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TARGETING THE PROMOTION OF INCUBATING SMEs COMPETENCIES THROUGH THE INTEGRATION OF A BUSINESS INCUBATION PROCESS WITH A VIRTUAL ENTERPRISE CREATION PROCESS

TESIS

PRESENTADA COMO REQUISITO PARCIAL
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POR:

RODRIGO MÁRQUEZ CASTILLO

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TECNOLOGÍAS DE INFORMACIÓN Y ELECTRÓNICA

Los miembros del comité de tesis recomendamos que la presente tesis del *Ing. Rodrigo Márquez Castillo* sea aceptada como requisito parcial para obtener el grado académico de Maestro en Administración de Tecnologías de Información.

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Julio, 2009

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SUPERIORES DE MONTERREY

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Dedicatoria

Al Espíritu Santo

A mi mamá que desde el cielo siempre está conmigo

A mi familia, ejemplo de unión y fortaleza

A Alma, mi futura esposa

Agradecimientos

Primordialmente a Dios y a mis padres por regalarme la vida.

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Executive Summary

Nowadays, Small and Medium Enterprises (SMEs) represent most of the income in the economies around the World. In spite of their undeniable importance, SMEs are highly prone to fail, in Mexico for example: around 90% of the SMEs go bankrupt before reaching their first year of existence, and this problem is caused very often by the little effectiveness of the companies to commercialize their products and/or services.

On the other hand, due to their informality and size, SMEs are managed generally by their owners, who usually lack of managing skills though they stand-out in operative-oriented skills caused by their closeness to company's daily operation. This situation represents a threat for the existence of SMEs because of the need of developing business skills in order to sell their products and/or services.

The competency-based collaboration, achieved through a Virtual Enterprise creation process, allows companies to promote their competencies in the same way as they promote their products and services; this kind of collaboration generates two important advantages for companies, the first one is the raise in the number of markets they will be able to reach and the second one is their involvement in collaboration business opportunities. Companies that belong to incubation stages are prone to adopt a schema of collaboration based-on competencies integration because incubation is the time when companies define important aspects like products and services that they will offer to the market and the competencies required to produce them.

In order to allow incubating companies to collaborate using a competency-based collaborative model, this research work proposes the integration between the ITESM business incubation model and the Virtual Enterprise creation process developed by ECOLEAD project. To achieve the proposed integration a modeling exercise including the ITESM business incubation processes and the Virtual Enterprise creation process using Business Process Modeling Notation (BPMN) and Business Process Integration concepts was carried-out.

Finally, it was developed a prototype tool implementing the business process integration previously described. This tool was designed using a Service Oriented Architecture (SOA) to facilitate the implementation of the Web Services needed to carry-out the proposed integration.

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CHAPTER 1: Introduction

1.1 Background

Most of the companies at world-wide level are catalogued as Small and Medium-sized Enterprises (SMEs), these companies are distinguished by their dynamic and short lifecycle, especially the ones referred as “small business”. The SMEs short lifecycle is turned-out from the difficulty of these companies to achieve a better position within the market due to the mostly operative-oriented profile of their owners/managers, showing management skills deficiencies in selling products and/or services.

However, the SMEs technical and operational backgrounds cannot longer be an obstacle for their growth and has to become into a boost for their sustainable and competitive development. This can be achieved by causing in the SMEs the inclusion of their core-competencies like marketable services and in this way extending their value offer and even their incursion into new markets and collaboration business opportunities.

On the other hand, the rise of the globalization and its effects in local markets have forced the SMEs to compete locally with multinational companies, in this way, the SMEs are being pushed into the necessity to penetrate in international markets in order to be able to subsist. In this scenario, the SMEs must find new ways to increase their competitiveness levels in order to maintain or even increase their sales, to do this, “collaboration” is proposed as an enabler for SMEs who want to access to more and more profitable “collaboration business opportunities”.

In spite of the previous scenario, the SMEs are not prepared in both technological and managerial sense to establish collaboration with similar companies; also the SMEs seem to ignore or misunderstand the real advantages of integrating themselves into organizational structures such as: “collaborative networks”, that allow them to participate in collaboration business opportunities and taking advantage of economies of scale.

The European Collaborative networked Organizations LEADership initiative (ECOLEAD) project aims to create strong foundations and mechanisms needed to establish the most advanced collaborative and network-based industry society: “In ten years most enterprises will be part of some sustainable collaborative networks that will act as breeding environments for the formation of dynamic virtual organizations in response to fast changing market conditions”.

This thesis work proposes to enable a Virtual Enterprise (VE) creation process for companies in the Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM) Business Incubator known as “EMPRENDETEC”, through a business process integration between the VE creation process designed from the concepts and tools developed within the ECOLEAD project and the ITESM business incubation process.

The mentioned VE creation process (simplified from Camarinha-Matos et al., 2005b; 2007) is divided into three sub-processes, the first sub-process was designed to manage the enterprises' profile and competencies (adapted from Ermilova & Afsarmanesh, 2006; 2007; 2008), and the second makes possible the characterization of collaboration business opportunities such as a product manufacturing and/or a service offer (adapted from Concha et al., 2008), and the last sub-process enables to the partners search and suggestion (adapted from Baldo et al., 2007) based-on the information produced in the first two sub-processes (e.g. a partners competency-based search and suggestion approach).

These sub-processes are based-on their corresponding ones designed within the ECOLEAD project and adapted for the general characteristics of the SMEs in incubation. The reason why this work is focused on incubating SMEs is because it is in the early stages of a company foundation where the self-definition based-on its competencies should be carried-out, and precisely this is the right moment to help SMEs in developing a business process-based structure instead of a function-based-one. It is expected that the previously mentioned sub-processes will contribute to the SMEs competencies definition.

1.2 Problem Statement

The term "globalization" is actually listened every day especially in business environments. The globalization is a process that is still on development though its pace varies over the years. One of the approaches of the globalization is the well-known as macroeconomic that makes the World one single market (e.g. the World is flat), according to this perspective, a direct relation exists between the globalization and the organizations, in fact the activities of an organization can stimulate, facilitate, maintain and extend the globalization (Jones & Dimitratos, 2004).

Globalization is a source of opportunities as well as of threats. The advantages derived from operating in a global market seem to be exclusively for large companies, unless SMEs can find new organizational models allowing them to participate in global business opportunities without suffering from lack of resources and avoiding the risk of direct investment (Freitas et al., 2000).

In the SMEs integration to globalization, they suffer from a twofold problem: on the one hand, limitations in critical resources and assets constraints; on the other hand, local markets are being attacked by large multinational organizations (Freitas et al., 2000).

According to Lerberg & Steen (2006), globalization does not just concern large companies but increasingly SMEs as well. As markets for semi-manufactured goods become more global, SMEs are gradually more integrated into global value chains.

The globalization in conjunction with other problems faced by enterprises causes that SMEs have a high mortality level, for instance, in Mexico the 90% of the enterprises close before reaching its first year of existence and of the remaining 10% only the 30% survives after the fifth year according to Mexican Association of Development Centers for the Small Enteprise (AMCDPE, 2008).

As a result of the globalization, SMEs are expected to combine global business strategies with strategies to fulfill both social and environmental standards across global production networks although they do not possess the same resources as large companies for doing so (Kaplinsky & Morris, 2001).

A "collaborative enterprise model" offers a way to reach a competitive performance in its operation, nevertheless there are some problems about specific administrative functions in SMEs and these are aggravated by the pressure to operate in unstable environments. Planning in the style of a corporative allows the collaborative enterprises to offer a substitute to the rigid planning of the traditional SMEs, allowing them to maintain their strategic flexibility that will enable them to respond quickly to the emerging requirements of their customers (Coleman, 2003).

Camarinha-Matos & Afsarmanesh (2008) say that at the time of the initial investments of a Virtual Enterprise creation process, its members stop guiding themselves by the methodologies based-on cases, this fact occurs normally because the degree of existing lack of formality during the same creation of an enterprise.

Frequently when a project for a collaborative network creation is initiated it is made from scratch, this means, without taking into account all the literature and research about collaborative networks, and without benefitting from previous experiences, because the knowledge generated by these research works have not been organized nor published (Camarinha-Matos & Afsarmanesh, 2008).

1.3 Objectives

To enable the Virtual Enterprise (VE) creation process (simplified from Camarinha-Matos et al., 2005b; 2007) within the ITESM business incubation model in order to make possible a competency-based collaboration between incubating SMEs.

- Research about the Virtual Enterprise (VE) / Virtual Organization (VO) and the Virtual Organization Breeding Environment (VBE) concepts developed within the ECOLEAD project.

- Research about the enterprise incubation model of the ITESM Business Incubator: "EMPRENDETEC".

- Research about Business Process Integration and their related technologies.

- Analyze the Profile & Competency Management System (proposed by Ermilova & Afsarmanesh, 2006; 2007; 2008), the Collaboration Opportunity Characterization model (proposed by Concha et al., 2008) and the Partners Search & Suggestion approach (proposed by Baldo et al., 2007), which are sub-processes designed within the ECOLEAD project in order to integrate them with the EMPRENDETEC incubation processes.

- To model the business processes of the VE creation process proposed by ECOLEAD project and the ITESM incubation process using Business Process Modeling Notation (BPMN).

- Achieve the Business Process Integration between the VE creation process and the ITESM business incubation process.

1.4 Justification

This thesis work aims to help the SMEs incubation process with the use of a VE creation process in order to have another way of doing business by allowing the SMEs to commercialize their own core-competencies in addition to their traditional products and/or services and in this way get involved in a greater number of markets and even in more profitable collaboration business opportunities. Also, collaboration opens a window for external brokers and enterprises that might bring more (collaboration) business opportunities to the companies in the incubator.

Also, this research work aims to contribute to the start-up enterprises at the ITESM-EMPRENDETEC incubator in order to set-up a collaborative environment based-on the tools and concepts developed within the ECOLEAD project. This research work is focused on the integration between a Virtual Enterprise (VE) creation process and the ITESM business incubation process in order to enable a "collaboration strategy" for SMEs at the ITESM-EMPRENDETEC incubator and in this way help them in their inclusion in more business opportunities.

The purpose of this thesis work is to enable a VE creation process between companies within the ITESM business incubator, and to do this, it is necessary to design and achieve the integration of a VE creation process with the ITESM business incubation process at a business process level.

1.5 Hypothesis

Enabling a "competency-driven collaboration" between SMEs on incubation to allow them to offer their competencies as marketable services towards their inclusion in Virtual Enterprises; this will expand their potential target market scope and consequently raise the number of business opportunities for them. At the same time, the "collaboration" will make possible for companies to take part in more profitable business opportunities.

1.5.1 Research Questions

- Is it possible to integrate a VE creation process with an enterprise incubation process?
- Which are the VE creation process characteristics and the requirements to integrate it to the ITESM business incubation process?
- Are the companies in incubation stages able to perform a "competency-driven characterization" of their products and/or services and of the company it-self?
- Is it possible to use a collaboration toolkit to support the suppliers'/providers' selection process of the SMEs in the ITESM incubator?
- Is it possible to use a collaboration toolkit to perform a competency-driven search and suggestion for strategic partners?

1.6 Methodology and Document Organization

The chosen methodology is based-on the proposal made by Espadas, Romero, Concha & Molina (2008). In their work, the authors use a Zachman framework (Zachman, 2008) approach and a business process driven modeling to achieve Enterprise Integration (EI).

Figure 1.1 depicts how the methodology has been used to perform the work done in this thesis. Also it is presented a relation of the methodological steps and the chapters where they are carried-out.

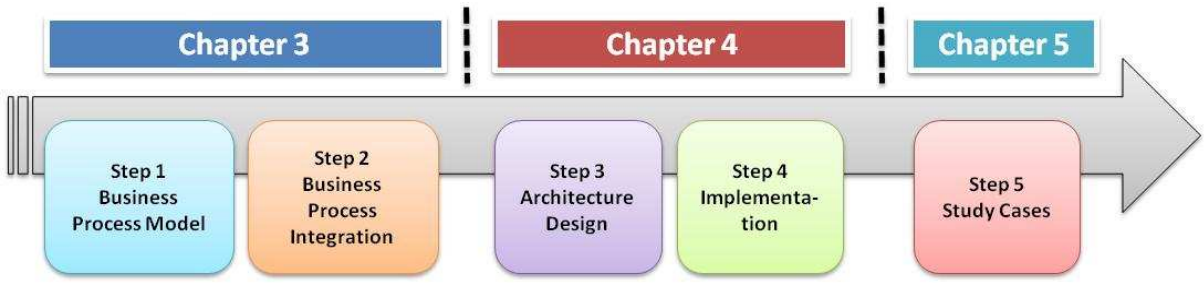

Figure 1.1 – Methodology's Implementation

The present document is divided into six chapters. Chapter 1 presents an introduction to the thesis work, including background of the research, the problem definition, objectives, justification and the hypothesis.

Chapter 2 presents a literature review of the related concepts, reference models, frameworks, technologies and tools used in this thesis, emphasizing those related to Business Incubation models, Collaborative Networked Organizations, Virtual Organization Breeding Environments, Virtual Enterprises / Virtual Organizations, Enterprise Architectures (the Zachman framework), Enterprise Integration and Business Process Modeling.

Chapter 3 is focused on the business process modeling of both, the VE creation process and the EMPRENDETEC incubation process, including their Business Process Integration approach. This chapter is considered as the core of this thesis work because of the importance of the integration at the business processes level.

Chapter 4 describes the integration requirements analysis and the design and implementation of the solution based-on the Business Process Integration approach obtained in Chapter 3 and the Applications Integration between the EMPRENDETEC Web portal system and the VE creation process tools.

Chapter 5 presents three different study cases, which are three companies in different incubation stage at the EMPRENDETEC incubator. The result of these study cases were used to validate the hypothesis presented previously in this chapter.

Finally, Chapter 6 presents results, conclusions and further research of this thesis work.

CHAPTER 2: Literature Review

This chapter presents the methodologies and technologies used to achieve the integration between the ITESM Business Incubation Model and the Virtual Enterprise (VE) creation process proposed by ECOLEAD project (simplified from Camarinha-Matos et al., 2005b; 2007). Also "Collaboration" and "Enterprise Application Integration (EAI)" (Qureshi, 2005) concepts are used to propose a solution for integrating the incubation processes with the proper tools that will support the VE creation process. Figure 2.1 shows the relationship between concepts used in this thesis work.

EAI provides the support to solve the sharing data requirements between information systems. Also, the "Service Oriented Architecture (SOA)" approach (He, 2003) is used to provide methods for systems integration where functionalities are grouped in business processes. SOA is also used to describe the IT architecture which allows different software applications to share data between them as they are involved in the support of collaborative business processes.

Figure 2.1 – Concepts Addressed in this Research Work

As mentioned earlier in Chapter 1, the "collaboration" concepts used in this research work are based-on the concepts, methodologies and tools developed within the ECOLEAD project. A Virtual Enterprise (VE), as defined in the ECOLEAD literature, lays the foundation of collaboration between enterprises and is the externally visible single unit of the collaboration process (Camarinha-Matos & Afsarmanesh, 2005).

2.1 Business Incubation models

"Business Incubation" is defined, accordingly to the National Business Incubation Association (NBIA, 2008), as a business support process that accelerates the successful development of start-ups and fledgling companies by providing entrepreneurs with an array of targeted resources and services to birth and grow. These services are usually developed or orchestrated by an incubator manager and offered both in the business incubator and through its network of contacts. The main goal of a business incubator is to produce successful firms that will leave the program financially viable and freestanding. These incubators' graduates have the potential to create jobs, revitalize neighborhoods, commercialize new technologies, and strengthen local and national economies.

Business incubators leverage the development of start-up companies, helping them to survive and grow on its early stages, when they are weak and vulnerable. The incubators provide to their client companies with supporting services on business processes and resources tailored for start-up firms. The common goals of incubation programs include jobs creation, retaining business in a community, building or accelerating growth in a local industry, and diversifying local economies… to mention a few (NBIA, 2008).

To build the basis for a successful incubation program, the developers must consider investing in a feasibility study. An effective feasibility study will determine whether the project has an attractive and solid market, a sound financial base and a strong community support, which are all critical factors in an incubator's success. Once defined, model business incubation programs commit to industry best practices such as structuring for financial sustainability, recruiting and appropriately compensating management with company-growing skills, building an effective board of directors, and placing the greatest emphasis on client assistance (NBIA, 2008).

Depending on the type of companies to which the incubator is focused on, the Ministry of Economy of Mexico (Secretaría de Economía, 2008) defines three different kinds of Business Incubators:

- **Traditional Incubator** – supports the creation of enterprises from traditional economic sectors with needs of basic physical and technologic infrastructure. The average incubation time of this kind of incubators is about three months.

- **Intermediate Technology-based Incubator** – supports the constitution of companies whose physical and technological infrastructure requirements, as well as their mechanisms of operation, are semi-specialized and involve semi-developed processes, in other words, they incorporate elements of innovation. The approximated time of incubation in this kind of intermediate technology-based enterprises is around 12 months.

- **Technology-based Incubator** – supports the creation of specialized companies in advanced industrial sectors between which are the following: Information and Communication Technologies (ICTs), microelectronics, Micro-Electro-Mechanical Systems (MEMS), biotechnology, and pharmaceutical among others. The start-ups that enter to these kinds of incubators can take-up to two years in completing their incubation process.

According to the National Enterprise Incubation System of Mexico (Contacto PyME, 2008), the incubator of Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM) offers three kinds of incubation: traditional, intermediate and high technology.

