohibitory factors for the adoption of SOA (and Web Services) within organizations were found to be:
    - "The lack of skills for the implementation and deployment of SOA-based Information Systems",
    - "the fact that the technology is still immature",

- "the lack of anticipated ROI", and
- "the lack of funding";

- All aspects associated with SOA (and Web Services) that were explored by this research work: "development tools", "enterprise service bus", "repository/registry", "monitoring and management", "security", "migration/legacy adapter tools" and "underlying protocols" are still evolving. This means that the SOA (and the Web Services technology) is still going though significant developments and it is not yet mature enough to cope with the demanding business pressures;
- "There will be a considerable (to great) increase in the adoption of SOA (and Web Services)" in five(5) years time from now. And, the top facilitators (toward that adoption) will be the "greater business flexibility and agility" provided by the SOA (and the Web Services), the "lowering of costs of integrating existing applications and systems", and "there will be proven success stories associated with the application of SOA-based systems in highly demanding environments indicating the inherent benefits of the technology";
- The prohibitory factors, though, for the adoption of SOA-based systems, in five(5) years time from now, are considered to be: "the skills needed to implement and use the technology will be very limited in respect to the capacity required by the technology", "the ROI will never be encouraging enough", "the technology will fail to prove itself when it will be implemented and deployed in systems where high security features are mandated", and "the Big supporters of the technology –Big IT companies like Microsoft, IBM, Oracle, etc- will abandon the technology and they will look for more profitable technologies/solutions".

These findings come from IT experts (IT Managers, IT Executives and CIOs) working with enterprises from the "Information Technology", "Banking and Finance", "Telecommunications" and "Utilities" industry sectors.

4. Conclusions And Reflections On This Exercised Delphi Work

This paper attempted to investigate the following issues:

- How Agile is Your Organization?
- What's the value of being an Agile Enterprise?
- How do you build a more Agile Enterprise?
- Are organizations adopting SOA seeking for agility and flexibility?
- Which are the biggest drivers of potential shift to SOA (Service-Oriented Architecture)?
- Which are the primary concerns towards adopting SOA?
- How will be the IT and business landscape in terms of SOA penetration and contribution in resolving key business issues in five(5) years time from now?
- Will SOA's current constraints be addressed in five(5) years time from now?

using the Delphi technique. The Delphi technique was chosen as a vehicle for this research work (and as it turned out, this selection was the most appropriate for the case) since its objective was to anticipate the adoption of the SOA (and, the Web Services) software paradigm five(5) years from today and which would be the driving forces and prohibitory factors for the "embracement" of this technology by achieving consensus among experts in the field.

Two(2) questionnaires were distributed to IT experts who provided their feedback on the points raised. Based on the feedback provided by IT experts who participated into this research activity, "there will be a considerable increase in the adoption of SOA" in five(5) years time from now and the drivers of this adoption will be the "greater business flexibility and agility" provided by the SOA (and the Web Services), the "lowering of costs of integrating existing applications and systems", and "there will be proven success stories associated with the application of SOA-based systems in highly demanding environments indicating the inherent benefits of the technology".

There will be prohibitory factors, though, towards the adoption of SOA-based systems that will still hold in five(5) years time from now. These will be: "the skills needed to implement and use the technology will be very limited in respect to the capacity required by the technology", "the ROI will never be encouraging

enough", "the technology will fail to prove itself when it will be implemented and deployed in systems where high security features are mandated", and "the Big supporters of the technology will abandon the technology and they will look for more profitable technologies/solutions".

What might be considered as a shortcoming of this work (and might be re-considered in future ones) is the number of participants in the panel of experts. The number of panel members could have been much more than twenty(20) so that the conclusions obtained to be more representing of the local market. But, based on the time-constraints set and on the criteria for the selection of panel members, that number was considered to be adequate enough and the conclusions derived are well representing the local IT market.

Following this document (Document 4), in Document 5, a formula (or a tool) will be created that could be used for deciding on the "readiness" of an organization to adopt the Web Services technology (or, SOA). If not, recommendations will be provided for the corrective actions need to be taken.

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6. Appendices

Appendix A: Delphi Technique Applied - First-Round Questionnaire

1. How well is your IT department keeping pace with the need to improve and/or rebuild key processes to meet changing business needs and pressures?

a. Very well, no difficulties
b. Pretty well, some difficulties
c. Significant difficulties
d. Can't keep up at all
e. Don't know

2. To what degree is IT helpful in assisting your lines of business in meeting their quarterly objectives and deliverables?

a. Vital and essential
b. Significant contributors
c. Somewhat helpful
d. Not relevant
e. Don't know

3. What factors tend to inhibit or detract from IT's ability to rapidly fix or improve important business practices? (Specify top three)

a. Availability of budget
b. Time and technical resources
c. Business comprehension
d. Process understanding
e. Complexity and cost
f. Unrealistic demands and requirements
g. Development tools
h. Aging IT infrastructure
i. Application integration issues
j. Other IT projects and priorities
k. Lack of expertise and knowledge
l. Attitude and mindset
m. Limits of internal capability
n. Unwilling to outsource
o. Lack of mandate from management
p. No accountability or consequences
q. Other (please specify)

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4. What percentage of your company's core business processes require an IT fix:

a. 10-20%
b. 20-40%
c. 40-60%
d. 60-80%
e. 80-100%

5. How important is the role of IT in creating market differentiation for your company, its products and services?

a. More important than ever
b. Important
c. Somewhat Important
d. Not very important
e. Less important than in the past

6. What do you believe the strategic priorities should be for IT in your organization? (Specify top three)

a. Improved customer experience
b. Better market intelligence
c. More efficient service delivery
d. Cost-effective procurement and purchasing
e. Greater operational visibility
f. Increased transactional volumes
g. Real-time access to critical, decision-support data
h. Automation of inefficient and labor-intensive practices
i. Integration of disparate business functions and processes
j. Quicker business agility and responsiveness
k. Improved accountability and governance
l. Stricter financial discipline and control
m. Application integration
n. Quantification and measurement of organizational performance
o. Executive dashboard views
p. Other (please specify)

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7. How well do these strategic priorities (above) map to actual activities?

a. Extremely closely
b. Closely
c. Somewhat
d. Not closely
e. Very far apart

8. How well does your IT organization demonstrate business value and ROI from its resources, activities and expenditures?

a. Very well
b. Pretty well
c. Has difficulty
d. Has significant difficulties
e. Failing miserably

9. What are the essential qualities and disciplines you would like to see in your IT organization? (Specify top three)

a. Makes business case for technology investment
b. Quick, flexible and responsive in application delivery
c. Performance-driven, outcome-oriented
d. Takes the initiative, brings new ideas
e. Realistic, practical and consultative
f. Understands strategic business needs
g. Works around challenges and problems
h. Meets deadlines and deliverables
i. Motivated, can do attitude
j. Experienced and knowledgeable about process change
k. Sensitive to user and cultural dynamics
l. Structured and rigorous approach
m. Quality and process minded
n. Budget and deadline driven
o. Other (please specify)

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10. How effective is your company in creating new value from existing IT investments and infrastructure?

a. Extremely effective
b. Effective
c. Fairly effective
d. Ineffective
e. Extremely ineffective
f. Don't know

11. How important do you think the adoption of Service-Oriented Architecture will be in helping companies become Agile Enterprises?

a. Very important
b. Important
c. Somewhat important
d. Not important
e. Don't know

12. How helpful do you think the adoption of Service-Oriented Architecture (and Web Services) is to your organization toward becoming more agile and flexible?

a. Very helpful
b. Helpful
c. Somewhat helpful
d. Not helpful
e. Don't know

13. To what degree is your enterprise embracing Service-Oriented Architecture and Web Services?

a. Well on our way
b. In the early stages
c. Some planning & discussions
d. No plans
e. Don't know

14. Which are the most important factors that are facilitating the "penetration" the Service-Oriented Architecture and Web Services within your enterprise? (Specify top three)

a. SOA (and Web Services, subsequently) enhances agility and flexibility; important ingredients for our organization
b. SOA improves our products' or services' time-to-market
c. SOA reduces information systems integration complexity
d. SOA eliminates inefficiencies by lowering operating costs
e. SOA creates new business opportunities through collaboration, outsourcing, and by enabling global presence for our goods and services
f. SOA accelerates growth by facilitating the integration of systems of acquired companies
g. Other (please specify)

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15. Which are the primary constraints that are prohibiting the "penetration" the Service-Oriented Architecture and Web Services within your enterprise? (Specify top three)

a. The technology (SOA) is still immature
b. There is a lack of skills for the implementation and deployment of SOA-based ("Web Services-based") Information Systems
c. There are still security implications on the technology
d. Other (please specify)

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16. How would you rate the maturity/capability of the following aspects of the SOA technology?

	Mature	Still Evolving	Inadequate
a. Development tools	_____	_____	_____
b. Enterprise service bus	_____	_____	_____
c. Repository/registry	_____	_____	_____
d. Monitoring and management	_____	_____	_____
e. Security	_____	_____	_____
f. Migration/legacy adapter tools	_____	_____	_____
g. Underlying protocols	_____	_____	_____

17. What will the SOA "penetration" be in five(5) years time from now?

a. SOA (and Web Services) will be the dominant technology in five(5) years time from now, like what the "static" Web is today
b. There will be a considerable (to great) increase in the adoption of SOA (and Web Services) by enterprises
c. There will be a slight (or no) increase in the adoption of the technology
d. It will be totally abandoned

18. What will the status of SOA be in five(5) years time from now, within your enterprise?

a. Same answer as the one provided in the previous question (17)
b. Different answer as the one provided in the previous question (17). If you had provided this response as your reply to the current question, please explain why you had differentiated your enterprise from the rest of the market's trend?

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19. If you had provided answers (a) or (b) in question 17, which do you think will be most important facilitators toward that trend?

a. There will be proven success stories associated with the application of SOA-based systems in highly demanding environments indicating the inherent benefits of the technology
b. The ROI will be promising
c. Greater business flexibility and agility
d. Lowering of costs of integrating existing applications and systems
e. Other (please specify)

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20. If you had provided answers (c) or (d) in question 17, which do you think will be most important prohibitory factors for the adoption of the technology (SOA)?

a. The ROI will never be encouraging enough
b. The technology will fail to prove itself when it will be implemented and deployed in systems where high security features are mandated
c. The skills needed to implement and use the technology will be very limited in respect to the capacity required by the technology
d. The Big supporters of the technology (Big IT companies like Microsoft, IBM, Oracle, etc) will abandon the technology and they will look for more profitable technologies/solutions
e. Other (please specify)

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21. What industry sector do you represent?

a. Information Technology (IT)
b. Banking and Finance
c. Insurance
d. Retail and Wholesale
e. Telecommunications
f. Utilities
g. Other (please specify)

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22. What answer best describes your position?

a. CEO
b. COO
c. CFO
d. CIO
e. Business Line Executive
f. Business Line Manager
g. IT Executive
h. IT Manager

Appendix B: Delphi Technique Applied - First-Round Questionnaire Findings

1. How well is your IT department keeping pace with the need to improve and/or rebuild key processes to meet changing business needs and pressures?

a. Very well, no difficulties **[1/20 – 5%]**
b. Pretty well, some difficulties **[5/20 – 25%]**
c. Significant difficulties **[10/20 – 50%]**
d. Can't keep up at all **[4/20 – 20%]**
e. Don't know **[0/20 – 0%]**

2. To what degree is IT helpful in assisting your lines of business in meeting their quarterly objectives and deliverables?

a. Vital and essential **[10/20 – 50%]**
b. Significant contributors **[7/20 – 35%]**
c. Somewhat helpful **[3/20 – 15%]**
d. Not relevant **[0/20 – 0%]**
e. Don't know **[0/20 – 0%]**

3. What factors tend to inhibit or detract from IT's ability to rapidly fix or improve important business practices? (Specify top three)

a. Availability of budget **[24/60 – 40%]**
b. Time and technical resources **[30/60 – 50%]**
c. Business comprehension **[3/60 – 5%]**
d. Process understanding **[3/60 – 5%]**
e. Complexity and cost **[0/60 – 0%]**
f. Unrealistic demands and requirements **[0/60 – 0%]**
g. Development tools **[0/60 – 0%]**
h. Aging IT infrastructure **[0/60 – 0%]**
i. Application integration issues **[0/60 – 0%]**
j. Other IT projects and priorities **[0/60 – 0%]**
k. Lack of expertise and knowledge **[0/60 – 0%]**
l. Attitude and mindset **[0/60 – 0%]**
m. Limits of internal capability **[0/60 – 0%]**
n. Unwilling to outsource **[0/60 – 0%]**
o. Lack of mandate from management **[0/60 – 0%]**
p. No accountability or consequences **[0/60 – 0%]**
q. Other (please specify) **[0/60 – 0%]**

Note: In this type of questions where top three(3) replies were asked by each of the respondents, the "hit rate" was calculated as if the number of respondents were 60 (20X3).

4. What percentage of your company's core business processes require an IT fix:

a. 10-20% **[2/20 – 10%]**
b. 20-40% **[5/20 – 25%]**
c. 40-60% **[10/20 – 50%]**
d. 60-80% **[3/20 – 15%]**
e. 80-100% **[0/20 – 0%]**

5. How important is the role of IT in creating market differentiation for your company, its products and services?

a. More important than ever **[12/20 – 60%]**
b. Important **[7/20 – 35%]**
c. Somewhat Important **[1/20 – 5%]**
d. Not very important **[0/20 – 0%]**
e. Less important than in the past **[0/20 – 0%]**

6. What do you believe the strategic priorities should be for IT in your organization? (Specify top three)

a. Improved customer experience **[0/60 – 0%]**
b. Better market intelligence **[0/60 – 0%]**
c. More efficient service delivery **[6/60 - 10%]**
d. Cost-effective procurement and purchasing **[0/60 – 0%]**
e. Greater operational visibility **[0/60 – 0%]**
f. Increased transactional volumes **[0/60 – 0%]**
g. Real-time access to critical, decision-support data **[0/60 – 0%]**
h. Automation of inefficient and labor-intensive practices **[0/60 – 0%]**
i. Integration of disparate business functions and processes **[9/60 - 15%]**
j. Quicker business agility and responsiveness **[30/60 - 50%]**
k. Improved accountability and governance **[0/60 – 0%]**
l. Stricter financial discipline and control **[0/60 – 0%]**
m. Application integration **[9/60 - 15%]**
n. Quantification and measurement of organizational performance **[0/60 – 0%]**
o. Executive dashboard views **[0/60 – 0%]**

p. Other (please specify)

Reduced time and costs to develop new applications [6/60 - 10%]

Note: In this type of questions where top three(3) replies were asked by each of the respondents, the "hit rate" was calculated as if the number of respondents were 60 (20X3).

7. How well do these strategic priorities (above) map to actual activities?

a. Extremely closely **[0/20 – 0%]**
b. Closely **[5/20 – 25%]**
c. Somewhat **[10/20 –50%]**
d. Not closely **[5/20 – 25%]**
e. Very far apart **[0/20 –0%]**

8. How well does your IT organization demonstrate business value and ROI from its resources, activities and expenditures?

a. Very well **[0/20 – 0%]**
b. Pretty well **[5/20 – 25%]**
c. Has difficulty **[10/20 – 50%]**
d. Has significant difficulties **[5/20 – 25%]**
e. Failing miserably **[0/20 – 0%]**

9. What are the essential qualities and disciplines you would like to see in your IT organization? (Specify top three)

a. Makes business case for technology investment **[6/60 - 10%]**
b. Quick, flexible and responsive in application delivery **[24/60 - 40%]**
c. Performance-driven, outcome-oriented **[6/60 - 10%]**
d. Takes the initiative, brings new ideas **[0/60 - 0%]**
e. Realistic, practical and consultative **[0/60 - 0%]**
f. Understands strategic business needs **[6/60 - 10%]**
g. Works around challenges and problems **[0/60 - 0%]**
h. Meets deadlines and deliverables **[6/60 - 10%]**
i. Motivated, can do attitude **[0/60 - 0%]**
j. Experienced and knowledgeable about process change **[0/60 - 0%]**
k. Sensitive to user and cultural dynamics **[0/60 - 0%]**

l. Structured and rigorous approach **[0/60 - 0%]**
m. Quality and process minded **[6/60 - 10%]**
n. Budget and deadline driven **[6/60 - 10%]**
o. Other (please specify) **[0/60 - 0%]**

Note: **In this type of questions where top three(3) replies were asked by each of the respondents, the "hit rate" was calculated as if the number of respondents were 60 (20X3).**

10. How effective is your company in creating new value from existing IT investments and infrastructure?

a. Extremely effective **[0/20 – 0%]**
b. Effective **[5/20 – 25%]**
c. Fairly effective **[5/20 – 25%]**
d. Ineffective **[10/20 – 50%]**
e. Extremely ineffective **[0/20 – 0%]**
f. Don't know **[0/20 – 0%]**

11. How important do you think the adoption of Service-Oriented Architecture will be in helping companies become Agile Enterprises?

a. Very important **[5/20 – 25%]**
b. Important **[10/20 – 50%]**
c. Somewhat important **[5/20 – 25%]**
d. Not important **[0/20 – 0%]**
e. Don't know **[0/20 – 0%]**

12. How helpful do you think the adoption of Service-Oriented Architecture (and Web Services) is to your organization toward becoming more agile and flexible?

a. Very helpful **[5/20 – 25%]**
b. Helpful **[10/20 – 50%]**
c. Somewhat helpful **[5/20 – 25%]**
d. Not helpful **[0/20 – 0%]**
e. Don't know **[0/20 – 0%]**

13. To what degree is your enterprise embracing Service-Oriented Architecture and Web Services?

a. Well on our way **[0/20 – 0%]**
b. In the early stages **[10/20 – 50%]**
c. Some planning & discussions **[5/20 – 25%]**
d. No plans **[5/20 – 25%]**
e. Don't know **[0/20 – 0%]**

14. Which are the most important factors that are facilitating the "penetration" the Service-Oriented Architecture and Web Services within your enterprise? (Specify top three)

a. SOA (and Web Services, subsequently) enhances agility and flexibility; important ingredients for our organization **[30/60 – 50%]**
b. SOA improves our products' or services' time-to-market **[0/60 – 0%]**
c. SOA reduces information systems integration complexity **[12/60 – 20%]**
d. SOA eliminates inefficiencies by lowering operating costs **[6/60 – 10%]**
e. SOA creates new business opportunities through collaboration, outsourcing, and by enabling global presence for our goods and services **[6/60 – 10%]**
f. SOA accelerates growth by facilitating the integration of systems of acquired companies **[6/60 – 10%]**
g. Other (please specify) **[0/60 – 0%]**

Note: In this type of questions where top three(3) replies were asked by each of the respondents, the "hit rate" was calculated as if the number of respondents were 60 (20X3).

15. Which are the primary constraints that are prohibiting the "penetration" the Service-Oriented Architecture and Web Services within your enterprise? (Specify top three)

a. The technology (SOA) is still immature **[12/60 – 20%]**
b. There is a lack of skills for the implementation and deployment of SOA-based ("Web Services-based") Information Systems **[24/60 – 40%]**
c. There are still security implications on the technology **[0/60 – 0%]**
d. Other (please specify)
   Lack of anticipated ROI [12/60 – 20%]
   Lack of funding [12/60 – 20%]

Note: **In this type of questions where top three(3) replies were asked by each of the respondents, the "hit rate" was calculated as if the number of respondents were 60 (20X3).**

16. How would you rate the maturity/capability of the following aspects of the SOA technology?

	Mature	Still Evolving	Inadequate
a. Development tools	**[3/20 - 15%]**	**[16/20 - 80%]**	**[1/20 - 5%]**
b. Enterprise service bus	**[3/20 - 15%]**	**[15/20 - 75%]**	**[2/20 - 10%]**
c. Repository/registry	**[3/20 - 15%]**	**[14/20 - 70%]**	**[3/20 - 15%]**
d. Monitoring and management	**[2/20 - 10%]**	**[13/20 - 65%]**	**[5/20 - 25%]**
e. Security	**[3/20 - 15%]**	**[13/20 - 65%]**	**[4/20 - 20%]**
f. Migration/legacy adapter tools	**[2/20 - 10%]**	**[14/20 - 70%]**	**[4/20 - 20%]**
g. Underlying protocols	**[5/20 - 25%]**	**[13/20 - 65%]**	**[2/20 - 10%]**

17. What will the SOA "penetration" be in five(5) years time from now?

a. SOA (and Web Services) will be the dominant technology in five(5) years time from now, like what the "static" Web is today **[5/20 - 25%]**
b. There will be a considerable (to great) increase in the adoption of SOA (and Web Services) by enterprises **[10/20 - 50%]**
c. There will be a slight (or no) increase in the adoption of the technology **[5/20 - 25%]**
d. It will be totally abandoned **[0/20 - 0%]**

18. What will the status of SOA be in five(5) years time from now, within your enterprise?

a. Same answer as the one provided in the previous question (17) **[20/20 - 100%]**
b. Different answer as the one provided in the previous question (17). If you had provided this response as your reply to the current question, please explain why you had differentiated your enterprise from the rest of the market's trend? **[0/20 - 0%]**

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19. If you had provided answers (a) or (b) in question 17, which do you think will be most important facilitators toward that trend? **(Specify top three)**

a. There will be proven success stories associated with the application of SOA-based systems in highly demanding environments indicating the inherent benefits of the technology **[9/45 - 20%]**
b. The ROI will be promising **[6/45 – 13.3%]**
c. Greater business flexibility and agility **[15/45 – 33.3%]**

d. Lowering of costs of integrating existing applications and systems **[15/45 – 33.3%]**
e. Other (please specify) **[0/45 - 0%]**

Note: **Fifteen(15) out of twenty(20) respondents provided answers (a) and (b) in Question 17, above. That is why the "hit rate" in this Question was calculated based on fifteen(15) responses.**
However, based on what has been done in this type of questions earlier (where top three(3) replies were asked by each of the respondents) the "hit rate" was calculated as if the number of respondents were 45 (15X3).

20. If you had provided answers (c) or (d) in question 17, which do you think will be most important prohibitory factors for the adoption of the technology (SOA)? (Specify top three)

a. The ROI will never be encouraging enough **[3/15 – 20%]**
b. The technology will fail to prove itself when it will be implemented and deployed in systems where high security features are mandated **[3/15 – 20%]**
c. The skills needed to implement and use the technology will be very limited in respect to the capacity required by the technology **[6/15 – 40%]**
d. The Big supporters of the technology (Big IT companies like Microsoft, IBM, Oracle, etc) will abandon the technology and they will look for more profitable technologies/solutions **[3/15 – 20%]**
e. Other (please specify)

Note: **Only five(5) out of twenty(20) respondents provided answers (c) and (d) in Question 17, above. That is why the "hit rate" in this Question was calculated based on five(5) responses.**
However, based on what has been done in this type of questions earlier (where top three(3) replies were asked by each of the respondents) the "hit rate" was calculated as if the number of respondents were 15 (5X3).

21. What industry sector do you represent?

a. Information Technology (IT) **[10/20 – 50%]**
b. Banking and Finance **[7/20 – 35%]**
c. Insurance **[0/20 – 0%]**
d. Retail and Wholesale **[0/20 – 0%]**
e. Telecommunications **[2/20 – 10%]**

f. Utilities **[1/20 – 5%]**

a. Other (please specify) **[0/20 – 0%]**

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22. What answer best describes your position?

a. CEO **[0/20 – 0%]**

b. COO **[0/20 – 0%]**

c. CFO **[0/20 – 0%]**

d. CIO **[5/20 – 25%]**

e. Business Line Executive **[0/20 – 0%]**

g. Business Line Manager **[0/20 – 0%]**

h. IT Executive **[5/20 – 25%]**

i. IT Manager **[10/20 – 50%]**

Appendix C: Delphi Technique Applied - Second-Round Questionnaire

1. Based on the previous questionnaire we handed-out,

a. 50% of the respondents replied: “Significant difficulties,”
b. 25% replied: “Pretty well, some difficulties,”
c. 20% replied: “Can’t keep up at all,” and,
d. 5% replied: “Very well, no difficulties,”

when asked how well their IT department is doing in keeping pace with the need to improve and/or rebuild key processes to meet changing business needs and pressures. Having known the preferences of the respondents(above), what do you think on the above statements? Which one between (a) to (d) is more likely to be closer to what really happens to contemporary enterprises?

2. The findings of the previous questionnaire revealed that:

a 50% of the respondents admitted that the IT is “Vital and essential,”
b. 35% said “Significant contributors,” and
c. 15% “Somewhat helpful,”

when asked to what degree is IT helpful in assisting your lines of business in meeting their quarterly objectives and deliverables. Considering those replies, what do you think of the role of IT in assisting your lines of business in meeting their quarterly objectives and deliverables? (Choose between –a-, -b-, -c-, above).

3. In the previous questionnaire, looking for the factors that tend to inhibit or detract from IT’s ability to rapidly fix or improve important business practices:

a. 50% of IT experts chosen “Time and technical resources,”
b. 40%, “Availability of budget,”
c. 5%, “Business comprehension,”
d. 5%, “Process understanding**”.**

Having this piece of information in mind, do you agree that these are the primary inhibitory factors to IT’s ability to rapidly fix or improve important business practices?

i. Yes
ii. No.

If you choose to go with the “No”, please specify which other factor(s) do you think might detract from IT’s ability to rapidly fix or improve important business practices.

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4. The following is the distribution of the percentages of the respondents who admitted that a percentage of their company's core business processes require an IT fix:

a. 50 percent of respondents believe that 40-60% of the company's core business processes require an IT fix,
b. 25 percent, 20-40%,
c. 15 percent, 60-80%,
d. 10 percent, 10-20%.

With which category of the ones specified above, do you -more likely- tend to agree as the more representative for your case (company)?

5. Considering the results of the previous questionnaire,

a. 60 percent of the participants think that IT is "More important than ever,"
b. 35 percent, "Important,"
c. 5 percent, "Somewhat Important,"

in creating market differentiation for your companies, their products and services. With which one of the three(3) option above (-a- to –c-) do you agree?

6. The previous questionnaire demonstrated that:

a. 50 percent of the respondents believe that "Quicker business agility and responsiveness,"
b. 15 percent, "Integration of disparate business functions and processes,"
c. 15 percent, "Application integration,"
d. 10 percent, "More efficient service delivery," and
e. 10 percent, "Reduced time and costs to develop new applications,"

should be the strategic priorities for their IT organizations. Based on this piece of information, what do you think? Which of this(these) option(s) do you believe is(are) the most important?

7. To what extent do you think, the above strategic priorities map to actual activities, considering that the previous questionnaire provided the following piece of information?

a. 50 percent of the respondents said: "Somewhat,"
b. 25 percent "Closely,"
c. 25 percent "Not closely".

Which one between (a) to (c) is the most representing option?

8. One of the most interesting findings of the previous questionnaire, is the fact that:

a. IT organizations of the IT experts' enterprises "Have difficulties" (50 percent),
b. Are doing "Pretty well" (25 percent), and
c. Are having "Significant difficulties" (25 percent)

to demonstrate business value and ROI from their resources, activities and expenditures. With which one (between –a- to –c-) do you tend to agree more?

9. The essential qualities and disciplines IT experts (participated in the previous questionnaire) would like to see in their IT organization are:

a. 40 percent of them, "Quick, flexible and responsive in application delivery,"
b. 10 percent, "Makes business case for technology investment,"
c. 10 percent, "Performance-driven, outcome-oriented,"
d. 10 percent, "Understands strategic business needs,"
e. 10 percent, "Meets deadlines and deliverables,"
f. 10 percent, "Quality and process minded,"
g. 10 percent, "Budget and deadline driven".

Which one(s) of these (above) do you think are the most important?

10. The previous questionnaire revealed that the companies are:

a. "Ineffective" (50 percent of the respondents),
b. "Fairly effective" (25 percent of the respondents),
c. "Effective" (25 percent of the respondents),

in creating new value from existing IT investments and infrastructure. What do you think on the companies' effectiveness in creating new value from the existing IT infrastructure? With which one (between –a- to –c-, above) do you agree more?

11. The adoption of Service-Oriented Architecture was considered (by IT experts, in their responses to the previous questionnaire):

a. "Important" (50 percent of respondents),
b. "Somewhat important" (25 percent of respondents),
c. "Very important" (25 percent of respondents),

toward helping companies become Agile Enterprises. Which one of the options above (-a- to –c-) do you think is more close to what it holds within your organization?

