Abstract. The purpose of this Thesis is to find a way to offer agility to the enterprises, building information systems that are ready to deal with change, easily reflecting the decisions made to face the modifications on their way of functioning. The term Virtual Enterprise is associated with the idea that an enterprise might be composed by many virtual enterprises, each one with its own business and specific clients. It’s even possible to have one virtual enterprise for each group of clients with some unique characteristics. The goal is that an enterprise can easily create a virtual enterprise and its support information system on top of its services and available resources. In order to ease the composition and modification of the enterprises it’s suggested the use of a services library, by which the enterprises may select the services they need. They may invoke those services from the service supplier or use them as a start point to build their own implementation.

Keywords: agility, change, unified services, services library, information system

1 Problem Identification

Nowadays enterprises are struggling to keep pace with the evolution and change in IT, market environment and customer needs and demands. Enterprises need to be prepared to deal with change as everything that surrounds them can be modified very quickly. This new challenge must not be seen only as a threat but also as an opportunity to explore new markets and offer new products and services [1].

In order to succeed, enterprises need to modify their structure, becoming more flexible and agile to adapt quicker to market shifts. The support Information Systems are the main core of an enterprise’s inflexibility and incapacity to react to change. These systems are usually bought as whole software package, implementing the market best practices for the specified business processes. Modifications to this type of system are most of the times difficult, expensive, and time consuming, acting as a barrier to keep up with new market tendencies.

2 Virtual Enterprises

The fact that enterprises need to change their organization and structure in order to achieve flexibility leads us to the term Virtual Enterprise. This term is associated with the idea that an enterprise might be composed by many virtual enterprises, each one with its own business and specific clients. It’s even possible to have one virtual enterprise for each group of clients with some unique characteristics. The goal is that an enterprise can easily create a virtual enterprise and its support information system on top of its services and available resources, as shown in Figure 1.
The word virtual refers not only to the fact that an enterprise can be easily configured and modified to reflect new constraints and objectives, but also to the fact that it doesn’t physically exist as it is built on top of an existing structure. This kind of enterprise might also be eliminated whenever its goal is achieved or when it is no longer a significant benefit to the enterprise.

The term service is central to this Thesis and is here defined as an entity (the provider) exhibiting a set of related capabilities that enable it to repeatedly provide value transfers to another entity (the consumer).

3 Thesis Objectives

The purpose of this Thesis is to investigate how enterprises should be organized and how their support information systems could be built to deal with change. The main goal is that a Virtual Enterprise might be initially configured to deal with specific constraints and easily reconfigured during its existence to reflect new challenges and opportunities. Enterprises can no longer be tied to an inflexible system that requires the enterprise to adapt its operating mode to the system itself.

The main idea is to build enterprises from modules, allowing its combination and reutilization to form other enterprises. Therefore, the formation of an enterprise would be based on the selection of the necessary available modules and the addition of new ones more specific to the business.

One of the main issues of the Virtual Enterprises is the ability to exchange business documents between them. These documents contain crucial business information that enterprises need to operate. Thus, an enterprise has to be able to adapt to sending and receiving a new type of information, becoming possible and beneficial the interaction with others.

4 State of the Art

Today information systems are modeled by the processes paradigm, mapping the system use cases into processes (sequences of operations that transform input data in output data). With this paradigm the reutilization is limited to the processes composition and the granularity of the system’s components is very high, contributing to the high impact that results from a change.
4.1 USF – Unified Services Framework

The services modeling framework (USF – Unified Services Framework) represents a new approach to system modeling, following a divide and conquer perspective. This framework intends to express and structure the variety of aspects that must be taken into care at the conception, implementation, operation and management of a service or group of services [2]. Here the concept of service refers to any kind of generic service, mapping the computer services into software and leaving the others at a modeling and documentation level or represented by computer service that act as interfaces with the resources. Services in the USF model real world entities, its state and behavior, representing the reality more precisely and mapping it into an information system.