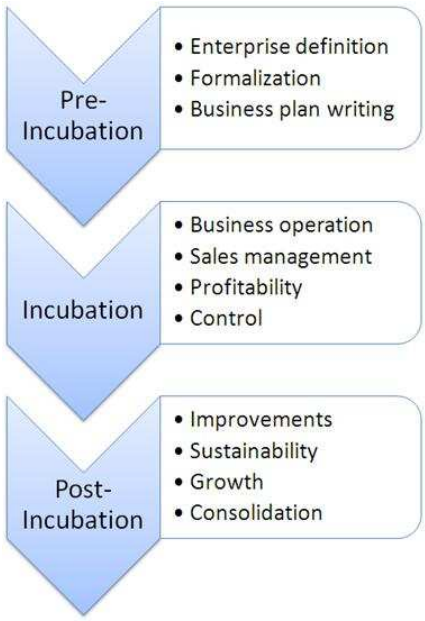

Figure 2.2 – ITESM Incubation Model (adapted from EMPRENDETEC, 2004)

The incubation model used in this research is taken from the ITESM Business Incubator process (see Figure 2.2) (EMPRENDTEC, 2004) and is defined as follows:

- **Pre-incubation.** In this first stage of the incubation process, it is offered integral services for the elaboration, development and completion of the business plan. During this stage the enterprise does not yet exist but the basics about the enterprise information are gathered and stored. The business plan also exposes some of the competencies intended for the enterprise along with some capacity and growing planning. This stage lasts about six months approximately.

- **Incubation.** In this intermediate stage of the incubation process, it is offered integral services to facilitate and guide to the companies in the execution of the business plan, this means the creation, operation and development of the company. During this stage the real enterprise competencies, capabilities and capacities are developed and taken out into the market. The expected duration of this stage is 12 months.

- **Post-incubation.** In this final stage of the incubation process, it is offered integral services to support the company in the pursuit of its objectives and its survival. This stage goes on for six months approximately.

An enterprise in incubation is the one going through the process described previously (see Figure 2.2). During the Pre-incubation, Incubation and Post-incubation stages, the Business Incubator offers different integral services such as: tutorship, consultancy, training, information, direction and business links… in order to fulfill the lack of knowledge, experience and management skills of businessmen/entrepreneurs; the information infrastructure/ system used by ITESM for the incubation process is the EMPRENDETEC Web portal system.

As this thesis work proposes, a Virtual Enterprise (organizational structure) and a collaboration (business) strategy, both are greater opportunities for SMEs to develop their core-competencies and get involved in collaboration business opportunities.

2.2 Collaborative Networks

The great development of computer networks and information technologies experimented in the last years improved the conditions for the institution of a networked society where new ways of collaboration are being explored. In fact, recently a wide variety of collaborative networks have arisen as a result of the new challenges that companies have to face (Camarinha-Matos & Afsarmanesh, 2008).

Camarinha-Matos & Afsarmanesh (2005) define a “Collaborative Network” as an organization composed of several autonomous entities, in most cases, geographically distributed and heterogeneous in terms of their operating environment, social capital, culture, size and even goals. These entities collaborate for improving their performance as a whole in the effort for achieving common or compatible goals. Nevertheless these entities support their interactions using computer networks as instruments for achieving integration, agility and flexibility.

Collaborative networks require the development of theories and formal models, not only like a support mechanisms to understand on the matter, but also, and most important, to establish the bases for the development of methods and tools to improve the decision-making process. In fact the decision-making in all the phases of the service life of the collaborative network must be based-on models and methodologies correctly validated. These models and methodologies form the foundation for the ICT-infrastructures (Rabelo et al. 2006; Rabelo & Gusmeroli, 2008) necessary to support the collaborative business processes, the cooperation in the organizational development and the coordination of networked enterprises operations.

In spite of the development on ICT-infrastructures (Rabelo et al. 2006; Rabelo & Gusmeroli, 2008) mentioned above, collaborative networks are adopting a large variety of forms characterized by relatively stable networks with well defined roles and requiring only minimal coordination and information exchange, in fact more dynamic structures are emerging in some industries (Camarinha-Matos et al. 2008).

Also, the wide range of challenges faced in the scientific and business world have caused the appearance of the mentioned large variety of collaborative networks, in this matter Camarinha-Matos & Afsarmanesh (2004) describe five different manifestations of collaborative networks and they are defined as follows:

- **Virtual Organization (VO)** – Is conceived as a set of legally independent organizations that share resources, skills or competencies to achieve a goal not necessary for profit.

- **Virtual Enterprise (VE)** – Is the particular case of a VO aimed to the generation of profit. *"This is the manifestation addressed in this research work"*.

- **Extended Enterprise (EE)** – An extended enterprise can be seen as a special case of a VE where a dominant organization takes all or some of its suppliers into its boundaries.

- **Dynamic Virtual Organization** – This term refers to a VO with a lifetime short enough to correspond with the time required to benefit from a specific market opportunity and dissolve once the short-term purpose has been accomplished.

2.2.1 Virtual Organization Breeding Environment (VBE)

Considering that when a VO is going to be created the issue of selecting the optimal partners for a collaboration business opportunity becomes a complicated and very important task, and then there are some important situations to overcome like: How are we going to first find the potential suitable partners and then make the right selection of them? How we will deal with different information sources? How are we going to know about relevant characteristics of the potential VO partners? How to implement an interoperable collaboration infrastructure over a diversity of legacy systems? How to build and maintain trust among partners? How to get to an agreement of operational principles?

As a solution to these situations, the "Virtual Organization Breeding Environment (VBE)" concept emerges defined as an association of organizations and their related support institutions, getting involved in a base long-term collaboration agreement and the adoption of common operating principles and infrastructures, with the main goal of increasing their preparedness towards the rapid configuration of temporary alliances for collaboration such as Virtual Organizations. Namely, when a collaboration business opportunity is identified by one VBE member (acting as a broker) a subset of organizations within the VBE (VBE members) can be selected to form a VE/VO (Camarinha-Matos & Afsarmanesh, 2008; Romero et al.,

2008a). Figure 2.3 represents the VO creation process, where a VBE is created from the open universe of organizations and acts as a pool for the rapid configuration of VOs, making easier the complex task of evaluating and selecting the right partners to fulfill the collaboration opportunity (see also Baldo et al., 2007; Romero et al., 2008b).

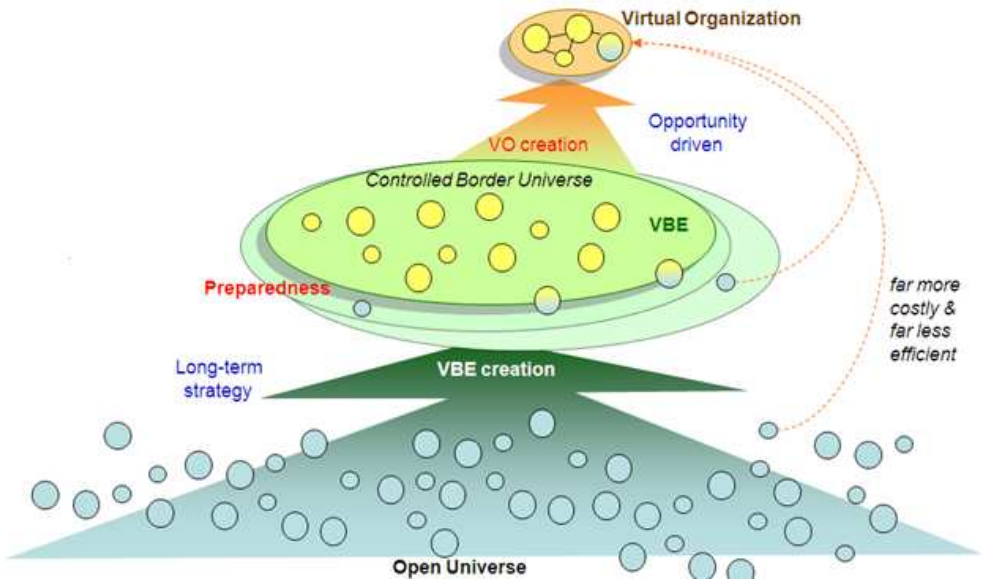

Figure 2.3 – VO Creation Process within a VO Breeding Environment (Camarinha-Matos et al., 2005)

2.3 Virtual Enterprises

Nowadays, the fully integrated supply chains and the Virtual Enterprises are good examples of a strong tendency in which entities, like enterprises, want to be complemented to participate in more challenging and competitive business opportunities (Camarinha-Matos & Afsarmanesh, 2008).

A Virtual Enterprise (VE) is a temporary alliance between enterprises that share their core-competencies and resources in order to better respond to business opportunities, all supported by computer networks (Camarinha-Matos et al., 2008). A VE is composed by independent enterprises that collaborate to reach a common objective. However, a VE is perceived for its clients as one enterprise, the collaboration is transparent for them (Jansson et al., 2008).

According to Molina et al (1998), the key attributes of a Virtual Enterprise are:

1. *Excellency*. Each partner brings its "core-competence" to the effort. Every function and process could be World class, something that is not possible to achieve by a single company.

2. *Technology*. Information networks will help companies and entrepreneurs link-up and work together from start to finish.

3. *Opportunism*. Partnerships will be less permanent and more opportunistic. Companies will work together to satisfy a specific business opportunity and will split afterwards.

4. *Trust*. The success of the virtual corporation depends on the degree of trust and cooperation among its members.

5. *No Borders*. The technology and globalization of the business world allows for members of the virtual corporation to be geographically distributed.

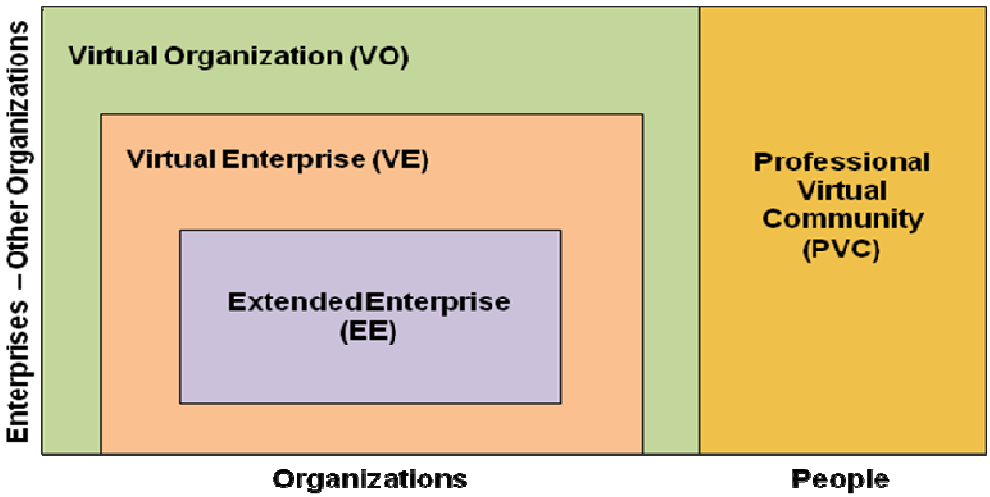

Figure 2.4 – Single-Opportunity Collaboration Network
(Camarinha-Matos & Afsarmanesh, 2005)

The VE concept addressed in this work is part of a taxonomy that includes Virtual Organizations and Virtual Communities; Figure 2.4 depicts the conceptual hierarchy of the VO, VE, EE and PVC concepts. This figure presents the EE as a particular case of VE, this last as a particular case of VO which is at the same conceptual level of PVC, besides, the figure expressed that PVC is different from VO in the fact that PVC is focused on people meanwhile VO is on organizations.

Therefore the aim of a Virtual Organization Breeding Environment (VBE) is to facilitate the configuration and establishment of a VE providing candidate preparedness by means of previous establishment of trust, a proper infrastructure and other commonalities. The border of the VBE is open but controlled by allowing organizations to join once they are prepared for a dynamic and agile establishment of an opportunity driven collaborative network (Camarinha-Matos & Afsarmanesh, 2005; Romero et al., 2008a).

2.4 VO Creation support services

Each phase of the VO/VE creation process faces different challenges that are why the ECOLEAD project developed a set of methodologies to ease this VO/VE creation process (Camarinha-Matos et al., 2005a; 2007). The Figure 2.5 presents a simplified creation process of a VO/VE.

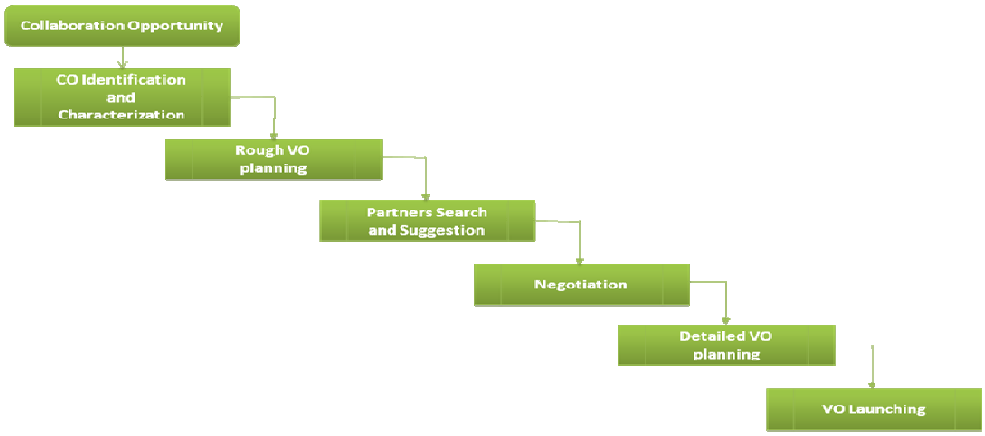

Figure 2.5 – VO/VE simplified creation process
(Camarinha-Matos et al., 2005a; 2007)

Camarinha-Matos et al. (2005a; 2007) describe the steps of the VO/VE creation process as follows:

- **Collaboration Opportunity Identification & Characterization.** This is the first step in the VO creation process and the initial activity is to identify a Collaboration Opportunity that will trigger the creation of the Virtual Organization (see Demšar et al., 2007). Once a Collaboration Opportunity (CO) is identified, it should be described and represented in a structured way in order to support the VO broker during the CO definition and characterization process (see Concha et al., 2008). In this stage, the preparation of a more detailed structure of the VO process is also needed.

- **Virtual Organization Rough Planning.** This step consist on identify the required competencies and capacities as a rough structure of the potential VO (see Concha et al., 2008).

- **Partners Search & Suggestion.** In this step the broker must identify the nearest optimal set of potential partners, going from the identification though assessment and selection. The search mechanisms must include assessment criteria, previous performance evaluation and actual level of readiness of the potential partners (see Baldo et al., 2007; Romero et al., 2008b).

- **Negotiation.** In this stage of the VO creation process an agreement must be achieved among the VO members' candidates by aligning needs and offerings. The relevant at this point are negotiation protocols, decision processes and representation of these agreements (see Oliveira et al., 2008).

- **Detailed VO planning.** In this step the VO rough plan is detailed by assigning roles and responsibilities to the selected members. The result of this step is the definition of the rules and the detailed definition of the collaboration process (see Concha et al., 2008).

- **Contracting.** This is the step in which contracts and agreements models are made as a result of the negotiation phase (see Oliveira et al., 2008).

- **VO Launching.** It's the last step of the VO creation process; it consists of tasks such as the configuration of the ICT infrastructure, assignment of resources and members notification (see Ollus et al. 2007).

This research work addressed the first and third steps of the VO creation process, the Collaboration Opportunity Identification and Characterization (based-on Concha et al., 2008) and the Partner Search and Suggestion (based-on Baldo et al., 2007), in addition, it is considered the Profile and Competencies Management for the partners in collaboration (based-on Ermilova & Afsarmanesh, 2006; 2007; 2008).

2.4.1 Profile and Competencies Management

It is a very important activity for enterprises in collaborative environments to make a complete and unambiguous definition of who they are, from the basic enterprise data to their core-competencies, capabilities and capacities that is why the Profile and Competencies Management component was developed among the ECOLEAD tools. This component was designed to manage important information about enterprises who want to be participating of collaboration business opportunities. This tool gather profile information like address, contact information, niche, partnerships and information about the enterprise competencies, this is vital to enable the enterprise for collaboration (Ermilova & Afsarmanesh, 2006; 2007; 2008).

For a better understanding of the enterprises' Profile and Competencies it is necessary to define both terms. Organization's profile is understood as the group of features that distinguish one organization from others, while organization competency is defined as the organization's ability to perform (business) processes by owning the necessary resources with the final aim to offer certain products and/or services (Ermilova & Afsarmanesh, 206; 2007; 2008).

Ermilova & Afsarmanesh (2006; 2007; 2008) mention the definition of *core-competency* proposed by Prahalad & Hamel, two business academicians whom introduced the concept in a 1990 Harvard Business Review article. They define *core-competency* as "an area of specialized expertise that is the result of harmonizing complex streams of technology and work activity".

Coyne, Hall, and Clifford (in Ermilova & Afsarmanesh, 2006; 2007; 2008) defined a *core-competence* as "a combination of complementary skills and knowledge bases embedded in a group or team that results in the ability to execute one or more critical processes to a world class standard". Two ideas are very important here. The skills or knowledge are complementary, and when taken together they make it possible to provide a superior product.

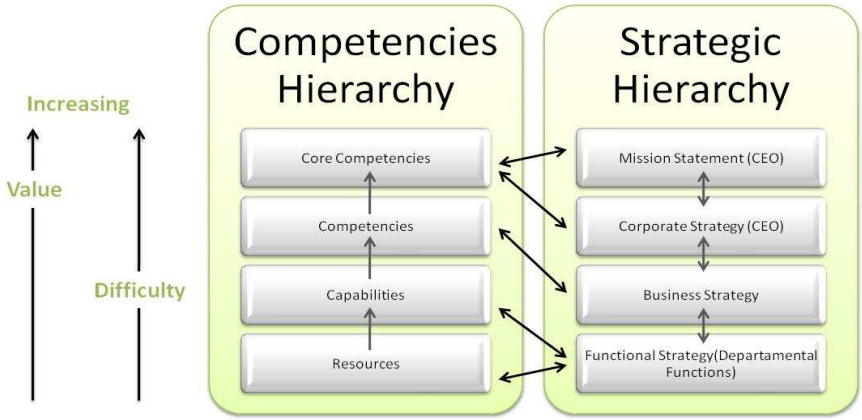

Figure 2.6 – Competencies Hierarchy & Strategic Hierarchy (Javidan, 1998)

Javidan (1998) describes the core-competence hierarchy as in Figure 2.6.