12. It was found that the IT experts' enterprises are

a. "In the early stages" (50 percent),
b. they are doing "Some planning & discussions" (25 percent), and
c. they are having "No plans" (25 percent),

when asked to specify the degree to which their enterprises are embracing Service-Oriented Architecture and Web Services. With which one (between –a- to –c-, above) do you agree more?

13. According to previous questionnaire's findings, the most important factors that are facilitating the "penetration" of Service-Oriented Architecture and Web Services within IT experts' enterprises are:

a. SOA (and Web Services, subsequently) enhances agility and flexibility; important ingredients for our organization (50 percent),
b. SOA reduces information systems integration complexity (20 percent),
c. SOA eliminates inefficiencies by lowering operating costs (10 percent),
d. SOA creates new business opportunities through collaboration, outsourcing, and by enabling global presence for our goods and services (10 percent),
e. SOA accelerates growth by facilitating the integration of systems of acquired companies (50 percent).

Which one(s) of this(these) factor(s) do you believe is(are) the most important one(s)? (Select between –a- to –e-, above).

14. Subsequently, it was also found that the primary constraints that are prohibiting the "penetration" of Service-Oriented Architecture and Web Services within enterprises are:

a. There is a lack of skills for the implementation and deployment of SOA-based ("Web Services-based") Information Systems (40 percent),
b. The technology (SOA) is still immature (20 percent),
c. Lack of anticipated ROI (20 percent),
d. Lack of funding (20 percent).

Which one(s) of this(these) factor(s) do you believe is(are) the most important one(s)? (Select between –a- to –d-, above).

15. Below you can see the percentages of the responses associated with the maturity/capability rate ("Mature", "Still Evolving", and "Inadequate") of the various aspects of the SOA technology. These results come from the previous questionnaire.

	Mature	Still Evolving	Inadequate
a. Development tools	**(i) 15%,**	**(ii) 80%,**	**(iii) 5%,**
b. Enterprise service bus	**(i) 15%,**	**(ii) 75%,**	**(iii) 10%,**
c. Repository/registry	**(i) 15%,**	**(ii) 70%,**	**(iii) 15%,**
d. Monitoring and management	**(i) 10%,**	**(ii) 65%,**	**(iii) 25%,**
e. Security	**(i) 15%,**	**(ii) 65%,**	**(iii) 20%,**
f. Migration/legacy adapter tools	**(i) 10%,**	**(ii) 70%,**	**(iii) 20%,**
g. Underlying protocols	**(i) 25%,**	**(ii) 65%,**	**(iii) 10%**

Choose between (i) to (iii) for every aspect of the SOA technology indicating which do you think is the most representative status of the aspect, for the time being.

16. The previous questionnaire showed that:

a. There will be a considerable (to great) increase in the adoption of SOA (and Web Services) by enterprises (50 percent),

b. SOA (and Web Services) will be the dominant technology in five(5) years time from now, like what the "static" Web is today (25 percent),

c. There will be a slight (or no) increase in the adoption of the technology (25 percent),

when the IT experts were asked to "predict" the SOA penetration in five(5) years time from now, both within their enterprises and to the broader business landscape. Which do you think is more likely to be the scenario from the options provided above (-a- to -c-)?

17. In addition to the above "prediction" (question 16), the IT experts provided their opinions regarding which factors are they considering most important toward facilitating the adoption of SOA (and Web Services) by enterprises.

a. 33.3 percent of them believe that SOA provides "Greater business flexibility and agility",
b. 33.3 percent, "Lowering of costs of integrating existing applications and systems",
c. 20 percent, "There will be proven success stories associated with the application of SOA-based systems in highly demanding environments indicating the inherent benefits of the technology", and
d. 13.3 percent, "The ROI will be promising".

With which one(s) of this(these) factor(s) do you agree more?

18. Subsequently, the IT experts provided their opinions regarding which factors are they considering as most prohibitory towards the adoption of SOA (and Web Services) by enterprises.

a. 40 percent believe that “The skills needed to implement and use the technology will be very limited in respect to the capacity required by the technology”,

b. 20 percent, “The ROI will never be encouraging enough”,

c. 20 percent, “The technology will fail to prove itself when it will be implemented and deployed in systems where high security features are mandated”,

d. 20 percent, “The Big supporters of the technology (Big IT companies like Microsoft, IBM, Oracle, etc) will abandon the technology and they will look for more profitable technologies/solutions”.

With which one(s) of this(these) factor(s) do you agree more?

Proposing

A Delphi-Derived, Inter-Enterprise

Service-Oriented Architecture

Maturity Model

- | -

Document 5: Thesis

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Abstract

Companies have long sought to integrate existing Information Systems (IS) in order to support existing and potentially new business processes spread throughout their "territories" and possibly to collaborating organizations. A variety of designs can be used to this end, ranging from rigid point-to-point electronic data interchange (EDI) interactions to "Web auctions". By updating older technologies, such as "Internet-enabling" EDI-based systems, companies can make their IT systems available to internal or external customers; but the resulting systems have not proven to be flexible enough to meet business demands. A more flexible, standardized architecture is required to better support the connection of various applications and the sharing of data. Service-Oriented Architecture (SOA) is one such architecture. It unifies ("orchestrates") business processes by structuring large applications as an ad-hoc collection of smaller modules called "Services". These applications can be used by different groups of people both inside and outside the company, and new applications built from a mix of services (located in a global repository) exhibit greater agility and uniformity.

Thus, SOA is a design framework for realizing rapid and low-cost system development and improving total system quality. SOA uses the Web Services standards and technologies and is rapidly becoming a standard approach for enterprise information systems integration.

SOA adoption by enterprises has been identified as one of the highest business priorities by a recent Gartner study (Gartner 2007) and enterprises increasingly recognize the requirement for an increased "Service-orientation" and relevant comprehensive frameworks, which will not only help them position themselves and evaluate their SOA initiatives, but also guide them in achieving higher levels of SOA maturity. This in turn, will help enterprises acquire (and retain) competitive advantage over other players in the market who are not (using SOA and thus they are not) so flexibly adjusting themselves to address new business requirements.

This paper proposes a new SOA Maturity Model (MM) using a Delphi-variant technique and this constitutes one of its distinguishing features because none of the relevant existing works utilized Delphi. Moreover, the fact that the proposed SOA MM supports inter-enterprise setups makes it even more distinct.

The newly proposed SOA MM is then used to help the participating organizations position themselves in respect to SOA (current status), guide them to achieve higher levels of SOA maturity, and anticipate their SOA maturity in five years' time.

Furthermore, the "local" or "global" nature of the proposed SOA MM is investigated. This is checked firstly against selected expert panel participants and secondly against local business practitioners.

Keywords: *Service-Oriented Architecture, Maturity Models, Delphi, Inter-Enterprise*

Contents

1. Introduction

Services, as perceived in the Service-Oriented Architecture (SOA), "are intrinsically un-associated units of functionality, which have no calls to each other embedded in them." (Wikipedia 2008) They typically implement functionalities most humans would recognize as a Service, "such as filling out an online application for an account, viewing an online bank statement, or placing an online booking or airline ticket order. Instead of Services embedding calls to each other in their source code, protocols are defined which describe how one or more Services can talk to each other." (Wikipedia 2008) This architecture (SOA) then relies on a business process expert to link and sequence services, in a process known as "orchestration", to meet a new or existing business requirement.

"The goal of SOA is to allow fairly large chunks of functionality to be strung together to form ad-hoc applications which are built almost entirely from existing software Services" (Wikipedia 2008) and its great promise is that the cost of creating any application should be negligible, as all of the software required already exists (in a repository of available Services); only "orchestration" is required to produce a new application.

The potential of SOA leads to the question of how advanced different organisations are in their SOA development and how can this be measured.

The notion of "maturity" has been proposed for various management approaches (Quality Management, Process Management, Project Management, etc) as a way to evaluate "the state of being complete, perfect, or ready" and the "fullness or perfection of growth or development" (Oxford University Press 2004). Maturity is also the means through which the capability and completeness in regards to SOA is being measured.

This thesis aims to develop a new CMM-based maturity model for the evaluation and scope of SOA initiatives using a Delphi-variant technique. This is the challenge (and at the same time the distinguishing feature) of this work. Moreover, the proposed SOA MM supports inter-enterprise setups (besides a company's internal aspects and factors) and thus capturing the model of contemporary organizations where it is a common scenario that their core business processes are accomplished through digital "networks" that are spread not only within an entire organization, but also throughout its collaborating organizations. This component also constitutes one more distinguishing feature of this work, in respect to those available because none of them addresses this issue (SOA MM in inter-enterprise environments).

The newly proposed SOA MM is then applied to help the participating organizations position themselves in respect to (their current status towards) SOA (and guide them in achieving higher levels of SOA maturity) and anticipate their SOA maturity in five years time. Both of these objectives are achieved through the contribution of a panel of IT experts (as mandated by the Delphi technique).

The final objective of this research work is to come up with a conclusion about the "local" or "global" nature of the proposed SOA MM. Firstly, this will be checked with some of the panel experts and subsequently, by conducting a set of interviews with selected business owners and business practice managers.

The structure of this paper is as follows: Section 2 presents what has been accomplished in the previous research documents (Documents 1 to 4), Section 3 defines the research problem and the associated research questions and Section 4 summarises relevant work already available. Following this, in Section 5, is an outline of the research approach and methods used throughout this work with a Delphi-variant technique being the "vehicle" for defining the new SOA MM. Section 6 details the newly proposed SOA MM and its application within the organizations of the panel experts indicating their current status with respect to SOA initiatives and what their SOA status will be in five years. Section 7 deals with the proposed SOA MM's breadth and applicability via interviews with some of the panel experts and selected business practitioners. Finally, Section 8 concludes with a review of the limitations of this research and suggestions for future relevant research.

2. Previous Documents Overview

In Document 2, a Critical Literature Review was carried out and an initial Conceptual Framework was formulated. Among others, the notions of “volatility” and “agility” as realized in contemporary organizations were introduced. Also, the SOA as a response of IT to the ever-changing business environment was discussed.

As described in Document 2, volatility is now a permanent feature of business life. Even though change is normal, the growing speed and unpredictability of change have pushed many enterprises to the very limits of manageability (Truex et al. 1999). Within this business landscape, contemporary organizations have to develop adaptive responses and innovative strategies in order to create value, no matter how unstable the market environment may be.

Agility, that is, the ability to detect and seize market opportunities with speed, is considered to be an important ingredient of the contemporary companies’ repertoire of responses to the volatile and highly competitive business environment (Brown and Eisenhardt 1997; Christensen 1997; D'Aveni 1994; Goldman et al. 1995).

SOA is the new software paradigm that aims to address most of the issues faced by the contemporary organizations thereby enhancing agility and addressing continuous change.

In Document 3, an interpretive philosophical perspective using the case study research method was adopted. The data used for the extraction of conclusions were collected mainly through semi-structured interviews using an open-ended questionnaire.

Reference to secondary data sources, such as press reports, company releases, and analyst reports was also a source of information for Document 3.

In Document 3, emphasis was placed on the context of the information system, the process whereby the information system influences and is influenced by its context, and the linkage between context and process (Walsham 1993). This approach was adopted throughout Document 3 considering that SOA is one of the software architectures that could be used for building, maintaining, and integrating information systems within enterprises.

Based (mainly) on Walsham's (1993) work, Document 3 attempted to investigate the attitude of business and IT executives in Cyprus toward SOA in respect to whether it:

- Enhances business processes agility and flexibility;
- Improves the time-to-market of products or services;
- Reduces the information systems integration complexity;
- Eliminates inefficiencies, otherwise observed between communicating integrated information systems;
- Creates new business opportunities through collaboration, outsourcing, and by enabling global presence for the goods and services;
- Accelerates growth by facilitating the integration of systems of acquired companies;
- Encounters any limitations or constraints, prohibiting its adoption;

In particular, throughout Document 3, a variation of the context/process model, as proposed by Walsham 1993, was adopted. Due to the fact that none of the organizations examined (and, none in Cyprus, the time that research work, Document 3, carried out) was using SOA-based information systems, the context/process model was applied to companies/organizations as if they had implemented and deployed such types of systems (but in reality they had not yet proceeded to do so). Thus, as companies had not implemented SOA, Document 3 was designed to anticipate the benefits and problems that could be associated with implementation of SOA.

Summarizing the findings of the interview sessions conducted, the majority of the interviewees admitted that SOA could enhance business processes agility and flexibility because "it provides a high degree of customization of the integrated systems, allowing enterprises a tremendous opportunity to rapidly wrap around applications and data in various combinations addressing a different need and request every time."

SOA could also "improve the time-to-market of products or services, contribute toward the reduction of information systems integration complexity (appeared to be a major challenge in the IT industry, frequently ending up in a complex, time-consuming, and expensive activity) and eliminate any inefficiencies (otherwise observed between communicating, integrated information systems)."

Moreover, it was also pointed out that SOA could create new business opportunities through collaboration, outsourcing, and by enabling global presence, and also accelerate growth by facilitating the integration of systems of acquired companies.

On the contrary, though, there were reservations for the immediate adoption of SOA, mainly because the technology was still immature, especially in terms of security.

Another prohibiting factor for the adoption of SOA (as revealed by the interviews) was that there was very limited expertise in it.

In Document 4, an investigation of the following issues:

- How agile is your organization?
- What is the value of being an agile enterprise?
- How do you build a more agile enterprise?
- Are organizations that adopt SOA seeking agility and flexibility?
- What are the biggest drivers of potential shift to SOA?
- What are the primary concerns in adopting SOA?
- What will the IT and business landscape be like (in terms of SOA penetration and contribution towards resolving key business issues) five years from now?
- Will SOA's current constraints be addressed five years from now?

was undertaken using the Delphi technique. The Delphi technique was chosen as a "vehicle" for that work (and as it turned out, its selection was the most appropriate for the case) because its objective was to anticipate (that's exactly where Delphi technique is ideal for) the adoption of SOA five years from the day that research work was initiated and what would be the driving forces and prohibiting factors for the "embracement" of this technology.

Two-rounds questionnaire was distributed to IT experts (who constituted the experts panel, as proposed by the Delphi technique) who provided their feedback on the points raised. Based on their feedback, "there will be a considerable increase in the adoption of SOA" in five years (from the time that research work started) and the drivers of the adoption would be the "greater business flexibility and agility" provided by SOA, the "lowering of costs of integrating existing applications and systems", and "there will be proven success stories associated with the application of SOA-based systems in highly demanding environments indicating the inherent benefits of the technology."

There would be prohibiting factors, though, in adopting SOA-based systems that would hold five years from the time that research work initiated: "the skills needed to implement and use the technology will be very limited in respect to the capacity required by the technology", "the ROI will never be encouraging enough", "the technology will fail to prove itself when it is implemented and deployed in systems where high security features are mandated", and "the Big supporters of the technology will abandon the technology and they will look for more profitable technologies/solutions."

3. The Problem And Research Questions

Throughout the years, various attempts were undertaken to come up with such an enterprise architectural paradigm that would be thorough and flexible enough to satisfy the objective of IT: to address the current business needs and support the long-term business strategy of the organizations where IT (including hardware, software and networking infrastructure) has been adopted and used as a strategic asset.

SOA, being the latest of the evolutions in this area (Enterprise Architectures), seems to be the most promising enterprise architectural paradigm because it encompasses those properties (flexibility, agility, etc) that enable the IT policy and business strategy to synchronize and the IT to facilitate the business in the most efficient manner.

It is due to those SOA's attributes (that is, the fact that SOA helps towards IT and business alignment and that IT is there to truly support business) that SOA has started to achieve acceptance in contemporary organizations which in turn, have started to measure their exposure and competence in it using corresponding maturity models (SOA MM).

None of the existing SOA MM, though, supports inter-enterprise setups and this is a significant deficiency because it is very common the practice to have inter-enterprise collaborations in the contemporary "networked" business environment.

This is one of the challenges of this research work along with the fact that the proposed SOA MM is derived using a Delphi-variant technique (considering that none of the existing SOA MM has been derived this way).

Into today's tough business environment, the reality is that the pressures do not lessen, the demands do not stabilize, and the Enterprise Architecture is lost in a myriad of tactical initiatives. As Paras (2004) and Zachman (1999) respectively argue: "The wild e-everything ride is over. Budgets are tighter and reality has set in. Executives tell us they must provide a solid, cost-effective IT foundation and simultaneously increase flexibility to respond to the increasingly diverse demands of the business. The effective use of information, technology, human resources, and investment capital must be balanced to achieve these goals. The solution is a portfolio focus, a return to disciplined, pragmatic approaches for strategy development and enterprise design, combined with robust processes for managing the enterprise portfolio of programs," (Paras 2004) and "Enterprise Architecture requires actual work. We keep looking for the 'quick fix,' a technological solution, a tool, a package, a new processor, the perennial 'silver bullet.' We wish we could simply throw money at the problem and have the pain go away,"(Zachman 1999) but an evolutionary, standards-based approach to (enterprise) architecture needs to be devised to address the business needs today and support the long-term business strategy of contemporary organizations.

The architectural paradigm shifts observed during the last few years are depicted in Figure 1 below. Looking at the figure, the first observation made is that there is a tendency to more “loosely coupled” systems. Moreover, it can be noticed that there is a trend towards more adaptable and flexible systems.
The mainframe systems of the 1960s were implemented as large blocks of functionality that ran on a single mainframe computer. On the contrary, services-oriented systems are implemented as discrete business services that are “loosely coupled” to other services running on -possibly- heterogeneous systems and platforms across an organization or beyond them.

Orton and Weick (1990) argue that three major definitions of “loosely coupling” are the dominant ones throughout the academic community. Glassman (1973) wrote that loose coupling is present when systems have either few variables in common or the variables they have in common are weak. Weick (1976) defined loose coupling as a situation in which elements are responsive, but retain evidence of separateness and identity. Later, he wrote that loose coupling is evident when elements affect each other "suddenly (rather than continuously), occasionally (rather than constantly), negligibly (rather than significantly), indirectly (rather than directly), and eventually (rather than immediately)" (Weick 1982).

The concept of “loosely coupled” is widely practiced in computing architectures. It is the foundation for the design of massively parallel computing systems.
This concept is also widely talked about, but far less widely practiced, in the software world. In some respects, the movement to three tier software architectures was a small step in the direction of loose coupling, at least at the level of standardizing interfaces across databases, application logic and presentation layers. In general, though, software has remained tightly coupled because of the inability of major vendors to agree on a universal set of standards to define interfaces across software modules. However, this appears to be changing. Web services technology (a SOA implementation) is built upon a loosely coupled design philosophy (Hagel 2004).
Besides the tendency to becoming more “loosely coupled”, the other shift that is observed in architectural paradigm throughout the period of the last forty years is the “migration” to more adaptable and flexible systems. Early mainframe systems used paper tape and punch cards to store data and programs. The use of mainframe processing time was strictly managed and allocated in sequential blocks or batches. On the contrary, services-oriented systems (implemented as discrete business services) are interconnected across an organization’s computer network, where it is possible to locate and re-use services registered with a central registry of services.

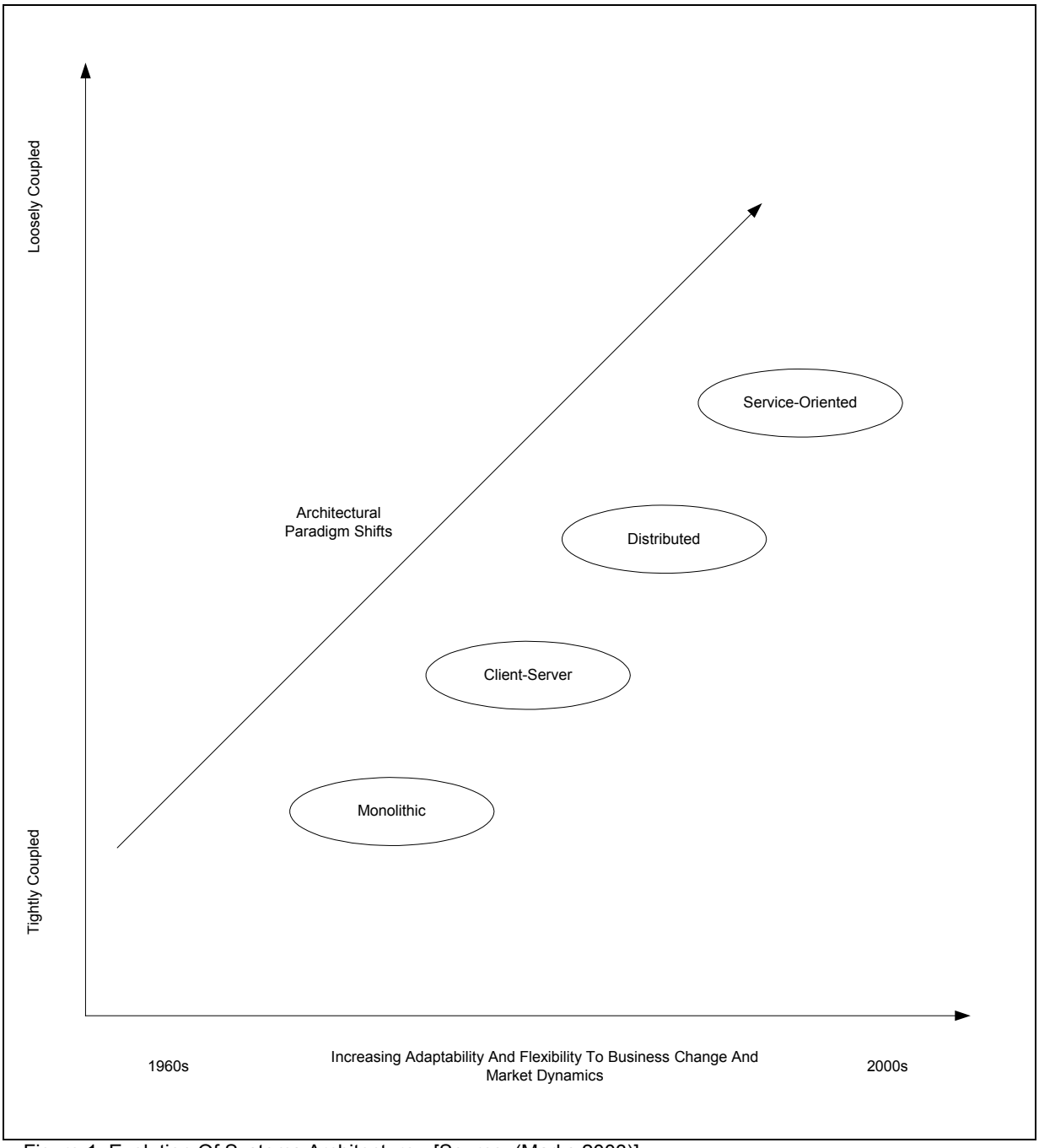

Figure 1. Evolution Of Systems Architecture - [Source: (Marks 2003)]

Even though there have been shifts in the architectural paradigm towards a more "loosely coupled", flexible and easily adaptable model over the last forty years, the current state of the IT industry is not yet an "ideal" place for business, especially for IT professionals (including the IT executives). For instance, today's IT executives have to deal with all sorts of technologies:

Business Applications - From large suites like Enterprise Resource Planning(ERP), Supply Chain Management(SCM), and Customer Relationship Management(CRM) packages to Portals and desktop productivity packages (like MS-Office, etc), as well as industry-specific applications;

Distributed Computing Architectures – Client-Server architectures for database-centric applications and N-tier architectures for Internet or intranet purposes, etc;

Middleware - The "glue" that keeps systems "talking" to each other, including message-oriented middleware (like IBM's MQ-Series), Application Servers(like BEA WebLogic, or Oracle's Application Server, etc), Enterprise Application Integration(EAI) solutions, and transaction monitoring and processing systems;

Miscellaneous Systems - Mainframes, mid-range computers, servers of all types and sizes, desktop systems(PCs), and any number of special-purpose systems, depending on industry;

Bloomberg (2003, 2) argues that: "this plethora of technologies, while intended to *address* business issues, often *presents* issues that the IT executive must resolve. Most of these issues fall into three broad categories: *complexity, inflexibility,* and *brittleness."*

All sorts of technologies encountered within contemporary organizations introduce unnecessary complexity. Today's enterprise IT environment contains many kinds of systems that work in many different ways. Enterprises must hire large, multi-skilled groups of workers to develop, deploy, and manage the heterogeneous collection of applications and systems needed.

Besides complexity, the existence of various kinds of technologies introduces inflexibility, considering that almost all enterprises have existing business applications that are difficult to upgrade, interoperate with, and worst of all, impractical to replace. Furthermore, heterogeneous systems tend to be difficult to integrate, each exposing different interfaces with different rules. Integration is therefore an expensive, difficult process that yields inflexible distributed systems.

But, inflexible systems also encompass the risk of failure and are a source of instability and brittleness. Traditional approaches to building IT environments lead to really messy approaches to integration. As a result, when business processes or requirements change, IT departments must either undertake expensive, risky upgrade projects, or simply drop the existing applications and systems because they no longer meet the business requirements.

Of course, the problems of complexity, inflexibility, and brittleness are nothing new in the enterprise. The need for a new solution (or approach) that will address all these issues encountered in the IT landscape today, seems to be, more than ever, an imperative matter. Today's IT executives need fresh approaches in dealing with heterogeneous environments and an increasing pace of change, in the face of tight budgets and a tough economy.

As a response to that need, a new approach to IT resources integration and systems architecture is gaining traction in enterprises across many industries. Known as *Service-Oriented Architecture* (SOA), this new way of thinking about how to integrate IT resources and access applications functionality in the enterprise aims to address most of the issues faced by enterprises today. “SOAs have the potential to rise to the challenges of brittle application infrastructures, inflexible technology, and high-risk, high-cost IT. Fundamentally, SOAs have the flexibility and responsiveness to finally enable business priorities to drive technology decisions. On the other hand, building service-oriented infrastructures is not easy. It requires commitment and expertise. The long-term business benefits of SOAs, however, can justify such investments. Many enterprises have already implemented SOAs and achieved quantifiable benefits from their investment in this new architectural approach.”(Bloomberg 2003, 1)

As a consequence, a SOA MM might be beneficial because it could help organizations position themselves in respect to SOA and guide them to achieve higher levels of SOA maturity. In particular, a maturity model is a framework that describes, for a specific area of interest (SOA in our case), a number of levels of sophistication at which activities in this area can be carried out. Existing literature (and SOA MM proposed by IT and other companies in the market) indicates important criteria to judge the level of SOA maturity within a single enterprise. However, identifying such criteria in an inter-enterprise environment is hardly addressed at all. Moreover, no inter-enterprise SOA MM has been defined for the time being.

According to resource dependence theory, a theory formulated in the 1970’s by Pfeffer and Salancik (1978), “the elemental structural characteristics of environments are concentration, the extent to which power and authority in the environment are widely dispersed; munificence, or the availability or scarcity of critical resources; and interconnectedness, the number and pattern of linkages, or connections, among organizations. These structural characteristics, in turn, determine the relationships among social actors – specifically, the degree of conflict and interdependence present in the social system. Conflict and interdependence, in turn, determine the uncertainty the organization confronts.” This theory clearly states that in an inter-enterprise environment, organizations manage their dependence with the goal of decreasing uncertainty by

creating formal inter-enterprise structures that formalize their relations with other organizations. In such a condition, organizations begin to collaborate together for a common purpose.

Therefore, the objective of this research is to bridge this gap; that is, to propose an inter-enterprise SOA MM by addressing a set of research questions:

- How many levels, stages of maturity will the proposed SOA MM contain?
- What are the domains (and the relevant focus areas) that will be included in the proposed SOA MM?
- Why is the chosen research methodology (a Delphi-variant technique) considered to be appropriate for this research?
- What are those features that need to be included in the proposed SOA MM to make it inter-enterprise (and that are not found in the existing SOA MMs)?

Besides the major research questions above, the following ones are also discussed throughout this research:

- What is the relationship of the proposed SOA MM to existing ones and to the CMMI model?
- How do we know that the proposed SOA MM is valid and appropriate for inter-enterprise settings?
- What potential benefits and problems does the inter-enterprise nature of the proposed SOA MM bring?

4. SOA, Maturity Models, SOA MM And Relevant Work

4.1. SOA

SOA is an approach to enterprise business systems and applications that considers software resources as services available and discoverable on a network. Such services provide functionality to the business while hiding the underlying implementation details. SOA consists of three components and there are three major operations through which the SOA participants interact (Figure 2).