According to USF any system might be seen as a service, recursively defined as a value chain of minor complexity services, until reaching elementary services that are not built at the expense of others but only using resources, as shown in Figure 2.

4.2 SIL – Unified Services Implementation Language

The purpose of SIL is to describe services and operations of any kind (technological services or not) and its implementation may correspond to a computer program or a procedures manual to be executed by humans [3]. This language is based on the untrusted and unreliable environment of services and distributed systems, being prepared to respond to unexpected situations and to the dynamics of change, such as the absence of a service, or the change of its behavior. It is targeted at concurrent systems, having asynchronous communication mechanisms and support for detection and tolerance of errors and failures.

Services communicate with each other exclusively by messages and only the predefined data types need to be known by all services. It supports the client (of the service) separation into application and interface (browser) to assure the preservation of client’s information whether in a temporary session or in a long term relation.

5 Solving problems with existing solutions

5.1 Creation of the Enterprise support Information System

The monetary amount involved in the creation of an Enterprise support Information System is very high, representing a huge effort of the company management. This kind of project needs to be faced with the same accuracy and discipline applied to other business areas. There are significant steps to take before the implementation takes place, as a set of studies and analysis (benefits and risk) to determine if it should really occur.

Usually in these projects there is an assumption that the adoption of a package like an ERP will radically transform the enterprise and make it much more efficient [4]. This is a
complete mistake as these systems are design to act as a tool to assist and facilitate the execution of business processes and reflect the business best practices, not solving all the existing problems within an enterprise.

An ERP is a modular software package intended to integrate the several organization processes, facilitating the information flow between business areas. The monolithic structure of these systems has always been an inconvenient to the enterprises, which buy a single package composed by many functionalities and then choose which ones to use in its activity. Nowadays enterprises are following a new approach as they are trying to modularize their systems, supplying only the functionalities that clients really need, reducing acquisition cost and making it possible to implement by phases.

Among the big issues of an ERP implementation is its customization to the enterprise, which might take approximately one year to be completed and is done by consultants of the software supplier with proprietary tools. There are even reported cases in which the enterprise has had to adapt to the system as it was too difficult or didn’t support some kind of change.

Cloud Computing is a new computation model that is being explored by a variety of companies in order to concede flexibility and offer a broad range of choice of applications and services. In Cloud Computing services and applications are available over the internet instead of being hosted locally at the user’s environment. With this approach users may have more than one supplier of the same service and choose which one to execute, having the possibility to dynamically change the contracted services or increase/decrease its capacity to face high/low periods of utilization [5]. One of the main advantages is that users only pay for the consumed services, based on its utilization, avoiding a high investment and difficulties on building a maintaining an IT infrastructure.

However this model brings some concerns with privacy, security, data integrity and intellectual property management. One of the main issues for the users is the fact that they stop having physical access to their data and the providers start being responsible for storage, backup and control. Even if storage security is assured, there are many factors that may temporarily condition the access to data and applications as network interruptions, denial of service attacks or even a failure at the provider infrastructure.

Despite of all the advantages of this model it is not exactly what is pretended for the enterprises as it only offers access to technological services with no or very limited human interaction, deployed at the providers’ infrastructure (cloud).

5.2 Adjustment and Evolution of the IS

The task of customizing an ERP doesn’t occur only at the implementation phase, occurring also along the growth and evolution of the enterprise, adding new functionalities, new modules, new partners and so on. This is an expensive process due to the cost of acquisition of new modules and the need to have the support of specialized consultants. The customization procedure might take a long time as the defined changes might imply some applications to be rewritten or even the update of some technology.

ERP systems are focuses on the process stability and not on the capacity to evolve. These systems do support change but the question is how quickly it can be done and what impact does it cause in the enterprise.

5.3 Business Data Exchange

To keep in business enterprises need to exchange data and documents as part of the business processes. They need to have the ability to communicate with each other and understand the exchanged messages, knowing what information to send and how to process the information received.