- The *Resources* are the inputs of the organization's value chain. According to Barney (1991), Javidan (1998) categorizes resources into three groups of physical (technological) resources such as: plant, equipment, location and assets; human resources such as: manpower, management team, training and experience; and organizational resources such as: culture and reputation.

- *Capabilities* refer to the corporation's ability to exploit its resources; they consist of a series of business processes and routines that manage the interaction among its resources. Capabilities are functionally based; they are resident in a particular function, e.g. marketing capabilities, production capabilities, distribution and logistics capabilities, among others. Example: Distribution Technologies of FedEx (e.g. Bar Coding), Information Technologies of Daimler-Benz.

- *Competencies* represent a cross-functional integration and coordination of capabilities. In a multi-business corporation, competencies are a set of skills and know-how housed in a SBU (Strategic Business Unit). Example: Package tracking of FedEx, Cross functional engineering knowledge in Daimler-Benz.

- *Core-competencies* represent cross SBU (Strategic Business Unit) boundaries; they result from the interaction between different SBU's competencies. Core-competencies are skills and areas of knowledge that are shared across business units and result from integration and harmonization of SBU competencies. A core-competency is a collection of competencies that are widespread in the corporation. Example: Logistics in the case of FedEx, Engineering Excellence for Daimler-Benz.

The Profile and Competency Management System (PCMS) provides a set of services for creation, maintenance, and management of profiles and competencies of three types of entities, namely: the VBE members, the VBE itself (VBE Administration), and the VOs that are registered within the VBE (Ermilova & Afsarmanesh, 2006; 2007; 2008). The Profile and Competency Management pursues the following main objectives:

- Improving the activities of definition and modification of profile and competency models for VBEs.

- Improving the activities of customization of existing generic VBE profile and competency models to each specific VBE environment, as well as the evolution of these models during the VBEs life cycle.

- Improving the activity of collection and organizing of more complete and comprehensive profile and competency information.

The Profile and Competency Management helps to define the profile and competency models of the VBE through customization of the generic/common profile model. This is an innovative feature, since other existing tools are developed only to support a specific VBE domain or one specific VBE, and do not offer generic features (Ermilova & Afsarmanesh, 2006; 2007; 2008)

2.4.2 Collaboration Opportunity Characterization

After a collaboration opportunity is identified it is necessary to make its decomposition in a structured way in order to be as schematic as possible to facilitate the labor of the VO broker, the collaboration opportunity characterization includes the decomposition of the collaboration opportunity into its components (Concha et al., 2008).

This decomposition helps to identify the required capabilities and capacities for accomplishing the opportunity objectives. The collaboration opportunity characterization tool was designed to decompose the collaboration opportunities into competencies, capabilities, capacities and resources in order to help in the partner search and suggestion activity. The ECOLEAD project also delivered a tool for performing such characterization; the tool named as "Collaboration Opportunity Characterization (COC)" allows the decomposition of the business opportunity as described before (Concha et al., 2008).

This research work only considers the Collaboration Project modality with one of two sub-modalities, the Collaborative Production sub-modality and the Collaborative Project sub-modality. Typical examples of the Collaboration Production sub-modality are distributed and collaborative manufacturing processes, like a distributed production planning. The Collaborative Project sub-modality is a traditional project editor, like existing solutions (e.g. MS Project, GanttProject) and examples for this case are collaborative project management and tendering-bidding processes. Only the first sub-modality, the Production one, is addressed in this work (Concha et al., 2008).

Concha et al. (2008), describes the Collaboration Opportunity Characterization process as follows:

1. The first step in Collaboration Opportunity Characterization is choose between create a new Collaboration Opportunity or modify an existent one

2. Then, it is necessary to identify the actor who is going to make the collaboration opportunity characterization. This actor could be the broker or the final customer. At this point of the VO creation process it is important to register the broker profile information.

3. Next step is to characterize the collaboration opportunity in terms of products and projects. Products can be characterized in terms of assemblies, components or even activities; every last part of a product is a called component because it is the last decomposition level. This cycle has to be done until the broker decides that the decomposition is completed. The same characterization schema is followed for projects. They can be decomposed in terms of activities and sub-activities depending on the necessities of the collaboration opportunity, being the sub-activity, the last decomposition of a project.

2.4.3 Partners Search & Suggestion

Once the collaboration opportunity was been identified and characterized it is time for the VO planner to make a critical decision in selecting the most suitable members for a VO regarding the requirements of a given collaboration opportunity (Baldo et al., 2007).

For doing that activity was defined the Partners Search & Suggestion process. This process aims to match the requirements of the collaboration opportunity in terms of competencies, capabilities and capacities to the enterprises offerings stored in the Profile & Competency Management tool. This activity is also supported by a tool, called Partners Search & Suggestion (PSS), which generates the matches between the collaboration opportunity and the VBE members' based-on competencies and search criteria (Baldo et al., 2007).

The result of the PSS tool is a list of possible configurations of the VO structure including a related risk analysis and the expected VO performance with respect to selection criteria (Jarimo et al., 2006). These possible VO configurations are presented to the VO Planner for a further decision making and final VO composition (Baldo et al., 2007).

The VO planner selects the Partners based-on predefined criteria for the VO realization. Besides traditional elements like price, delivery date and quality level, performance indicators will be applied both in the searching (e.g. filtering inadequate organizations) and in the suggestion (e.g. electing the ones that better fit the desired indicators) steps so that the results can be achieved in a faster and potentially better ways (Baldo et al., 2007). Along the searching step a negotiation process is triggered in order to drive the agreement on the several contract's negotiation objects (Oliveira et al., 2008).

It is important to identify the most suitable Performance Indicators (PIs) to be used to compare and then suggest the proper potential partners for a new VO, to do this it was developed a methodology that aids the human user to easily identify these PIs. This methodology is composed of two parts. One that runs just once, called preparation phase, and another one that runs whenever a new VO needs to be created to fulfill a certain CO, called execution phase (Baldo et al., 2007).

The first part of the methodology comprises the setup of the environment as well as the acquisition of information in order to identify the PIs. In the second phase of the methodology, it intended to be as generic as possible in order to be used for every VBE that has a pre-defined set of PIs applied to measure performance among its members. This methodology uses ontology to perform the PIs identification (Baldo et al., 2007).

2.5 Methodology

Espadas et al (2008) proposed a methodology for enterprise integration. This methodology relies on an "Enterprise Architecture Modeling Approach" using the Zachman framework to identify opportunity areas for enterprise integration using a business process modeling approach to recognize dependency relationships that have to be integrated to become interoperable. First of all we need to define what Enterprise Architecture and the Zachman framework are.

2.5.1 Enterprise Architecture and the Zachman framework

Espadas et al (2008) describes an Enterprise Architecture (EA) as a provider of a common view of the enterprise resources and the way they interact to provide enterprise drivers (business objectives). This common enterprise view helps to understand the high-level integration requirement within enterprises.

According to Nogueira (2006), Enterprise Architecture (EA) can be considered as the basis for the design and implementation of the whole enterprise systems. The EA is a structure or framework that shows the interrelation between all the different components and functions within the company.

The "Enterprise Architecture and Information Systems Architecture framework" was developed by John A. Zachman from observing how industries like Architecture and Construction, and Engineering and Manufacturing evolved over hundreds of years to handle the elaboration of complex products of their respective activity. He applied these concepts to the construction of other complex products: the design and change of enterprises and the computer systems that support them.

Zachman (2008) defines his enterprise architecture framework as the intersection between two historical classifications that have been in use for literally thousands of years. The first is the fundamentals of communication found in the primitive interrogatives: what, how, when, who, where and why. It is the integration of answers to these questions that enables the comprehensive, composite description of complex ideas. The second is derived from reification, the transformation of an abstract idea into an instantiation that was initially postulated by ancient Greek philosophers and is labeled in the Zachman framework: identification, definition, representation, specification, configuration and instantiation.

The Zachman framework is typically depicted as a 6 x 6 matrix with the communication interrogatives as columns and the reification transformations as Rows. The intersection between the transformations and the intersections represents the framework classifications, which mean that they are represented by the cells (Zachman, 2008). Table 2.1 is an example of a simplified Zachman framework.

Table 2.1 – Simplified Zachman Framework (Adapted from Inmon & Zachman, 1997)

	Data	**Function**	**Network**	**People**	**Time**	**Motivation**	
Planner	Class of Business Thing	Class of Business Process	Major Business Location	Major Organization Unit	Major Business Event	Major Business Goal	Scope
Owner	Business Entity	Business Process	Business Location	Organization Unit	Business Event	Business Objective	Enterprise Model
Designer	Data Entity	Application function	Node Function	Role	System Event	Criterion	System Model
Builder	Segment or Row	Computer Function	System Software	User	Execute	Condition	Technical Model
Subcontractor	Field Data	Language Statement Function	Address Network	Identity Organization	Interrupt Schedule	Sub-condition Strategy	Components

2.5.2 Methodology description

The proposed approach made by Espadas et al. (2008) is depicted in Table 2.2; this table describes how the Zachman framework (Enterprise Architecture) is used to define the business process modeling approach to achieve enterprise integration according to each row:

- The scope level or row presents a list of entities (business processes and units) that are relevant for the enterprise integration project.

- The business model row refers to a set of business process models (using BPM notation) in where the different business units are represented to show how business process and units are associated according to the business rules.

- The system model row depicts the information and application architectural design requirements to achieve business information systems interoperability, in this case addressed through a software architecture design (SOA) approach.

- The technology model row attends the software and hardware that will be used to achieve the enterprise integration and interoperability requirements, in this occasion authors propose the use of BPEL as the business process execution language for the system design.

Table 2.2 – Enterprise Architecture based-on Zachman Framework for Business Process Driven Integration (Espadas et al., 2008)

Zachman Row	Model	Artifact	Tool	Description
Scope (Contextual)	Enterprise Business Processes	Business Units	Organizational Charts	Architecting Enterprise & Business Unit Business
Business Model (Conceptual)	Business Process Models	Business Processes	BPMN	Process Modeling
System Model (Logical)	Logical Data Models & Application Architecture	Modeling Diagrams	UML & SOA	Service Oriented Design
Technology Model (Physical)	Physical Data Models, Technology Architecture & System Design Implementation	Business Process Execution & Implementation	BPEL & Software components	Business Process Execution & Integration

The methodology used in this work is based-on the Espadas et al (2008) proposed methodology. The methodology starts modeling the business perspective using Business Process Modeling Notation (BPMN) as the process definition notation, in this step the ITESM incubation process and the VE creation process are modeled independently each other and then used as the base for the business process integration. The second step is modeling the system perspective by transforming the process models into artifacts like the Application Architecture.

The third step is developing the Technology Architecture; in this step the Business processes execution and integration model is proposed as a specific technical architecture.

The fourth step is the System Design Implementation which is carried out by developing the business processes integration based-on the SOA.

Finally, the fifth step is the validation of the whole work directly with the potential users and the corresponding documentation in cases of study.

2.6 Enterprise Application Integration

Enterprise Application Integration (EAI) entails integrating applications and enterprise data sources so that they can easily share business processes and data (Qureshi, 2005). EAI also implies that integrating the applications and data sources must be accomplished without requiring significant changes to these existing applications and data.

Very often those enterprise applications that were not designed to interoperate need to be integrated enterprise and community wide. In the same manner, as enterprise departments interacts in a day-to-day basis and business processes extends across multiple enterprises and business lines, the need for information integration leads to the adoption of best suited EAI approach. Thus, all the systems on the enterprise, newer or legacy ones can be integrated to provide the business with greater competitive advantage.

The volatile nature of business requirements, the effort to lower total cost of ownership, and the need to rapidly introduce new products in value chains require decoupled, event and service oriented (e.g. SOA & EDA) functionality of enterprise applications. These enterprise services not only provide new functionality but also leverage investments in legacy systems running the enterprise's key business-critical applications (Qureshi, 2005).

2.7 Business Process Modeling

According to Aguilar-Savén (2004), a business process is defined as the combination of a set of activities within an enterprise with a structure describing their logical order and dependence whose objective is to produce a desired result. Business process modeling enables a common understanding and analysis of a business process. A process model can provide a comprehensive understanding of a process. An enterprise can be analyzed and integrated through its business processes. Hence the importance of correctly modeling its business processes.

The integration proposed by this research work involves a Business Incubation Process and a Virtual Enterprise creation process. The methodology that will be used uses Enterprise Integration (EI) for the integration of enterprise business processes and their corresponding support information systems in order to facilitate the communication between their workflows and databases. Once the EI effort is finished Enterprise Application Integration (EAI) is used to link-up separated and isolated systems and give them greater leverage (Lam & Shankararaman, 2004).

The first task of the methodology is to define the business process, which is a very important step to achieve an efficient and optimum background.

Once the individual business processes models are finished, they are used to visualize the Business Process Integration (BPI) needs. Such needs are then depicted through a new process model reflecting how the actual process integration will take place (Huang & Fan, 2007).

2.8 Service Oriented Architecture (SOA)

SOA can be defined as an architectural style which goal is to achieve loose coupling among interacting software agents. In this context, a service is considered as a unit of work done by a service provider to attain desired end results for a service consumer.

The idea of SOA departs significantly from object oriented programming, which strongly suggests that you should bind data and its processing together. So, in object oriented programming style, every CD would come with its own player and they are not supposed to be separated. This sounds odd, but it's the way we have built many software systems (He, 2003).

The way in which SOA achieves loose coupling among interacting software agents is by employing two architectural constraints:

1. Simple and ubiquitous interfaces to all participating software agents. The interfaces should be always accessible for all providers and consumers.
2. Messages defined and delimited by an extensible schema delivered through the interfaces. A schema limits the vocabulary and structure of messages. An extensible schema allows new versions of services to be introduced without breaking existing services.

According to He (2003), in order to consider architecture to be service oriented, there must be expressed application-specific semantics in the messages shared through interfaces. Although, any kind of message can be sent over interfaces, there are always a few rules to follow in order to maintain a service oriented architecture:

- **Descriptive.** The messages should be descriptive instead of instructive, because the service provider is responsible for solving the problem.
- **Format.** Structure and vocabulary shared by all parties.
- **Extensibility.** Software must be ready to respond to the changes in the environment, in the technological context.
- **Mechanism to find a service provider.** SOA must have a mechanism that enables consumer to discover a service provider under the context of a service sought by the consumer.

CHAPTER 3: Business Process Analysis and Integration

This chapter presents the proposed integration between both collaboration and incubation business processes. The integration was achieved by using Business Process Modeling Notation (Object Management Group, 2009) in order to obtain the incubation and collaboration business processes models which were used to define which processes would be a part of the "integration" and the terms under it will be done.

The work done in this chapter corresponds to the first step of the methodology described in the previous chapter (section 2.5.2), this is, the second row called Business Model of the adapted Zachman framework.

According to Aguilar-Savén (2004), for inter-organizational business modeling there are three identified requirements: (1) modular model design, (2) modular model analysis and (3) model decomposition and integration. The idea is to show features that a business process model should have in order to be classified as performing successfully.

Following the suggestions made by Aguilar-Savén (2004), this chapter is divided in three sections:

1. The first section of this chapter shows how is done the modeling of the collaboration and incubation business processes in a modular approach, and also shows the way those business processes interact within its own domain.

2. The second section approaches the analysis of the mentioned business process models to determine what business processes are those that have an important role on the intended integration.

3. Finally, the third section describes the decomposition and integration of the models in order to establish how the processes are going to interact once integrated and the terms in which this integration will be done.

3.1 Business Process Modeling phase

Business Process Models have two different notational approaches one is for software development and another for business process analysis.

In the software development process approach normally diagrammatic notation is required, for capturing an understandable view of the business process. Very often the user does not need to interact with the model but rather just observe it. For the business process analysis approach it is necessary to have more sophisticated mechanisms than qualitative analysis of static diagrammatic models, models that present both dynamic and functional aspects of the business process (Aguilar-Savén, 2004).

This research work uses the software development approach for business process modeling because the goal of the work is to observe both incubating process and Virtual Enterprise (VE) creation processes, and figured out the required integration.

Once the individual business processes are modeled, they are used for visualizing the Business Process Integration (BPI) needs. Such needs are then depicted through a new business process model reflecting how the actual business process integration will take place (Huang & Fan, 2007).

3.1.1 Incubation Process Modeling

The business incubation process regarded in this thesis work is the one used by ITESM Business Incubator through its Web Portal system called: “EMPRENDETEC”, Annex 1 shows a screenshot of the system. This incubation process, as the mostly of the existent ones, can be classified in three sub-processes: re-Incubation, Incubation and Post-Incubation. All the activities of the sub-processes are supported by tools of the EMPRENDETEC Web Portal system. Figure 3.1 presents the Business Process model of the mentioned Incubation process. According to the former classification each sub-process will be analyzed independently and finally it will be an analysis of the whole incubation process.