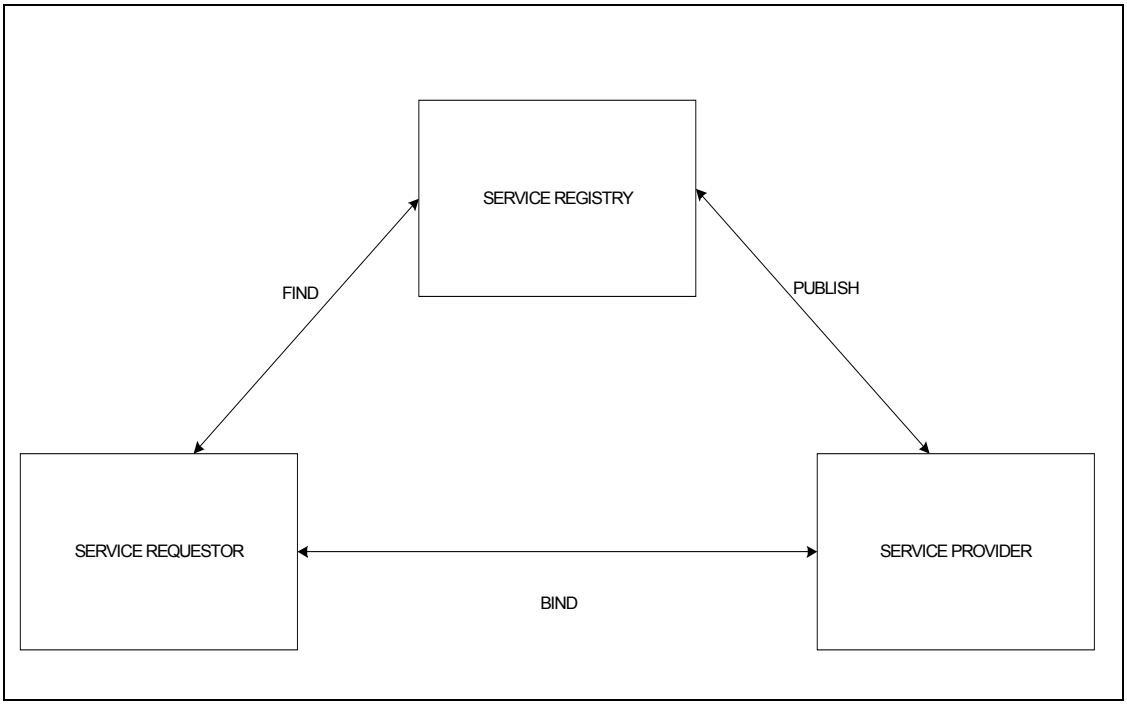

Figure 2. The Service Oriented Architecture - [Source: (Cutlip 2001)]

The "Service Provider" creates and publishes the services in the "Service Registry" which is responsible for registering and categorizing the services. These services are being "consumed" by the "Service Requestor" which discovers the required services by searching the registry and then invoking them by communicating with the actual "Service Provider".

The interaction between the major components of the SOA architecture is done via means of three basic operations: *Publish* (the "Service Provider" publishes its services to the "Service Registry"), *Find* (the "Service Requestor" locates, searches, and discovers the services stored by the "Service Registry"), and *Bind* (the "Service Requestor" binds and uses the service(s) provided by the "Service Provider" (through the "Service Registry").

SOA is primarily differentiated from previous architectural paradigms (Monolithic, Client-Server, and Distributed) due to certain distinct characteristics: the fact that the exchange of information between the communicating parties ("Service Provider" and "Service Requestor") is realized using "Open" interface standards (particularly, XML-based technologies), the fact that in SOA we strive to create coarse-grained services, meaning that each service delivers a significant piece of data or functionality which represents a well-defined step in a business process or transaction. On the contrary, in the applications or systems that are based on the Monolithic, Client-Server, or Distributed architectural paradigms, we create fine-grained components that implement low-level technical functions (and not real business functionality).

The most decisive factor, though, that distinguishes a SOA-based system from systems that are based on the other architectural paradigms, is its "loosely coupled" attribute. "Loosely coupled is an attribute of systems, referring to an approach to designing interfaces across modules to reduce the interdependencies across modules or components – in particular, reducing the risk that changes within one module will create unanticipated changes within other modules. This approach specifically seeks to increase flexibility in adding modules, replacing modules and changing operations within individual modules" (Hagel 2004). Indeed, traditional systems are tightly coupled (which means that the implementation of a "Service Provider" had to be closely tied to the implementation of the "Service Requestor" for the communicating parties to "talk" to one another), as opposed to SOA-based systems where the exchange of information between communicating parties takes the form of exchanging flexible, loosely tied services.

Finally, the other attribute that makes SOA distinct is the fact that in a SOA-based environment, services are published in the "Service Registry". "Service Registry" is a central repository, either within an organization or on the Web, which can be used to *dynamically discover* services at run-time, as opposed to rigid, monolithic and very specific references (to components) observed in the traditional architectural paradigms.

To conclude, SOA could address the complexity, inflexibility, and brittleness issues of existing approaches to integration through coarse-grained, loosely coupled, reusable services that could be easily and agilely "orchestrated" into different business processes to meet new or existing business system requirements every time.

4.2. Maturity Models

The concept of “maturity” literally means the change from one initial state to another, more advanced state (Fraser et al. 2002). Implicitly, the concept of “maturity” incorporates the notion of gradual evolution through intermediate states. The evolutionary nature of these states is expressed by Shapiro (1996) pointing out the fact that all companies that improve their processes pass through phases of evolution.

Maturity as a measure to evaluate the capabilities of an organization in regards to a certain discipline has become popular since the Capability Maturity Model (CMM) which was proposed by the Software Engineering Institute at the Carnegie Mellon University (Paulk et al. 1993). Whilst the original CMM focuses specifically on the evaluation of software development processes, the model has been varied and extended and is now applied to IT Infrastructure Management, Enterprise Architecture Management and Knowledge Management to name a few.

The roots of maturity approaches, though, lie in quality management. Crosby (1979) introduced the first maturity model named ”Quality Management Maturity Grid.” Since that first maturity model, many models have been introduced in different areas. Maturity is not only related to quality management; there are maturity models that measure the capacity and maturity of other disciplines and practices, too. For instance, there are maturity models that measure the maturity of a project management practice (Kerzner 2005), of software maintenance (April et al. 2005), of business processes (Rosemann and de Bruin 2005) and of outsourcing (Adelakun 2004). Maturity models are also able to explain the maturity of an enterprise architecture by describing the ability to manage its development, implementation and maintenance (van der Raadt et al. 2005).

Alleman (2005) argues that the idea of maturity assessment aims at addressing three major aspects in an organization: identifying risks, focusing improvement and identifying areas from which it can have financial and other benefits. So, it can be said that the establishment of an organization’s maturity can be the first step toward the development of its improvement strategy which in turn, can help it establish goals for process improvement and identify opportunities for business optimization.

A maturity model can also allow an organization of improve its processes by benchmarking itself against other internal or external organizations. By benchmarking its processes, an organization can measure the efficiency of its operations against similar operations of other entities.
Nowadays, many organizations are trying to setup and execute a process management improvement strategy in an attempt to gain real financial and other benefits. Unfortunately, as

Gainer (1998) notes, there is often significant resistance in some organizations to formalized process initiatives. In particular, some organizations are so preoccupied with market and daily demands that a serious process improvement initiative is practically impossible. Thus, seeking formal improvement within those organizations can be time consuming and expensive, but the rewards in the quality of the processes can be significant.

Moreover, a maturity model can offer an improvement path to the firm in terms of its predictability which is realized through a greater accuracy in anticipating results and thus effectively contributing to the planning and budgeting of resources allocation and utilization (Garcia Romero 2001).

An additional benefit that can be provided by a maturity model is the fact that it can allow a possible interested party to be certain of the potential of an organization. Depending on the level of maturity that an organization has, an external party (another organization, a stakeholder, a client, or a supplier) can have a clearer idea about the organization's capabilities and potential, in order to decide whether it is risky or not to have economic dealings with it.

Summarizing, with maturity models the organizations can determine their maturity and capability in various areas, and this might enable them to evolve toward a culture of process improvement excellence which, in turn, leads to greater efficiency of operations, more accurate planning, safer decision making, less risks and higher credibility.

4.3. SOA MM And Relevant Work

Recently a number of models to measure the maturity of SOA initiatives by organizations has been proposed. The common base for the majority of these models has been the Capability Maturity Model (CMM). This model is "a process improvement approach that provides organizations with the essential elements of effective processes. It can be used to guide process improvement across a project, a division, or an entire organization. CMMI (CMM, Integration-specific) helps integrate traditionally separate organizational functions, set process improvement goals and priorities, provide guidance for quality processes and a point of reference for appraising current processes." (CMMI 2006)

Pyster (2005) describes CMMI model as a relatively complete and widely used framework for process improvement in software development. CMMI's maturity levels are defined as evolutionary plateaus of process improvement, which should help to predict the future performance of an organization by describing the range of expected results. In particular, five levels of process improvement maturity are defined, and the level an organization is currently located (in terms of its process improvement stage) is determined according to the fulfillment (or not) of well-(pre-)defined indicators (Table 1).

CMMI Level	CMMI Level Brief Description
Level 1: Performed	Base practices are performed in order to achieve specific goals;
Level 2: Managed	A managed process institutionalized by, for example, establishing policy, creating standards and training people;
Level 3: Defined	The process should be institutionalized and tailored to the company to be able to apply it to the whole company;
Level 4: Quantitatively Managed	The process should be controlled by quantitative techniques;
Level 5: Optimizing	This level is characterized by a process adopted to meet relevant current and projected business objectives through continuous process improvement;

Table 1. CMMI Model (Based On: CMMI 2006)

According to CMMI (2006), both business and technical benefits are expected from the adoption of the CMMI framework by organizations. Among others, these include: "the substantial reduction in systems integration and test time with greater probability of success," "CMMI is considered to be the cause of integration of, and interaction among, the various engineering functions," "CMMI contribute to the overall project and organization success," "CMMI leverages previous process improvement investments" and the "increased focus and consistency in requirements development and management, systems design and development, systems integration, risk management, and measurement and analysis." (CMMI 2006)

Bush and Dunaway (2005) also argue that CMMI emphasizes the importance of detecting defects early in the process where it is applied and then preventing them: “the process improvement initiated by this model involves an organizational discipline that recognizes and deals with problems early, accepts independent quality reviews, and promotes discomfort when quality procedures are missing which in turn motivates positive change.“ (Bush and Dunaway 2005)

Furthermore, the real-world benefits enjoyed by organizations whose
“software development”-related projects were implemented using the CMMI model proved the model’s potential. Indicatively, “Lockheed Martin”, a military and defense systems company, managed to increase software productivity by 30% and decrease defect find and fix costs by 15%; for “General Motors Corporation”, an automotive manufacturing company, the use of CMMI model resulted in improved projects’ schedules, that is, projects met milestones and were fewer days late; CMMI helped “Thales ATM”, an air traffic management company, to see into the future with a known level of confidence, have an increasing number of processes under statistical control and achieve return on investment due to earlier defect detection, improved risk management and better control of projects; Improvements caused by CMMI adoption were also realized by “Bosch Gasoline Systems”, a leading global supplier of technology in the automotive industry: the internal on-time delivery improved by 15%, the first pass yield improved by 10% and there was a reduction in error cases in the factory by one order of magnitude; “J.P. Morgan Chase & Co.”, a leading global financial services firm, also enjoyed CMMI-related benefits: there was an improved predictability of delivery schedule, a reduction of post-release defects, a reduced severity of post-release defects and an increased throughput.

Besides the real-world cases and benefits enjoyed by organizations that adopted CMMI, a set of CMMI’s strengths and weaknesses, separated in five major domains (Size, Structure, Scope, Interpretability, Sustainability of Commitment), testified by engineers of a leading Systems Integrator, EDS (2007), which plans, designs and implements CMMI-based projects for other organizations, constitute a good indicator for the model’s potential and shortcomings mainly because it is based on their extensive exposure and experience in the area.

As far as the size of the model is concerned, EDS engineers argue that even though the model provides a large amount of background and guidance information based on industry best practices which can be valuable if used correctly, the size of the model can result in information overload, leading to either “paralysis” or “blind practice implementation.” (EDS 2007)

Regarding structure, the strengths identified are the facts that: “by providing a hierarchy of process areas, CMMI promotes an evolutionary approach to improvement which is more effective and sustainable” and “the separation of process areas allows for more focused and manageable process improvement efforts.” (EDS 2007) On the contrary, the large number of separate process areas makes it difficult to clearly identify and understand their relationships and the fact that in some cases, organizations develop process architectures which reflect CMMI’s process areas rather than their business operations, are the major weaknesses of the CMMI model in respect to its structure.

CMMI’s limitation of scope allows for a greater level of detail and guidance for project-related processes. Its limited scope, though, provides limited support for non-project related business functions.

According to EDS (2007), “CMMI goals and generic practices are worded in such a way as to be applicable to a wide range of organizations and projects” and “the CMMI contains a large amount of interpretive guidance for organizations and projects focused on large-scale development” are regarded as CMMI’s strong points, in respect to interpretability. On the other hand, the fact that the CMMI model refers to specific practices and the interpretive guidance tends to be worded to apply to large-scale development and limited guidance is provided to interpret this for “small enhancements” or “non-development” projects is considered to be the major shortcoming as far as the interpretability of the CMMI model is concerned.

Finally, in respect to the CMMI’s sustainability of commitment domain, EDS engineers argue that the fact that CMMI provides maturity levels as a means for setting and evaluating progress towards process improvement targets and that it has a strong focus on measurement which assists with determining the return on investment for process improvement activities, are among the strengths of CMMI regarding this domain. The weaknesses, though, of the CMMI model, in respect to the sustainability of commitment domain, according to the EDS (2007), constitute the facts that the “implications of targets are not always understood and this can lead to the CMMI becoming the end in itself and not a means to drive improvements” and that the “timeframes for achievement of CMMI targets may be inconsistent with short-term business cycles.” (EDS 2007)

To conclude, the CMMI model incorporates both strong and weak attributes. Even though one may argue that:
(a) CMMI's underlying assumption: "good processes lead to good results" is both a questionable assumption and one that leads to too much introspection about process and too little focus on actual results, and
(b) it is impossible, especially for any non-trivial project, to get one level of the CMMI model perfected before moving on to the next phases (as it also happens to all staged models),
CMMI remains a widely accepted and a relatively complete model that has been designed for process improvement in software development. It is due to all these CMMI's properties and strengths that most of the SOA maturity models are having CMMI as a common base.

Currently, SOA is the new trend in IT Architecture and consequently specialized maturity models (among others, IBM 2006, HP 2006, Oracle 2006, Sonic Software Corp. et al. 2005, Arsanjani and Holley 2005) were created to describe the maturity of a SOA initiative.

The SOA Maturity Model might become the enabling force for an enterprise to be drawn into the "vehicle" of this new software paradigm (SOA) because it designates the degree to which an enterprise might benefit from the SOA adoption at the point in time the model is being applied and what actions are needed to proceed to higher levels in the SOA maturity scale and thus further "reap" the value "encapsulated" within SOA. It is due to this SOA property that the IT giants (IBM, Accenture, Microsoft, Sun Microsystems, Oracle, HP, BEA, etc) and others (for instance, CBDI Forum) not only came up with formal guidelines (or even planning tools) for successfully adopting SOA, but also started proposing SOA maturity models. A detailed presentation of these SOA maturity models can be found in Appendix I (titled: "Major SOA Maturity Models").

All these SOA MM, though, lack an important ingredient that this research tries to address: consideration of domains (and corresponding focus areas) observed in inter-enterprise environments.
I think that this very important as changes in the business environment and competition force companies to re-think the way they are doing business. More and more organizations nowadays take advantage of the next level of re-engineering approaches which capitalize on connecting and aligning one company's operations with other companies to meet important organizational goals. The origin of these interconnected inter-enterprise business structures, called networked businesses, are explained by the resource dependence theory (Pfeffer and Salancik 1978). In summary, the resource dependence theory tells us that organizations must study themselves in relation to the organizations with which they want to share resources. In such a study,

organizations need to give special attention to external control which they could face when their processes depend partially, or completely, on other organizations' resources.

Based on this, it is considered that the proposed SOA MM should include inter-enterprise parameters to be complete and valuable to the organizations that will adopt it.

5. Research Approach And Methods

5.1. Delphi: Introduction, Implementation of The Method & Strengths And Limitations

5.1.1. Delphi: Introduction

The Delphi method is a structured method for deriving experts' opinion on a topic (Adler and Ziglio 1996) and generating forecasts in technology, education, and other fields (Cornish 1977). Its objective is fulfilled by reaching a consensus and position by a selected group of experts whose opinion on a defined issue is gathered via a series of questionnaires (Helmer 1983).
Even though the experts' judgment on a defined issue might be considered to be subjective, it is believed to be more reliable than individual's statements and is thus more objective in its outcome (Johnson and King 1988, Masini 1993). As Linstone and Turoff (1975) also argue: "Delphi may be characterized as a method for structuring a group communication process, so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem."

The Delphi method, which has its origins back in 1953 and it was created by Olaf Helmer and Norman Dalkey at the RAND corporation to address future military issues, has been widely accepted because of its flexibility and applicability in various areas: it is a method for structuring a group communication process to facilitate group problem solving (Linstone and Turloff 1975), it can be used as a judgment, decision-aiding or forecasting tool (Rowe and Wright 1999), and can be applied to program planning and administration (Delbeq et al. 1975). It can also be used when there is incomplete knowledge about a problem or phenomena (Adler and Ziglio 1996; Delbeq et al. 1975). Moreover, the Delphi method can be used to investigate what does not yet exist (Czinkota and Ronkainen 1997; Halal et al. 1997; Skulmoski and Hartman 2002).

5.1.2. Delphi: Implementation of The Method (The Process)

According to Fowles (1978), the Delphi method involves: (a) selection of panel of expert based on pre-determined criteria (for example, proven academic qualifications and professional expertise on a defined issue under investigation, publications, etc); (b) formulation of the first-round questionnaire which is distributed to the selected experts; (c) completion of the questionnaire (by the panel experts) and its submission to the researcher (or codification team) who (or which) is performing the study; (d) analysis of the participating experts' answers and identification of the general tendency in their responses on the various points raised; (e) check whether appearance of convergence between the participating experts' points of view is observed (this normally starts appearing after the second-round questionnaire); if not, a new questionnaire is prepared and sent out to the panel experts; this cycle (constituting of stages –c- to –e-) is repeated until a sufficient convergence of opinions is reached; (f) preparation of a summary of the process followed and drawing up of the final report with findings and conclusions (when, of course, the expected convergence of experts' opinions is reached); These main stages of a typical Delphi method process implementation are shown in Figure 3.

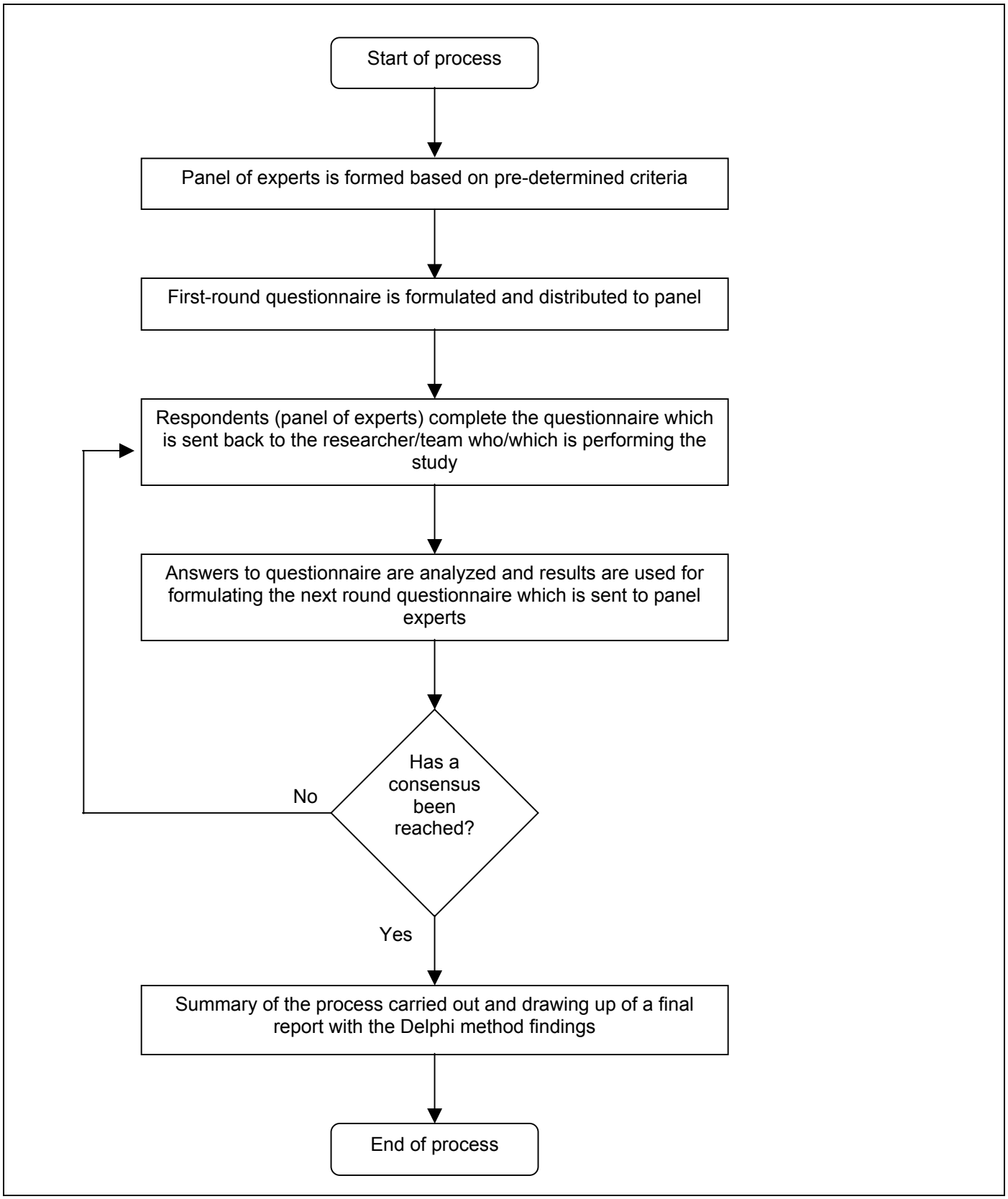

Figure 3. Typical Delphi Method Process Implementation

5.1.3. Delphi: Strengths And Limitations

Throughout the years, various criticisms have been leveled at Delphi. In particular, according to Gordon and Hayward (1968), Gatewood and Gatewood (1983), and Adler and Ziglio (1996), a major problem identified into the implementation and application of Delphi surveys has been the experts' approach toward the investigated issue. In particular, most of the times, experts treat the issues under investigation in a very simplistic way, failing to have a more holistic view and overlooking all involved factors and parameters.

Other criticisms of Delphi studies include the works by Erffmeyer et al. (1986), Schmidt (1997), Turoff (1970), and van de Ven and Delbecq (1974) who argue that Delphi study design is not so flexible, and the conclusions drawn by Ono and Wedemeyer (1994) and Woudenberg (1991) who support that the accuracy and validity of Delphi study outcomes is something that is questionable.

Also, according to Makridakis and Wheelwright (1978), the key problems reported, with regards to the Delphi method implementation, include: "poor internal consistency and reliability of judgments among experts, and therefore low reproduce-ability of forecasts based on the results elicited; sensitivity of results to ambiguity and respondent reactivity in the questionnaires used for data collection; difficulty in assessing the degree of expertise held by participating experts."

Moreover, Martino (1978) argues that: "the results of a Delphi survey are only as valid as the opinions of the experts involved."

On the other hand, reported advantages of Delphi studies include: (a) the fact that anonymity leads to more creative outcomes and adds richness to data (van de Ven and Delbecq 1974; Okoli and Pawlowski 2004), (b) the argument that the possibility of having issues associated with the face-to-face interactions (that is, dominate personalities, conflict and group pressures, etc) as the ones occurred throughout a Delphi study implementation are virtually eliminated through the rules and restrictions imposed while carrying out the study (Helmer 1967; Loo 2002; Murphy et al. 1998) and (c) the fact that geographic boundaries and associated travel and co-ordination factors are essentially removed because the study can be implemented either via fax or other electronic means –electronic mail, etc- (Loo 2002; Okoli and Pawlowski 2004; Powell 2003).

There are also studies (Ament 1970; Wissema 1982; Helmer 1983; Ono and Wedemeyer 1994) suggesting that, in general, the Delphi method is useful in the cases of single-dimension issues and their outcomes proven to be accurate. Similarly, Ascher and Overholt (1983) argue that: "Delphi studies have an excellent record of forecasting, among others, in computer capability advances."

5.2. Current Research Approach: A Variant To Delphi Technique

5.2.1. Applicability Of The Approach

It is interesting to look at what researchers -who extensively work with the Delphi method- suggest of Delphi's applicability: according to Okoli and Pawlowski (2004) and Ono and Wedemeyer (1994), Delphi studies are considered beneficial when one deals with complex issues; Bass (1983) argues that Delphi can be used when one seeks to combine views to improve decision making; Delbecq et al. (1975) suggest that Delphi is appropriate in cases where an incomplete state of knowledge about a problem or phenomenon is observed and it can be used to contribute to its enrichment; and Murphy et al. (1998) support that Delphi is appropriate where there is a lack of empirical evidence.

Considering these opinions about Delphi applicability, it has been concluded that the most appropriate methodology for this thesis is a Delphi-variant technique with the major arguments being: (a) a desire to maximize the benefit of the available pool of local SOA experts and (b) to incorporate the innovativeness of the research topic.

Also, in an attempt to reap the maximum potential outcomes from the current Delphi study, both the strengths and the limitations of the method (as presented in the previous paragraph) have been considered when designing its overall structure and the selection of the experts' panel and the codification team.

5.2.2. Delphi Study Structure

To determine the appropriate number of iterations for the proposed Delphi study both the aim of the study and the experiences from similar studies were considered. Time constraints indicated 'the sooner the better' but this had to be balanced such that a meaningful and creative input was provided to panel experts and at the same time the best possible outcomes were obtained. Erffmeyer et al. (1986), in a study into the optimal number of rounds, achieved stability after the fourth round. In more recent studies, Mulligan (2002), Powell (2003) and Richards and Curran (2002) considered three rounds were appropriate, whilst Murphy et al. (1998) and van de Ven and Delbecq (1974) suggest two or more and Loo (2002), three to four. These suggestions, combined with the aims of the study, had led to the development of a three-rounds Delphi study for the purposes of this thesis' objectives.

5.2.3. Codification And Experts Panel Teams Selection; Ethical Issues Addressed Through Standards, Restrictions And Rules

Setting some rules and restrictions both for the panel of experts selection and for the codification team and the way they would be functioning led to an elimination of any ethical issues that might be raised and that, in turn, to an increased reliability and accuracy for the thesis.

5.2.3.1 Codification Team

I was in charge of the execution and administration of this Delphi study. Moreover, I was playing the role of the codification team having the responsibility of consolidating panel members' responses and preparing the next round's questionnaire.

Having this role, some restrictions were imposed making sure of the undertaken study's integrity:

- I was not able to participate in the experts panel at any stage;
- I was unaware of the identity of experts panel members (except the experts panel co-ordinator with whom I was interacting with and collaborating);
- I was not advised of any demographic details (except from the fact that they were all working in Cyprus) of the experts panel members in relation to responses being coded;

5.2.3.2. Experts Panel Selection

An important aspect of the Delphi studies is the selection of the panel of experts. Powell (2003) indicates that this selection will potentially determine the success of a Delphi study.

As far as the expert classification is concerned, two primary aspects were considered: category (that is, whether the expert comes from Industry or Academia) and expertise in any of the factors (or domains) involved in this area (SOA).

To address the key design issue of "Academia vs. Practice", a balance of academics and industry representatives was considered for the category classification. Industry practitioners were further assessed on the basis of their specialization, i.e. the aim was to include representatives from both IT consulting organizations and organizations from any field interested in adopting such the proposed model (SOA MM).

Whilst some attempts were made to classify experts based on the factors identified by the various SOA MM in existence, that is, Architecture, Infrastructure, Governance, etc, this was left to the participants to self-assess their expertise and to nominate for the factors in which they felt best qualified to participate. Self-nomination for participation would potentially increase motivation and commitment to the study, but also would not pre-establish the factors (or domains) that would be included in the proposed SOA MM (which needs to be derived from the execution of the Delphi study).