EDI (Data Interchange) is a possibility to define the process of business information exchange between partners, using standard formats previously agreed, which is widely used by high dimension and multinational enterprises [6]. Here the documents such as buying
orders, expenditure notes, catalogs or invoices are sent over a network in a structured computer processing format. Employing EDI implies the point to point integration between applications, allowing that both recognize the messages format. Due to its high implementation costs, small and medium enterprises have not been able to adopt this process. Another issue of this process is that it maintains a specific pattern for each negotiation or business partner, which is not adequate for today’s multiplicity of relations between enterprises.

ebXML (Electronic Business eXtensible Markup Language) is another global business pattern that intends to ease and simplify the relations between enterprises, defining a structure for the electronic business and facilitate the entrance of new enterprises to the business [7]. ebXML presents a framework for defining the business processes and the key documents to realize business exchanges. Contrarily to EDI, ebXML is an open standard based in XML.

In this pattern an enterprise presents its way of doing business while the others may consult it, searching in a repository, and accept or decline its conditions and characteristics. Trying to standardize business exchanges is very difficult as there is a vast quantity of different enterprises, with different businesses and different ways of working.

6 Solution proposal

The main objective of this proposal is to leave behind the rigid and monolithic systems and start building new structured systems composed by interconnected components that communicate with each other. The granularity pretended to these components is much higher than the module’s, facilitating the modification and diminishing its impact.

It must be possible to reflect the quick evolution of the market on the enterprises, integrating new partners, creating new connections with new business components or replacing existing ones (Figure 3), avoiding high investments a long implementation period.

It’s proposed the application of the unified services paradigm on the modeling of the enterprise, being able to contemplate all kind of services, technological or not. This model allows a better representation of the enterprise and its real activities, not limiting its scope to the automated processes.

The services identified by the application of the services paradigm should be implemented according to SIL language, providing them the fundamental mechanisms to function in a distributed and dynamic environment, being prepared to deal with situations like services fallibility. With this language it’s possible to describe services functioning and its interaction model, which occurs through messages exchange (invocation of an operation in the receptor service).

One of the advantages of having a IS decomposed in small components is that it can build other ISs for special cases, like a set of clients with similar characteristics or even for a particular offering. These are the so called Virtual Enterprises that represent ramifications of the main enterprise and are constituted by services of that enterprise, its specific services and external services.

![Figure 3 - Enterprises Information Systems adaption](image-url)
The agility of an enterprise must be assured at the act of its creation, providing the necessary means to reach that objective. The creation process must correspond to a simple and quick process, making the system available as soon as possible. There should exist a library of generic services, as the classes libraries of programming languages, that enterprises could use and adapt, diminishing the creation time and taking advantage of pre-tested service that reflect business best practices.

**Figure 4** represents the constitution of two enterprises based on a services library. Enterprise 1 is formed by two services from the library (blue parts), functioning like outsourcing. These services are invoked by the enterprise system, while its support and execution is a responsibility of the supplier. To these services the enterprise adds one more, specially created for its activity (red part), because there are no adequate services on the library or because this service contains knowledge and competitive advantage to the enterprise.

![Services Library Diagram](image)

**Figure 4 - Building enterprises from a services library**

This construction could be aided by a tool that would present a list of the available services and its characteristics. The enterprise could then choose the wanted services and join the customized ones to form the final system, accordingly with the enterprise goals and objectives.

## 7 Conclusions

Enterprises need to keep pace with business transformation and innovation, being able to adapt to the new demands and tendencies. They have to change their structure in order to be more flexible and react to change quickly and in a smoothly way. The idea is to have the enterprise systems decomposed into small pieces (services) that together supply the functionalities needed make business. This decomposition makes it easier to modify the functionalities of the system, being able to replace a service by another, have two different services for the same task or even outsource a service at any time.

The formation of the enterprises could be aided by a tool that made use of a services library, promoting the reusability of services and making it possible to use them as a starting point to the definition of other services.

## References