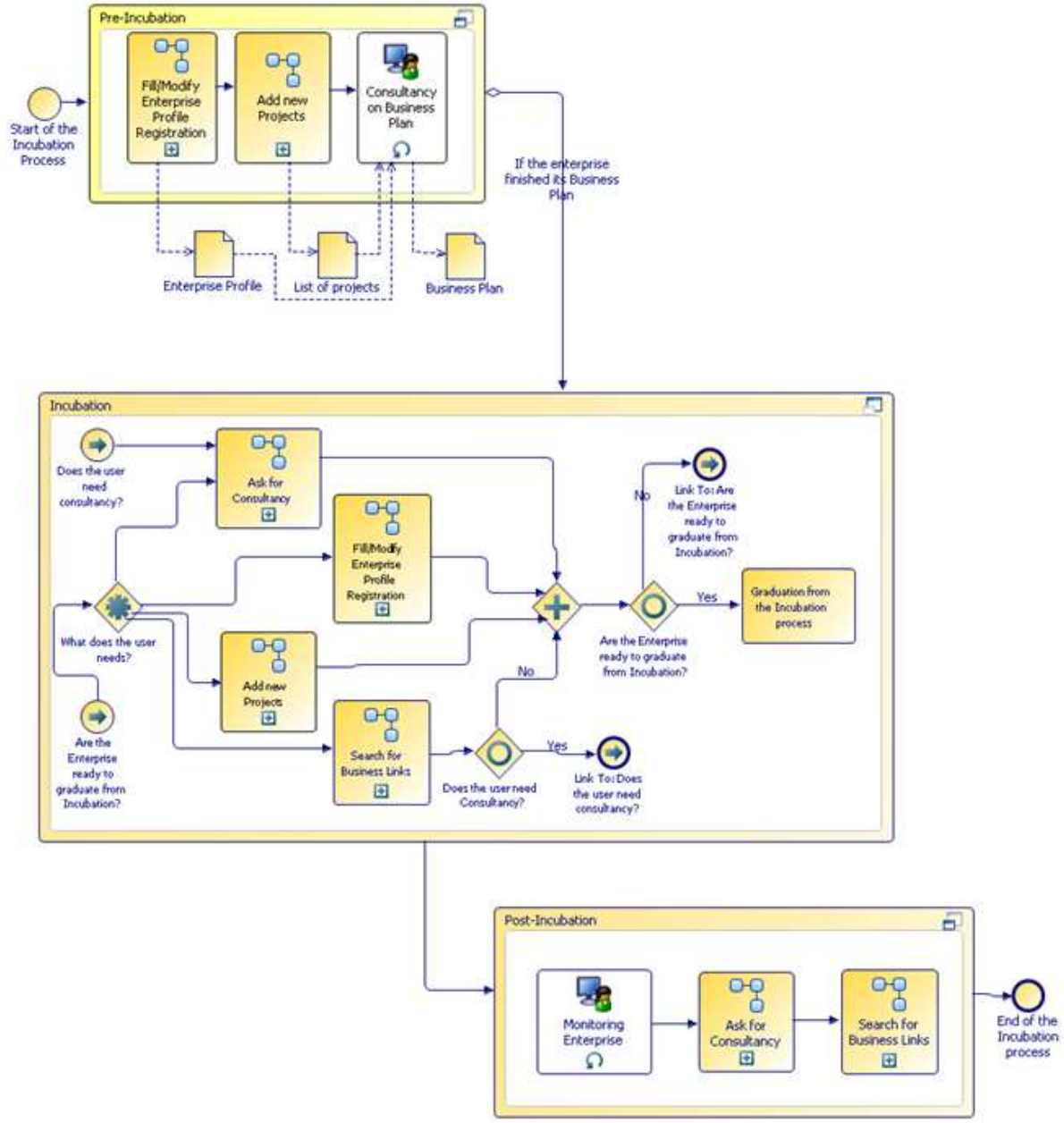

Figure 3.1 Incubation business process model

Pre-Incubation Phase

The Pre-Incubation phase is the first one of the whole incubation process. The purpose of this stage is to set-up the basic aspects of the company, particularly the “business plan”, which is an indicator with which it determines if the company is ready to enter to the next stage (incubation).

As Figure 3.2 depicts, the Pre-Incubation sub-process is made up with three activities and its corresponding output documents. The first two activities are actually independent: “Fill/Modify Enterprise Profile Registration” and “Add New Projects” with the output documents ‘Enterprise Profile’ and ‘List of Projects’ respectively, the third activity is the one called “Consultancy on Business Plan” with a ‘Business Plan’ as its resulting document.

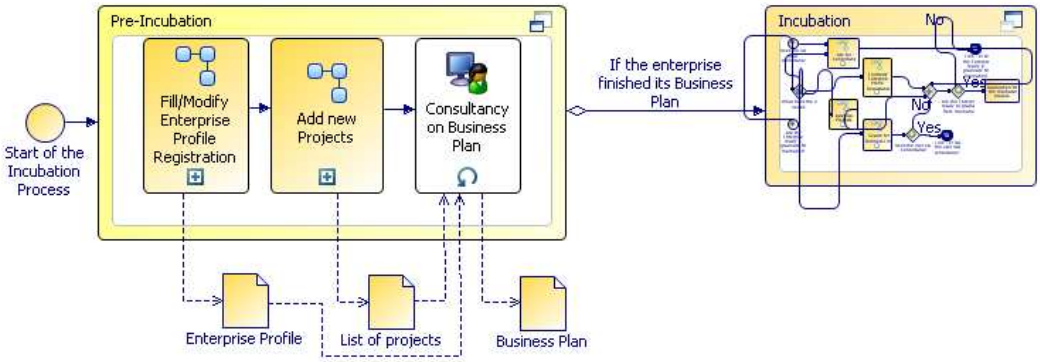

Figure 3.2 Pre-Incubation Sub-process Model

The “Fill/Modify Enterprise Profile Registration” can be found detailed in Figure 3.3, in this model is possible to observe that the first step is the filling of personal information (of the account’s owner) like: title, surname, last name, gender and date of birth. The second step requests contact information such as: house telephone, e-mail, mobile and work phone. The following step consists of providing information about the user’s account; in this step only the password is requested as user information. In the fourth and last step, the user must define its own maximum study degree as part of its academic profile. In each step, before advancing to the next step, the provided information is validated and it is a condition that must be satisfied in order to advance to the next step.

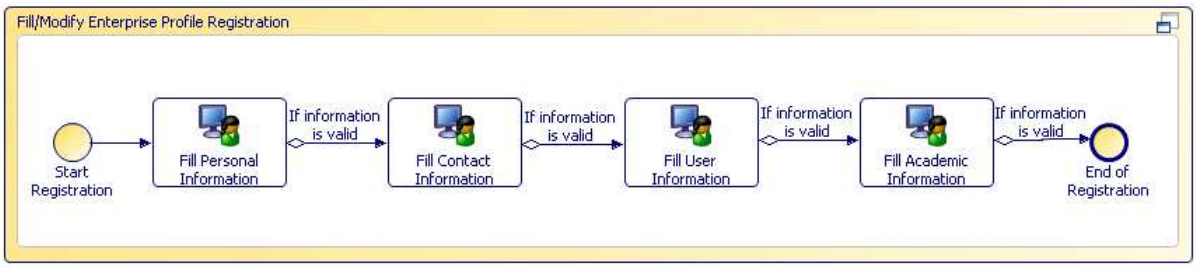

Figure 3.3 Fill/Modify Enterprise Profile Registration Activity Model

After filling the enterprise profile registration, the user must add at least one project in order to provide some information about the enterprise’s core products and/or services that is why the next activity of the Pre-Incubation sub-process is the one called “Add New Projects”. This activity can be appreciated in detail in Figure 3.4.

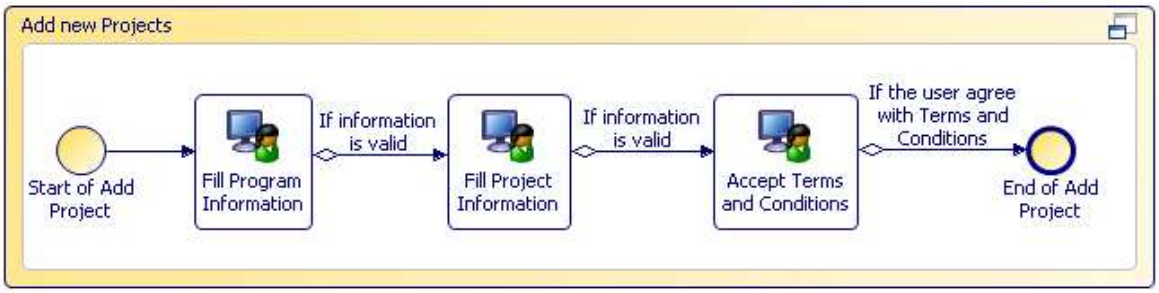

Figure 3.4 Add New Project(s) Activity Model

To add new projects the user must define first the related information about the program from the ITESM incubators network to which it will belong. In this activity, the user provides information like: program name, modality (virtual, on site or mixed) and stage (pre-incubation or incubation).

Straight afterwards, the user must describe the new project by providing information like: project name, description, line of business, sector and business area. In addition, the user must answer questions like the following ones:

- Do you have a business plan for this project/enterprise?
- Does your enterprise is already legally constituted?
- Does your enterprise is formally operating?
- Are you looking for shareholders?
- Do you want your information be published in the public Web page of EMPRENDETEC?
- What is your motivation to undertake an enterprise?
- What needs are going to satisfy your product and/or service?
- Describe the competitive advantages of your product and/or service?

The importance of this activity resides in the fact that tutors and other experts usually consult this information in order to have a quick overview of the project/enterprise and in this way offer a better advice.

In the next activity the user must accept or decline the terms and conditions of use of the EMPRENDETEC services (Web Portal system). In order to complete the creation of a new project the user must accept the terms and conditions determined by the incubator's network administration.

Finally, the last activity of the Pre-Incubation sub-process is the consultancy on the Business Plan development. In this activity the user can ask for assistance to the experts in any of the business areas required to make a business plan. Contact between experts and users are made through e-mail or a personal interview, the nature of this activity is to be executing as a loop until the user finished correctly his/her Business Plan and have not doubts or questions about it.

The resulting document of this activity is the “Business Plan”, once complete this document the enterprise is considered to enter to the Incubation phase.

Incubation Phase

The Incubation sub-process is composed of five activities: (1) Ask for Consultancy, (2) Add new Project(s), (3) Fill/Modify Enterprise Profile Registration, (4) Search for Business Links and (5) Graduation from the Incubation process.

In this phase there are three activities that are the same as in the previous phase, these activities are: (1) Ask for Consultancy, (2) Fill/Modify Enterprise Profile Registration and (3) Add new Projects. The difference resides in the fact that the user still needs consultancy and may need access to modify his/her enterprise’s profile and the addition of new projects.

Figure 3.5 depicts the flow between the activities in this phase. First, we encounter a complex decision based-on what the user wants/needs to do with alternatives like: (a) Ask for Consultancy, (b) Fill/Modify Enterprise Profile Registration, (c) Add new Projects and/or (d) Search for Business Links.

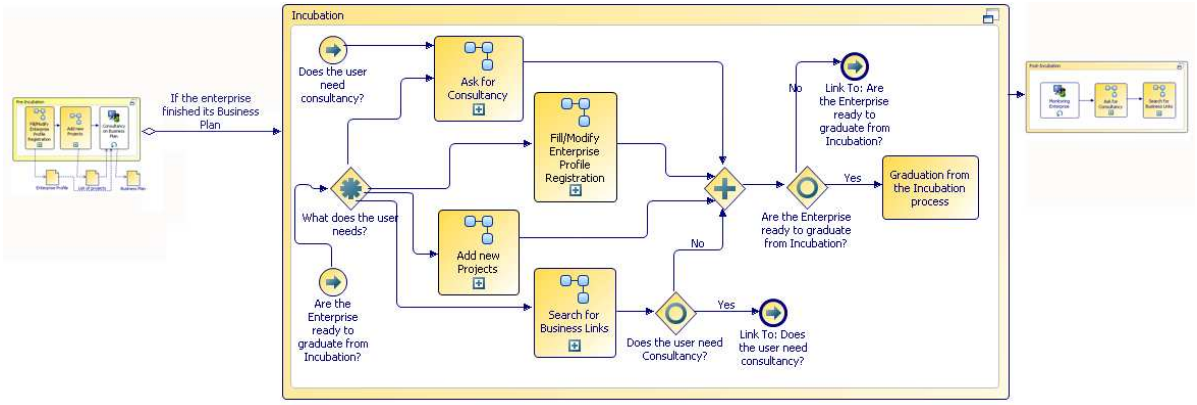

Figure 3.5 Incubation Sub-process Business Process Model

The “Ask for Consultancy” activity, as mentioned before, is the process when the entrepreneur exposes enterprise’s problems and doubts to an expert on the matter in order to learn how to solve those problems and doubts. This activity is iterative because the user generally won’t stop making questions until all his/her doubts are cleared up.

When the user wants to modify his/her enterprise's profile he/she must choose the activity called: "Fill/Modify Enterprise Profile Registration", generally the user has already filled the profile (in the pre-incubation phase) and only wants to modify the existent data, but in the case in which the enterprise did not pass through the pre-incubation stage, the activity allows user to create the profile and later make modifications (if needed). The process model of this activity is shown in Figure 3.3.

"Adding New Projects" is also possible in this sub-process as well as in the pre-incubation sub-process, and this is because the user always needs the flexibility to add/remove/modify the projects under his/her responsibility. Figure 3.4 shows the activities involved in "Adding new projects".

The next activity is defined as "Search for Business Links" (shown in Figure 3.6) and its purpose is to enable enterprises to search in a database with information of companies registered in EMPRENDETEC, both external and internal, with the aim of establish business links with the enterprises in the ITESM incubator network.

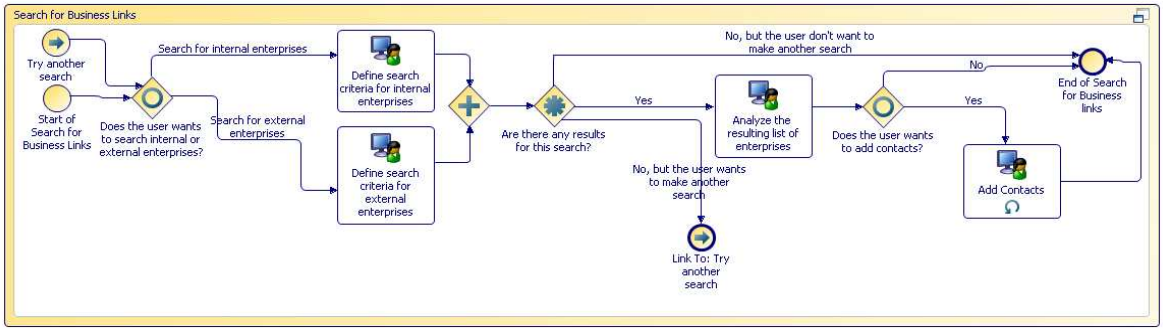

Figure 3.6 Search Business Links Activity Model

The user can search for enterprises registered in the incubation program that actually are on incubation or enterprises that are registered as external in order to do business, that is why the very first decision in this activity is the selection of search external or internal enterprises. If the user chooses to make an internal search then is redirected to the activity "Define Search Criteria" for internal enterprises and then he/she must proceed with the definition of the criteria with parameters like: enterprise name, business line, business area, products or services, sector, commercial activity (exportation or importation), etc. If the user chose to make a search for external enterprises, the flow is pretty much the same as the internal search, the difference resides in the parameters for the search criteria, in this case are: enterprise name, business line, sector and stage (pre-incubation, incubation, post-incubation, acceleration or technological park).

In both cases, after the search, if the search did not throw any result, the user must decide if he/she wants to perform another search, with different criteria, or he/she wants to end the "Search for Business Links" activity. In the case when the search did throw at least one result the user shall decide if he/she should add that enterprise as a contact or not. Whether the user adds the contact or not the activity ends after this decision.

Post-Incubation

When an enterprise on the incubation sub-process is stable and growing in size and/or profits and fulfills the requirements to graduate then this enterprise is considered to forward to the post-incubation phase. Figure 3.7 shows the flow between activities in the post-incubation phase.

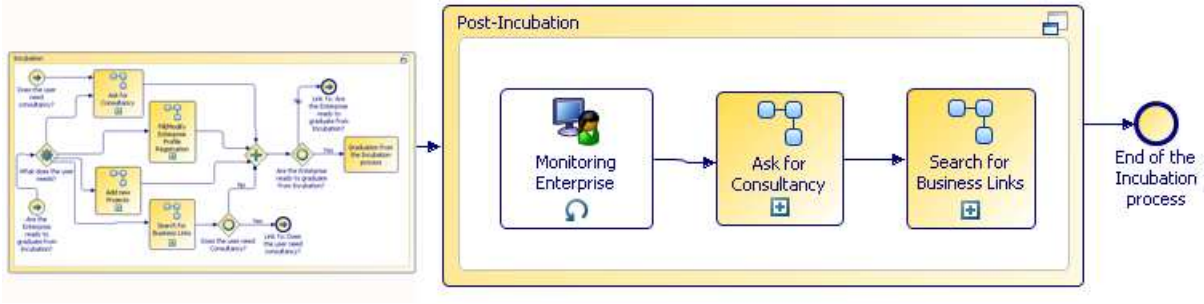

Figure 3.7 Post-Incubation Business Process Model

In the Post-Incubation phase the enterprises are monitored by an expert that every certain period of time makes a contact with the enterprise and checks their performance indicators in order to prevent the enterprise from certain risks.

When the expert realizes about some kind of problematic situation for the enterprise, he/she must encourage the entrepreneur to start a "consultancy", that's why the next activity is the one called "Ask for Consultancy". This activity is performed exactly the same as in the previous stage (incubation).

Once the enterprise reaches a stable level of performance and fulfills certain number of parameters it can pass to the last activity of the post-incubation sub-process and of the whole Incubation process, the "Graduation from Incubation" activity.

3.1.2 Virtual Enterprise Creation Process Modeling

The proposed VE creation process is divided into three sub-processes that interact between each other in order to enable enterprises to establish a collaborative way-of-doing business. The first stage is the one called: "Profile & Competency Management", in this process the enterprise must describe it-self, including what they do and how they do it; this description uses a competency-based approach (adapted from Ermilova & Afsarmanesh, 2006; 2007; 2008).