In determining the appropriate number of experts for inclusion in the panel, both the relevant literature and the aims of the study were considered. Between 15 and 20 experts was considered to be an appropriate number and was consistent with guidelines from other researchers (Loo 2002; Okoli and Pawlowski 2004; Powell 2003; Richards and Curran 2002).

Besides the above set of criteria for the experts panel selection, an additional experts' attribute is the fact that they were all working at Cyprus. The time frame for completing the thesis was very limited, so the idea for considering SOA experts (both from the industry and academia) from abroad was abandoned. The "local" or "global" nature of the proposed SOA MM which was derived from local experts only, was checked, as already mentioned, by conducting interviews, as an integral part to Delphi, with some of the panel experts and local business practitioners (business owners and business practice managers).

To comply with the restrictions and rules set for the current Delphi session, the final selection of the expert panel members was left to a colleague from academia who was chosen because of his understanding of qualitative research methods and deep knowledge on SOA and who was my contact point and the coordinator of the experts panel during the Delphi execution.

6. The Proposed SOA MM

6.1. Delphi Technique Applied – First-Round Questionnaire And Its Findings

The application of the Delphi technique's life-cycle started by distributing an overview of the various available SOA Maturity Models (as presented in paragraph 4.3 SOA MM & Relevant Work and in Appendix I) and the CMMI maturity model (also presented in paragraph 4.3) to the panel experts (through their coordinator).

In particular, the panel experts were asked to review the available SOA MM and comment on whether they were complete (specifically in respect to whether they considered inter-enterprise elements, attributes) or whether any additions might be needed. Moreover, they were asked to propose what might be recommended to include in a new SOA MM and what form this might take. Panel experts were encouraged to draw upon their experiences, and use any historical data, research, or other available resources to help in answering the posed questions.

Upon receipt of panel experts' comments (in an unstructured and informal format), the first-round questionnaire (shown in **Appendix A: Delphi Technique Applied – First-Round Questionnaire**) was formulated based on their feedback and on what this research work was trying to investigate. That is, the responses provided by the panel experts designated the major themes of the first-round questionnaire:

- how many levels might be included in the newly proposed SOA MM;
- what domains might be considered as SOA enablers and recommended for inclusion in the new SOA MM;
- what are the focus areas on which the identified SOA MM domains will be evaluated;

which were complemented with questions that were trying to also address other objectives of the thesis:

- help the participating experts' organizations position themselves in respect to SOA (current status) and anticipate their SOA maturity in five years time;

Once the first-round questionnaire was prepared, it was distributed to each panel member for completion though their coordinator. When all twenty panel experts responded to the questionnaire, the panel coordinator returned the questionnaire back to the codification team (myself) which was responsible for reviewing, compiling and using the responses for developing the next rounds questionnaires.

Even though the Delphi study in progress was in its initial stages, the findings of the first-round questionnaire (shown in **Appendix B: Delphi Technique Applied – First-Round Questionnaire Findings**) started providing initial points of convergence to the various issues this research was trying to investigate.

In particular, 60 percent of the respondents preferred "Five" to the question: "Considering the various available SOA Maturity Models (distributed earlier to you) and the CMMI maturity Model (also distributed earlier to you), how many levels/stages do you think might be included to a newly proposed SOA Maturity Model?".

Of the 60 percent, 35 percent chose "Five" mainly because "The HP's and Oracle's Maturity Model is the most complete" and because of "The high success rate of SOA projects by enterprises that adopted HP's and Oracle's SOA Maturity Model, according to independent studies/surveys" (as revealed by Question 4).

The other 25 percent selected "Five" because "The proposed SOA Maturity Model need not be based on any IT vendor's SOA Maturity Model(s), but instead on an independent's body/entity (if any)" and because the "CMMI was introduced by the leading IT academic institution in the US (Carnegie Mellon University) and, as such, it is recommended as the basis of all the Maturity Models of any type/kind" (as revealed by Question 5).

With Question 6 through Question 17, an attempt was made to come up with the domains (along with the "focus areas" on which these domains would be evaluated) which are the "SOA Enablers" and it is recommended they be included in the newly proposed SOA Maturity Model (pSOAMM).

For Question 6 an assumption was made: any of the available replies that score 10 and above, would be seriously considered for inclusion in the proposed SOA Maturity Model (those with 15 and above would definitely be part of the model). This assumption was made because of the fact that the panel of IT experts was asked to choose as many of the available replies as needed.

Based on this assumption and the results of the panel, the domains: "Architecture"(18 preferences), "Business Processes"(18 preferences), "Information or Data Format"(17 preferences), "Enabling Technologies / IT Infrastructure"(16 preferences), "Governance"(15 preferences), "Business / Organization"(15 preferences) and "Delivery Methods"(15 preferences) were identified as definite to be included in the proposed SOA Maturity Model.

The "focus areas" on which the domains (tentatively identified in Question 6) would be evaluated, were revealed starting with Question 7 (through Question 17).
As far as the domain "Business / Organization" is concerned, the panel members selected the "Whether (or not) there is and the degree of IT alignment with Business strategy" (37.7percent), the "Whether (or not) there is and the degree of business involvement and understanding of SOA activities/projects" (33.3 percent), and the "Change management (how easily the employees will adopt the change to SOA)" (22.2 percent), as the most representing focus areas.

"The scope (inter-enterprise, enterprise-wide, department-wide, etc) of organized SOA efforts" (33.3 percent), the "Whether (or not) and to what extent there are policy enforcement schemes, reporting and exception handling guidelines/procedures across the collaborating enterprises" (33.3 percent) and the "Whether (or not) there is and the degree of funding for projects" (28.9 percent) were the focus areas the panel recommended be considered as the key evaluators as to whether the "Governance" domain had reached (or not) a certain level/stage of maturity.

For the "Architecture" domain, the "Whether there is an Enterprise Architecture (and which is its role) in the organization and whether it also governs the organization's relationships with its collaborating organizations" (29.6 percent), the "Whether (or not) there is and the degree to which the Enterprise Architecture is being considered in the enterprise-wide and inter-enterprise planning activities" (27.7 percent) and the "Whether (or not) there is and the degree to which services are cataloged and reused across the collaborating organizations" (25.9 percent) were the top three choices of the panel.

The panel chose: "Whether the right tools (for software design, development, deployment, etc), technologies are in place", "Whether industry standards are being followed (in respect to all aspects of IT operations)" and "Whether security, monitoring, and management tools (solutions) are in place," all with the same percentage of respondents' preference, 29.1 percent, as focus areas for the "Enabling Technologies / IT Infrastructure" domain.

An equal percentage of respondents, 33.3 percent, also preferred the focus areas for the "Delivery Methods" domain: "Whether there are any policies, practices (throughout the collaborating enterprises) for delivering the SOA solutions", "Whether there are skills and expertise (throughout the collaborating enterprises) for delivering the SOA solutions" and "Whether there are any methodologies, modeling and abstraction techniques (throughout the collaborating enterprises) for delivering the SOA solutions".

In respect to the “Information or Data Format” domain, the focus areas proposed were: “Whether the collaborating enterprises are using industry standards for the representation of data (e.g. XML)” (35.3 percent), “Whether the collaborating enterprises are not only using industry standards for the representation of data (like XML), but also other canonical formats and metadata management standards (like XSD, XSLT, XPath, Expression Language, etc)” (35.3 percent), and “Whether the data is in a single location (that is, whether there is any kind of data consolidation in place throughout the collaborating enterprises)” (29.4 percent).

The “Whether any kind of business process automation is in place” (37 percent), the “Whether there is any kind of business process monitoring tool used (throughout the collaborating enterprises)” (27.7 percent) and the “Whether a cross-application orchestration of business processes has been deployed (throughout the collaborating enterprises)” (27.7 percent) were the top three options selected from those available as the focus areas for evaluating the “Business Processes” domain.

Coming into the second set of questions, where an attempt was made to establish the current and the future status of SOA (in respect to the proposed SOA Maturity Model), the replies have shown that 50 percent of the panel members either “Use selectively, without a clear strategy” (30 percent) or “Have an enterprise-level strategy and commitment for SOA” (20 percent).
The other 50 percent either “Will pursue within the next twelve to twenty-four months” (25 percent) or “Not pursuing, and no immediate plans to do so” (25 percent).
These results have shown that the SOA adoption in the local market is halfway to being fully utilized/used.

Also, an interesting finding in respect to SOA projects’ applicability is revealed by the question “What are you currently using SOA for?”. In particular, according to panel members, SOA projects are mainly encountered in Internal and External Integration activities (at 50 percent and 20 percent respectively) but also in “Strategic business transformation” activities (30 percent).

Moreover, the top three factors that facilitate the “penetration” of SOA within their organizations are: the “SOA enhances agility and flexibility; important ingredients for our organization” (33.3 percent), the “SOA reduces information systems integration complexity” (33.3 percent), and the “SOA lowers costs by re-using existing IT assets” (33.3 percent).

It is interesting to compare these results with those derived from a similar question raised 18 months ago in a questionnaire distributed to the same group of participants for the purposes of Document 4 of this research work.
18 months ago, to the panel members participating in that work, the top three factors that facilitated the "penetration" of SOA within their organizations were: "SOA enhances agility and flexibility; important ingredients for our organization" (50 percent), "SOA reduces information systems integration complexity" (20 percent), and with equal preference among respondents, at 10 percent, the following: "SOA eliminates inefficiencies by lowering operating costs", "SOA creates new business opportunities through collaboration, outsourcing, and by enabling global presence for our goods and services", and "SOA accelerates growth by facilitating the integration of systems of acquired companies."

Out of these two studies, it is important to point out the fact that both the reply "SOA enhances agility and flexibility; important ingredients for our organization" and "SOA reduces information systems integration complexity" were among the top preferred replies (with some changes in the popularity between this study and the one carried out in the past) and also the fact that the third most popular reply in the current study is "SOA lowers costs by re-using existing IT assets" which was not among the top three replies in the study performed earlier.
This means that the replies "SOA enhances agility and flexibility; important ingredients for our organization" and "SOA reduces information systems integration complexity" are steadily among the most popular to the panel members.
Moreover, during the time elapsed from the previous study to this one, the panel experts appeared to realize that one of the most important benefits of SOA is re-usability; that is, the fact that they are not "directed" to rip-and-replace their existing IT infrastructure, but to re-use it.

On the contrary, the top three prohibiting factors for the adoption of SOA (and Web Services) within organizations were found to be the same as those found in the previous study (which, as said earlier, took place 18 months ago and was distributed to the same group of participants for the purposes of Document 4 of this research work): "There is a lack of skills for the implementation and deployment of SOA-based Information Systems" and "lack of funding" (at 33.3 percent of respondents' preference) and "the technology is still immature" and there is a "lack of anticipated ROI" (at 16.7 percent of respondents' preference).
In the previous study, the prohibiting factors for the adoption of SOA (and Web Services) within organizations were found to be: "A lack of skills for the implementation and deployment of SOA-based Information Systems" (40 percent), "the technology is still immature", "lack of anticipated ROI", and "lack of funding" all at 20 percent of respondents' preference.

Comparing the two studies, that is this one and the one which took place 18 months ago, it is observed that the reply "There is a lack of skills for the implementation and deployment of SOA-based Information Systems" was reduced from 40 percent of respondents' preference to 33.3 percent, which indicates a trend for IT professionals (in general) to acquire the skills needed to minimize the gap between "demand and supply" for this new IT paradigm (SOA).
In addition, the replies: "the technology is still immature" and the "lack of anticipated ROI" were reduced to 16.7 percent of respondents' preference (from 20 percent) suggesting that the technology (SOA / Web Services) is becoming more and more mature and that the first reliable testimonials on "returns-on-SOA-related-investments" have started persuading people about this technology's business value.
What is also important to point out is the fact that the reply "lack of funding" rose to 33.3 percent of respondents' preference in the current study, from 20 percent in the previous one. This, of course, indicates that funding of SOA projects is still a problem (that is, cannot be easily secured), but at the same time this also means that -most probably- many more requests were made for SOA activities/projects (since the previous study) and they were rejected. This is a reasonable explanation to the reply's "lack of funding" increasing trend.

As with the previous study (the one performed for Document 4, 18 months ago), a different question was raised concerning the SOA "penetration" five years from now in the broader business landscape and a different one concerning the SOA "penetration" in five years within their organizations.
Of interest, though, in both studies is the fact that the panel members responded in the exact same way in the current study as in the previous one: they believe that the status of SOA five years from now within their enterprises and in the broader business landscape will be the same. In both questions, the percentage of respondents' preference replying: "there will be a considerable (to great) increase in the adoption of SOA (and Web Services)" in this study was exactly the same as the previous one(50 percent). What has changed, though, is the percentage of respondents' preference to the replies: "SOA (and Web Services) will be the dominant technology in five years time, like what the 'static' Web is today" (35 percent now, from 25 percent) and "there will be a slight (or no) increase in the adoption of the technology" (15 percent now, from 25 percent) which clearly shows the increased "trust" of people in SOA.

Both in the previous study and in the current one, the top facilitators of the SOA adoption five years from now were considered: the "greater business flexibility and agility", the "lowering of costs of integrating existing applications and systems", and the fact that "there will be proven success stories associated with the application of SOA-based systems in highly demanding environments indicating the inherent benefits of the technology". The surprising feature, though,

in this point/question, is the fact that the percentages of respondents' preferred replies in the current study were almost the same as those provided in the previous one (33.3 now vs. 33.3 then, 33.3 now vs. 33.3 then, 20 now vs. 19.6 then).
So, 1.5 years later the panel members continue to believe that the SOA adoption facilitators are the same as the ones chosen in the previous study.

The prohibiting factors for the adoption of SOA-based systems, five years from now, as revealed by the current study, are considered to be: "the skills needed to implement and use the technology will be very limited in respect to the capacity required by the technology" (44.4 percent) and "the ROI will never be encouraging enough" along with "the technology will fail to prove itself when it will be implemented and deployed in systems where high security features are mandated" both at 22.2 percent of preferences.
The previous study, though, was slightly different from the current one on this specific point/question. According to the previous study, the prohibiting factors for the adoption of SOA-based systems, in five years time, were considered to be: "the skills needed to implement and use the technology will be very limited in respect to the capacity required by the technology" (40 percent), "the ROI will never be encouraging enough", "the technology will fail to prove itself when it is implemented and deployed in systems where high security features are mandated", and "the big supporters of the technology –Big IT companies like Microsoft, IBM, Oracle, etc- will abandon the technology and they will look for more profitable technologies/solutions", all three with 20 percent of preferences.
What is important to stress, if a comparison between the two studies was done in respect to this point/question, is the fact that the IT people (the panel experts in the case of the current study) started to believe that the big IT vendors "are here to stay", as far as SOA technology, is concerned. That's the reason why the reply "The big supporters of the technology (Big IT companies like Microsoft, IBM, Oracle, etc) will abandon the technology and they will look for more profitable technologies/solutions" decreased to 11.1 percent of respondents' preference in the current study (in respect to 20 percent of the previous one).

The findings of the first-round questionnaire were also distributed to the panel experts who were allowed to review their responses in light of the opinions of other experts, add comments, and change their responses if desired. The codification team then reviewed the responses and used this information to develop more specific questions to be used in the second questionnaire (shown in **Appendix C: "Delphi Technique Applied - Second-Round Questionnaire"**).

6.2. Delphi Technique Applied – Second-Round Questionnaire And Its Findings

The new questions (which constituted the second-round questionnaire) formulated by the codification team were posed to the panel (through the experts panel coordinator). Upon completion, panel members returned their answers back to the codification team. The findings of the second-round questionnaire started showing a consensus among panel experts about the topics the research was trying to investigate.

Five levels/stages might be included in the new SOA Maturity Model mainly because "the HP's and Oracle's Maturity Model is the most complete" and because of "the high success rate of SOA projects by enterprises that adopted HP's and Oracle's SOA Maturity Model, according to independent studies/surveys."

Moreover, the choice of five levels/stages in the proposed SOA Maturity Model is further supported by the arguments: "The proposed SOA Maturity Model need not be based on any IT vendor's SOA Maturity Model(s), but instead on an independent's body/entity model (if any)" and because the "CMMI was introduced by the leading IT academic institution in the US (Carnegie Mellon University) and as such it is recommended as the basis of all the Maturity Models of any type/kind."

Another important piece of information "captured" by the panel experts is the interpretation that could be given to these five levels of the proposed SOA Maturity Model (pSOAMM).

They agreed that their choice to select five as the ideal number of levels/stages to be included in the pSOAMM also implied that not only the number of level/stages of the proposed SOA Maturity Model might be the same as those of HP's & Oracle's and CMMI's, but also the interpretation provided by these models for each of the levels/stages would resemble that of the pSOAMM.

This means that when, for instance, an enterprise is in Level 1, SOA is a relatively new concept to it. Level 2 means that the enterprise has committed to adopting SOA for certain parts of the organization. SOA Maturity Level 3 is "awarded" to enterprises that have adopted SOA as a strategic enterprise-wide architectural paradigm. Level 4 means that SOA is fundamental to the way the enterprise operates and services might be used outside the enterprise (for instance, to be "consumed" by business partners or customers). When an enterprise reaches Level 5 maturity, it means that this enterprise operates a dynamic SOA with business and IT synchronized to achieve an optimum balance of agility, performance, risk and cost.

To be able to classify an enterprise at a certain SOA level, though, a set of domains (or dimensions) are required. In essence, domains are capability areas where an enterprise must focus to increase SOA maturity. Each domain requires a set of capabilities at each maturity level. Within a domain, capabilities are centered around "focus areas" on which the domains are evaluated.

The panel members recommended that the domains (or SOA enablers) be included in the proposed SOA Maturity Model (pSOAMM) are: "Architecture", "Business Processes", "Information or Data Format", "Enabling Technologies / IT Infrastructure", "Governance", "Business / Organization" and "Delivery Methods".

As far as the "Business / Organization" domain is concerned, the panel members selected the "Whether (or not) there is and the degree of IT alignment with Business strategy", the "Whether (or not) there is and the degree of business involvement and understanding of SOA activities/projects", and the "Change management (how easily the employees will adopt the change to SOA)" as the most representing focus areas for this domain.

"The scope (inter- enterprise, enterprise-wide, department-wide, etc) of organized SOA efforts", the "Whether (or not) and to what extent there are policy enforcement schemes, reporting and exception handling guidelines/procedures across the collaborating enterprises" and the "Whether (or not) there is and the degree of funding for projects" were the focus areas the panel members recommended be considered as the key evaluators as to whether the "Governance" domain has reached (or not) a certain level/stage of maturity.

For the "Architecture" domain, the "Whether there is an Enterprise Architecture (and which is its role) in the organization and whether it also governs the organization's relationships with its collaborating organizations", the "Whether (or not) there is and the degree to which the Enterprise Architecture is being considered in the enterprise-wide and inter-enterprise planning activities" and the "Whether (or not) there is and the degree to which services are cataloged and reused across the collaborating organizations" were the top three choices of the panel.

The panel chose: "Whether the right tools (for software design, development, deployment, etc) and technologies are in place", "Whether industry standards are being followed (in respect to all aspects of IT operations)" and "Whether security, monitoring, and management tools (solutions) are in place" as focus areas for the "Enabling Technologies / IT Infrastructure" domain.

The recommended focus areas for the “Delivery Methods” domain were: “Whether there are any policies and practices (throughout the collaborating enterprises) for delivering the SOA solutions”, “Whether there are skills and expertise (throughout the collaborating enterprises) for delivering the SOA solutions” and “Whether there are any methodologies, modeling and abstraction techniques (throughout the collaborating enterprises) for delivering the SOA solutions,” according to panel preference.

In respect to the “Information or Data Format” domain, the focus areas proposed were: “Whether the collaborating enterprises are using industry standards for the representation of data (e.g. XML)”, “Whether the collaborating enterprises are not only using industry standards for the representation of data (like XML), but also other canonical formats and metadata management standards (like XSD, XSLT, XPath, Expression Language, etc)” and “Whether the data is located on a single location (that is, whether there is any kind of data consolidation in place throughout the collaborating enterprises).”

The “Whether any kind of business process automation is in place”, the “Whether there is any kind of business process monitoring tool used (throughout the collaborating enterprises)” and the “Whether a cross-application orchestration of business processes has been deployed (throughout the collaborating enterprises)” were the top three options selected from those available as the focus areas for evaluating the “Business Processes” domain.

Capturing the maturity levels and the SOA domains (along with their focus areas) from the panel members who participated in this study (as revealed by the findings of the “Delphi Technique Applied - Second-Round Questionnaire”) led to the “birth” of the proposed SOA Maturity Model (pSOAMM) as shown in Table 2 below.

	Maturity Levels				
	Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**
pSOAMM's SOA Enabler / Domain (Along With Its Focus Areas)					
Architecture (*Focus Areas:* a. Role of Enterprise Architecture; b. Cataloging and Reuse; c. Planning and Guidance)	a. No formal Enterprise Architecture; b. No cataloging or reusing Web Services; c. Enterprise Architects are not involved in Planning;	a. There is an Architecture teams within the collaborating organizations, but their impact on their enterprises is not well understood; b. No formal catalog of Web Services, but reuse is taking place informally; c. Architects offer their advice, but their influence in Planning is minimal;	a. Heavy investments from the collaborating organizations in Enterprise Architecture, but they are only at the beginning of realizing associated benefits; b. There is a formal method for registering and finding Web Services; c. Enterprise Architects have a fair degree of authority;	a. Enterprise Architecture proves its value through business results; b. The use of Web Services repositories is enforced; c. Enterprise Architects are involved in every line of business within the collaborating organizations;	a. Enterprise Architecture transforms IT into business value; b. Advanced users of Web Services repositories; c. Enterprise Architects have a seat at the board room table within the collaborating organizations;
Infrastructure (*Focus Areas:* a. Standards; b. Security and Monitoring; c. Management and Operations)	a. No any formal stance regarding standards; b. Individual systems have their own security and monitoring models; little has been done to unify them; c. Individual systems have their own separate management and operations mechanisms;	a. IT assets started to be rationalized into standards-based versus non-standards; b. Security is addressed on a case-by-case basis; c. Automation techniques started to be utilized to make systems more manageable;	a. A formal position is held on which standards are important; b. Started standardizing the security schemes of the various systems across the collaborating organizations; c. Common management platform for all systems in the collaborating organizations is in place, but coverage is not complete;	a. Adherence to standards plays a critical role for all projects, particularly those spread throughout the collaborating organizations; b. Centralized security mechanisms have been fully deployed; c. Management platform has been fully deployed;	a. Continuous investment in emerging standards; b. Security has been completely abstracted out of all systems; Compliance to all security regulatory standards; c. Management has been consolidated into a unified console, allowing easy troubleshooting and monitoring;

	little has been done to consolidate them;				
Delivery (*Focus Areas:* a. Project vs. Inter-Enterprise Focus; b. Skills and Methodologies in Place; c. Modeling and Abstraction Techniques)	a. Each new application is treated as an independent new project; b. No formal assessment has been performed for SOA skills and methodologies; c. Limited and inconsistent modeling and abstraction techniques across projects;	a. New applications are subject to review and approval by an architectural review board which is composed of members from the collaborating organizations; b. SOA-related skill-set assessment is currently taking place; c. Modeling and abstraction techniques are under development;	a. Project changes may be mandated in the interest of maximizing benefits of the collaborating organizations (inter-enterprise focus); b. A baseline for skills and methodologies has been established and it is standardized across the collaborating enterprises; c. Modeling and abstraction techniques are employed in all new projects;	a. The disciplined inter-enterprise focus has resulted in significant service reuse, faster time-to-market, and less custom development; b. The required skill levels and methodologies are in place throughout the collaborating organizations; c. Modeling and abstraction techniques expanded to be used in legacy systems, too;	a. New application development is minimal, being replaced by rapid "orchestration" of services located in the inter-enterprise repository; b. Continuous investment in new skills and methods; c. Modeling and abstraction techniques are inextricable parts of every system throughout the collaborating organizations;
Information (*Focus Areas:* a. Data Standards and Canonical Formats; b. Metadata Management; c. Single Source of Truth)	a. No data standards or canonical data formats are in place; b. Metadata management is not viewed as important; c. No common data model in place for any application;	a. Design has begun on data representation standards and canonical formats; b. Design has begun on a metadata management solution; c. A common data model has been constructed but is in limited use;	a. Inter-enterprise data model is under construction; b. Plan for a metadata management solution is implemented for specific types of business data; c. Multiple applications are using a common data model;	a. Plan for data standardization is complete and fully deployed; b. Plan for metadata management is complete and fully deployed; c. All applications are tied into the common data model, but data duplication and cleansing are still an issue;	a. Plan continuously evolves to address new industry requirements; b. Data management plan is adjusted as new requirements evolve; c. All applications are tied into the common data model; no data duplication is encountered or data cleansing is needed;

Process (*Focus Areas*: a. Process Automation; b. Composite Application Development; c. Process Measurement and Scoring)	a. Process automation is taking place as an ad-hoc response, not a strategic plan; b. Limited composite application development; c. Process measurement and scoring are loosely defined;	a. Some process modeling techniques are being used; b. Growing capabilities for composite application development is encountered; c. Process measurement and scoring metrics have started to be in place throughout the collaborating organizations;	a. Process automation techniques are being used in the majority of lines of business (throughout the collaborating organizations); b. Repeatable success across some lines of business (throughout the collaborating organizations); c. Meaningful metrics have been established, but only for a limited set of processes;	a. Process automation techniques have become standardized across most lines of business (throughout the collaborating organizations); b. Repeatable success across all lines of business(throughout the collaborating organizations); c. Meaningful metrics have been established across all key business processes;	a. Automation capabilities have advanced to an optimum degree throughout the collaborating organizations; b. Application development has transformed into application assembly, leading to rapid time to market and ideal levels of flexibility; c. Metrics have been established across all business processes;
Organization (*Focus Areas:* a. IT Alignment with Business Strategy; b. Change Management; c. Business Involvement and Understanding)	a. IT and business groups across the collaborating organizations do not have frequent contacts; b. SOA impact in the collaborating organizations is not well understood; c. Only IT departments or people (of the collaborating organizations) are involved with the maintenance of Web Services;	a. IT and business started discussing the impact of Web Services on the business; b. Started learning how SOA will change the way things are carried out; c. Business people are beginning to understand Web Services potential impact;	a. IT and business closely collaborate on supporting key business processes; b. Partial understanding of SOA's impact in the collaborating organizations; c. Gain greater understanding of the business and IT benefits expected to accrue from reusable services;	a. IT understands business processes extremely well and it is responsive to most new business requirements; b. Understanding of SOA's value to business and how this is affecting the majority of the business processes; c. Tangible and intangible benefits derived by shared services used in the major lines of business are realized by business people;	a. IT is perceived as very critical for the planning and execution of critical business strategy, innovation and differentiation in the market; b. Clear understanding of SOA's value to business which leads to a change management strategy for driving SOA throughout the collaborating enterprises; c. Clear understanding by business people of the costs and benefits of SOA

					across all levels of the collaborating enterprises;
Governance (*Focus Areas:* a. Funding and Accounting; b. Scope Of Organized SOA Efforts; c. Policies, Reporting, and Exception Handling)	a. Each business unit in the collaborating organizations treats Web Services as a standalone cost because there is no service reuse; b. Only certain people in the IT department(s) of the collaborating organizations are aware of SOA; c. They are treated as additional work for IT and are handled on an ad-hoc basis;	a. Limited Service reuse across the collaborating enterprises; no formal cost allocation model has been formulated; b. Service awareness is pervasive throughout the IT departments of the collaborating organizations; c. Roles and responsibilities have been formally modeled to address policy management and reporting;	a. Service reuse is occurring across the collaborating enterprises, but no formal cost allocation model is used; b. Service awareness spreading to business process owners in certain lines of business of the collaborating organizations; c. Individual business units (in the collaborating organizations) have centralized their policy enforcement, reporting, and exception handling;	a. Service reuse is occurring across the collaborating enterprises and there is a formal cost allocation model in place; b. Services strategy is in place and followed by most of the lines of business of the collaborating organizations; c. A single centralized team has been formed and it is responsible over policy, compliance, and exception handling;	a. Careful metering of shared service usage allows effective models of budget distribution across all business units of the collaborating enterprises; b. The services strategy is understood and mandated across all lines of business of the collaborating organizations; c. A central policy team can dynamically implement rule and policy changes independent of underlying IT systems;

Table 2: The pSOAMM Including The Maturity Levels And SOA Domains (SOA Enablers) Along With Their Focus Areas

The proposed model captures the need identified for an inter-enterprise SOA MM by incorporating the appropriate focus areas for each of the domains in the model. In particular, it is the focus areas (and the way these were evolved through the Delphi questionnaires) along with their corresponding benchmarking scheme adopted and included in the model (Table 2) that considers all those elements that measure the capability of how well an organization is interacting with its collaborating organizations' resources, in respect to SOA.