The second stage is known as: "Collaboration Opportunity Characterization" and as its name indicates it is used to describe (characterize) a business opportunity in a predefined structure based-on competencies (adapted from Concha et al., 2008).

The third activity is called: "Partners Search & Suggestion", and basically is used to find the partners that best suit the requirements fixed in the Collaboration Opportunity Characterization (adapted from Baldo et al., 2007). The business process model of the VE creation process is depicted in Figure 3.8. Screenshots of the three tools that implements developed in ECOLEAD are presented in Annex 2.

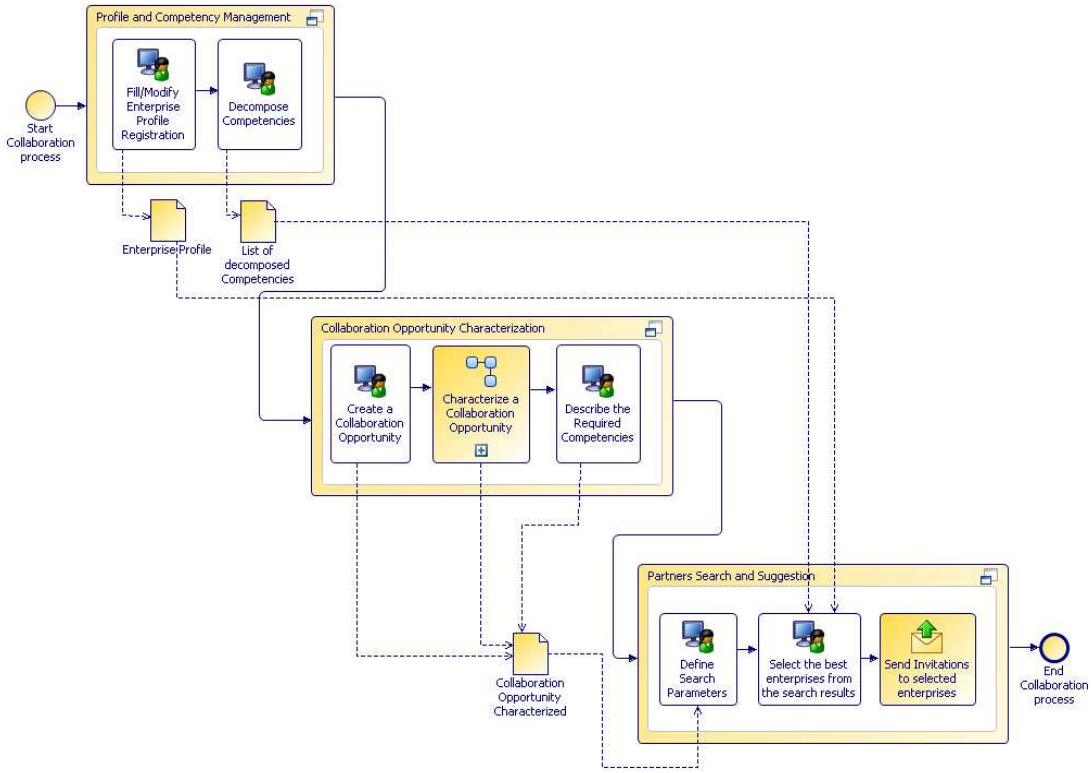

Figure 3.8 – VE Creation Process Model Proposed
(adapted from Camarinha-Matos et al., 2005; 2007)

Profile & Competency Management

The first activity of the Profile & Competency Management sub-process is the "Fill/Modify Enterprise Profile Registration". In this activity the user must provide information like: enterprise description and contact information. As Figure 3.9 shows, the resulting document from this activity is the enterprise profile.

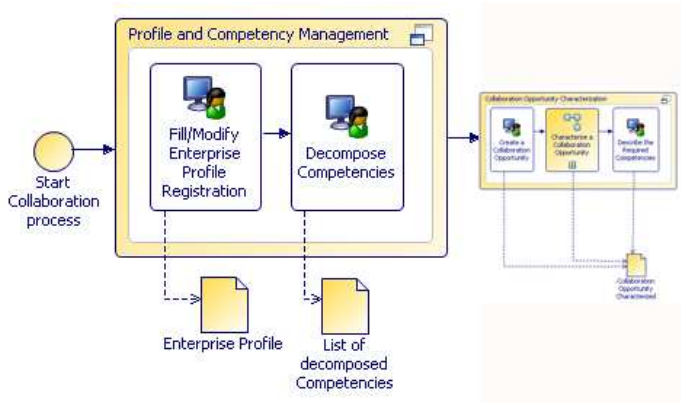

Figure 3.9 – Profile & Competency Management Business Process Model

The next activity is called: "Decompose Competencies" and it consists in a competency-based description of the enterprise and its projects and products. This activity outcome is a list of decomposed competencies as a result of it.

Collaboration Opportunity Characterization

A very important step for the collaborative work is the definition of a business opportunity as a collaboration opportunity using a common ontology language that all the other participants must understand, that is precisely what the Collaboration Opportunity Characterization sub-process does (Concha et al., 2008). The business process model of this activity is presented in Figure 3.10.

The sub-process begins with the activity called: "Fill CO Description" in which the user must provide information about the Collaboration Opportunity like: name, description, delivery date, city and country where the CO are going to be delivered, units of the product/service, broker name, phone and email.

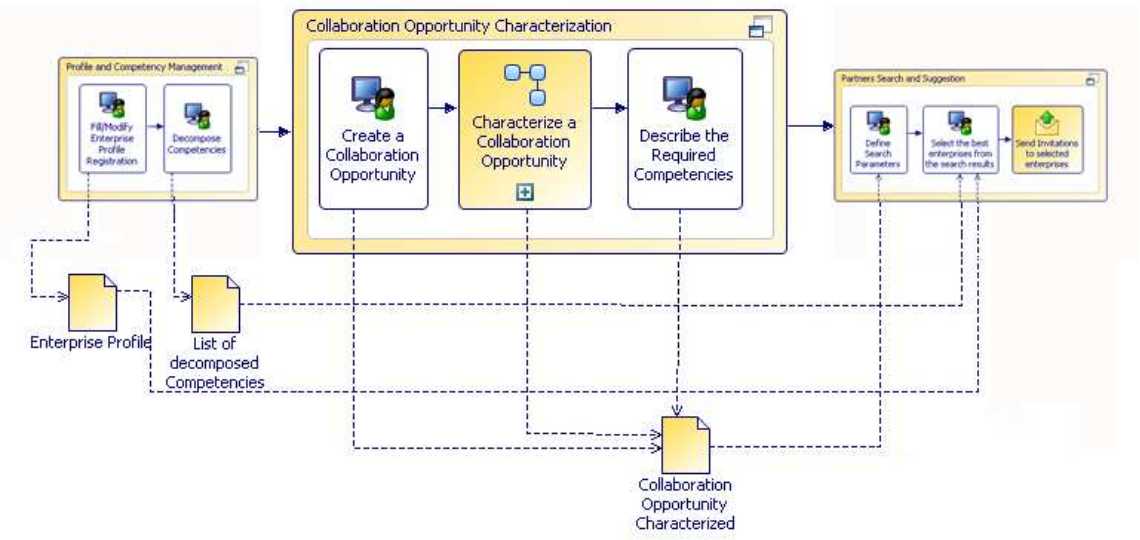

Figure 3.10 Collaboration Opportunity Characterization Business Process Model

Afterwards the user chooses whether add a product or a service and proceeds to provide the corresponding information. Once the activity is done, the user follows to the activity called: "CO breakdown in Competencies", here the user describes the Collaboration Opportunity in a competency-based structure using a common ontology. This activity is similar to the activity called: "Decompose Competencies" of the Profile & Competency Management activity.

At the end of this sub-process, these three activities throw a result a document called: "Collaboration Opportunity Characterized" which is used to make a match between the required competencies and the offered ones.

Partners Search & Suggestion

In a collaborative environment, when a person or an enterprise brings a Collaboration Opportunity and is in charge of the selection of partners is known as a "broker". One of the most important duties of the broker is the selection of the right partners that will work together, the complexity resides in the fact that the broker must be sure of the right kind of competencies of each one of the selected partners. In order to simplify the process and increase the probability of success of the partner's selection it was designed a sub-process that allows the user to make more informed decisions about the enterprises that fulfill the requirements predetermined by the Collaboration Opportunity.

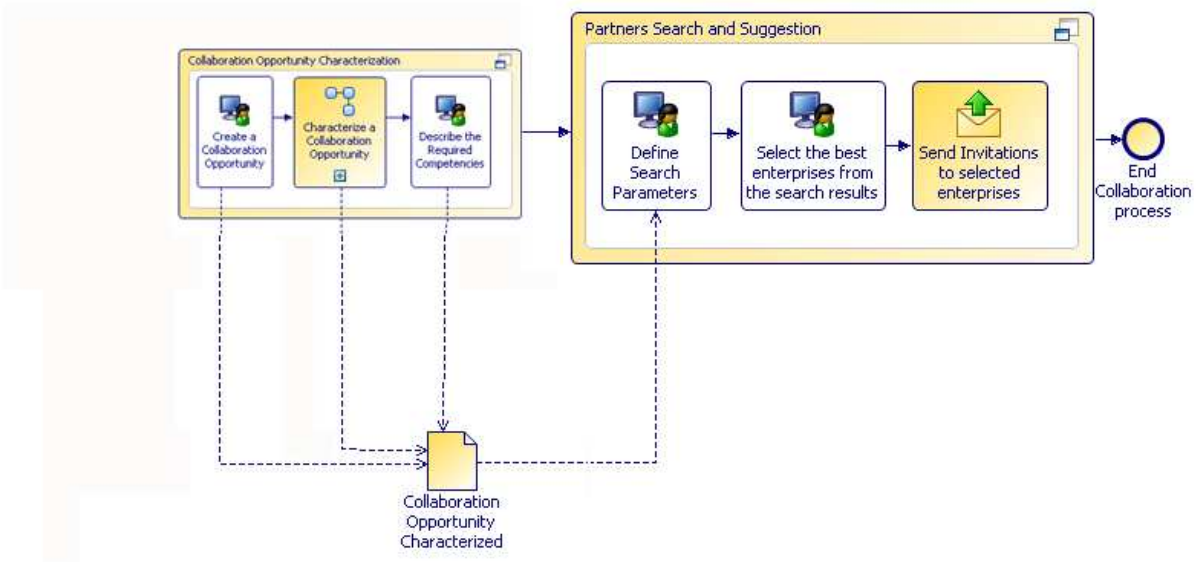

Figure 3.11 – Partners Search & Suggestion Business Process Model

As Figure 3.11 presents, the first step is the "Definition of the Search Parameters", in this activity the user provides the collaboration opportunity requirements like capabilities (processes) and capacities (resources) among others.

Search's result is displayed as a list of enterprises that matches at least one of the search parameters. This list is used by the broker to make a selection of those enterprises which are going to be invited to take part in the collaboration opportunity.

After the broker selects the best enterprises he/she must invite them to participate in the collaboration opportunity, one way to do this is through email and that is precisely the next activity called "Send Invitations" to selected enterprises. At the end of the VE creation process, the broker has a list with the enterprises with the competencies and the willingness to participate in the Virtual Enterprise.

3.2 Incubation and Collaboration Models Analysis

3.2.1 Incubation business process model analysis

The very purpose of any enterprise incubation process is help projects/enterprises to achieve a sustainable way-of-operation. That substantially increases their possibilities of lasting and remaining profitable. Taking into account this purpose, we can realize that the Incubation process of ITESM is coherent with it because of the emphasis on "consultancy" and the creation and realization of "business opportunities".

The process was designed considering the natural evolution of an enterprise, thus in the first stage (Pre-Incubation) the priority is the making of the business plan which is a document that must outline important aspects of the enterprise such as: competencies, capabilities, capacities, products/services, and financial and business issues.

In the second stage (Incubation), the focus is on the execution of the business plan and in order to do it well the user could ask experts for consultancy on any of the areas of business plan. Also, the enterprises have access to a directory with external and internal companies. After this stage the enterprise is considered as graduated and must pass to the next stage, the post-incubation.

The last stage is the Post-Incubation, in this stage the enterprises are being monitored by experts and still have access to ask for consultancy. Also, the enterprises will still have the opportunity to search for business opportunities with internal and external enterprises. After this stage the enterprise is considered as graduated from the whole Incubation process.

3.2.2 VE Creation Business Process Model Analysis

The proposed VE creation process covers three of the very first steps of the VE creation process designed in the ECOLEAD project (2008) (see also Camarinha-Matos et al., 2005; 2007). The proposed VE creation made in this work obey to the aim of simplify the way in which enterprises in an incubation environment can create a Virtual Enterprise in order to respond to bigger and better (collaboration) business opportunities.

Most of the enterprises in incubation stage are still making its firsts efforts in defining and developing their core-competencies and a vast majority of them does not even know how they are going to commercialize its products and/or services, what business model are going to adopt and many more features considered as an important part of the enterprise definition. Taking this into account, it was simplified the VE creation process to allow enterprises in incubation to take part in collaboration business opportunities through the formation of Virtual Enterprises.

3.3 Business Process Integration

The Business Process Integration (BPI) of the EMPRENDETEC-ITESM Incubation process and the VE creation process are detailed in this section.

3.2.1 BPI of Pre-Incubation and Profile and Competency Management sub-processes

The first activities to be integrated are the one called "Fill/Modify Enterprise Profile Registration" of the Pre-Incubation sub-process and the one called "Fill/Modify Enterprise Profile Registration" of the Profile and Competency Management from the VE creation process. These two activities complement each other and avoid the redundant information request. Figure 3.12 shows the business process integration of these two activities.

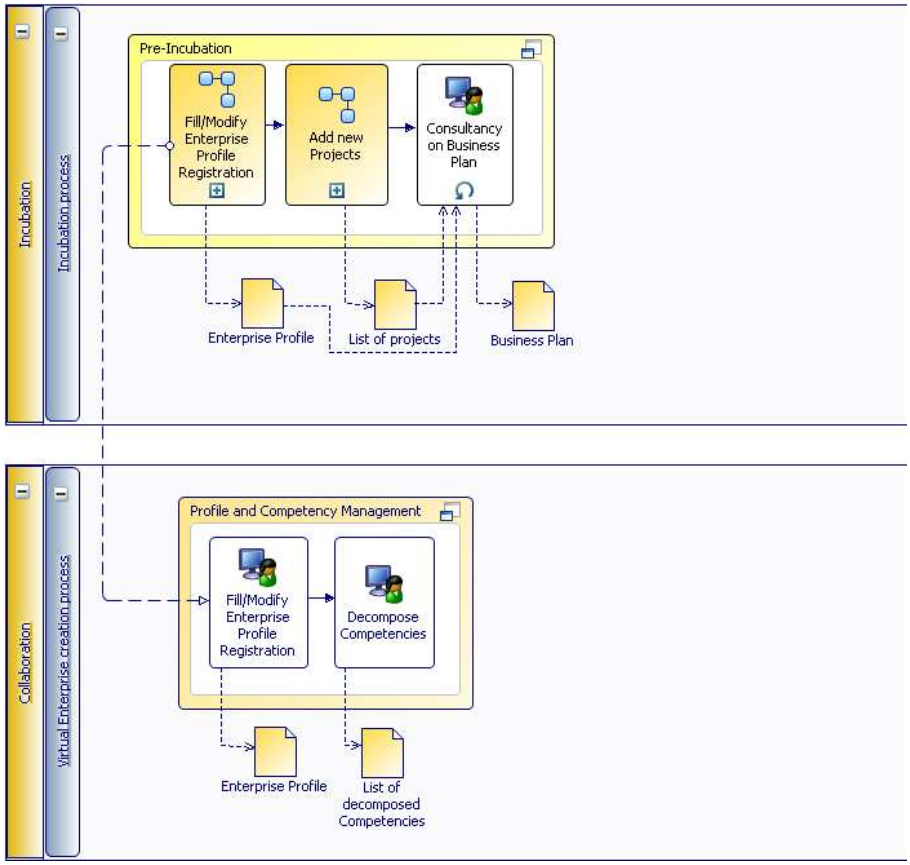

Figure 3.12 – Business Process Integration of Activities in the Pre-Incubation and the Profile & Competency Management Sub-processes

Both activities are similar and both were designed to gather together the basic information of the enterprises. However, there are some differences in the kind of information they require from the enterprises, this is a minor issue and will be resolved easily.

3.2.2 BPI of the Incubation and Post-Incubation sub-processes with the Collaboration Opportunity Characterization and the Partners Search & Suggestion sub-processes

The "Business Links" activity was integrated with the "Collaboration Opportunity" activity; this was done because of the collaborative-based nature of both activities. The "Business Links" activity in the Incubation and Post-Incubation sub-processes was designed to manage information of enterprises on the Incubator who wanted to be listed in a kind of directory, enabling communication via e-mail between the enterprise who wanted to make business links and the one selected from the directory. The Figure 3.13 depicts the business process integration between the Incubation sub-process, the Collaboration Opportunity Characterization, and the Partners Search & Suggestion sub-processes.

The "Business Links" activity provided by the Incubator consists only in a directory of enterprises on the Incubator with their description and contact information, there is no collaboration tools implemented to improve the number of successful business opportunities among enterprises in the Incubator. That is why the integration of this activity with Collaborative tools represents an opportunity for the incubating enterprises.

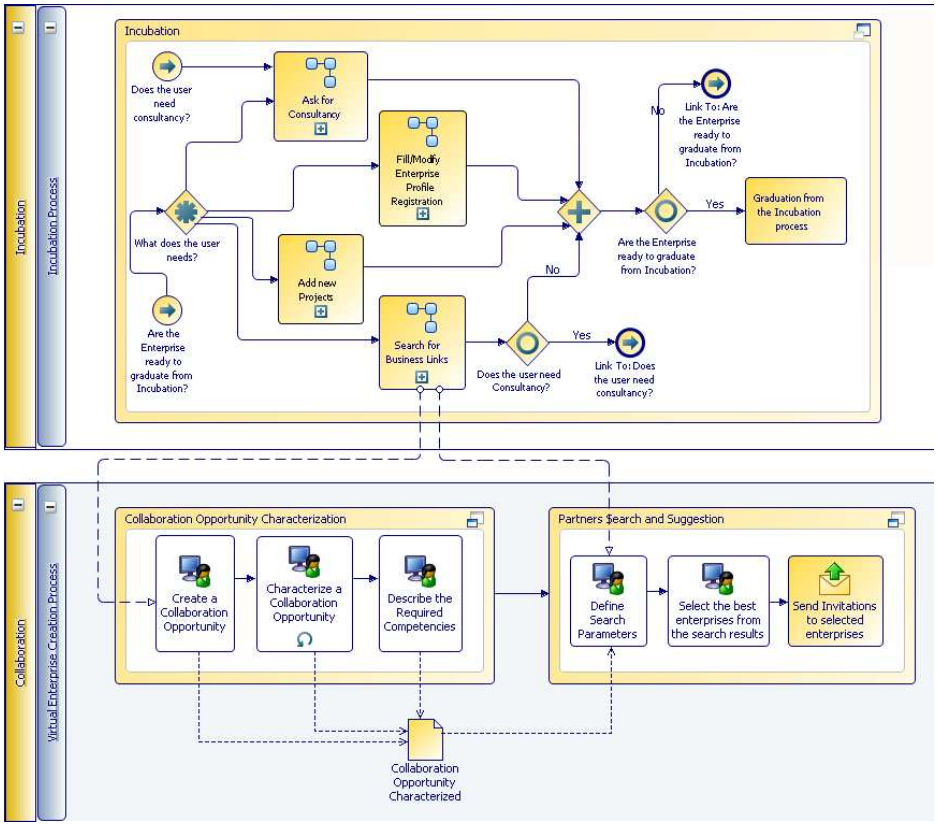

Figure 3.13 – Business Process Integration of Activities between the Incubation Sub-Process, the Collaboration Opportunity Characterization Sub-Process and the Partners Search & Suggestion Sub-processes

The “Create a Collaboration Opportunity” activity was designed to register and decompose the collaboration business opportunities that any member of the pool of enterprises may have with the purpose of open the business opportunity to any enterprise in the pool that have the competencies required to take part of the business.

The integration of both activities consist of presenting to the enterprises on the Incubator the possibility to create a Collaboration Opportunity in the EMPRENDETEC Web portal system considering the characteristics offered in the “Business Links” activity and adding the “Collaboration” activity mentioned before. This “Collaboration Opportunity Characterization” activity may increment the number of businesses obtained by the enterprises in the Incubator. Figure 3.14 presents the business process integration between the Post-Incubation sub-process, the Collaboration Opportunity Characterization sub-process, and the Partners Search & Suggestion sub-processes.

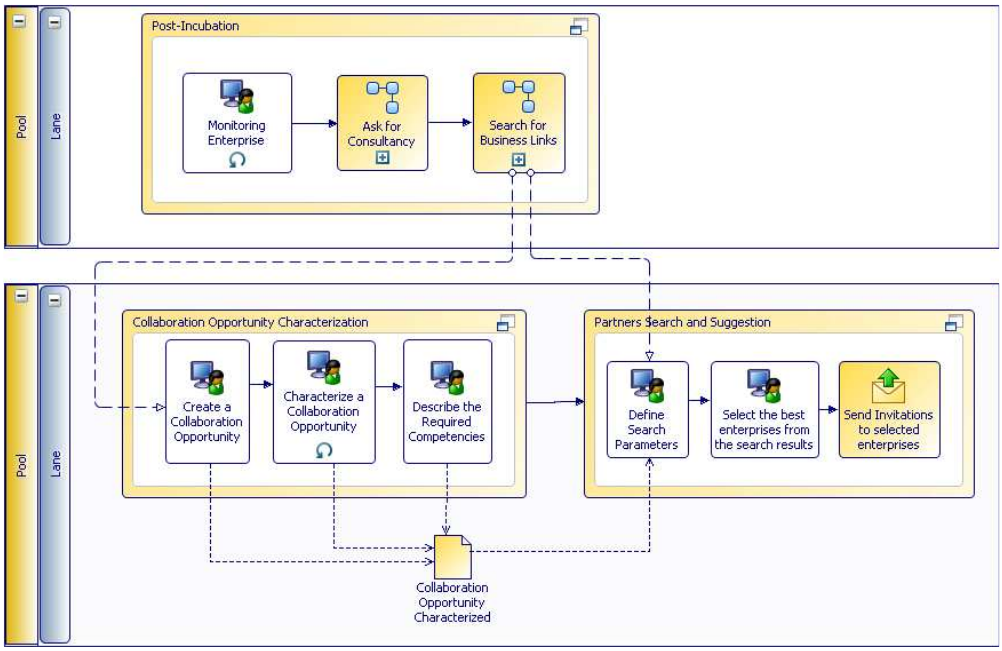

Figure 3.14 – Business Process Integration of Activities in the Post-Incubation Sub-Process, the Collaboration Opportunity Characterization Sub-Process and the Partners Search & Suggestion Sub-Processes

Both “Business Links” activities also have been integrated with the “Define Search Parameters” activity, of the Partners Search & Suggestion sub-process. In this activity the user selects a collaboration opportunity and introduces some parameters and filters to search all the enterprises in the pool that also fulfill the competencies required for the selected collaboration opportunity. This integration complements the “Business Links” activity by adding a more restricted search based-on an existent collaboration opportunity.

CHAPTER 4: Architecture Design and Enterprise Application Integration

Previous chapter described the Incubation and Collaboration processes by using Business Process Models Notation and how these processes were integrated; following with the chosen methodology, this chapter presents the architecture design needed to carry out the proposed business process integration defined in Chapter 3. Also the integration is addressed by using Enterprise Application Integration (EAI) between the Emprendetec web system and the Collaborative tools designed to perform the proposed Virtual Enterprise creation process.

4.1 General Approach

First of all, it is very important to describe the context in which the architecture design was developed; this implementation includes the Emprendetec services and an approach to the Collaborative tools designed in ECOLEAD project. Next subsections describe the context of the integrated applications, though in the case of the collaborative tools they were adapted from three of the tools designed in the ECOLEAD project also these adaptations are described.

Due to the independency between the two systems that are going to be integrated, the EAI solution presented is intended to go in a different way than traditional EAI solutions because the systems to integrate do not belong to the same enterprise, although it seems not to be a great difference, there is, at least conceptually. To avoid or minimize this difference, the architecture design was made based on the Business Process Integration developed in the previous chapter; this business-process-driven approach helps to focus in the process-to-process integration, reducing the probabilities of failure due to a wrong integration design.

4.1.1 EMPRENDETEC Incubation Services Context

The EMPRENDETEC Web portal system is composed by three phases of incubation described and modeled in the Chapter 3. This portal is a Web-based system that offers the proper services for the incubation process.

This portal system implements a Web-based architecture, which means, the interaction between business processes in the application uses Web pages and an Internet browser as access interface.

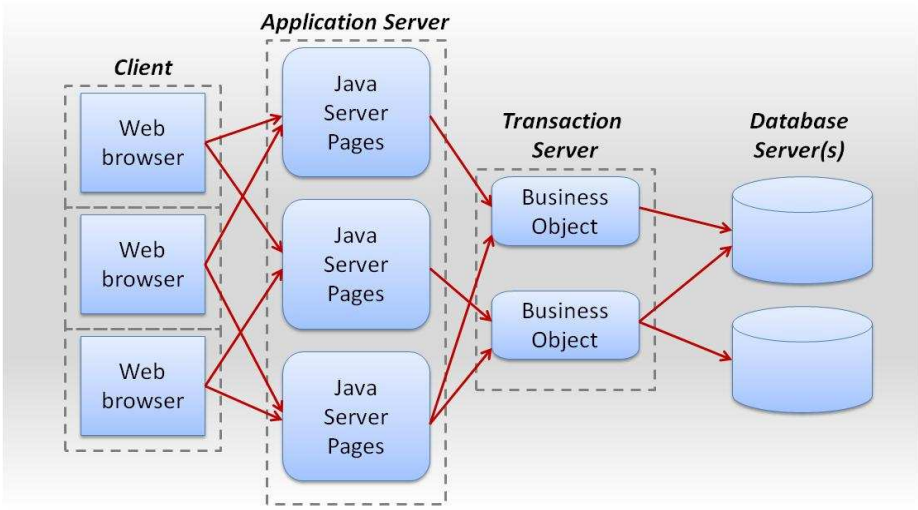

Figure 4.1 EMPRENDETEC Web-based Architecture

Emprendetec's system architecture consists, in its lower level, by several database servers where all the application-related information is stored; this data is accessed via business objects, which are stored in a transaction server, by Java Server Pages (JSP) and displayed in the client side through a web browser. Figure 4.1 depicts the Emprendetec's architecture.

4.1.2 Collaborative Tools Architecture

As mentioned in Chapter 3, each of the three business processes in the Virtual Enterprise creation process have a corresponding Web-based system designed in the ECOLEAD project specifically to execute that process; these systems were built as three independent applications communicated through Web services.

Figure 4.2 depicts the architecture used in the ECOLEAD project and shows how the Profile and Competencies Management System (PCMS) (Ermilova & Afsarmanesh, 2006; 2007; 2008) is connected with the Partners Search & Suggestion (PSS) system (Baldo et al., 2007) using a Web service interface and a Web service client respectively. On the other hand, the Collaboration Opportunity Characterization (COC) system (Concha et al., 2008) is connected with the Partners Search & Suggestion system (Baldo et al., 2007) via Web services, by implementing a Web service interface in the COC and a Web service client in the PSS (see Camarinha-Matos et al., 2007).

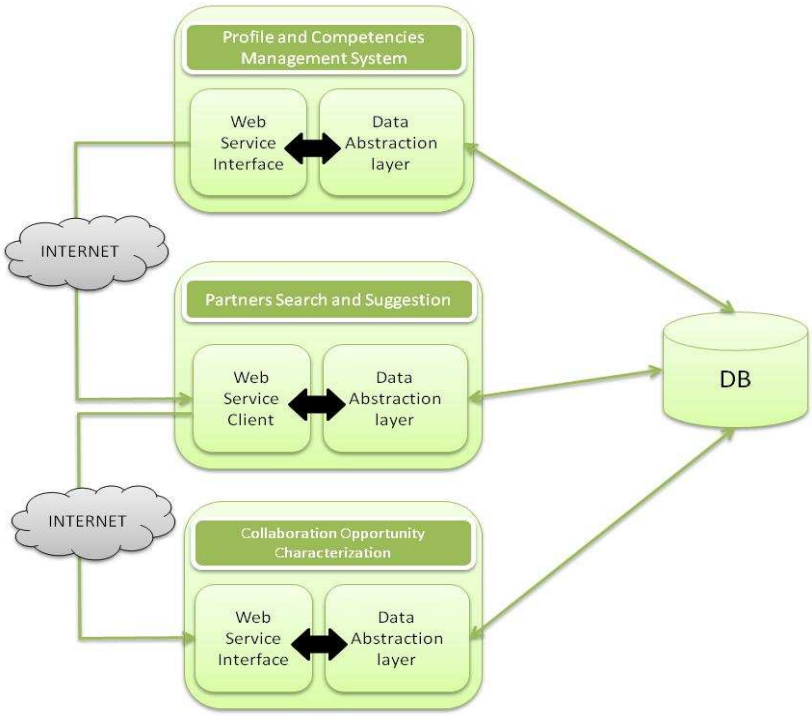

Figure 4.2 – ECOLEAD Tools Web-based Architecture

This architecture was designed considering the particular circumstances of the ECOLEAD project where each system was developed separately one from another by different teams in different countries; as a result, the systems were designed considering the use of Web services as the mechanism of communication among them.

4.2 Software Analysis

4.2.1 System Requirements

The purpose of integrate the Incubation process with the Virtual Enterprise creation process is to enable collaboration among companies that already belong to the EMPRENDETEC Incubation process. In this way, integration needs to be performed in two ways, in first place, the simplification of the Virtual Enterprise creation process composed by three tools: the Profile & Competency Management System (Ermilova & Afsarmanesh, 2006; 2007; 2008), the Collaboration Opportunity Characterization (Concha et al., 2008) and the Partners Search & Suggestion (Baldo et al., 2007). In second place, the design of a Service Oriented Architecture (SOA) in order to make possible the communication between the EMPRENDETEC Web Portal system and the VE creation tools, to do this, a Web service interface in the EMPRENDETEC Web system and a Web service client in the VE creation tools' side need to be implemented.

The most important requirements are:

- To create a Collaboration Opportunity and its Characterization according to the literature developed in ECOLEAD project (see Concha et al., 2008).
- To manage the Profile and Competencies of companies in the EMPRENDETEC Web system.
- To enable companies/broker to search for partners that fulfills a certain number of parameters established by the Collaboration Opportunity.
- To generate a SOA design by using Web services interfaces and Web services clients in order to integrate the EMPRENDETEC Web system with the VE creation tools.

4.2.2 Integration through Web Services

The interactions and structure of the integration through Web Services effort were defined based- on the business process integration work made in Chapter 3.

When a user of the EMPRENDETEC Web system is adding or modifying information from the enterprise profile, the user must also have access to the Profile & Competency Management module, in order to enable this interaction, the EMPRENDETEC Web system should access to that module and at the same time make available a Web service interface that enables the Profile & Competency Management System for retrieving information through a Web Service client.

The integration was designed by using a Service Oriented Architecture (SOA) approach and Web services in both sides of the integration. Figure 4.3 shows how the interaction between Web Services is performed.

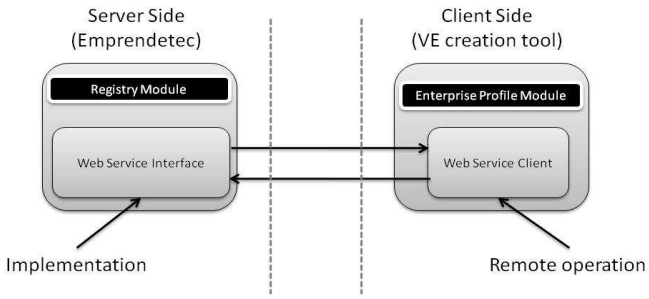

Figure 4.3 Mechanism for integration through Web services

Figure 4.3 depicts the mechanism used to achieve the mentioned integration. In the server side the Registry Module of EMPRENDETEC provides a Web service interface to be accessed by the Web service client in the enterprise profile module of the VE creation tool.

4.3 System design

4.3.1 Use cases

Use Case: Registry module extended to Enterprise profile registration

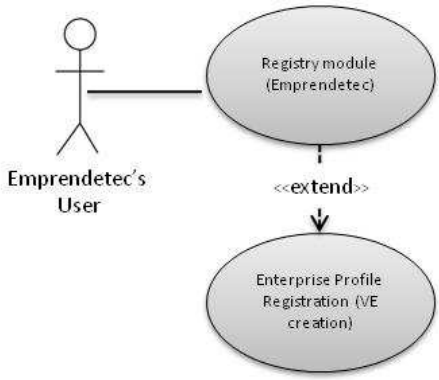

Figure 4.4 Registry module and Enterprise Profile Use Case Diagram

In this use case the user complements the information about his project/enterprise; that is because the EMPRENDETEC Web Portal system requests just for information that describes the enterprise in general terms, but in order to enable enterprises to participate in the VE creation process they must be described in competencies, capabilities, capacities and products/projects terms. This complementary information is actually requested by the enterprise profile registration within the Profile & Competency Management sub-process of the VE creation process. Figure 4.4 depicts the interaction between the EMPRENDETEC user and the system.

Use case: Business Links extended to Collaboration Opportunity Characterization

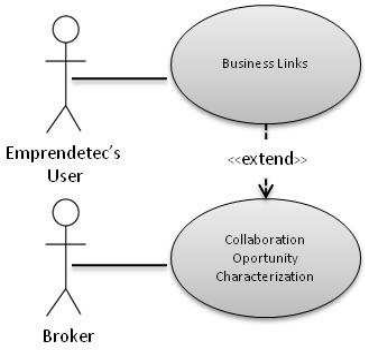

Figure 4.5 Business Links extended to Collaboration Opportunity Characterization Use Case Diagram

When a user needs to search for companies that can help to satisfy a collaboration opportunity then he/she must use the "Business Links" module of the EMPRENDETEC Web Portal system, nevertheless, as mentioned in Chapter 3, this module allows only searches according to some general parameters such as company's name, business sector, line of business and stage (pre-incubation, incubation, post-incubation, acceleration and technological park). This module is inefficient since it does not offer information like competencies, capabilities, capacities, products and services, and consequently neither allow to carry out a search based-on that information. Figure 4.5 shows the use case diagram for this use case.

The EMPRENDETEC system provides access to the "Collaboration Opportunity Characterization" module in order to enable to users to fill a competency-based description of the collaboration opportunity proposed by the companies to the businesses community.

Once the users get access to the "Collaboration Opportunity Characterization" module they will add/modify one collaboration opportunity and describe it in terms of competencies, capabilities, capacities, products and services; in this way the collaboration opportunity could be used in the module Search Partners and Suggestion to obtain a possible list of partners or suppliers that can participate in this collaboration opportunity.