It is true that the domains included in the proposed SOA Maturity Model ("Architecture", "Business Processes", "Information or Data Format", "Enabling Technologies / IT Infrastructure", "Governance", "Business / Organization" and "Delivery Methods") may also be encountered in other SOA MM available, but none of them includes focus areas and a corresponding benchmarking scheme which captures and measures the capability of the organization to capitalize on connecting and aligning its operations with other (collaborating) companies to meet important organizational goals using one the latest IT evolutions: Service-Oriented Architecture, as the proposed SOA MM does (Table 2).

For instance, if we were to determine the maturity level of the "Governance" domain in an organization (both internally and in respect to its interaction with collaborating enterprises), the key evaluators (focus areas) on which our "judgment" would be based on were identified to be:

- "Whether (or not) there is and the degree of funding for projects";
- "The scope (inter-enterprise, enterprise-wide, department-wide, etc) of organized SOA efforts";
- "Whether (or not) and to what extent there are policy enforcement schemes, reporting and exception handling guidelines/procedures across the collaborating enterprises";

In particular, this means that when an enterprise is in Level 1(that is, SOA is a relatively new concept in respect to "Governance" domain) the following capability level holds for each of the focus areas respectively:

- "Each business unit in the collaborating organizations treats Web Services as a standalone cost because there is no service reuse";
- "Only certain people in the IT department(s) of the collaborating organizations are aware of SOA";
- "They are treated as additional work for IT and are handled on an ad-hoc basis";

To the other end, Level 5 means that the enterprise operates a dynamic SOA with business and IT synchronized to achieve an optimum balance of agility, performance, risk and cost, in respect to "Governance" domain. In particular, the capability level for each of the corresponding focus areas is as follows:

- "Careful metering of shared service usage allows effective models of budget distribution across all business units of the collaborating enterprises";
- "The services strategy is understood and mandated across all lines of business of the collaborating organizations";
- "A central policy team can dynamically implement rule and policy changes independent of underlying IT systems";

Levels 2 to 4 (in respect to "Governance" domain) fall within Levels 1 and 5 extremes and relevant capability levels for the focus areas hold and are as shown in Table 2.

The remaining of the findings of the "Delphi Technique Applied - Second-Round Questionnaire" helped conclude on the other research objectives.

Trying to establish the current status of SOA within the panel experts' enterprises (but also of the broader business landscape), the replies provided by the panel members have shown that the majority either "use selectively, without a clear strategy," or "have an enterprise-level strategy and commitment to SOA," or "will pursue within the next twelve to twenty-four months".
Only a quarter of the respondents replied "Not pursuing, and no immediate plans to do so" in respect to their "relationship" to SOA.

As far as the future status (in particular, after five years) of SOA is concerned, a very large number of respondents replied that "there will be a considerable (to great) increase in the adoption of SOA (and Web Services)" and that "SOA (and Web Services) will be the dominant technology five years from now, like what the –static- Web is today."

Some other interesting findings were also revealed by the second-round questionnaire in respect to SOA. For instance, to the panel members, SOA projects are mainly observed in "Internal and External Integration" activities but also in "Strategic business transformation" activities.

Moreover, the top three factors that facilitate the "penetration" of SOA within panel members' organizations are: the "SOA enhances agility and flexibility; important ingredients for our organization," the "SOA reduces information systems integration complexity," and the "SOA lowers costs by re-using existing IT assets."

Even five years from now, the top facilitators in the SOA adoption/penetration were considered to be the "greater business flexibility and agility", the "lowering of costs of integrating existing applications and systems", and the fact that "there will be proven success stories associated with the application of SOA-based systems in highly demanding environments indicating the inherent benefits of the technology."

On the contrary, the top three prohibiting factors for the adoption of SOA (and Web Services) - today- within organizations were found to be: "There is a lack of skills for the implementation and deployment of SOA-based Information Systems", the "lack of funding", "the technology is still immature" and the "lack of anticipated ROI".

The prohibiting factors for the adoption of SOA-based systems, even five years from now, as revealed by the second-round questionnaire, are considered to be: "the skills needed to

implement and use the technology will be very limited in respect to the capacity required by the technology", "the ROI will never be encouraging enough" and "the technology will fail to prove itself when it is implemented and deployed in systems where high security features are mandated."

Due to the fact that the objective: "what the status of SOA will be within enterprises in the future, in respect to the proposed Maturity Model" was not readily derived from this second-round questionnaire, a third-round was required and executed.

6.3. Delphi Technique Applied – Third-Round Questionnaire And Its Findings (Application/Use Of The Proposed Inter-enterprise SOA MM)

In this round, the panel members were asked to designate the maturity level of their enterprises on each of the SOA domains identified in the derived SOA Maturity Model (which was the outcome of the second-round questionnaire) both for the current status of SOA and the status of SOA in five years.

The proposed SOA Maturity Model (shown on the previous page as Table 2) was handed-out to the panel members along with the third-round questionnaire (shown as **Appendix D: Delphi Technique Applied - Third-Round Questionnaire**)

In particular, the panel members were called to designate their choices by drawing the appropriate boxes in the model indicating the maturity level of each of the available domains.

Sample responses both for the current status of SOA and the status of SOA in five years within the panel members' enterprises are shown in **Appendix E: Delphi Technique Applied - Third-Round Questionnaire Sample Responses (as "E1.Current Status Of SOA" and "E2.Status Of SOA In Five Years" respectively).**

Collectively, the results obtained, in respect to the current status of SOA within the panel members' enterprises (and subsequently of the majority of the local enterprises) are illustrated in Table 3 below.

	Maturity Levels				
	Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**
pSOAMM's SOA Enabler / Domain (Along With Its Focus Areas)					
Architecture (*Focus Areas:* a. Role of Enterprise Architecture; b. Cataloging and Reuse; c. Planning and Guidance)	**3 / 20**	**9 / 20**	**3 / 20**		
Infrastructure (*Focus Areas:* a. Standards; b. Security and Monitoring; c. Management and Operations)	**5 / 20**	**6 / 20**	**4 / 20**		

Delivery (*Focus Areas:* a. Project vs. Enterprise Focus; b. Skills and Methodologies in Place; c. Modeling and Abstraction Techniques)	**8 / 20**	**4 / 20**	**3 / 20**		
Information (*Focus Areas:* a. Data Standards and Canonical Formats; b. Metadata Management; c. Single Source of Truth)	**7 / 20**	**5 / 20**	**3 / 20**		
Process (*Focus Areas*: a. Process Automation; b. Composite Application Development; c. Process Measurement and Scoring)	**9 / 20**	**4 / 20**	**2 / 20**		
Organization (*Focus Areas:* a. IT Alignment with Business Strategy; b. Change Management; c. Business Involvement and Understanding)	**7 / 20**	**6 / 20**	**2 / 30**		

Governance (*Focus Areas:* a. Funding and Accounting; b. Inter-Enterprise / Cross-Organizational Involvement; c. Policies, Reporting, and Exception Handling)	**9 / 20**	**4 / 20**	**2 / 20**		

Table 3: Current Status Of SOA Using The pSOAMM

First of all, Table 3 above shows that the total number of actual entries in the various maturity levels per SOA domain (provided by the panel members) is fifteen out of twenty. This justifies the 25 percent of the panel members who admitted that they are "not pursuing any SOA activities, or have no immediate plans to do so."

What is also interesting to point out is the fact that the responses provided by the panel experts (concerning the SOA status-es within their organizations) are distributed between the first three levels of maturity for all the SOA domains.
This means that currently SOA is a relatively new concept to most of the panel members' enterprises, but also that some of these enterprises have committed to adopting SOA even for certain parts of the organization. A smaller number of panel members' enterprises have adopted SOA as a strategic enterprise-wide architectural paradigm.

Similarly, the results obtained in respect to the status of SOA in five years within the panel experts' enterprises (and subsequently of the majority of the local enterprises) are shown in Table 4 below.

	Maturity Levels				
	Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**
pSOAMM's SOA Enabler / Domain (Along With Its Focus Areas)					
Architecture (*Focus Areas:* a. Role of Enterprise Architecture; b. Cataloging and Reuse; c. Planning and Guidance)	**4 / 20**	**7 / 20**	**5 / 20**	**2 / 20**	**2 / 20**
Infrastructure (*Focus Areas:* a. Standards; b. Security and Monitoring; c. Management and Operations)	**5 / 20**	**5 / 20**	**4 / 20**	**4 / 20**	**2 / 20**

Delivery (*Focus Areas:* a. Project vs. Enterprise Focus; b. Skills and Methodologies in Place; c. Modeling and Abstraction Techniques)	**6 / 20**	**4 / 20**	**5 / 20**	**3 / 20**	**2 / 20**
Information (*Focus Areas:* a. Data Standards and Canonical Formats; b. Metadata Management; c. Single Source of Truth)	**7 / 20**	**5 / 20**	**3 / 20**	**3 / 20**	**2 / 20**
Process (*Focus Areas*: a. Process Automation; b. Composite Application Development; c. Process Measurement and Scoring)	**9 / 20**	**4 / 20**	**3 / 20**	**2 / 20**	**2 / 20**
Organization (*Focus Areas:* a. IT Alignment with Business Strategy; b. Change Management; c. Business Involvement and Understanding)	**7 / 20**	**6 / 20**	**4 / 30**	**2 / 20**	**1 / 20**

Governance (*Focus Areas:* a. Funding and Accounting; b. Inter-Enterprise / Cross-Organizational Involvement; c. Policies, Reporting, and Exception Handling)	**9 / 20**	**5 / 20**	**5 / 20**	**1 / 20**	

Table 4: Status Of SOA In Five(5) Years Using The pSOAMM

Comparing the information presented in Table 3 to the information in Table 4, it can be concluded that **all** the panel experts believe that their enterprises will be "somewhere" in the roadmap toward SOA adoption, five years from today, as opposed to the previous finding concerning the current SOA status, where 15 out of 20 of the panel experts indicated that their enterprises are using SOA somehow.

Furthermore, it is obvious, if we were to compare the two tables (Table 3 and Table 4 above) that the SOA penetration is expected to be greater five years from now. Particularly, the panel experts' responses are spread throughout all five levels of the newly proposed SOA Maturity Model. That is, it is consciously believed that the SOA will be fundamental to the way the enterprises will operate and services might be used outside the enterprise, too (for instance, to be "consumed" by their business partners or customers).
Moreover, there were responses that indicated that the panel experts expected that their enterprises would operate a dynamic SOA with business and IT synchronized in order to achieve an optimum balance of agility, performance, risk and cost, in five years time.

To conclude, it can be said that even though some of the panel experts' enterprises (meaning also a representative sample of the local market) are not currently using SOA, they are confident enough that they will do so within the next five years.

7. Proposed SOA MM Broadness And Applicability (In Particular: "Local" or "Global" SOA MM)

The final objective of this research work: to come up with a conclusion about the "local" or "global" nature of the proposed SOA MM, was fulfilled by conducting interviews with two different groups of interviewees. Firstly, I check the "locality" of the proposed SOA MM by taking a sample population of those who contributed to the formation of the model (panel experts) and secondly, by conducting a set of interviews with the selected business owners and business practice managers.

The set of points discussed is slightly different from one group to the other. In particular, the points discussed with the selected panel experts is shown as **Appendix F** (titled **"Selected Panel Experts Interview -On Proposed SOA MM Locality-"**) and in **Appendix H** (titled **"Business Practitioners -Business Owners And Business Practice Managers- Interview -On Proposed SOA MM Locality-"**) the set of points discussed with business owners and business practice managers is shown.

A good sample (3 out of 20) of the population of the panel experts was asked (again, through the expert panel coordinator who had also chosen them) to also contribute towards the final objective of this research work; that is, to determine whether the proposed SOA MM can be used by (and be beneficial to) Cypriot organizations only, or whether it is a "global" one (that is, it can also be used outside Cyprus, too).

The selection of the three experts was left to the expert panel coordinator's discretion mainly because I wanted to continue securing research work's reliability and minimize any criticisms of biases.

The points discussed with the selected experts can be found in **Appendix F** (titled **"Selected Panel Experts Interview -On Proposed SOA MM Locality-"**) in an attempt to come up with conclusions mainly on:

- whether they think that the Delphi technique is the most appropriate tool for carrying out this type of research work (proposing a new SOA MM);
- whether they think that the proposed SOA MM is appropriate for local organizations only or whether it can be used (and have a real value) by organizations outside Cyprus, too;
- the factors that make them certain that the proposed SOA MM can only be used in Cyprus, if they had chosen to reply so in the previous point;

- the ingredients that make the proposed SOA MM "global" (that is, that it can be used by organizations outside Cyprus, too), if they had chosen to reply so in one of the previous points;
- the domains/factors that could be added to the proposed SOA MM that would make it "global" (that is, that it can be used by organizations outside Cyprus, too), if it is currently a "local" one;
- whether anything else could be added to the proposed SOA MM to make it even more complete, broad and "global"?

The second group was composed of five business owners and business practice managers, one from each of the major industries contributing to the Cyprus economy (Tourism, Banking) or industries heavily invested in IT (Government, Telcos, Utilities). The identification of the companies and subsequently the individuals from those organizations (who were asked to have an interview with me) was based on the size and distributiveness (that's where Integration / SOA-based solutions are desired) of the organization they came from and its impact on the country's economy (business owners) and/or their relationship with the topic (business practice managers).

The points discussed during the interviews with the business owners and business practice managers can be found in **Appendix H** (titled **"Business Practitioners -Business Owners And Business Practice Managers- Interview -On Proposed SOA MM Locality-"**). Again, the objective was to determine whether the proposed SOA MM can be used by (and be beneficial to) Cypriot organizations only, or whether it is a "global" one (that is, it can also be used outside Cyprus, too), raising not only those points discussed with the chosen panel experts (above), but also the following:

- whether the proposed SOA MM addresses real, day-to-day business challenges, or whether they consider it to be just a theoretical framework with no (or minimal) business value;
- whether the proposed SOA MM addresses the challenge of incorporating those domains/factors/"ingredients" that refer to inter-enterprise settings;

Both groups were provided a description of the proposed SOA MM, an introduction on SOA (titled: **"The Business Imperative For SOA"** -shown as **Appendix G**-), and an introduction on Delphi technique (as shown in section 5.1), which supported/enabled them to address the points I wanted to examine.

The findings from the interviews (both with the panel experts and the business owners and practice managers) were interesting and shed some light on the points I wanted to investigate. In particular, the following conclusions were drawn:

- the proposed SOA MM addresses real, day-to-day business challenges mainly because of the fact that it was formed also by the feedback provided by industry representatives (not only academia representatives) who were members of the experts panel and as such it is likely to be of value to organizations that will use it;

- the Delphi technique seems to be the most appropriate tool for proposing a new SOA MM mainly because Delphi's strength lies in the fact that it is ideal when the research issue is complex enough, as Okoli and Pawlowski (2004) and Ono and Wedemeyer (1994) suggested, (and proposing a new SOA MM was indeed a challenging task), but also due to the fact that the existing SOA MMs lacked the "inter-enterprise"-related domains/factors and Delphi is -also- ideal when "there is a need for further contribution to an incomplete state of knowledge around a research topic" (Delbecq et al. 1975);

- the proposed SOA MM incorporates the appropriate domains/factors and corresponding focus areas that address the requirements observed in inter-enterprise settings;

- even though the technology itself (SOA) is universal and some of the panel experts are working for global companies with operations in Cyprus, too, and most of them studied at foreign universities (so one may infer that the proposed SOA MM could be considered "global"), the fact that there was no participant from any other country (in particular, doing business in any other area of the world) "narrows" the proposed SOA MM "broadness" and that's why it is characterized as a "local" one, with no guarantee of having a real value to organizations outside Cyprus;

- IT services, SOA, SOA MM (and particularly the proposed SOA MM) seem to be ideal for Cyprus mainly because:
    - in Cyprus, the business landscape is primarily service-oriented; so any IT technologies, architectures, etc, that have the same "DNA" as the business landscape (that is, the ability to constantly change, to be agile and flexible, to respond quickly, etc), are very appealing to local organizations;

- of the fact that the majority of Cypriot organizations are small-to-medium sized enterprises (even, family-owned enterprises) makes them depend on many other collaborating organizations in order for a transaction or a business process to be successfully completed; that's where our proposed SOA MM could be called in to address this inter-enterprise requirement (where none of the others available can do);

- the proposed SOA MM (and the others, too) will give the opportunity to Cypriot organizations, if they desire to be competitive players in the global business arena, to comply with industry standards/policies/rules by enforcing them within their organizations in order to be able to collaborate/cooperate with other global partners and suppliers;

- of the fact that the political and business landscape is in constant flux and it is very frequent the case that there is a need for organizations to comply to the European Union and other (legal, etc) regulations (SOA along with its corresponding MM addresses that requirement);

8. Conclusions, Limitations And Future Research

The major objective of this research work was to come up with a new Delphi-derived inter-enterprise SOA Maturity Model and then use this model to "capture" both the current SOA status and the SOA status in five years within the enterprises of the participating panel experts (and consequently, of the broader business environment, assuming that the panel constitutes a representative sample of the whole market). Another objective of this work was to come up with a conclusion about the "local" (or "global") nature of the proposed SOA MM.

At the end of this work, a new inter-enterprise SOA Maturity Model was developed and this was achieved by conducting a three-round questionnaire (as proposed by Delphi, which was used as the "vehicle" for this research) which was distributed to the panel experts who provided their feedback and contributed the most towards the new SOA MM realization.

In the proposed SOA maturity model (pSOAMM), five levels of SOA maturity were identified and a set of SOA domains along with their corresponding focus areas on which the domains would be evaluated were defined. In general, the pSOAMM can be used by enterprises to facilitate their SOA adoption because pSOAMM provides an insight into the current SOA maturity level and a roadmap on how higher levels of SOA maturity can be achieved (and thus, benefit even more from further SOA initiatives).

After building the new SOA maturity model (pSOAMM), it was used to capture the current SOA status and the SOA status in five years within the representative sample of local enterprises (through panel experts).
As far as the current SOA status is concerned, the majority of the panel experts' responses revealed that SOA is a relatively new concept to most of the experts' enterprises, but also that some of these enterprises have committed to adopting SOA even for certain parts of the organization. A smaller number of panel experts' enterprises have adopted SOA as a strategic enterprise-wide architectural paradigm.

Attitudes will be much more optimistic (in respect to SOA) in the next five years, according to the opinion of the representing body of the local market (panel experts). In particular, panel experts believe that the SOA will be fundamental to the way the enterprises will operate and services might be used outside the enterprise, too (for instance, to be "consumed" by their business partners or customers). Moreover, they expect that their enterprises will operate a dynamic SOA with business and IT synchronized in order to achieve an optimum balance of agility, performance, risk and cost, in five years.

The research also revealed that there is an expressed trust (with an increasing trend) in SOA. This trust will be further boosted by repeated SOA projects' successes and by the proven benefits of SOA. Also, it can be concluded that SOA is gradually and steadily being accepted as the de-facto technology both in the IT and business community.
These findings comply (for instance) with similar works implemented -mainly- in the US (InfoWorld 2006, CIO 2006), where the patterns revealed in this research also appear in those studies on a much larger scale and intensity, of course.

Interesting were also the findings in respect to the final objective of the research: to come up with a conclusion on whether the proposed SOA MM is applicable and useful to the local organizations, or whether it could be used (and provide business value) to organizations outside Cyprus, too. The conclusion was that even though the technology itself (SOA) is universal and some of the panel experts are working for global companies with operations in Cyprus, too, and most of them studied at foreign universities (so one may infer that the proposed SOA MM could be considered "global"), the fact that there was no participant from any other country (in particular, doing business in any other area of the world) "narrows" the proposed SOA MM "broadness" and that's why it is characterized as a "local" one, with no guarantee of having a real value to organizations outside Cyprus.

Moreover, the research illustrated that IT services, SOA, SOA MM (and particularly the proposed SOA MM) seem to be ideal for Cyprus because of the size of the local market and of the nature of the business landscape (constant and rapid changes which require adaptive and agile technologies and enterprise architectural paradigms; SOA and its corresponding MMs seem to be an answer).

This work, though, has a number of limitations. Firstly, the proposed Delphi-derived inter-enterprise SOA MM was only applied to the organizations the experts came from. This constitutes a limited number of organizations in respect to the total. Future work may apply the newly proposed SOA Maturity Model in many more enterprises in the local market in order to further improve it, but also prove that the panel's opinions were a truly representative sample of the broader -local- business landscape.

Limitation also constitutes the fact that the inter-enterprise "nature" of the proposed SOA MM was not heavily "tested" / applied in truly collaborative inter-enterprise environments. So, a future assignment would be to have them applied in such environments (when time and conditions permit).

Moreover, the number of interviewees in the second group (which was composed of business owners and business practice managers) used for determining whether the proposed SOA MM is a “local” one (or, whether it could be used -with business value- by organizations outside Cyprus, too) was very limited (five) to gauge the opinion of the whole population on this issue. To obtain more accurate feedback, a greater number of interviews need to be conducted in the future.

Finally, for the “local” proposed SOA MM (with no guarantee of real value to organizations outside Cyprus, either) to be “promoted” into a “global” one, there is a need to have it reviewed and adjusted accordingly by academia and industry representatives from all the regions of the world (Europe, Americas, Asia, Australia, etc).

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10. Appendices

Appendix A: Delphi Technique Applied - First-Round Questionnaire

1. Considering the various available SOA Maturity Models (distributed earlier to you) and the CMMI maturity model (also handed-out to you), how many levels/stages do you think it is advisable be included in a newly proposed SOA Maturity Model?
[Select the one best reply]

a. Four, as proposed by the CBDI Forum
b. Seven, as suggested by IBM
c. Five, as described by HP's and Oracle's SOA Maturity Model
d. Five, to also comply to CMMI model which, even though it is a Process Improvement Maturity Model, is considered to be the basis of all types/kinds of Maturity Models
e. Other (please specify)

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2. If you have chosen (a) in the Question 1 above, what were the factors that made you choose that answer?
[Select the one best reply]

a. The completeness of the SOA Maturity Model proposed by CBDI Form
b. The high success rate of SOA projects by enterprises that adopted the CBDI Forum's SOA Maturity Model, according to independent studies/surveys
c. CBDI Forum's credibility on SOA advising
d. Other (please specify)

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3. If the answer provided for Question 1 was (b), why did you come up with such an answer?
[Select the one best reply]

a. IBM is the most trust-worthy IT vendor and we would like to have IBM engaged in all IT-related activities (concerning Hardware, Software and Consulting Services) within our enterprise
b. IBM's SOA Maturity Model seems to be the most complete
c. The high success rate of SOA projects by enterprises that adopted the IBM's SOA Maturity Model
d. Other (please specify)

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4. If you have provided (c) as your reply to Question 1 above, why have you made such an answer?
[Select the one best reply]

a. The HP's and Oracle's Maturity Model is the most complete
b. The high success rate of SOA projects by enterprises that adopted HP's and Oracle's SOA Maturity Model, according to independent studies/surveys
c. Both HP and Oracle are among the most reliable IT vendors
d. Other (please specify)

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5. If (d) was selected as an answer to Question 1 above, why have you made such a choice?
[Select the one best reply]

a. CMMI was introduced by the leading IT academic institution in the US (Carnegie Mellon University) and as such it is recommended as the basis of all the Maturity Models of any type/kind
b. The proposed SOA Maturity Model need not be based on any IT vendor's SOA Maturity Model(s), but instead on an independent's body/entity (if any)
c. Other (please specify)

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6. Given the various SOA Maturity Models distributed earlier to you, which of the following domains/dimensions do you think might be considered as "SOA Enablers" and recommended for inclusion in the newly proposed SOA Maturity Model?
[Select as many as you think are appropriate for inclusion in the proposed model]

a. Business / Organization
b. Projects / Program Management
c. Governance
d. Architecture
e. Enabling Technologies / IT Infrastructure
f. Operations and Management
g. Supply and Demand
h. Delivery Methods
i. Information or Data Format
j. Business Processes
k. People
l. Other (please specify)

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7. If (a) was selected as an answer to Question 6 above, what are the three focus areas in which you are going to measure whether the domain/dimension (Business / Organization) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether (or not) there is and the degree of IT alignment with Business strategy
b. Change management (how easily the employees will adopt the change to SOA)
c. Whether (or not) there is and the degree of business involvement and understanding of SOA activities/projects
d. Whether (or not) there are and the degree to which SOA projects affect the organizational structure or management hierarchy
e. The level of impact of SOA projects on an organization's brand and reputation
f. Other (please specify)

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8. If you have chosen (b) in Question 6 above, what are the three focus areas in which you are going to measure whether the domain/dimension (Projects / Program Management) has reached (or not) a certain level/stage of maturity? [Select the three best replies]

a. Whether the SOA projects rollout is spanned across teams
b. Whether the SOA projects rollout is spanned across departments
c. Whether the SOA projects rollout is spanned across business units
d. Whether the SOA projects rollout is spanned across the entire enterprise
e. How well the management of the services portfolio is carried out
f. Other (please specify)

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9. If the answer provided for Question 6 was (c), what are the three focus areas in which you are going to measure whether the domain/dimension (Governance) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether (or not) there is and the degree of funding for projects
b. The scope (inter-enterprise, enterprise-wide, department-wide, etc) of organized SOA efforts
c. Whether (or not) an enterprise is in discussions to acquire/merge with another organization
d. Whether (or not) and to what extent there are policy enforcement schemes, reporting and exception handling guidelines/procedures across the collaborating enterprises
e. Whether an enterprise is publicly or privately owned and managed
f. Other (please specify)

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10. If you have provided (d) as your reply to Question 6 above, what are the three focus areas in which you are going to measure whether the domain/dimension (Architecture) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether there is an Enterprise Architecture (and which is its role) in the organization and whether it also governs the organization's relationships with its collaborating organizations
b. Whether the Enterprise Architecture is being built by an organization's management or by its IT department
c. Whether (or not) there is and the degree to which services are cataloged and reused across the collaborating organizations
d. Whether the Enterprise Architecture describes the IT infrastructure (hardware, software, networking, etc) of an enterprise
e. Whether (or not) there is and the degree to which the Enterprise Architecture is being considered in the enterprise-wide and inter-enterprise planning activities
f. Other (please specify)

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11. If you have chosen (e) in Question 6 above, what are the three focus areas in which you are going to measure whether the domain/dimension (Enabling Technologies / IT Infrastructure) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether the right tools (for software design, development, deployment, etc), technologies are in place
b. Whether industry standards are being followed (in respect to all aspects of IT operations)
c. Whether security, monitoring, and management tools (solutions) are in place
d. Whether the required (IT) expertise by human resources is found within the enterprise
e. Whether the .NET or the Java2 EE frameworks for software development and deployment are used
f. Other (please specify)

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12. If you have chosen (f) in Question 6 above, what are the three focus areas in which you are going to measure whether the domain/dimension (Operations and Management) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether the right people exist within the enterprise to operate and manage the SOA activities/projects
b. Whether the people in charge of operating and managing the SOA activities/projects have sound knowledge and expertise in both IT and business

c. Whether the right procedures are in place to operate and manage the SOA activities/projects
d. Whether management and auditing tools (solutions) are in place
e. Whether any Quality-of-Service practices are followed
f. Other (please specify)

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13. If the answer provided for Question 6 was (g), what are the three focus areas in which you are going to measure whether the domain/dimension (Supply and Demand) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. The level of growth of SOA activities/projects within an enterprise
b. Whether any services' providers are out there in the industry with whom an enterprise might desire to co-operate
c. The degree of readiness of people (within an enterprise) to provide/use services
d. Whether any services' "consumers"/users are out there in the industry with whom an enterprise might desire to co-operate
e. The degree of readiness of an enterprise's lines-of-business or departments to use services
f. Other (please specify)

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14. If you have provided (h) as your reply to Question 6 above, what are the three focus areas in which you are going to measure whether the domain/dimension (Delivery Methods) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether there are any policies, practices (throughout the collaborating enterprises) for delivering the SOA solutions
b. Whether .NET or Java2 EE-compliant platform is used as the deployment stage for SOA applications/solutions
c. Whether there are skills and expertise (throughout the collaborating enterprises) for delivering the SOA solutions
d. Whether there are any methodologies, modeling and abstraction techniques (throughout the collaborating enterprises) for delivering the SOA solutions
e. Whether there are dedicated people to deliver the SOA solutions
f. Other (please specify)

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15. If the answer provided for Question 6 was (i), what are the three focus areas in which you are going to measure whether the domain/dimension (Information or Data Format) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether the collaborating enterprises are using industry standards for the representation of data (e.g. XML)
b. Whether there is any kind of auditing mechanism for checking who is accessing/modifying the enterprise data
c. Whether the data is in a single location (that is, whether there is any kind of data consolidation in place throughout the collaborating enterprises)
d. Whether (or not) the XBRL (eXtensible Business Reporting Language) format is supported
e. Whether the collaborating enterprises are not only using industry standards for the representation of data (like XML), but also other canonical formats and metadata management standards (like XSD, XSLT, XPath, Expression Language, etc)
f. Other (please specify)

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16. If you have chosen (j) in Question 6 above, what are the three focus areas in which you are going to measure whether the domain/dimension (Business Processes) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether there is any kind of business process analysis toolkit used (within an enterprise)
b. Whether any kind of business process re-engineering has taken place lately in the enterprise
c. Whether there is any kind of business process monitoring tool used (throughout the collaborating enterprises)
d. Whether any kind of business process automation is in place
e. Whether a cross-application orchestration of business processes has been deployed (throughout the collaborating enterprises)
f. Other (please specify)

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17. If you have chosen (k) in Question 6 above, what are the three focus areas in which you are going to measure whether the domain/dimension (People) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether the people (in an enterprise) have roles that are more of a combination of business and IT rather than being just one or the other
b. Whether there are constant organizational structure changes that are based around services
c. Whether an enterprise's human resources are shared across an enterprise and business managers
d. Whether an enterprise's Information Systems are not solely under a specific department's control, but is shared with others
e. Whether there is dependency of one department (of an enterprise) on other groups or other parts of the business
f. Other (please specify)

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18. Which of the following best describes your firm's approach to or status of SOA?
[Select the one best reply]

a. Not pursuing, and no immediate plans to do so
b. Will pursue within the next twelve to twenty-four months
c. Use selectively, without a clear strategy
d. Have an enterprise-level strategy and commitment for SOA
e. Other (please specify)

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19. What are you currently using SOA for?
[Select the one best reply]

a. Internal integration
b. External integration (that is, integration with partners' and/or customers' systems)
c. Strategic business transformation
d. Other (please specify)

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20. What are the most important factors that facilitate the "penetration" of the Service-Oriented Architecture and Web Services within your enterprise?
[Select the three best replies]

a. SOA (and Web Services) enhances agility and flexibility; important ingredients for our organization
b. SOA improves our products' or services' time-to-market
c. SOA reduces information systems integration complexity
d. SOA lowers costs by re-using existing IT assets
e. SOA creates new business opportunities through collaboration, outsourcing, and by enabling global presence for our goods and services
f. SOA accelerates growth by facilitating the integration of systems of acquired companies
g. Other (please specify)

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21. What are the primary constraints that prohibit the "penetration" of the Service-Oriented Architecture and Web Services within your enterprise?
[Select the three best replies]

a. The technology (SOA) is still immature
b. A lack of skills for the implementation and deployment of SOA-based ("Web Services-based") Information Systems
c. There are still security implications on the technology
d. Other (please specify)

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22. What will the SOA "penetration" be five years from now?
[Select the one best reply]

a. SOA (and Web Services) will be the dominant technology five years from now, like what the "static" Web is today
b. There will be a considerable (to great) increase in the adoption of SOA (and Web Services) by enterprises
c. There will be a slight (or no) increase in the adoption of the technology
d. It will be totally abandoned

23. What will the status of SOA be five years from now, within your enterprise?

[Select the one best reply]

a. Same answer as the one provided in the previous Question (22)
b. Different answer as the one provided in the previous Question (22). If you provided this response as your reply to the current question, please explain why you had differentiated your enterprise from the rest of the market's trend

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24. If you chose (a) or (b) in Question 22, what do you think will be the most important facilitators toward that trend?