Use case: Business Links extended to Partners Search & Suggestion

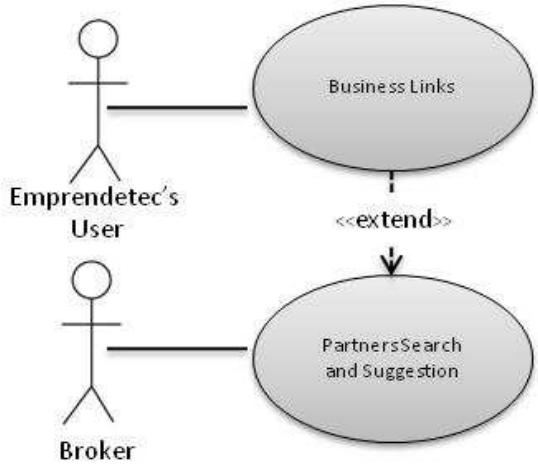

Figure 4.6 Business Links extended to Partners Search & Suggestion Use Case diagram

Figure 4.6 depicts the diagram of the Business Links and Partners Search & Suggestion use case. After the collaboration opportunity characterization mentioned in the previous use case, a user of the EMPRENDETEC Web Portal system who may need to search for companies to establish business relations as clients or suppliers will use the "Business Links" module, which allows to search companies by name, business line, area and other general parameters, nevertheless, if the user needs to search for companies based-on a previously defined business opportunity or simply wants to search by products, services or competencies, then the module business links offers access to the module Partners Search & Suggestion to extend the possibilities of the user in their search of companies to establish collaboration.

4.4 Architecture Design

Once the analysis of requirements is completed it is moment to design the system architecture. The design work was based-on the work done in Chapter 3 section 3.3 that approaches the business process integration between EMPRENDETEC business incubation process and the VE creation process. In the business process integration is mentioned that the "Fill/Modify Enterprise Profile Registration" realized of EMPRENDETEC must have an information flow towards the process "Fill/Modify Enterprise Profile Registration" of the VE creation process, this is depicted in Figure 3.12 (Chapter 3), translated to architecture terms it is integration between two modules of two different and independent systems.

The previous mentioned integration requirements were solved with the implementation of Web services that enable communication between the "EMPRENDETEC Registry" module and "Enterprise Profile" module of the VE creation process. Figure 4.7 depicts the architecture designed from the analysis of requirements and the business process integration.

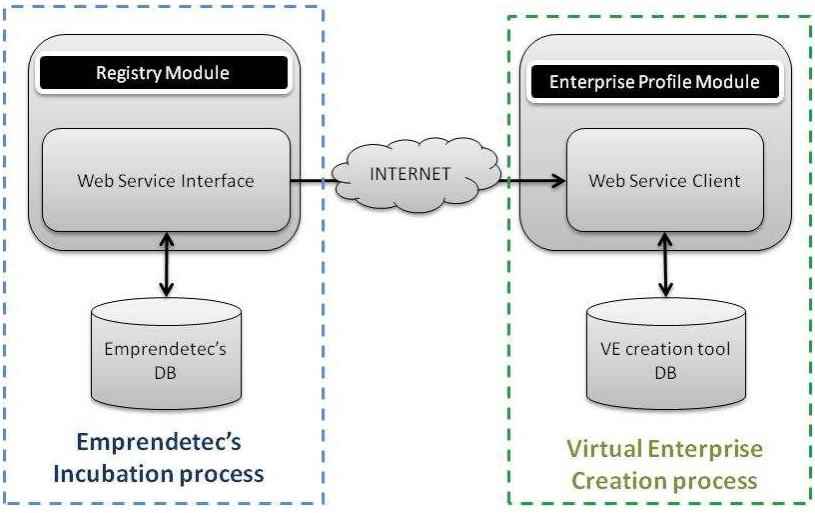

Figure 4.7 System Architecture for Integration between Registry Module and Enterprise Profile Module

Next, business process integration between the "Business Links" and the "Collaboration Opportunity Characterization" sub-processes, depicted in figures 3.13 & 3.14 (Chapter 3), supports the designed system architecture where these two sub-processes are communicated via Web services. Figure 4.8 illustrates the architecture design for these two modules.

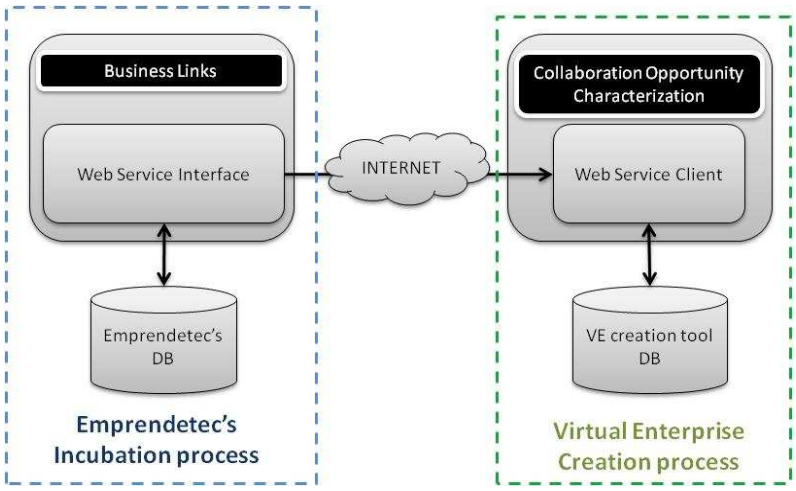

Figure 4.8 System's Architecture for Integration between
Business Links Module and the Collaboration Opportunity Characterization Module

The last module of this architecture design is the one that corresponds to the business process integration implemented by using the "Business Links" and the "Partners Search & Suggestion" sub-processes, figures 3.13 and 3.14 (Chapter 3) illustrate the mentioned integration. The resulting system architecture is depicted in figure 4.9.

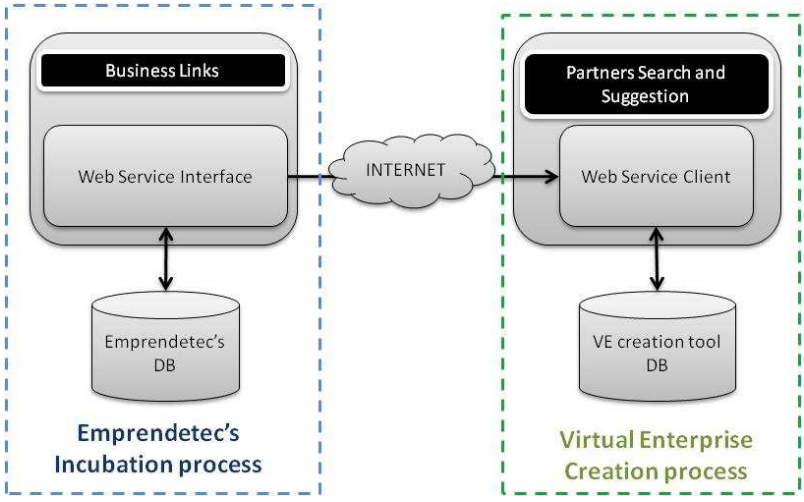

Figure 4.9 System's Architecture for Integration between
Business Links Module and the Partners Search & Suggestion Module

Based-on the three components of the architecture presented in figures 4.7, 4.8 and 4.9 it was designed an architecture that makes possible the integration of EMPRENDETEC and VE creation processes as mentioned in Chapter 3 section 3.3.

Figure 4.10 shows the architecture designed for the proposed integration. This integration was performed by analyzing the EMPRENDETEC's business incubation process architecture, the Virtual Enterprise creation process architecture, and enabling the communication between them using Web services.

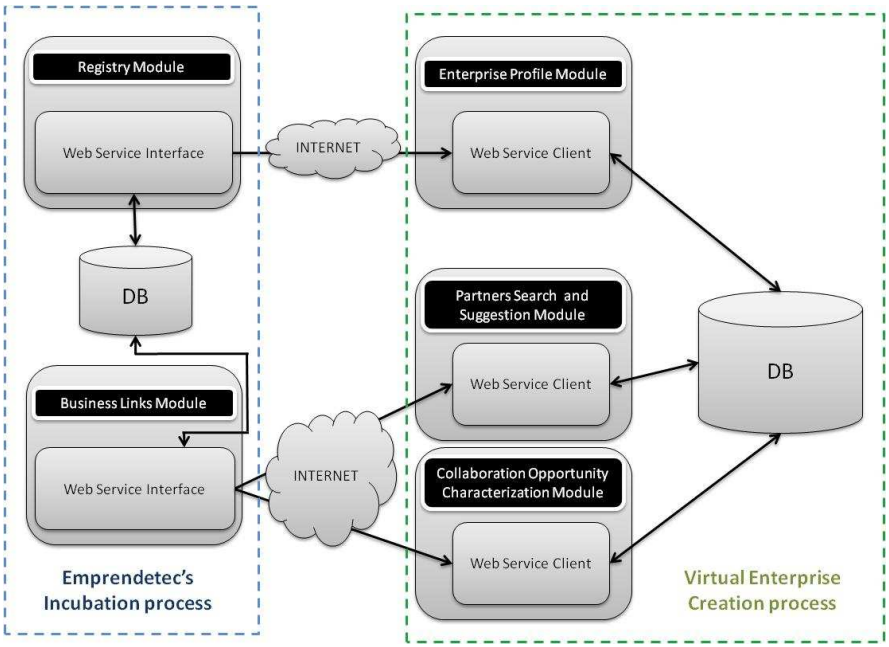

Figure 4.10 System Integration with SOA

The first component to be described is the integration between the "Registry" module of the EMPRENDETEC business incubation process and the "Enterprise Profile" module in the VE creation process. These two modules were integrated to be complementary, in this case, the "Enterprise Profile" module is used to collect the profile information of the company to be used in the collaboration processes but not captured in the "Registry" module of the incubation process.

The next component is the integration between the "Business Links" module with the "Partners Search & Suggestion" module, the purpose of the integration of these two modules is to offer a different option in the "Business Links" module, allowing the company to search for commercial partners, suppliers or enable to a broker to find the companies which satisfy certain business opportunity.

The last component is the integration between the "Business Links" module and the "Collaboration Opportunity Characterization" module. This integration was proposed with the aim of make possible to companies inside or outside the incubator to play the role of broker and bringing new collaboration business opportunities in order to create a Virtual Enterprise with the companies that fulfill the business requirements.

4.5 Prototype Implementation

This section describes the technologies used in the implementation of the use cases presented in Section 4.3.1. This section does not detail in greater depth the implementation of the prototype tool; it only describes the most important aspects of its design.

4.5.1 Implementation Architecture

The selection of technologies to implement was carried out considering the requirements specified in Section 4.2.1. The programming language selected was Java Enterprise Edition 5, Apache Struts 2.0 as the Model View Controller Framework, Hibernate 3.3 to manage the database persistence and MySQL as the database manager. Table 4.1 shows the main technologies used in this implementation.

Table 4.1 Implementation Technologies

Technology	Description	Version
Java Enterprise Edition	Platform for server programming in the Java programming language	5
Apache Struts	Open-source Web application framework for developing Java EE Web applications. It uses and extends the Java Servlets API to encourage developers to adopt a model –view controller (MVC) architecture.	2.0
Hibernate	Object-relational mapping (ORM) library for the Java language, providing a framework for mapping an object-oriented domain model to a traditional relational database.	3.3
Apache Axis2	Apache Axis2 is the successor to the Apache Axis SOAP project. It is a major improvement of the Web services core engine and aims to be the platform for the next generation of Web services and Service-Oriented Architecture (SOA). It is becoming increasingly popular by being a clean and extensible open source Web services platform. The architecture of Axis2 is highly flexible and supports much additional functionality such as reliable messaging and security.	1.5
MySQL	MySQL is a relational database management system (RDBMS) that runs as a server providing multi-user access to a number of databases.	5.0

Figure 4.11 depicts the architecture designed for this implementation. The architecture was designed using a multi-tier approach that leverages the logical separation of architectural components, that is, there is a “presentation layer” on the top of the architecture that is in charge of presenting an interface to the user, next is a “flow control logic layer” that manage the flow of the application, then there is a “business logic layer” which manages all the data requests, replies and the operations performed over the data. The following layer is divided in two sub-layers, one of the sub-layers is the “data abstraction” which is in charge of mapping an object-oriented domain model to a relational database. Another sub-layer is the “integration”, this sub-layer is responsible for enabling Web services and their management. Besides, in the next part of this section the architecture is described one layer at a time.

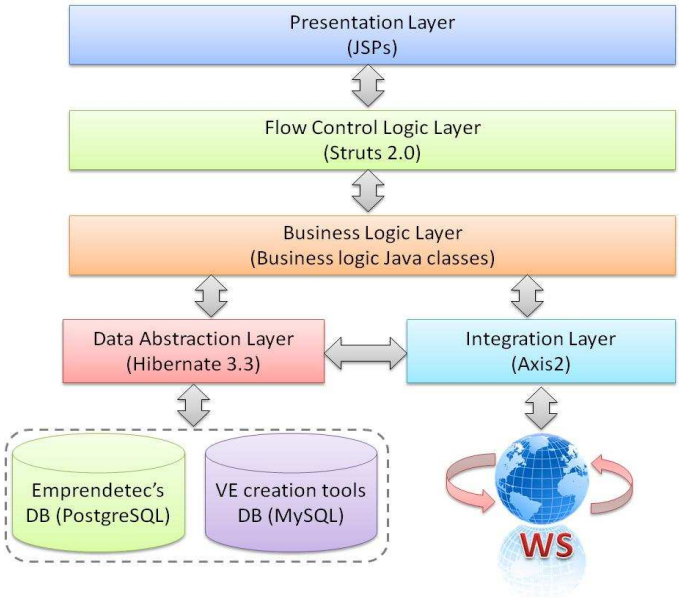

Figure 4.11 Implementation architecture

4.5.1.1 Presentation Layer

The main objective of this layer is to show an interface that enables interaction between the user and the system. This layer presents all the screens and information aimed to the user and the look and feel of the system.

This layer use Java Server Pages (JSP) in order to generate the HTML pages that users will see and interact with. The reason why JSP was chosen is because Apache Struts framework, selected in the Flow control layer, uses JSP to display information to the user via HTML pages. Also JSP uses Servlets technology, and this is a requirement to enable communication with the logic control implemented using Apache Struts framework.

Apache Struts provides a certain number of custom HTML tags, used in JSP, in order to enabling the setting and getting of variables of the HTML tags to the objects passed to the flow control logic layer. Although this layer is in charge of displaying user interfaces, it is a job for the flow control logic layer to decide when and where to show them.

4.5.1.2 Flow Control Logic layer

All the flow control logic architecture is supported by the Apache Struts framework. This framework drives the developer to use the Model View Controller (MVC) pattern which separates the presentation layer, the flow control logic layer and the data model component. The very core of Struts can be defined as the centralized management of the flow control achieved through a XML configuration file.

In this layer reside the flow control classes that are responsible to make the calls to the business logic layer, and to request the proper view according to the business logic layer response. The most important benefit from this centralized approach is the minimum effort invested when an application flow modification is needed.

4.5.1.3 Business Logic layer

This layer is responsible for retrieving data from the data abstraction layer and the execution of the rules and calculations over it. The main function of this layer is to separate operations and calculations of data from the presentation and the data abstraction layers.

The classes in this layer receive a user request through the presentation layer and execute a set of operations over the data retrieved from the data abstraction layer. Afterwards, the operations results are passed to the flow control logic layer and the next view is requested.

4.5.1.4 Data Abstraction layer

In this layer the data objects and their attributes are defined in order to separate the operations performed in the top layers from the details of data sources, communication protocols, database driver and localization. This separation helps particularly when it is needed to change any of the details mentioned above, a considerably less effort is needed when the architecture includes the separation on different layers of the business logics and the data model using a data abstraction layer.

Hibernate is defined as an object-relational mapping (ORM) layer, and it provides a framework for mapping an object-oriented domain model to a traditional relational database system. In this implementation, Hibernate 3.3 was used to access to the databases.

4.5.1.5 Integration layer

This layer is responsible for the management of the Web services interfaces that enable communications between EMPRENDETEC Web Portal system and the VE creation tools. In this layer was used Axis2 as the core engine for Web services. This technology provides the capability to add Web services interfaces to Web applications, although it also functions as a standalone server application, in this implementation Axis2 is used in a Web-based context.

This layer uses an approach based-on a Service Oriented Architecture (SOA). In this approach, Web services make functional building-blocks that can be accessed via standard Internet protocols and platform and programming languages independent implementations.

Every SOA building block can perform the role of service provider and/or service requester according to its data requirements. *Service provider* - A service provider must create a Web service and make public its interface and access information. The provider must select which services to share and manage the security of the service. *Service requester* - Also known as the Web service client, it is in charge of invoking one of the Web services of a determined service provider, in order to do this, the client must follow the Web service provider specifications to use the service.

4.5.2 Web Service Interfaces

Figure 4.10 depicts the Web service interfaces used to integrate the two systems and based-on the specifications and requirements presented in Section 4.2.1, next section describes each of the interactions between Web service providers and clients.

4.5.2.1 Registry Module Enterprise Profile Module Integration through Web Services

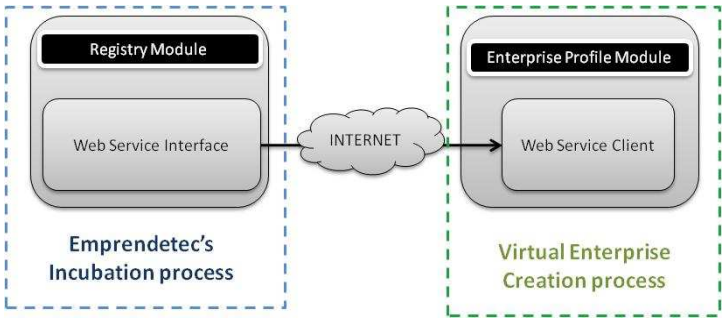

Figure 4.12 Registry Module and Enterprise Profile Module Web service Interfaces

Figure 4.12 depicts the integration mechanism between these two modules. The “Registry” module of the EMPRENDETEC incubation process offers a Web service interface in order to provide information about enterprises in the system. The consumer of this service is the “Enterprise Profile” module of the VE creation tool through a Web service client designed according to the specifications of the Web service provider.