[Select the one best reply]

a. There will be proven success stories associated with the application of SOA-based systems in highly demanding environments indicating the inherent benefits of the technology
b. The ROI will be promising
c. Greater business flexibility and agility
d. Lowering of costs of integrating existing applications and systems
e. Other (please specify)

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25. If you chose (c) or (d) in Question 22, what do you think will be the most important prohibiting factors for the adoption of the technology (SOA)?

[Select the one best reply]

a. The ROI will never be encouraging enough
b. The technology will fail to prove itself when it is implemented and deployed in systems where high security features are mandated
c. The skills needed to implement and use the technology will be very limited in respect to the capacity required by the technology
d. The Big supporters of the technology (Big IT companies like Microsoft, IBM, Oracle, etc) will abandon the technology and they will look for more profitable technologies/solutions
e. Other (please specify)

Appendix B: Delphi Technique Applied - First-Round Questionnaire Findings

1. Considering the various available SOA Maturity Models (distributed earlier to you) and the CMMI maturity model (also handed-out to you), how many levels/stages do you think might be included in a newly proposed SOA Maturity Model?
[Select the one best reply]

a. Four, as proposed by the CBDI Forum **[2/20 – 10%]**
b. Seven, as suggested by IBM **[6/20 – 30%]**
c. Five, as described by HP's and Oracle's SOA Maturity Model **[7/20 – 35%]**
d. Five, to also comply to CMMI model which, even though it is a Process Improvement Maturity Model, is considered to be the basis of all types/kinds of Maturity Models **[5/20 – 25%]**
e. Other (please specify) **[0/20 – 0%]**

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2. If you have chosen (a) in Question 1 above, what were the factors that made you choose that answer?
[Select the one best reply]

a. The completeness of the SOA Maturity Model proposed by CBDI Form **[0/2 – 0%]**
b. The high success rate of SOA projects by enterprises that adopted the CBDI Forum's SOA Maturity Model, according to independent studies/surveys **[1/2 – 50%]**
c. CBDI Forum's credibility on SOA advising **[1/2 – 50%]**
d. Other (please specify) **[0/2 – 0%]**

Note: Two out of twenty respondents selected answer (a) in Question 1, above. That is why the "hit rate" in this Question was calculated based on two responses.

3. If the answer chosen for Question 1 was (b), why did you come up with such an answer?
[Select the one best reply]

a. IBM is the most trust-worthy IT vendor and we would like to have IBM engaged in all IT-related activities (concerning Hardware, Software and Consulting Services) within our enterprise **[4/6 – 66.6%]**
b. IBM's SOA Maturity Model seems to be the most complete **[1/6 – 16.6%]**
c. The high success rate of SOA projects by enterprises that adopted the IBM's SOA Maturity Model **[1/6 – 16.6%]**
d. Other (please specify) **[0/6 – 0%]**

Note: Six out of twenty respondents selected answer (b) in Question 1, above. That is why the "hit rate" in this Question was calculated based on six responses.

4. If you have chosen (c) as your reply to Question 1 above, why have you made such an answer? [Select the one best reply]

a. The HP's and Oracle's Maturity Model is the most complete **[4/7 – 57.1%]**
b. The high success rate of SOA projects by enterprises that adopted HP's and Oracle's SOA Maturity Model, according to independent studies/surveys **[2/7 – 28.6%]**
c. Both HP and Oracle are among the most reliable IT vendors **[1/7 – 14.3%]**
d. Other (please specify) **[0/7 – 0%]**

Note: Seven out of twenty respondents selected answer (c) in Question 1, above. That is why the "hit rate" in this Question was calculated based on seven responses.

5. If (d) was selected as an answer to Question 1 above, why have you made such a choice? [Select the one best reply]

a. CMMI was introduced by the leading IT academic institution in the US (Carnegie Mellon University) and as such it is recommended as the basis of all the Maturity Models of any type/kind **[2/5 – 40%]**
b. The proposed SOA Maturity Model need not be based on any IT vendor's SOA Maturity Model(s), but instead on an independent's body/entity model (if any) **[3/5 – 60%]**
c. Other (please specify) **[0/5 – 0%]**

Note: Five out of twenty respondents selected answer (d) in Question 1, above. That is why the "hit rate" in this Question was calculated based on five responses.

6. Given the various SOA Maturity Models distributed earlier to you, which of the following domains/dimensions do you think might be considered as "SOA Enablers" and recommend be included in the newly proposed SOA Maturity Model?
[Select as many as you think are appropriate to include in the proposed model]

a. Business / Organization **[15]**
b. Projects / Program Management **[5]**
c. Governance **[15]**
d. Architecture **[18]**
e. Enabling Technologies / IT Infrastructure **[16]**
f. Operations and Management **[6]**
g. Supply and Demand **[4]**
h. Delivery Methods **[15]**
i. Information or Data Format **[17]**
j. Business Processes **[18]**
k. People **[9]**
l. Other (please specify) **[0]**

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7. If (a) was selected as an answer to Question 6 above, what are the three focus areas in which you are going to measure whether the domain/dimension (Business / Organization) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether (or not) there is and the degree of IT alignment with Business strategy **[17/45 – 37.7%]**
b. Change management (how easily the employees will adopt the change to SOA) **[10/45 – 22.2%]**
c. Whether (or not) there is and the degree of business involvement and understanding of SOA activities/projects **[15/45 – 33.3%]**
d. Whether (or not) there are effects and the degree to which SOA projects affect the organizational structure or management hierarchy **[2/45 – 4.4%]**
e. The level of impact of SOA projects on an organization's brand and reputation **[1/45 – 2.2%]**
f. Other (please specify) **[0/45 – 0%]**

Note: Fifteen out of twenty respondents selected answer (a) in Question 6 above. That is why the "hit rate" in this Question was calculated based on fifteen responses.
In these types of questions, though, where the respondents were asked to choose three replies, the "hit rate" was calculated as if the number of respondents was 45 (15 participants X 3 replies).

8. If you have chosen (b) in Question 6 above, what are the three focus areas in which you are going to measure whether the domain/dimension (Projects / Program Management) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether the SOA projects rollout is spanned across teams **[2/15 – 13.3%]**
b. Whether the SOA projects rollout is spanned across departments **[2/15 – 13.3%]**
e. Whether the SOA projects rollout is spanned across business units **[2/15 – 13.3%]**
f. Whether the SOA projects rollout is spanned across the entire enterprise **[7/15 – 46.6%]**
e. How well the management of the services portfolio is carried out **[2/15 – 13.3%]**
f. Other (please specify) **[0/15 – 0%]**

Note: Five out of twenty respondents selected answer (b) in Question 6 above. That is why the "hit rate" in this Question was calculated based on five responses.
In these types of questions, though, where the respondents were asked to choose three replies, the "hit rate" was calculated as if the number of respondents were 15 (5 participants X 3 replies).

9. If the answer provided for Question 6 was (c), what are the three focus areas in which you are going to measure whether the domain/dimension (Governance) has reached (or not) a certain level/stage of maturity? [Select the three best replies]

a. Whether (or not) there is and the degree of funding for projects **[13/45 – 28.9%]**
b. The scope (inter-enterprise, enterprise-wide, department-wide, etc) of organized SOA efforts **[15/45 – 33.3%]**
c. Whether (or not) an enterprise is in discussions to acquire/merge with another organization **[1/45 – 2.2%]**
d. Whether (or not) and to what extent there are policy enforcement schemes, reporting and exception handling guidelines/procedures across the collaborating enterprises **[15/45 – 33.3%]**
e. Whether an enterprise is publicly or privately owned and managed **[1/45 – 2.2%]**
f. Other (please specify) **[0/45 – 0%]**

Note: Fifteen out of twenty respondents provided answer (c) in Question 6 above. That is why the "hit rate" in this Question was calculated based on fifteen responses.
In these types of questions, though, where the respondents were asked to choose three replies, the "hit rate" was calculated as if the number of respondents was 45 (15 participants X 3 replies).

10. If you have provided (d) as your reply to Question 6 above, what are the three focus areas on which you are going to measure whether the domain/dimension (Architecture) has reached (or not) a certain level/stage of maturity? [Select the three best replies]

a. Whether there is an Enterprise Architecture (and what is its role) in the organization and whether it also governs the organization's relationships with its collaborating organizations **[16/54 – 29.6%]**
b. Whether the Enterprise Architecture is being built by an organization's management or by its IT department **[3/54 – 5.5%]**
c. Whether (or not) there is and the degree to which services are cataloged and reused across the collaborating organizations **[14/54 – 25.9%]**
d. Whether the Enterprise Architecture describes the IT infrastructure (hardware, software, networking, etc) of an enterprise **[6/54 – 11.1%]**
e. Whether (or not) there is and the degree to which the Enterprise Architecture is being considered in the enterprise-wide and inter-enterprise planning activities **[15/54 – 27.7%]**
f. Other (please specify) **[0/54 – 0%]**

Note: Eighteen out of twenty respondents selected answer (d) in Question 6 above. That is why the "hit rate" in this Question was calculated based on eighteen responses.
In these types of questions, though, where the respondents were asked to choose three replies, the "hit rate" was calculated as if the number of respondents was 54 (18 participants X 3 replies).

11. If you have chosen (e) in Question 6 above, what are the three focus areas in which you are going to measure whether the domain/dimension (Enabling Technologies / IT Infrastructure) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether the right tools (for software design, development, deployment, etc), technologies are in place **[14/48 – 29.1%]**
b. Whether industry standards are being followed (in respect to all aspects of IT operations) **[14/48 – 29.1%]**
c. Whether security, monitoring, and management tools (solutions) are in place **[14/48 – 29.1%]**
d. Whether the required (IT) expertise by human resources (IT expertise) is found within the enterprise **[3/48 – 6.3%]**
e. Whether the .NET or the Java2 EE frameworks for software development and deployment are used **[3/48 – 6.3%]**
f. Other (please specify) **[0/48 – 0%]**

Note: Sixteen out of twenty respondents selected answer (e) in Question 6 above. That is why the "hit rate" in this Question was calculated based on sixteen responses.
In these types of questions, though, where the respondents were asked to choose three replies, the "hit rate" was calculated as if the number of respondents was 48 (16 participants X 3 replies).

12. If you have chosen (f) in Question 6 above, what are the three focus areas in which you are going to measure whether the domain/dimension (Operations and Management) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether the right people exist within the enterprise to operate and manage the SOA activities/projects **[3/18 – 16.6%]**
b. Whether the people in charge of operating and managing the SOA activities/projects have sound knowledge and expertise in both the IT and the business **[6/18 – 33.3%]**
c. Whether the right procedures are in place to operate and manage the SOA activities/projects **[3/18 – 16.6%]**
d. Whether management and auditing tools (solutions) are in place **[3/18 – 16.6%]**
e. Whether any Quality-of-Service practices are followed **[3/18 – 16.6%]**
f. Other (please specify) **[0/18 – 0%]**

Note: Six out of twenty respondents selected answer (f) in Question 6 above. That is why the "hit rate" in this Question was calculated based on six responses.
In these types of questions, though, where the respondents were asked to choose three replies, the "hit rate" was calculated as if the number of respondents was 18 (6 participants X 3 replies).

13. If the answer provided for Question 6 was (g), what are the three focus areas in which you are going to measure whether the domain/dimension (Supply and Demand) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. The level of growth of SOA activities/projects within an enterprise **[6/12 – 50%]**
b. Whether any services' providers are out there in the industry with whom an enterprise might desire to co-operate **[3/12 – 25%]**
c. The degree of readiness of people (within an enterprise) to provide/use services **[0/12 – 0%]**
d. Whether any services' "consumers"/users are out there in the industry with whom an enterprise might desire to co-operate **[3/12 – 25%]**
e. The degree of readiness of an enterprise's lines-of-business or departments to use services **[0/12 – 0%]**
f. Other (please specify) **[0/12 – 0%]**

Note: Four out of twenty respondents selected answer (g) in Question 6 above. That is why the "hit rate" in this Question was calculated based on four responses.
In these types of questions, though, where the respondents were asked to choose three replies, the "hit rate" was calculated as if the number of respondents was 12 (4 participants X 3 replies).

14. If you have selected (h) as your reply to Question 6 above, what are the three focus areas in which you are going to measure whether the domain/dimension (Delivery Methods) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether there are any policies, practices (throughout the collaborating enterprises) for delivering the SOA solutions **[15/45 – 33.3%]**
b. Whether .NET or Java2 EE-compliant platform is used as the deployment stage for SOA applications/solutions **[0/45 – 0%]**
c. Whether there are skills and expertise (throughout the collaborating enterprises) for delivering the SOA solutions **[15/45 – 33.3%]**
d. Whether there are any methodologies, modeling and abstraction techniques (throughout the collaborating enterprises) for delivering the SOA solutions **[15/45 – 33.3%]**
e. Whether there are dedicated people for the delivery of the SOA solutions **[0/45 – 0%]**
f. Other (please specify) **[0/45 – 0%]**

Note: Fifteen out of twenty respondents selected answer (h) in Question 6, above. That is why the "hit rate" in this Question was calculated based on fifteen responses.
In these types of questions, though, where the respondents were asked to choose three replies, the "hit rate" was calculated as if the number of respondents was 45 (15 participants X 3 replies).

15. If the answer selected for Question 6 was the (i), what are the three focus areas in which you are going to measure whether the domain/dimension (Information or Data Format) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether the collaborating enterprises are using industry standards for the representation of data (e.g. XML) **[18/51 – 35.3%]**
b. Whether there is any kind of auditing mechanism for checking who is accessing/modifying the enterprise data **[0/51 – 0%]**
c. Whether the data is located on a single location (that is, whether there is any kind of data consolidation in place throughout the collaborating enterprises) **[15/51 – 29.4%]**
d. Whether (or not) the XBRL (eXtensible Business Reporting Language) format is supported **[0/51 – 0%]**
e. Whether the collaborating enterprises are not only using industry standards for the representation of data (like XML), but also other canonical formats and metadata management standards (like XSD, XSLT, XPath, Expression Language, etc) **[18/51 – 35.3%]**
f. Other (please specify) **[0/51 – 0%]**

Note: Seventeen out of twenty respondents selected answer (i) in Question 6 above. That is why the "hit rate" in this Question was calculated based on seventeen responses.
In these types of questions, though, where the respondents were asked to choose three replies, the "hit rate" was calculated as if the number of respondents was 51 (17 participants X 3 replies).

16. If you have chosen (j) in Question 6 above, what are the three focus areas in which you are going to measure whether the domain/dimension (Business Processes) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether there is any kind of business process analysis toolkit used (within an enterprise) **[2/54 – 3.7%]**
b. Whether any kind of business process re-engineering has taken place lately in the enterprise **[2/54 – 3.7%]**
c. Whether there is any kind of business process monitoring tool used (throughout the collaborating enterprises) **[15/54 – 27.7%]**
d. Whether any kind of business process automation is in place **[20/54 – 37%]**
e. Whether a cross-application orchestration of business processes has been deployed (throughout the collaborating enterprises) **[15/54 – 27.7%]**
f. Other (please specify) **[0/54 – 0%]**

Note: Eighteen out of twenty respondents selected answer (j) in Question 6 above. That is why the "hit rate" in this Question was calculated based on eighteen responses.
In these types of questions, though, where the respondents were asked to choose three replies, the "hit rate" was calculated as if the number of respondents was 54 (18 participants X 3 replies).

17. If you have chosen (k) in Question 6, what are the three focus areas in which you are going to measure whether the domain/dimension (People) has reached (or not) a certain level/stage of maturity?
[Select the three best replies]

a. Whether the people (in an enterprise) have roles that are more of a combination of business and IT rather than being just one or the other **[7/27 – 25.9%]**
b. Whether there are constant organizational structure changes that are based around services **[5/27 – 18.5%]**
c. Whether an enterprise's human resources are shared across an enterprise and business managers **[5/27 – 18.5%]**
d. Whether an enterprise's Information Systems are not solely under a specific department's control, but they are shared with others **[5/27 – 18.5%]**
e. Whether there is dependency of one department (of an enterprise) on other groups or other parts of the business **[5/27 – 18.5%]**
f. Other (please specify) **[0/27 – 0%]**

Note: Nine out of twenty respondents selected answer (k) in Question 6. That is why the "hit rate" in this Question was calculated based on nine responses.
In these types of questions, though, where the respondents were asked to choose three replies, the "hit rate" was calculated as if the number of respondents was 27 (9 participants X 3 replies).

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18. Which of the following best describes your firm's approach to or status of SOA?
[Select the one best reply]

a. Not pursuing, and no immediate plans to do so **[5/20 – 25%]**
b. Will pursue within the next twelve to twenty-four months **[5/20 – 25%]**
c. Use selectively, without a clear strategy **[6/20 – 30%]**
d. Have an enterprise-level strategy and commitment for SOA **[4/20 – 20%]**
e. Other (please specify) **[0/20 – 0%]**

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19. What are you currently using SOA for?
[Select the one best reply]

a. Internal integration **[5/10 – 50%]**
b. External integration (that is, integration with partners' and/or customers' systems) **[2/10 – 20%]**
c. Strategic business transformation **[3/10 – 30%]**
d. Other (please specify) **[0/10 – 0%]**

Note: Ten out of twenty respondents selected answers (c) and (d) in Question 18 above. That is why the "hit rate" in this Question was calculated based on ten responses.

20. Which are the most important factors that facilitate the "penetration" the Service-Oriented Architecture and Web Services within your enterprise?
[Select the three best replies]

a. SOA (and Web Services) enhances agility and flexibility; important ingredients for our organization **[20/60 – 33.3%]**
b. SOA improves our products' or services' time-to-market **[0/60 – 0%]**
c. SOA reduces information systems integration complexity **[20/60 – 33.3%]**
d. SOA lowers costs by re-using existing IT assets **[20/60 – 33.3%]**
e. SOA creates new business opportunities through collaboration, outsourcing, and by enabling global presence for our goods and services **[0/60 – 0%]**
f. SOA accelerates growth by facilitating the integration of systems of acquired companies **[0/60 – 0%]**
g. Other (please specify) **[0/60 – 0%]**

Note: In these types of questions where the respondents were asked to choose three replies, the "hit rate" was calculated as if the number of respondents was 60 (20 participants X 3 replies).

21. Which are the primary constraints that prohibit the "penetration" the Service-Oriented Architecture and Web Services within your enterprise?

[Select the three best replies]

a. The technology (SOA) is still immature **[10/60 – 16.7%]**
b. There is a lack of skills for the implementation and deployment of SOA-based ("Web Services-based") Information Systems **[20/60 – 33.3%]**
c. There are still security implications on the technology **[0/60 – 0%]**
d. Other (please specify)

   Lack of anticipated ROI [10/60 – 16.7%]

   Lack of funding [20/60 – 33.3%]

Note: In these types of questions where the respondents were asked to choose three replies, the "hit rate" was calculated as if the number of respondents was 60 (20 participants X 3 replies).

22. What will the SOA "penetration" be five years from now?

[Select the one best reply]

a. SOA (and Web Services) will be the dominant technology five years from now, like what the "static" Web is today **[7/20 - 35%]**
b. There will be a considerable (to great) increase in the adoption of SOA (and Web Services) by enterprises **[10/20 - 50%]**
c. There will be a slight (or no) increase in the adoption of the technology **[3/20 - 15%]**
d. It will be totally abandoned **[0/20 - 0%]**

23. What will the status of SOA be five years from now, within your enterprise?

[Select the one best reply]

a. Same answer as the one provided in the previous Question (22) **[20/20 - 100%]**
b. Different answer to the one provided in the previous Question (22). If you had provided this response as your reply to the current question, please explain why you had differentiated your enterprise from the rest of the market's trend **[0/20 - 0%]**

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24. If you had selected answers (a) or (b) in Question 22, which do you think will be the most important facilitators toward that trend?

[Select the three best replies]

a. There will be proven success stories associated with the application of SOA-based systems in highly demanding environments indicating the inherent benefits of the technology **[10/51 – 19.6%]**
b. The ROI will be promising **[7/51 – 13.7%]**
c. Greater business flexibility and agility **[17/51 – 33.3%]**
d. Lowering of costs of integrating existing applications and systems **[17/51 – 33.3%]**
e. Other (please specify) **[0/51 - 0%]**

Note: Seventeen out of twenty respondents selected answer (a) or (b) in Question 22 above. That is why the "hit rate" in this Question was calculated based on seventeen responses.

However, based on what has been done in these types of questions earlier, the "hit rate" was calculated as if the number of respondents was 51 (17 participants X 3 replies).

25. If you had selected answers (c) or (d) in Question 22, which do you think will be the most important prohibiting factors for the adoption of the technology (SOA)?

[Select the three best replies]

a. The ROI will never be encouraging enough **[2/9 – 22.2%]**
b. The technology will fail to prove itself when it is implemented and deployed in systems where high security features are mandated **[2/9 – 22.2%]**
c. The skills needed to implement and use the technology will be very limited in respect to the capacity required by the technology **[4/9 – 44.4%]**
d. The Big supporters of the technology (Big IT companies like Microsoft, IBM, Oracle, etc) will abandon the technology and they will look for more profitable technologies/solutions **[1/9 – 11.1%]**
e. Other (please specify)

Note: Only three out of twenty respondents provided answers (c) and (d) in Question 22 above. That is why the "hit rate" in this Question was calculated based on three responses.

However, based on what has been done in these types of questions earlier, the "hit rate" was calculated as if the number of respondents was 9 (3 participants X 3 replies).

Appendix C: Delphi Technique Applied - Second-Round Questionnaire

1. Based on the first-round questionnaire handed-out,

a. 60% of the respondents suggested that the proposed SOA Maturity Model might have five levels/stages, as described by HP's and Oracle's SOA Maturity Model (35%) and in order to comply to CMMI Model which is considered the basis of all types/kinds of Maturity Models (25%)
b. 30% of the respondents proposed seven levels/stages as recommended by IBM
c. 10% of the respondents selected four, as proposed by CBDI Forum

when asked: "how many levels/stages do you think might be included in a newly proposed SOA Maturity Model?"

Knowning the preferences of the respondents(above), what do you think of the above statements? Which one from (a) to (c) is more likely to be closer to what is ideal to include in the proposed SOA Maturity Model?

This also implies that not only will the number of levels/stages of the proposed SOA Maturity Model be the same as those of HP's & Oracle's and CMMI's, but also the interpretation provided by these models for each of these levels/stages (that is, Level 1 means that SOA is a relatively new concept in the enterprise, etc) will resemble that of the proposed model.

Do you agree with this statement?

i. Yes
ii. No.

If you have chosen "No", please indicate any other interpretation.

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2. The findings of the first-round questionnaire revealed that 60% of the respondents suggested that the proposed SOA Maturity Model might have five levels/stages, as described by HP's and Oracle's SOA Maturity Model (35%) and in order to comply with CMMI Model, which is considered the basis of all types/kinds of Maturity Models (25%). Out of those who responded in favor of five levels/stages because of HP's and Oracle's SOA Maturity Model:

a1. 57.1% of them have chosen to do so because HP's and Oracle's Maturity Model is the most complete

b1. 28.6% of them because of the high success rate of SOA projects by enterprises that adopted HP's and Oracle's SOA Maturity Model, according to independent studies/surveys

c1. 14.3% of them because both HP and Oracle are among the most reliable IT vendors

Also, out of those who selected five levels/stages because they wanted the proposed SOA Maturity Model to comply with CMMI Model which is considered the basis of all types/kinds of Maturity Models:

a2. 60% of them have supported their preference on the fact that "the proposed SOA Maturity Model need not be based on any IT vendor's SOA Maturity Model(s), but instead on an independent's body/entity model (if any)"

b2. 40% of them because CMMI was introduced by the leading IT academic institution in the US (Carnegie Mellon University) and as such it is recommended as the basis of all the Maturity Models of any type/kind

when asked to justify their preference to a SOA Maturity Model with five levels/stages. Considering these replies, which of them do you think can be used as strong arguments in favor of five levels/stages? (Choose from a1 to c1, and a2 or b2, above).

3. In the first-round questionnaire, looking for the domains/dimensions that might be considered as "SOA Enablers" and are recommended be included in the newly proposed SOA Maturity Model:

a. 18/20 respondents were in favor of "Architecture" and "Business Processes"
a. 17/20 respondents selected "Information or Data Format"
b. 16/20 respondents selected "Enabling Technologies / IT Infrastructure"
c. 15/20 respondents selected "Governance", "Business / Organization" and "Delivery Methods"

Having this piece of information in mind, do you agree that these are the most important domains/dimensions that might be included in the newly proposed SOA Maturity Model?

i. Yes
ii. No.

If you choose to go with the "No", please specify any other domains/dimensions you think might be included in the model.

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4. The following is the distribution of the percentages of the respondents who chose "Business / Organization" as one of the domains/dimensions that need to be included in the proposed model and who were called to identify the three focus areas in which this specific domain would be evaluated:

a. 37.7 percent of respondents selected "Whether (or not) there is and the degree of IT alignment with Business strategy"
b. 33.3 percent of respondents selected "Whether (or not) there is and the degree of business involvement and understanding of SOA activities/projects"
c. 22.2 percent of respondents selected "Change management (how easily the employees will adopt the change to SOA)"
d. 4.4 percent of respondents selected "Whether (or not) there are and the degree to which SOA projects affect the organizational structure or management hierarchy"
e. 2.2 percent of respondents selected "The level of impact of SOA projects on an organization's brand and reputation"

With which three of the statements above, are you more likely agree with as the most appropriate to be included as focus areas for this domain?

5. Considering the results of the first-round questionnaire,

a. 33.3 percent of the participants have chosen "The scope (inter-enterprise, enterprise-wide, department-wide, etc) of organized SOA efforts" and
b. An equal percent of the participants (33.3) the **"**Whether (or not) and to what extent there are policy enforcement schemes, reporting and exception handling guidelines/procedures across the collaborating enterprises**"**
c. 28.9 percent, the "Whether (or not) there is and the degree of funding for projects"
d. 2.2 percent, the "Whether (or not) an enterprise is in discussions for acquiring/merging with another organization" and
e. Another 2.2 percent the "Whether an enterprise is publicly or privately owned and managed"

as the most appropriate (three) focus areas on which the "Governance" domain/dimension would be evaluated. With which three options (from –a- to –e-) do you agree more?

6. The first-round questionnaire demonstrated that:

a. 29.6 percent of the respondents selected the "Whether there is an Enterprise Architecture (and what is its role) in the organization and whether it also governs the organization's relationships with its collaborating organizations"
b. 27.7 percent, the "Whether (or not) there is and the degree to which the Enterprise Architecture is being considered in the enterprise-wide and inter-enterprise planning activities"
c. 25.9 percent, the "Whether (or not) there is and the degree to which services are cataloged and reused across the collaborating organizations"
d. 11.1 percent, the "Whether the Enterprise Architecture describes the IT infrastructure (hardware, software, networking, etc) of an enterprise"
e. 5.5 percent, the "Whether the Enterprise Architecture is being built by an organization's management or by its IT department"

as the possible focus areas for the "Architecture" domain/dimension. Based on this piece of information, what do you think? Which of these options do you believe are the three most important focus areas to be included in the proposed SOA Maturity Model?

7. The population distribution of responses provided for the candidate focus areas concerning the "Enabling Technologies / IT Infrastructure" domain/dimension were:

a. 29.1 percent of the participants replied that the focus area: "Whether the right tools (for software design, development, deployment, etc) and technologies are in place" might be included as a metric for the "Enabling Technologies / IT Infrastructure" domain
b. 29.1 percent selected "Whether industry standards are being followed (in respect to all aspects of IT operations)"
c. 29.1 percent selected "Whether security, monitoring, and management tools (solutions) are in place"
d. 6.3 percent selected "Whether the required (IT) expertise by human resources is found within the enterprise"
e. 6.3 percent selected "Whether .NET or Java2 EE frameworks for software development and deployment are used"

Which three from (a) to (e) above do you qualify to be used as focus areas concerning the "Enabling Technologies / IT Infrastructure" domain?

8. Looking for the three most appropriate focus areas in which the domain/dimension "Delivery Methods" would be evaluated, the following responses were obtained from the first-round questionnaire:

a. 33.3 percent of the respondents selected "Whether there are any policies and practices (throughout the collaborating enterprises) for delivering the SOA solutions"
b. 33.3 percent of the respondents selected "Whether there are skills and expertise (throughout the collaborating enterprises) for delivering the SOA solutions"
c. 33.3 percent of the respondents selected "Whether there are any methodologies, modeling and abstraction techniques (throughout the collaborating enterprises) for delivering the SOA solutions"

Do you agree that these three options are the most appropriate focus areas for evaluating the "Delivery Methods" domain?

i. Yes
ii. No.

If you choose to go with the "No", please specify any other focus areas you think might be considered for the "Delivery Methods" domain.

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9. The replies to the question requesting the three most appropriate focus areas for evaluating the "Information or Data Format" domain were:

a. 35.3 percent of respondents selected "Whether the collaborating enterprises are using industry standards for the representation of data (e.g. XML)"
b. 35.3 percent of respondents selected "Whether the collaborating enterprises are not only using industry standards for the representation of data (like XML), but also other canonical formats and metadata management standards (like XSD, XSLT, XPath, Expression Language, etc)"
c. 29.4 percent of respondents selected "Whether the data is located on a single location (that is, whether there is any kind of data consolidation in place throughout the collaborating enterprises)"

Is that what you expected?

i. Yes
ii. No.

If you choose to go with the "No", please specify any other focus areas you think might be considered for the "Information or Data Format" domain.

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10. The population distribution of responses provided as candidate focus areas concerning the "Business Processes" domain/dimension were:

a. 37 percent of the respondents chose: "Whether any kind of business process automation is in place"
b. 27.7 percent of the respondents chose: "Whether a cross-application orchestration of business processes has been deployed (throughout the collaborating enterprises)"
c. 27.7 percent of the respondents chose: "Whether there is any kind of business process monitoring tool used (throughout the collaborating enterprises)"
d. 3.7 percent of the respondents chose: "Whether there is any kind of business process analysis toolkit used (within an enterprise)"
e. 3.7 percent of the respondents chose: "Whether any kind of business process re-engineering has taken place lately in the enterprise"

Which three from (a) to (e) above do you qualify to be used as focus areas for evaluating the "Business Process" domain?

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11. The first-round questionnaire also revealed information concerning the panel members' enterprises status in respect to SOA. In particular:

- **a.** 50 percent of the respondents are currently using SOA (either selectively, without a clear strategy -30 percent-, or they do "have an enterprise-level strategy and commitment for SOA" -20 percent-)
- b. 25 percent of the respondents "will pursue within the next twelve to twenty-four months"
- **c.** 25 percent of the respondents are "not pursuing, and no immediate plans to do so"

Do you think that these responses properly illustrate the SOA status in your enterprise (and subsequently, in the local market)?

i. Yes

ii. No.

If you choose to go with the "No", please specify what you think is a more appropriate statement for describing the SOA status in your organization (and, subsequently, in the country).

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12. As far as the SOA applicability (that is, in which areas or type of projects SOA is being used) is concerned, the participants' replies were:

a. 50 percent of the respondents selected "Internal integration"

b. 30 percent selected "Strategic business transformation"

c. 20 percent selected "External integration (that is, integration with partners' and/or customers' systems)"

Do you think that these are the areas or types of projects SOA is mainly being used for?

i. Yes

ii. No.

If you choose to go with the "No", please specify what other areas or types of projects SOA might be used for.

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13. According to the first-round questionnaire's findings, the most important factors that facilitate the "penetration" of Service-Oriented Architecture and Web Services within IT experts' enterprises are:

a. "SOA (and Web Services) enhances agility and flexibility; important ingredients for our organization" (33.3 percent)
b. "SOA reduces information systems integration complexity" (33.3 percent),
c. "SOA lowers costs by re-using existing IT assets" (33.3 percent)

It is widely accepted that all three factors chosen (above) are the most important facilitators for SOA "penetration" within enterprises. The same piece of information has been revealed by the findings of the first-round questionnaire. Is that acceptable to you?

i. Yes
ii. No.

If you choose to go with the "No", please specify any other important facilitators for SOA "penetration" within your organization.

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14. It was also found (in the first-round questionnaire) that the primary constraints that prohibit the "penetration" of Service-Oriented Architecture and Web Services within enterprises are:

a. "Lack of funding" (33.3 percent)
b. "There is a lack of skills for the implementation and deployment of SOA-based ("Web Services-based") Information Systems" (33.3 percent),
c. "Lack of anticipated ROI" (16.7 percent)
d. "The technology (SOA) is still immature" (16.7 percent),

Do you agree with these findings?

i. Yes
ii. No.

If you choose to go with the "No", please specify any other important prohibiting factor(s) for SOA "penetration" within your organization.

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15. Another finding derived from the first-round questionnaire was that:

a. “There will be a considerable (to great) increase in the adoption of SOA (and Web Services) by enterprises” (50 percent),

b. “SOA (and Web Services) will be the dominant technology five years from now, like what the -static- Web is today” (35 percent),

c. “There will be a slight (or no) increase in the adoption of the technology” (15 percent),

when the IT experts were asked to “predict” the SOA penetration five years from now, both within their enterprises and to the broader business landscape.

Is that what you expected?

i. Yes

ii. No.

If you choose to go with the “No”, please specify what you anticipate will happen in five years, in respect to SOA.

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16. In addition to the above “prediction” (Question 15), the IT experts provided their opinions regarding which factors they consider most important toward facilitating the adoption of SOA (and Web Services) by enterprises five years from today.

a. 33.3 percent of them believe that SOA provides “Greater business flexibility and agility”,

b. 33.3 percent, “Lowering of costs of integrating existing applications and systems”,

c. 19.6 percent, “There will be proven success stories associated with the application of SOA-based systems in highly demanding environments indicating the inherent benefits of the technology”, and

d. 13.7 percent, “The ROI will be promising”.

Do you agree with these findings?

i. Yes

ii. No.

If you choose to go with the “No”, please specify any other important facilitator(s) for SOA “penetration” within enterprises in five years’ time.

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17. Moreover, the IT experts provided their opinions regarding which factors they consider as most prohibiting towards the adoption of SOA (and Web Services) by enterprises, five years from today.

a. 44.4 percent believe that "The skills needed to implement and use the technology will be very limited in respect to the capacity required by the technology",
b. 22.2 percent, "The ROI will never be encouraging enough",
c. 22.2 percent, "The technology will fail to prove itself when it is implemented and deployed in systems where high security features are mandated",
d. 11.1 percent, "The big supporters of the technology (Big IT companies like Microsoft, IBM, Oracle, etc) will abandon the technology and they will look for more profitable technologies/solutions".

Do you think that these responses are what you were expecting?

i. Yes
ii. No.

If you choose to go with the "No", please specify any other important prohibiting factor(s) for SOA "penetration" within enterprises in five years' time.

Appendix D: Delphi Technique Applied - Third-Round Questionnaire

The second-round questionnaire revealed that three-quarters (that is, 75 percent) of the panel members are currently using SOA (either selectively, without a clear strategy or they do "have an enterprise-level strategy and commitment to SOA") or they will pursue SOA projects within the next twelve to twenty-four months.
The remaining quarter (25 percent) of the respondents admitted that they are "not pursuing, and no immediate plans to do so."

As far as the future status (in particular, after five years) of SOA is concerned, a very large number of respondents replied that "there will be a considerable (to great) increase in the adoption of SOA (and Web Services)" and that "SOA (and Web Services) will be the dominant technology five years from now, like what the -static- Web is today", demonstrating not only their willingness to "embrace" the technology(SOA), but also the technology's reliability over the last few years and its increasing acceptance in the business.

1. Considering:

(i) this piece of information stated above,
(ii) the information you had provided in the two(2) questionnaires distributed to you earlier,
(iii) what is really happening within your organizations in respect to SOA, and,
(iv) the derived SOA Maturity Model which was the outcome of the second-round questionnaire (and it was handed-out to you along with this questionnaire),

where would you locate the current status of your enterprise (that is, into which maturity level) in respect to the various SOA domains identified in the model?
Please designate your choices by drawing the corresponding boxes in the SOA Maturity Model (Table 2) which was handed out to you.

2. Repeat what has been done in Question 1 above, but now indicate (if possible, using a different color) the status of SOA in five years' time.

Appendix E: Delphi Technique Applied - Third-Round Questionnaire Sample Responses

E1. Current Status Of SOA:

Panel Member X – Sample Responses:

	Maturity Levels				
	Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**
pSOAMM's SOA Enabler / Domain (Along With Its Focus Areas)					
Architecture (*Focus Areas:* a. Role of Enterprise Architecture; b. Cataloging and Reuse; c. Planning and Guidance)					
Infrastructure (*Focus Areas:* a. Standards; b. Security and Monitoring; c. Management and Operations)					

Delivery (*Focus Areas:* a. Project vs. Enterprise Focus; b. Skills and Methodologies in Place; c. Modeling and Abstraction Techniques)					
Information (*Focus Areas:* a. Data Standards and Canonical Formats; b. Metadata Management; c. Single Source of Truth)					
Process (*Focus Areas*: a. Process Automation; b. Composite Application Development; c. Process Measurement and Scoring)					
Organization (*Focus Areas:* a. IT Alignment with Business Strategy; b. Change Management; c. Business Involvement and Understanding)					

Governance (*Focus Areas:* a. Funding and Accounting; b. Inter-Enterprise / Cross-Organizational Involvement; c. Policies, Reporting, and Exception Handling)					

E2. Status Of SOA In Five Years

Panel Member X – Sample Responses:

	Maturity Levels				
	Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**
pSOAMM's SOA Enabler / Domain (Along With Its Focus Areas)					
Architecture (*Focus Areas:* a. Role of Enterprise Architecture; b. Cataloging and Reuse; c. Planning and Guidance)					

Infrastructure (*Focus Areas:* a. Standards; b. Security and Monitoring; c. Management and Operations)					
Delivery (*Focus Areas:* a. Project vs. Enterprise Focus; b. Skills and Methodologies in Place; c. Modeling and Abstraction Techniques)					
Information (*Focus Areas:* a. Data Standards and Canonical Formats; b. Metadata Management; c. Single Source of Truth)					
Process (*Focus Areas*: a. Process Automation; b. Composite Application Development; c. Process Measurement and Scoring)					

Organization (*Focus Areas:* a. IT Alignment with Business Strategy; b. Change Management; c. Business Involvement and Understanding)					
Governance (*Focus Areas:* a. Funding and Accounting; b. Inter-Enterprise / Cross-Organizational Involvement; c. Policies, Reporting, and Exception Handling)					

Appendix F: Selected Panel Experts Interview (On Proposed SOA MM "Locality")

Interview Agenda
Setting Objective of Interview: *Determine whether the proposed SOA MM can only be used locally or whether it is a "global" model.*
Interview Points To Be Discussed: *1. Based on the brief introduction handed-out to you regarding the Delphi technique (as shown in section 5.1 and which was used as the "vehicle" for carrying out this research work and allowing me to come up with the proposed SOA), do you think that this technique is the most appropriate tool for carrying out this type of research work (proposing a new SOA MM)?* *2. Do you think that the proposed SOA MM (which has been derived through your contribution, too) is for local organizations only or can it be used (and have a real value) by organizations outside Cyprus, too?* *3. If you think that the proposed SOA MM is only for Cypriot organizations, what are those factors that make you feel confident of your opinion / perception?* *4. On the other hand, if you think that the proposed SOA MM can be used by organizations outside Cyprus (that is, it is a "global" model), what are those ingredients that make it "global"?* *5. What are those domains/factors that could be added to the proposed SOA MM that would make it "global"?* *6. Is there anything else that could be added to the proposed SOA MM to make it even more complete, broad and "global" one?*
Follow-Up There was no need to have a follow-up session with any of the selected panel experts.

Appendix G: The Business Imperative For SOA (Integration)

Executive Summary

While change may have been a constant since time immemorial, the rate of change is accelerating far faster than ever before, and this is having a profound effect on business. Business cycles are shrinking rapidly. The way business was conducted even a decade ago is no longer acceptable if an organization wishes to remain competitive. Organizations have had to change how they interact with customers, how they manufacture goods, and how they are organized and managed.

Rapid changes are only possible when the organization itself is agile. The notion of an agile business has long captured the imagination of business executives. The agile business is able to embrace changes in market conditions, organizational structure, and the regulatory environment without missing a beat. An agile business empowers the management team to focus its collective acumen on delivering substantially increased value to its stakeholders.

The desire for greater business agility is making integration increasingly important. Agility is the combination of speed and adaptability: speed to bring new solutions to markets more quickly, and adaptability to new business requirements and competitive pressures. This can only be achieved when business processes are able to change easily. And that, in turn, is possible only when the underlying IT systems are integrated flexibly to accommodate the speed of change required.

Integration also enables organizations to leverage existing IT investments to streamline their processes for greater efficiency and productivity. IT infrastructures need to utilize existing applications and systems to the extent possible. This requires an integrated infrastructure along with end-to-end visibility of the business processes across disparate systems. It also requires an approach that supports the implementation of business solutions from existing components. This is the idea behind Service Oriented Architecture, or SOA.

Challenges to Business Agility

Currently, business agility is constrained by a number of obstacles. These include inflexible applications that cannot be easily changed or enhanced; non-integrated stovepipe applications; inefficient business processes; a lack of visibility into business processes and operations; challenges brought about by mergers, acquisitions, and regulations; and a lack of alignment between an organization's strategic objectives and daily operations.

Integration technology can play a role in removing these obstacles. In fact, in today's business climate, organizational growth may be inhibited without integration. Integration technology is a key enabling factor in helping business and IT executives transform their organizations; get to market more quickly; respond faster to business opportunities, competitive pressures, and regulatory requirements; and differentiate how their organizations do business. Business responsiveness has become a function of an organization's ability to rapidly marshal the underlying IT systems in alignment with business needs. This means leveraging existing assets while creating new business functionality.

The Mandate for Integration

One only needs to look at the history of computing and the evolution of business software to see why integration is a priority for most chief information officers (CIOs) today. In the beginning, back-office operations were run by mainframe systems. These systems were built to optimize expensive computing resources, but not business agility. They were—and remain—difficult to change and brittle to boot: Changing one thing could easily break something else. The legacy systems still in place today generally run an organization's core back-end operations in a robust and reliable way. However, they are usually batch systems and are unable to respond flexibly to business needs for realtime information or new functionality. That unfulfilled business need gave rise to the first wave of distributed computing with the emergence of minicomputers. Department managers could purchase them with their budgets and select them based on their particular needs. Often, the availability of a packaged application that met 50% to 80% of the department's specific needs led to the introduction of these new platforms.

Unix, PCs, and client server software further reduced the cost of department systems, and they began to proliferate throughout organizations. Low-cost desktop productivity and development tools —such as Microsoft Excel, Access, and Visual Basic —supported ad hoc solutions, which also proliferated and often became more strategic than they were originally designed to be. Individual business units established their own computing facilities and application development capabilities, in effect setting up shadow IT organizations. This gave them the desired level of agility —at least at first— to respond more rapidly and independently to new business needs. However, it also led to islands of automation: hundreds of applications spread across the organization, many of them on desktops. These applications used organizational information and were in turn used to report on business operations. But they were not under organizational IT management and were certainly not integrated consistently.

The emergence of the Internet and the associated rush to e-business further punctuated the need for organizations—and, by association, IT—to become more responsive to market dynamics. But with different departments launching their own initiatives and often duplicating one another's work, the result was reduced visibility and control, along with reduced economies of scale.

The widespread adoption of distributed systems often meant that large organizations had multiple platforms running hundreds of applications that managed similar information through different portions of various business processes. Unfortunately, these applications were not designed to integrate with one another, so the organizations had to find ways to keep the information in sync across the systems. Rekeying the data —a means of last resort, but all too often the approach taken— was slow, resource intensive, and prone to errors that could be costly to trace and resolve. So an easier way to integrate the disparate stand-alone systems was needed.

Another problem was that each packaged application was designed to focus on specific department processes. Business agility requires the optimization of business processes end-to-end. This includes improving the process for initiators such as customers, partners, and suppliers as well as people in different business roles, and developing systems that support different parts of the business.

While some emerging technologies look for a business problem to address, integration was a business problem long before it was a technology. Packaged software systems were far from being turnkey solutions. The integration costs of implementing the typical enterprise resource planning (ERP) system could be three to five times the cost of the software. The problem was that the integration involved point-to-point hand-coding. This required an understanding of the application program interfaces (APIs) of all the systems to be integrated and a high level of expertise. It also took a great deal of time and was inflexible to change. The number of interfaces rose exponentially with the number of systems being integrated. Such integration "spaghetti" was difficult to manage and change, and upgrading to a new version of any of the applications meant going through the process all over again.

This brings us to the present. Although the current state of affairs is largely the result of short-term business decisions, it is ultimately viewed as an IT problem. That's because business change is intimately tied to the underlying IT systems' flexibility—or lack thereof. As markets move quickly and new opportunities and competitors emerge, organizations are increasingly challenged to close the gap between their business needs and the lack of flexibility in their IT infrastructures. Perhaps the biggest obstacle to closing this gap is that change has to be implemented while the core IT operations that support the business continue to function smoothly

and seamlessly. The challenge is akin to upgrading the wings of a plane while it's in flight. This is where Service Oriented Architecture enters the picture.

Integration and SOA

At the core, SOA is about creating systems out of standard building blocks. The concept is not new. Many of the principles underlying SOA, such as isolating functionality to promote reusability, are long-standing best practices. In the past, however, the adoption of SOA was hindered by a lack of widely accepted standards for putting together these building blocks. Now, the pressing demands of business—which necessitate increased system flexibility and adaptability—have inspired nearly all organizations to align on a single set of standards for SOA: Web services.

While SOA involves much more than Web services, standardization is largely responsible for removing the barriers to SOA and fostering a future where systems can be more easily assembled and incrementally modified. Today, in the face of growing competitive pressure and the accelerating pace of business, organizations realize that they run a risk if they do not move toward SOA.

So how are SOA and integration related? In fact, they are highly complementary.

SOA is inherently about a distributed architecture, with systems that span computing platforms, data sources, and technologies. A distributed architecture requires integration. By standardizing how systems interoperate, Web services simplify the task of integration. Web services alone, however, do not suffice. Organizations need an evolutionary approach to SOA that incorporates legacy (non-Web-services-based) systems. Integration software provides the bridge between the legacy systems and SOA, allowing organizations to leverage existing software assets while managing their transition to SOA.

Integration solutions also contribute mature technologies—such as messaging, routing, data translation and transformation, and event management—along with organizational disciplines that are necessary for full-fledged, enterprise SOA. Moreover, integration capabilities such as business process management (BPM) and business activity monitoring (BAM) allow organizations to realize a higher level of business productivity from SOA by enabling the optimization of business processes and the alignment of strategic objectives with operational actions. In short, integration should play a central role in any organization's SOA strategy.

Appendix H: Business Practitioners (Business Owners And Business Practice Managers) Interview (On Proposed SOA MM "Locality")

Interview Agenda
Setting Objective of Interview: *Determine whether the proposed SOA MM can only be used locally or whether it is a "global" model..*
Interview Points To Be Discussed: *1. The proposed SOA MM (handed-out to you, along with an Introduction on SOA titled: "The Business Imperative For SOA"-* shown as Appendix G-*, and an introduction on Delphi technique (-as shown in section 5.1-) evolved from the contribution/feedback provided by of a team of experts (both from Academia and Industry) and it aims at: (a) helping you position your company's initiatives in respect to SOA initiatives, (b) anticipating what that status (in respect to SOA) might be in a few years, and (c) providing guidance for achieving higher levels of SOA maturity within your organizations. Do you think that the proposed SOA MM takes into consideration real, day-to-day business challenges, or it is just a theoretical framework with no (or minimal) business value?* *2. Based on the brief introduction handed-out to you regarding the Delphi technique (which had been used as the "vehicle" for carrying out this research work and allowing me to come up with the proposed SOA), do you think that this technique is the most appropriate tool for carrying out this type of research work (proposing a new SOA MM)?* *3. Do you think that the proposed SOA MM addresses the challenge of incorporating those domains/factors/"ingredients" that refer to inter-enterprise settings?* *4. Do you think that the proposed SOA MM is geared towards local organizations only or can it be used (and have a real value) by organizations outside Cyprus, too?*

	5. If you think that the proposed SOA MM is appropriate only for Cypriot organizations, what are the factors that make you feel confident of your opinion / perception? *6. On the other hand, if you think that the proposed SOA MM can be used by organizations outside Cyprus (that is, it is a "global" model), what are the ingredients that make it "global"?* *7. What are the domains/factors that could be added on the proposed SOA MM that would have made it "global"?* *8. Is there anything else that could be added to the proposed SOA MM to make it even more complete, broad and "global"?*
Follow-Up I had to insist a bit on the interviews with business practitioners (business owners and business practice managers) because –most of the time- they were busy; I also had to "educate" them on concepts/notions like SOA, Maturity Models, Delphi, etc, in order to acquire/"capture" the information required. So, a number of follow-up sessions took place with this group of interviewees.	

Appendix I: Major SOA Maturity Models

CBDI Forum's SOA Maturity Model

CBDI Forum, a "dedicated-to-SOA" research organization, advises that "in order to synchronize business requirements, technology capabilities and investments with ROI, a roadmap approach which identifies stages of maturity for the various areas impacted, is needed." (CBDI 2006) In particular, Figure 4 below shows a generic SOA Roadmap which links SOA drivers and strategies to stages of maturity, as proposed by CBDI(2006).

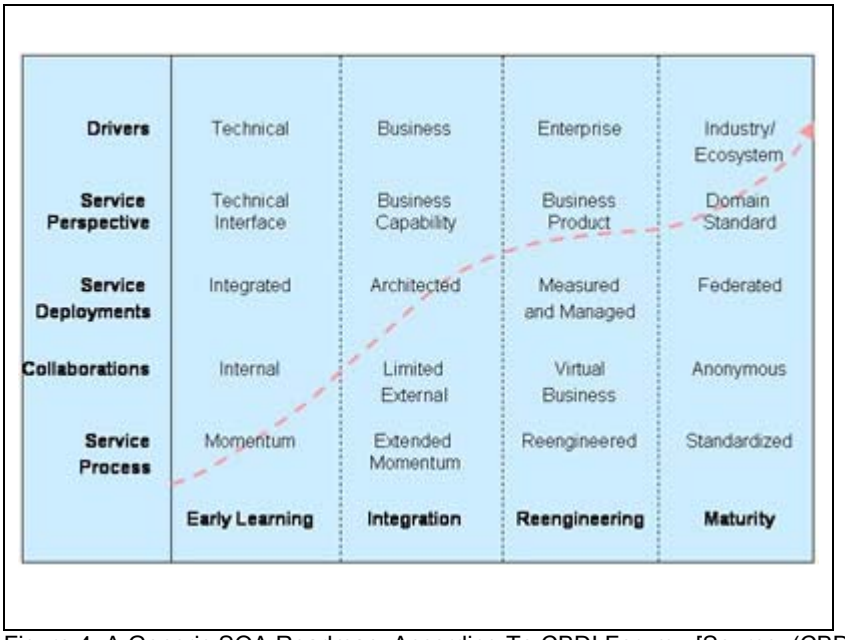

Figure 4. A Generic SOA Roadmap, According To CBDI Forum - [Source: (CBDI 2006)]

In the SOA Roadmap proposed by CBDI Forum, four(4) distinct stages of SOA maturity are identified: "Early Learning", "Integration", "Re-Engineering" and "Maturity".

In the "Early Learning" stage, basic capabilities are put in place as experimental activity. Short-term ROI and specific project based activities make this stage a low risk and impact stage.

During the "Integration" stage**,** an organization is likely to see opportunities from integration with existing core systems. In addition, some organizations may choose to enable key services which can provide immediate business benefit, whereas others will choose to service-enable a complete set of common services.

In summary, in the "Integration" stage, basic business and technical services are becoming available, together with the service infrastructure.

Once the SOA infrastructure is established and the basic services are available to be "consumed", the "Re-Engineering" stage can take place. In this stage, many enterprises can see opportunity in re-engineering business models. Also at this stage it is likely that the increasing business criticality will require more sophisticated management techniques to be employed in order to monitor and manage service provision.

The final stage of the SOA Roadmap, according to CBDI (2006), is the "Maturity" stage. Relative maturity of service architecture can be realized at this stage, if most (of an enterprise) business products and processes are aligned with the service perspective. In this mature state, there is seamless integration throughout the enterprise systems, its customers' and suppliers' systems, and there is a high level of automation of the entire service life cycle. In addition, there is an integrated management of business process execution through to deployed resources.

IBM's SOA Maturity Model

IBM (2006), another big player in this arena -SOA-, proposes a SOA maturity model and a process for achieving desirable stages of maturity called the Service Integration Maturity Model (SIMM) as shown in Figure 5. The level of service de-coupling and amount of flexibility achievable at each stage of maturity are what make up the following seven levels of maturity:

(a) Silo (data integration);
(b) Integrated (application integration);
(c) Componentized (functional integration);
(d) Simple services (process integration);
(e) Composite services (supply-chain integration);
(f) Virtualized services (virtual infrastructure);
(g) Dynamically reconfigurable services (eco-system integration)

Each of these levels has a detailed set of characteristics and criteria for assessment, and what follows is a brief description of the highlights of each level:

(a) Level One: The organization starts from proprietary and quite ad-hoc integration;
(b) Level Two: The organization moves toward some form of EAI (Enterprise Application Integration), with proprietary connections and integration points;
(c) Level Three: At this level, the organization "component-izes" and modularizes major or critical parts of its application portfolio. In particular, "it uses legacy transformation and renovation methods to re-factor legacy J2EE or .NET-based systems with clear component boundaries and scope, exposing functionality in a more modular fashion. The integration between components is through their interfaces and the contracts between them;" (IBM 2006)

(d) *Level Four*: The organization embarks on the early phases of SOA by defining and exposing services for consumption internally or externally for business partners;

(e) *Level Five*: In this level, "the organization extends its influence into the value chain and into the service eco-system. Services form a contract among suppliers, consumers, and brokers who can build their own eco-system for on-demand interaction;" (IBM 2006)

(f) *Level Six*: According to IBM's Maturity Model, in this level "the organization now creates a virtualized infrastructure to run applications. It achieves this level after decoupling the application, its services, components, and flows. Now the infrastructure is more finely tuned, and the notions of the grid and the grid service render it more agile. It externalizes its monitoring, management, and events;" (IBM 2006)

(g) *Level Seven*: The organization now has a dynamically re-configurable software architecture. Particularly, "the organization can compose services at run-time using externalized policy descriptions, management, and monitoring." (IBM 2006)

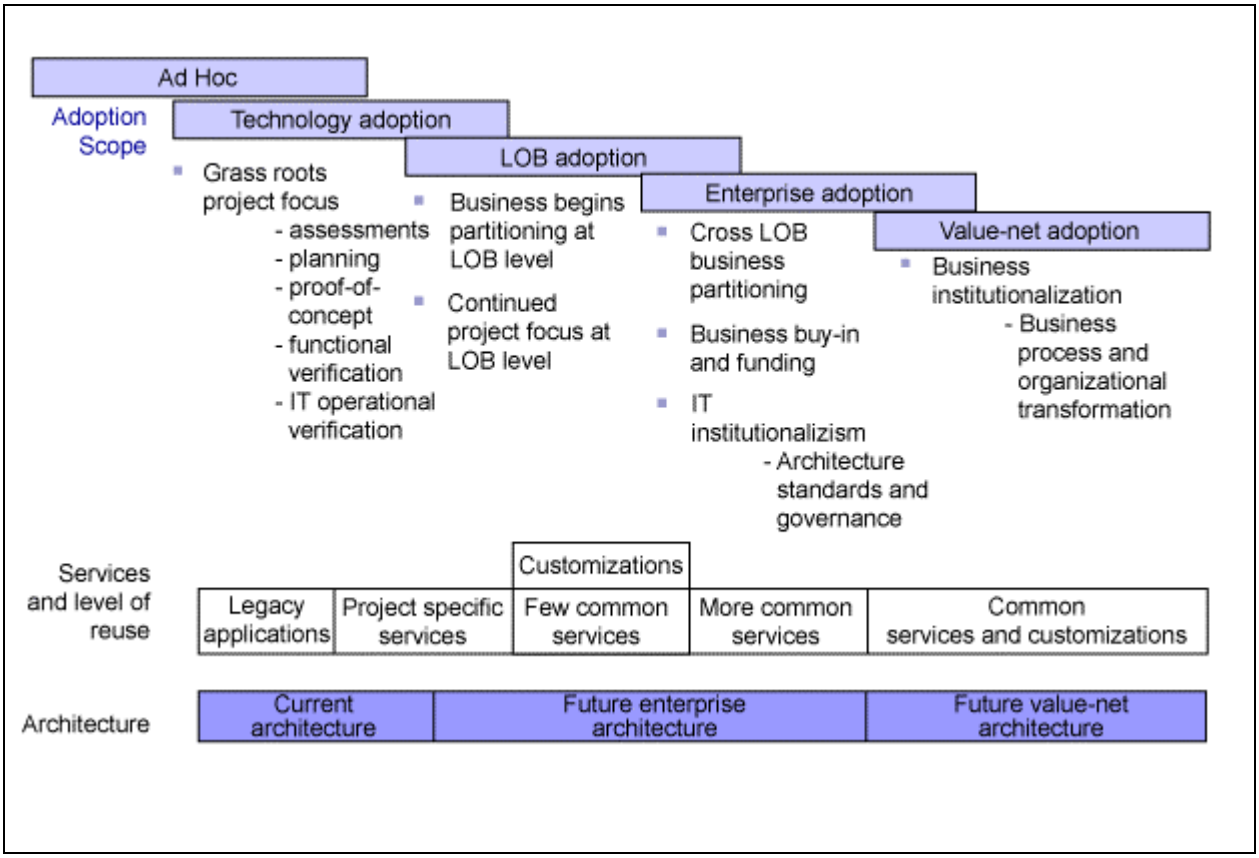

Figure 5. IBM's SOA Maturity Model - [Source: (IBM 2006)]

BEA's SOA Maturity Model

BEA Systems (2006), a leader in the areas of middleware infrastructure and SOA, came up with a SOA Assessment Service, an approach for creating a roadmap to SOA for organizations, which provides an analysis of the business needs and IT constraints that can be addressed through SOA. BEA's SOA Assessment Service provides an overview of SOA methodologies and underlying technologies, and an understanding of the organizational challenges in moving towards SOA and a "reusability" driven IT culture. It also helps organizations by producing a Gap Analysis between the current and desired SOA state.

Accenture's SOA Maturity Model

Another big player in the area of SOA implementations (and thus a provider of SOA Readiness Assessment and Maturity tools) is Accenture (2006), one of the biggest IT Consulting companies. Accenture's SOA Assessment Model is a tool that provides customized, practical analysis to support an organization's SOA planning, and to help it move more rapidly toward implementation. In particular, Accenture's SOA Assessment Model is comprised of a Web-based diagnostic and prescriptive tool which provides unique value by:

(b) Examining an organization's existing and planned business strategies to identify key areas where SOA can have a significant positive impact;
(c) Providing a functional and technical high-level Gap Analysis (between the current and the desired SOA state);
(d) Suggesting the next steps on how to bridge the gaps (as identified by the Gap Analysis) and identifying accelerators to ensure that an organization's SOA adoption is successful and that it produces the intended business benefits;
(e) Recommending the applicable SOA composite design pattern, along with the various foundational design patterns, to help an enterprise conceptualize its solution;
(f) Providing a case study detailing how an implementation has produced a dramatic return on investment (ROI);

Sun Microsystems' SOA Maturity Model

Sun Microsystems (Sun 2006), another big player in the area of SOA solutions, also proposed a SOA Readiness Assessment Service which involves four major activities:

(a) Discovery. During this activity a determination of the existing business and technology strategies, methodologies, processes, infrastructure, and enterprise application integration (EAI) and business-to-business (B2B) architectures through interviews and document collection, takes place;

(b) Analysis. In the Analysis activity, a comparison of the existing SOA state and the Sun's SOA guidelines occurs in order to determine the best practices and gaps;

(c) Working Sessions. This is the activity where Sun's IT architects and consultants conduct multiple 1-2 day architecture working sessions with key customer stakeholders to identify SOA opportunities and challenges, explain findings, and validate tactical and strategic recommendations;

(d) Findings. During this activity, a delivery of SOA Readiness Assessment results in the form of a written report and/or onsite presentation to key customer stakeholders. The SOA Readiness Assessment will include both tactical and strategic recommendations for migration to a SOA.

HP's and Oracle's SOA Maturity Model

Even though the above-mentioned SOA Readiness Assessment tools and SOA Maturity Models are relatively complete, the most influential to our proposed Maturity Model is the one defined by HP (HP 2006) and Oracle (Oracle 2006), as shown in Figure 6 below. This is because of its clear identification of key indicators that help determine enterprise's current SOA maturity level and how this could be leveraged.

According to these vendors' SOA maturity model, assessment of an SOA program is based on a core set of domains (that comprise the SOA Domain Model). The HP's (2006) and Oracle's(2006) SOA Domain Model provides a unifying framework for the SOA Readiness Assessment and it also forms the basis for their proposed Maturity Model.

The SOA Domain Model proposed by HP and Oracle are based on the analysis of the many different SOA implementations the companies' consultants have undertaken and eight primary domains were identified:

(a) Business; According to HP's and Oracle's joint effort on SOA, its adoption has an impact upon and provides benefits for both business and IT. In order to successfully adopt SOA across the enterprise, it's imperative that both business and IT commit to the program. Both sides must recognize that there will be different ways of working, and both should recognize that there will be benefits realized for each.

(b) People; At the heart of the People Domain is communication. Looking at the other domains, it is clear that all the discoveries and decisions need to be communicated across the organization. People need to understand what is happening from the beginning, the goals of the SOA adoption program, how all these disparate pieces actually fit together, and what benefits will be realized—not only for the organization as a whole, but for the people specifically.

This model's providers (HP and Oracle) argue that when the SOA is adopted by an organization, people might take on new roles that are more of a combination of business and IT rather than being just one or the other. Moreover, organizational structure changes might be observed, moving away from layers of technology to structures that are more based around services.

For example, rather than having a team that looks after the network or a specific software application, there will be a team that looks after the financial services, the team that overlooks inventory management services, and so on.

"Fundamentally, SOA requires a change in the way that IT people work together and in the way they work with others in the organization. Trust becomes a key issue, particularly as resources are shared across an enterprise and business managers find that a system that was once solely under their control is now being shared with others. Similarly, they will find that they are now dependent on other groups and other parts of the business to meet their needs." (HP 2006, Oracle 2006)

(c) Program Management; In the Program Management Domain an important element is the organizational span of the SOA rollout across teams, departments, business units, and the entire enterprise, as well as managing the depth of the service portfolio.

In particular, the two providers propose that "the SOA adoption requires an iterative approach, with SOA rolled out as a series of steps. Each step provides a complete business solution, and each step delivers measurable business value." (HP 2006, Oracle 2006)

(d) Governance; This domain concerns the models, systems and processes by which an enterprise's operations are governed: "What are the key activities that need to happen?", "What are the key decisions that need to be made?", "Who is responsible for making those decisions?", "What information is needed to be able to make those decisions?", etc.

The Governance Domain must include things such as portfolio management, risk and compliance management and, of course, financial management. While most of the focus is upon governance of information technology, it is imperative that the IT governance models are coupled directly to the enterprise's overall corporate governance model.

(e) Architecture; The Architecture Domain covers the full architecture spectrum: enterprise architecture, solution architecture and technology architecture.
In an SOA world, with well-defined, loosely coupled, modular services, such an architectural model allows the rapid and cost-effective response to change and the capability to take advantage of opportunities, with both confidence and predictable results.
(f) Enabling Technologies; "The Enabling Technology Domain encompasses the tools and technologies needed to support achievement of the goals of the other seven SOA domains and to realize the infrastructure needed to support a SOA within an enterprise." (HP 2006, Oracle 2006)
(g) Operations and Management; In this domain "processes and policies defined in the governance model are applied. The domain covers all aspects of operating and managing the SOA." (HP 2006, Oracle 2006)
(h) Supply and Demand; The Supply & Demand Domain is the one where we anticipate significant growth and increasing focus as an enterprise's SOA implementation matures.

HP (2006) and Oracle (2006) argue that when all these domains are mastered, an enterprise does have the capabilities and the assets in place to effectively adopt and operate an SOA.

LEVELS / **DOMAINS**	**Level1 (Ad-hoc)**		**Level3 (Standardized)**	**Level4 (Managed)**	**Level5 (Adaptive)**
	Minimal interest in SOA	Aware of SOA	Generally complies with SOA	Proactively supports SOA	SOA fundamental to business ops
Program Management	SOA project focused	SOA efforts are BU-based	SOA federated, not integrated	SOA integrated at corporate level	SOA enterprise wide, extends to partners
Governance	Some acknowledgement of issues	Some processes, individual responsibility	Guidelines defined and integrated	Value of governance understood	Advanced understanding
Architecture	Limited or ineffective architecture	Program exists & architecture well defined	All IT initiatives comply	Business driven and auditable linked	Architecture and business executed as integrated
Operations and Management	No mgmt. of services, infrastructures elements only	Mgmt. in terms of Slaps	Mgmt. of business services	Proactive mgmt. of svcs. linked to component svcs.	Integrated mgmt. of business services into operations

Supply and Demand	Business needs met using tech. components	Services provided internally	Value-based sourcing	Sourced from multiple providers	Dynamic service sourcing of multiple sources
People	Little or no knowledge of SOA	Knowledge limited to IT mgmt. & architects	SOA education required for IT staff	Ongoing education for all staff	SOA is embraced & actively promoted
Enabling Technologies	No service Infrastructure	SOA infrastructure limited	Standard enterprise-wide SOA	Large-scale managed SOA infrastructure	Integrated, dynamic SOA infrastructure

Figure 6. HP's and Oracle's SOA Maturity Model - [Source: (HP 2006, Oracle 2006)]

The HP's and Oracle's SOA Maturity Model is structured as a matrix with two primary axes (Figure 6). Each row represents one of the eight SOA domains. Each column represents a different level of maturity using five maturity levels, from the least mature in the left-most column to the most mature in the right-hand column:

Level 1 (Ad-hoc); Level 1 is the starting point for most SOA "journeys". For an enterprise at Level 1, SOA is a relatively new concept. The enterprise has either taken no real steps toward SOA, or they may have conducted some limited, initial Web Services or Service-based activities that are project-centric, experimental and often technology-focused.

Level 2 (Basic); Typically, enterprises that are at Level 2 maturity have made a firm commitment to adopting SOA, although this may still be limited to certain parts of the organization. They will have completed a pilot or initial project with SOA applied consistently across the project and will have deployed a set of services that are in production use by the enterprise.

Level 3 (Standardized); Enterprises that have achieved Level 3 maturity have adopted SOA as a strategic enterprise-wide architectural principle. An enterprise service catalog has been established and an enterprise-wide service model is defined and used. A set of SOA standards has been defined and is applied across the enterprise. The enterprise has governance systems that ensure that all new projects are compliant with the enterprise's SOA principles.

Level 4 (Managed); At Level 4, SOA is fundamental to the way the enterprise operates both its business and its information technology, and services may extend outside the enterprise. The enterprise's service portfolio is well-managed with quantitative, integrated, enterprise-wide visibility and control of service operations. Service operational metrics are collected and reported in both business and technology contexts according to the audience.

Level 5 (Adaptive); When an enterprise reaches Level 5 maturity, it truly can be described as an Adaptive Enterprise. The whole enterprise operates a dynamic SOA with business and IT synchronized to achieve an optimum balance of agility, performance, risk and cost.

SOA and Web Services Technology:
Architecture, Business Strategies and Opportunities

Document 6: A Reflective Journal

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Contents

1. Introduction

This paper maps my journey as a Doctorate of Business Administration (DBA) student which had given me the opportunity to challenge and change my understanding regarding both the research methodology and my own practice (Information Systems- IS- and Information Technology -IT- Management).

My embarking on DBA was mainly driven by the desire to further boost my technical -IT-, business, and research related skills. There was a trend (which remains valid today too) in the IT world which mandated that the IT professionals needed to "couple" their technical with business related skills. That need initially made me pursuit a MBA and then the DBA.
DBA's unique structure, which is different than the classic PhD, required that six documents had to be prepared, with Documents 3 to 5 being its core. This venture turned out to be a very challenging "journey".

This research work became a great personal and professional development. At the beginning of this journey my expectations with regards to the research methodology were simplistic: I thought of the research methodology as a linear approach - clean, predictable and sequential. However what has been discovered is that the research methodology is rather a dynamic, complex and apparently unpredictable process. A search for authenticity for all six Documents (required for the undertaken degree: Doctorate of Business Administration) mandated a different methodology and approach.

The topic that stimulated my interest was Service-Oriented Architecture (SOA) which is the software architectural paradigm that mostly bridges the gap between IT and business and this because SOA promises that fairly large chunks of functionality can be easily and quickly strung together to form ad-hoc applications that reflect existing or new business processes in order to address existing and new business requirements.

2. Reflective Journaling

Journaling is accepted and widely used in humanity-based subjects. This is particularly true in the case of professions that require some practicum experience such as education, nursing and social work. In particular, reflective journaling is the process of assessing information or events, and thinking about and analyzing them and then using the results to change or enhance future events (Bullock and Hawk 2001).

Dewey (1933) is viewed as the originator of the concept of reflection in the twentieth century. Dewey believed that reflection was a deliberate cognitive process, which addressed problem solving before a solution was reached.

Reflection has continued to be a popular area for research throughout the years. The notions of "reflection-in-action" and "reflection-on-action" were central to Schon's (1987) efforts in the area of reflection. The former ("reflection-in-action") involves looking to our experiences, connecting with our feelings, and attending to our theories in use. It entails building new understandings to inform our actions in the situation that is unfolding. According to Schon (1987), the act of "reflecting-on-action" enables us to spend time exploring why we acted as we did, what was happening in a group and so on. In so doing we develop sets of questions and ideas about our activities and practice.

Besides Schon's work on reflection, many other researchers contributed in the area. Smyth (1992) commented on the relationship between reflection and knowledge and developed a four stage sequential model of reflection to describe, inform, confront and reconstruct experiences.

Kolb (1976) is one of the most influential researchers in the field suggesting that learning is the process of transforming experience to create knowledge. This basis suggests that: "learning is cyclical, and there is a continuum of learning moving from concrete experience - being involved in a new experience, to reflective observation - watching others or developing observations about own experience, through abstract conceptualisation - creating theories to explain observations and finally active experimentation– testing theories to solve problems and make decisions." (Kolb 1976)

Noblitt and Pochis (1997) also argue that the journal is a valuable method of engaging students with deep learning of a subject.

It is obvious that there is a close relationship between learning and reflective journaling; particularly, reflective journaling is used to provide the opportunity to learn from previous cases and to maximize the benefit of experience via the reflection.

This paper relates researcher's experiences in the areas of research methodology (including qualitative research and Delphi) and practice (IS and IT Management) to learning in the sense that any relevant future works could be reflected on this research observations and outcomes to solve problems or make decisions.

3. Embarking And Reflecting On The Journey

A journey often begins with people, baggage and a plan. The same applies to this research journey which included these fundamentals. In particular, in the research undertaken, key people were the DBA student (myself) with the appropriate academic and professional background, and the DBA course leader along with the other course contributors and the advisors.
This journey's plan was the course structure and its curriculum along with the supporting sessions that took place throughout the journey and which were the "road-signs" that guided us avoid possible pitfalls and reach our destination safely.
Our baggage was the plethora of research methodology and IS & IT Management related literature ranging from Hirschheim's (1992) work on "Information Systems Epistemology", Orlikowski's and Baroudi's (1991) work on "Studying Information Technology in Organizations", Walsham's (1993) work on "Interpreting Information Systems in Organizations" to Adler's and Ziglio's (1996), Helmer's (1977), Wissema's (1982), Baldwin's (1975) and Cornish's (1977).

Walsham's (1993) work was the vehicle used for Document 3. According to Walsham(1993), interpretive methods of research in Information Systems are "aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context." (Walsham 1993)
In particular, Document 3 attempted to investigate the attitude of business and IT executives in Cyprus toward Web Services technology in respect to whether:

- Web Services technology:
  - enhances business processes' agility and flexibility;
  - improves the time-to-market of products or services;
  - reduces the information systems integration complexity;
  - eliminates inefficiencies, otherwise observed between communicating integrated information systems;
  - creates new business opportunities through collaboration, outsourcing, and by enabling global presence for the goods and services;
  - accelerates growth by facilitating the integration of systems of acquired companies;
- There are any limitations or constraints prohibiting the adoption of Web Services technology;

The qualitative research methodology was identified to be the most appropriate paradigm for Document 3 and the assumption that was initially made was that the "very stringency of the method guarantees good research results." (Alvesson and Skoldberg 2000). In essence, I thought that the chosen method itself would be enough to help me produce the desired results. That is, I believed that the interviews (along with distributed questionnaires) and the other methods (secondary data sources, etc) employed throughout the research would have been adequate

means for extracting the desired outcomes. As the time progressed, though, I realized that the qualitative research methodology alone was not the recipe that, if followed, would have produced the “cake”, but rather it was an enabling strategy to guide decision making in the journey and that important elements like reflexivity (Shacklock and Smyth 1998) were not present and needed to be incorporated.

Alvesson and Skoldberg present three powerful reasons for not regarding empirical material as the whole truth, or as a decisive path to knowledge. Their argument is based on “the fact that any capture of data or insight is only a fragment, and may not capture the context within which that snippet occurs.” (Alvesson and Skoldberg 2000) Related to this is that “such data may not identify the social conditions, ideologies and communicative processes which are operating in unexplored assumptions, and which mean that the results of interviews and questionnaires are ambiguous at least and may in fact be erroneous.” (Alvesson and Skoldberg 2000) The final reason given is that “studies of what is deemed to presently exist fix our attention on the actual and draw it away from what can be.” (Alvesson and Skoldberg 2000)

In this part of the journey (Document 3), the research methodology itself required reflective practice and offered me possibilities for professional growth - in research, in practice (IS and IT Management) and in self-understanding. Its outcome was to conclude that: “the most pertinent philosophical assumptions are those that relate to the underlying epistemology that guides the research. Epistemology refers to the assumptions about knowledge and how it can be obtained.” (Hirschheim 1992)
Orlikowski’s and Baroudi’s (1991) work further helped to clarify things. Particularly, in their work, they suggest three(3) categories for qualitative research, based on the underlying research epistemology: positivist, interpretive and critical. As it turned out the underlying research epistemology that would have been adopted throughout Document 3 was interpretive, particularly, Walsham’s (1993) work was very influential.

Among the most important “lessons learned” from Document 3 (and its outcomes) that could used as a compass for future relevant journeys are:

- The method adopted for conducting this piece of research work (Document 3), that is, a series of interviews with business and IT executives of organizations with operations in Cyprus, was given me the opportunity to capture only a segment of the whole spectrum of the context (organizations with operations in Cyprus) within which Web Services were investigated and this was due to the fact that even though the interviews were as extensive as possible and lasted many hours, the feeling experienced was that a thorough understanding of the Web Services’

impact on the investigated organizations and the organizations' influence on Web Services adoption and success would have been achieved only by becoming a part, an active member of the "system" (organization). That was the only way through which the investigated organizations' specifics and internal procedures awareness could have been achieved.
To conclude, interviewing is a good tool for data gathering but as Wolcott (1992) suggests: "experiencing, enquiring and examining are data gathering techniques that can be more accurate and provide thorough understanding and insight of the investigated organizations";

- The selected target group may not only include business and IT executives from the investigated organizations but also all types of employees because the objective of the research is to produce an understanding of the context (organizations with operations in Cyprus) of Web Services, and the process whereby the Web Services influence and is influenced by the context and this can be better achieved by engaging all types of employees of the investigated organizations;

- People who are aware of or specialized on a topic are more skeptic to abandon a proven technology or practice for the sake of a new, still immature technology, even though it is considered to be very promising and superior to the existing technologies. Moreover, no matter how promising a technology might be, certain aspects like Security are not negotiable.
This is in fully compliance to the available relevant literature: indicatively, Hagel and Brown (2001) and Hagel (2002) also advocate about the people reluctance to immediately adopt Web Services technology (mainly, because of its limitations in respect to security features). The surprising feature of this finding is the fact that IT people are more risk-averse than the other people, as also pointed out by Hagel and Brown (2001).
This finding is also in line with Checkland's (1991) notable work on "human" factors that need to be considered when investigating information systems (or information systems-related technologies, including Web Services technology).
Future relevant research may (more closely) look into human attitudes toward a new technology considering that people, employees are part of the context within which the new technology is being investigated and the most decisive factor for the technology's acceptance (and success) or not.

As the journey progressed and proceeded into Document 4, a different stance has been adopted. The Delphi technique was selected to be the vehicle for that piece of research work because its objective was to anticipate the adoption of SOA (and Web Services) five years from the time the research work was initiated and what might be the driving forces and prohibiting factors for the technology embracement.

Particularly, in Document 4, the Delphi technique was applied for addressing a series of research questions:

- How agile the participating organization is;
- What is the value of being an agile enterprise;
- How do you build a more agile enterprise;
- Are organizations that adopt SOA seeking for agility and flexibility;
- What are the biggest drivers of potential shift to SOA (Service-Oriented Architecture);
- What are the primary concerns towards adopting SOA;
- What will the IT and business landscape be like (in terms of SOA penetration and contribution in resolving key business issues) five years from now;
- Will SOA's current constraints be addressed five years from now;

The Delphi technique was considered to be the most appropriate research methodology because it is used in cases when a forecasting about the state of or attitude toward a phenomenon is desired and the issue under investigation is very complex and requires the contribution of a pool of experts. Despite of the criticism of the reliability of the Delphi method, the widespread use of this method indicates that it has survived this criticism. Empirical findings prove that qualitative comments and reasons of their judgments are a more effective form of feedback in Delphi than quantitative (e.g., statistical) feedback alone (Rowe and Wright 1999). Thus, the benefit of Delphi technique may come from qualitative comments reflecting insights of group members, combined with quantitative judgments.

Similar approach (to the one adopted in Document 4) was followed throughout Document 5 where a three-rounds questionnaire was distributed to IT experts with the objective to come up with a new SOA Maturity Model that would support inter-enterprise setups (besides a company's internal factors) and thus capturing the model of contemporary organizations where it is a common scenario that their core business processes are accomplished through digital "networks" that are spread not only within an entire organization, but also throughout its collaborating organizations.

Some important “lessons learned” from the work done throughout Documents 4 and 5 that could used as a guidance for future relevant attempts are:

- Even though the Delphi technique proved to be beneficial when there is a need to obtain views and judgments from geographically dispersed knowledgeable people, the fact that the panel of experts selected for this research originated from local -only- Industry and Academia, did not affect its success and reliability because all the other factors (besides locality) were preserved: diversity of knowledge and expertise, acceptable group size whose members never functioned in a simultaneous face-to-face meeting, etc. However, there is no guarantee that the proposed SOA MM is of real value to organizations outside Cyprus and this needs to be evaluated, reviewed and adjusted accordingly by academia and industry representatives from other regions of the world;

- The Delphi technique proved to be a potentially useful method for forecasting and obtaining experts’ opinion on a topic. However, being that this was the first time this sort of method (variation of Delphi) was used for deriving a SOA Maturity Model, the possibility that shortcomings and limitations on the model might be observed is high. Among others, the inter-enterprise nature incorporated into the model needs to be further checked from participants originated from all collaborating organizations. For this reason a mechanism should be in place for inviting experts from all collaborating organizations, but at the same time preserving that they never function in a simultaneous face-to-face meeting;

- Have a mechanism for both accepting critique of the questionnaires’ design and content. It may be useful to let participants comment on topics where they are (proven to be) experts because this may lead to more complete and accurate final results;

- The electronic version of Delphi (known as “e-Delphi”) might also be used in future works instead of the traditional version because it provides a number of benefits: quicker and easier implementation and management of the questionnaires, enhancement of the Delphi technique’s reliability because no human intervention would be involved, etc;

4. Conclusions

Concluding, the DBA journey undertaken did worth it because it helped me have a more critical thinking and provided me with insights that otherwise might not be visible to me. The journey was tough, but in many aspects beneficial.

The research became personal professional development because it enabled me to learn and apply new research methodologies (qualitative research and Delphi) and leaded to learning in the sense that any relevant future works could be reflected on this research observations and outcomes to solve problems or make decisions.

The help and support provided by Prof. Colin Fisher, Prof. Jim Stewart, Prof. John Halikias, Prof. Paul Bawker and the DBA program administrators Ms. Emma Brown and Mrs. Anna-Maria Gounari were invaluable and without their contribution this work might not have been concluded. I am grateful to them for their time, hard work and patience.

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