4.5.2.2 Business Links extended to Collaboration Opportunity Characterization

This integration uses a Web service interface provided by the “Business Links” module of EMPRENDETEC and a Web service client in the “Collaboration Opportunity Characterization” module of the VE creation tool. Figure 4.13 depicts this integration.

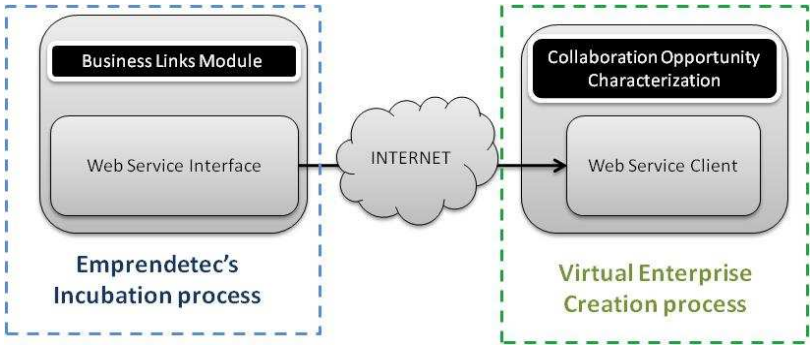

Figure 4.13 Business Links and Collaboration Opportunity Characterization Web Service Interfaces

4.5.2.3 Business Links extended to Partners Search & Suggestion

The Web service interfaces used in order to achieve this integration are provided by the “Business Links” module of EMPRENDETEC and the “Collaboration Opportunity Characterization” module of the VE creation tool using a Web service interface and a Web service client respectively. Figure 4.14 depicts how the integration through Web services is achieved.

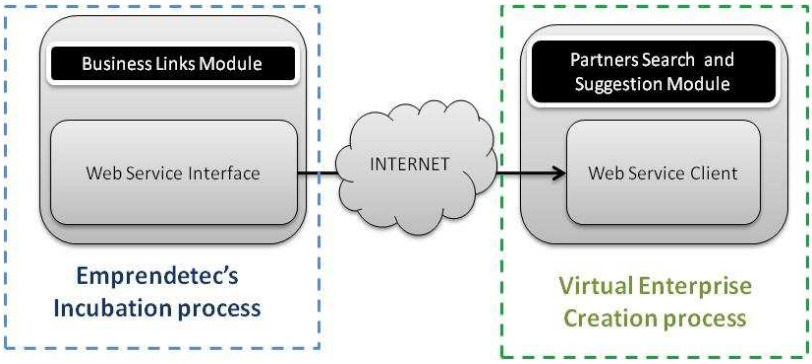

Figure 4.14 Business Links and Partners Search & Suggestion Web Service Interfaces

4.6 Overview

This chapter presented the design of the Systems Architecture that supports the business process integration defined in Chapter 3; also the implementation architecture and the proposed technologies were defined based-on the requirement analysis.

CHAPTER 5: Study Cases

This chapter presents three study cases made with three different companies that at the time of writing this thesis work are participating in the ITESM business incubator. The first study case was made with the company D4 Reality which currently is on the Pre-Incubation stage. The second study case was made with the company WWest Mexico which is on the Incubation stage. Finally, the third study case was made with the company Power Engineering Services & Solutions which actually is on the Post-incubation stage. The objective of this chapter is to guide in the better understanding and the right use of the integrated processes implemented in the tools presented in Chapter 4.

The business models descriptions are presented in this chapter using a business model ontology proposed by Osterwalder (2004). The information presented in this Chapter is based-on interviews made to the managers of each of the previously mentioned companies.

The scenario includes the Porter's Five Forces analysis, which is a framework for the industry analysis and business strategy development. This analysis will help in the identification of the constraining forces especially to determine if the company should make efforts in establishing collaboration either with clients or with suppliers.

The collaboration scenarios presented in each of the study cases are based-on the information taken from the interviews to the companies and on assumptions we made.

5.1 D4 Reality Study Case Scenario

D4 Reality starts in 2006 as a solution to the lack of competitive educational services in the architectonic, graphic, multimedia and engineering design market. The company is now well positioned in the market as a result of offering high quality in technological services.

D4 Reality is divided in the following two business lines:

- **Studio & Academy.** This line of business has the mission of provide training to students and professionals in the area of graphic design, architecture, multimedia projects and Web design.

- **Technological Services.** This business line is focused on the offering of services like graphical design, multimedia projects, Web design and interactive innovation for industries like education, constructing and real estate companies, architecture and museums.

Nowadays the company is on the pre-incubation stage of the ITESM business incubator and is located in *Pabellón Tec suite 38-5 Garza Sada Avenue, Monterrey, Nuevo León*; the legal representative is Mr. Oziel Salinas.

5.1.1 Products and Services Description

D4 Reality offers only a few products, all of them related to the core business of the company. The products offered are laptops, tablet pens and USB flash memories. The sales of these products represent less than 5% of the total sales revenue of the company.

The remaining 95% of sales are obtained by the commercialization of services which as mentioned earlier, are divided in two business lines: Studio & Academy and Technological Services.

In the Studio & Academy division the company offers regular and certificate courses in some technical areas like:

Regular Courses:

- Web technologies
- Multimedia tools
- Architecture and 3D modeling
- Drawing
- Productivity (Office suites, science and simulation software)
- Programming languages
- Industrial

Certificate Courses:

- Graphical design
- Web design
- Digital 3D animation
- Digital architecture
- Construction
- Digital engineering
- Programming
- Video and Animation
- Comics
- Videogames programming

The technological services offered are the following:

Web

- Web templates
- Web pages
- Static photo galleries
- Static banners
- Flash animations
- Video to Flash conversion
- Images digitalization
- Professional photography
- Icons design
- Hosting

Architecture and 3D Environments

- Rendering
- 3D modeling
- Maps generation
- Space or environment modeling
- Design of Virtual tours

Corporate Identity

- PowerPoint templates
- Guide of Corporate identity
- Company logo
- Design of products catalog

5.1.2 Business model

The business model of D4 Reality is focused on a value proposition that consists in offering a great variety of courses targeted to university and high school students. Figure 5.1 depicts the business model description of D4 Reality.

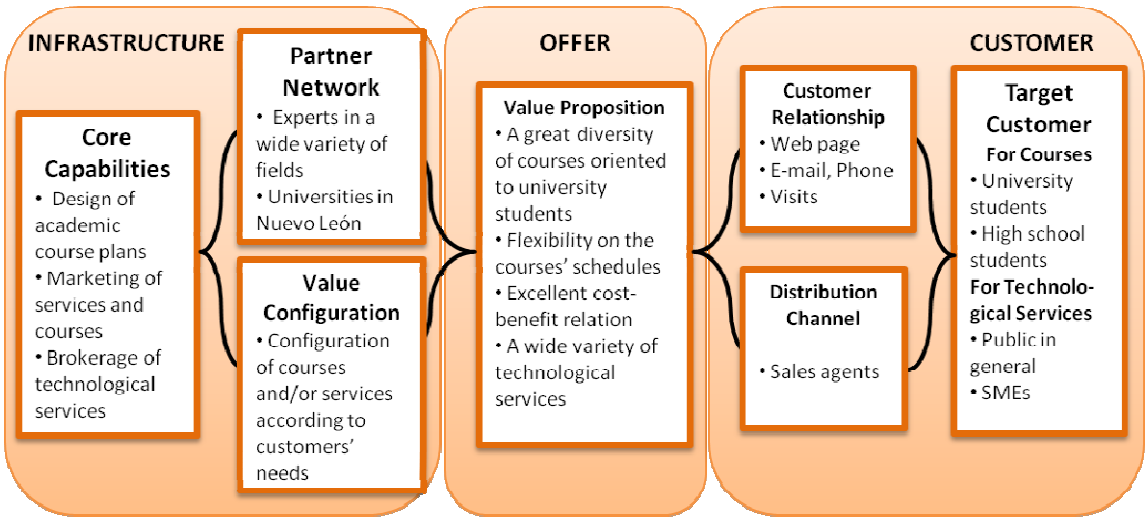

Figure 5.1 D4 Reality Business Model Description
(using Osterwalder (2004) Business Model Ontology)

The core capabilities of D4 Reality are the design of academic course plans, the marketing of services and courses and the brokerage of technological services. The first mentioned core capability is used to configure the courses from content to the logistic including the selection of teacher.

The partner network includes experts from a great diversity of subjects, really the experts does not work for D4 Reality, instead of that they are hired only to give determined courses. The company is permanently seeking for alliances with universities in order to gain access to campuses and offer courses to their students.

The value configuration component consists on the configuration of courses taking into account the customer needs. The value configuration is of great importance for value creation of the infrastructure section, in the case of D4 Reality the ability to adapt some of the variables of the course according to the needs of the client is of great value for these since often, aspects as the class schedule or the date of beginning of the course influence the client's decision about registering to the course or not.

One of the most important components of the business model is the value proposition made to customers in this case D4 Reality based their value proposition in the great variety of courses offered, the flexibility of the courses' structure and schedules and the attractive cost-benefit relation of the courses. In the technological services division the value proposition consist on offering a wide variety of services specialized in Architecture and 3D environments, Web design and Corporate identity.

The customer relationship is maintained by using the company's Web page to keep customers updated with news of courses and services, also phone calls and e-mails are used to contact customers and to receive feedback from them. The distribution of products or services used by the company is made through sales agents who are in charge of visiting clients and close sales.

This entire business model is intended to end in a specific market niche that is why the definition of the target customers is so relevant, in this case D4 Reality is focused on university and high school students, it is, young people from 18 to 23 years who are currently studying and wants to complement their studies with a course in a specific field or subject.

5.1.3 Porter's Five Forces Analysis

The company is affected by forces like the bargain power of customers and suppliers among others. Figure 5.2 shows how the five forces interact with the forces of the company.

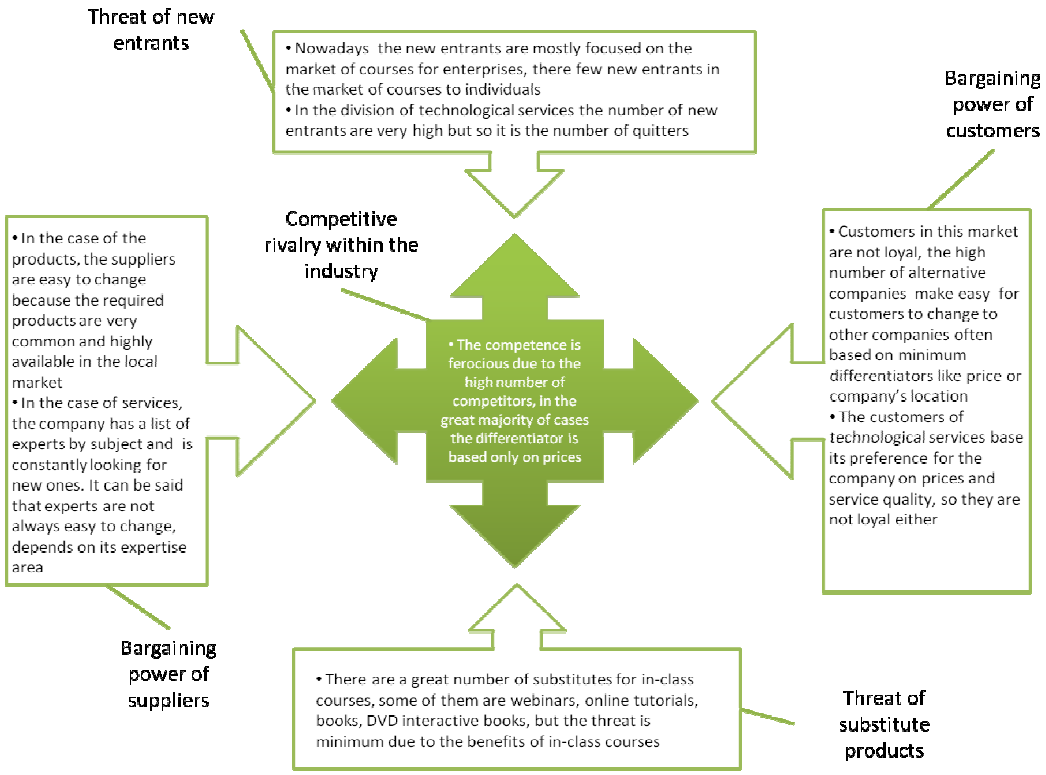

Figure 5.2 D4 Reality Analysis of Porter's Five Forces

This analysis reveals that the suppliers have very little bargain power over the company since the required products are highly available in the market, on the other hand, the effort of changing suppliers is very low since many suppliers exist in the local market and the products are not part of any important process of the company, they are just commercialized by the company. The technological services suppliers, or the experts, are not unique but changing them supposes a significant effort mainly because of the required expertise level.

Regarding customers' bargain power, the company has concluded on the basis of its experience that the clients are not loyal and due to the many alternatives available in the market a high number of clients left the company and go to the competitors.

One of the analyzed forces is represented by the substitute products, in this way are considered services and products like books, Webinars, on-line tutorials, interactive DVDs as the ones that might replace the services and products offered by the company. The increasing presence and diversity of the substitute products and the easily access to them make this an important threat for the company.

On the other hand, the threat represented by the new entrants are companies that are following the tendency to focus in offering their training services to big companies instead of individual clients.

Finally, the force represented by the competitive rivalry within the industry is characterized in this case by the ferocious competition due to the great number of existing competitors and the little differentiation among them.

The analysis reveals that the company is weak in their customer relationships and has a strong position when dealing with suppliers so it is recommended that the company make efforts to enter in collaboration with suppliers in order to take advantage from the high bargaining power with them. Also the analysis shows that new entrants are focusing on training services for enterprises and substitute products are appearing as new ways of learning, especially on-line resources.

5.1.4 Supply Chain and Customer Relationship Management Efforts

The initiative of supply chain management in the company does not use any specialized software this means that transactions with suppliers are done manually through their page Web, or by means of phone calls, e-mails or sporadically personal visits.

When the company needs to look for new suppliers they use internet or yellow pages, also sometimes companies go directly to the D4 Reality office to offer their products or services and became new suppliers.

The company does not use any customer relationship management software instead of that it uses the company's Web page, phone calls and e-mails to stay in touch with clients. The company uses their Web page, advertising in universities and Google and Yahoo as ways to contact new customers.

5.1.5 Collaboration Scenario

This section describes a collaboration scenario for the company D4 Reality in this case the company needs to outsource some components of a Web Design course. It is important to notice that D4 Reality is an EMPRENDETEC user, registered and currently in the pre-incubation phase.

As mentioned earlier, the company D4 Reality has a collaboration opportunity that consists in giving a Web Design course, then, in order to convert that collaboration opportunity into business the company wants to know which components of the course could be fulfilled by another companies with the right competencies and the willingness to create a Virtual Enterprise and thus collaborate to fulfill the business opportunity.

The company D4 Reality enters to the business links module on the EMPRENDETEC Web Portal system in order to find partners for the collaboration opportunity; the company has two alternatives, one is search into the directory of companies in EMPRENDETEC and then select the best companies to fulfill some of the competencies required by the collaboration opportunity and contact them in order to know more details and decide which companies are going to be invited to the collaboration opportunity.

Another alternative for the D4 Reality is searching companies using a competency-based characterization of the collaboration opportunity, but first, the company must enter to the "Collaboration Opportunity Characterization" module and characterize the collaboration opportunity. Next is presented the characterization of the Collaboration Opportunity.

Characterization of a Collaboration Opportunity from D4 Reality:

- *Collaboration Opportunity name: Web Design course*
- *Competencies:*
  - *Course design*
  - *Logistics of the course*

- *Capacities:*
  - *Maximum number of students per course*
  - *Maximum simultaneous groups of the same course*

- *Evidences*
  - *Number of satisfied customers*
  - *Customer testimonials*
  - *Success stories*
  - *Curriculum Vitae teachers*

- *Processes*
  - *Marketing of the course*
  - *Definition of course's subjects*
  - *Reserve classroom*
  - *Assign teacher*
  - *Define schedule*

- *Resources*
  - *Name: Expert in Web design and with teaching experience*
  - *Type: Human Resource*

  - *Name: Classroom*
  - *Type: Physical*

  - *Name: Laptops*
  - *Type: Information Technologies*

  - *Name: Dreamweaver*
  - *Type: Information Technologies*

- *Raw material*
  - *Blank paper sheets*
  - *Pencils*
  - *Printers*

- *Products*
  - *Handbooks*
  - *CD/DVD with teaching material*

Once the collaboration opportunity was characterized, the company is able to use the "Partners Search & Suggestion" module in order to search for companies using criteria defined by the user and the elements defined in the collaboration opportunity characterization.

The resulting list from the search includes companies that have one or more of the necessary competencies for the collaboration opportunity fulfillment; the company must select from that list the partners that are going to integrate the Virtual Enterprise, once the companies are selected the system sends a customizable e-mail to the legal representatives of the selected companies with the aim of invite them to become partners in the Virtual Enterprise. Figure 5.3 depicts an example of the results view.

Figure 5.3 Result List displayed by the Partners Search & Suggestion Module

The VE creation process finishes in this point because the scope of this thesis work addresses only the Collaboration Opportunity Characterization and the Partners Search & Suggestion processes.

5.1.6 Conclusions

In this scenario we can realize that the traditional process, it is the business links module, allow users to search for companies just using parameters like business line, products and/or services, business area and even by company's name. This is particularly annoying for users because they need to know very specific information like company's name or very general information like business line or business area which certainly will make the search very difficult. Also, this alternative is inefficient because the search results did not show enough information of the companies compelling users to contact them only to ask for more information, this alternative consumes a lot of time and can be frustrating for users because of the necessity of establish contact with companies that often are unavailable or reluctant to give information.

On the other hand, the second alternative uses collaborative tools integrated to the EMPRENDETEC Web Portal system, these tools allow user to make a competency-based search of partners, the first step is to describe the collaboration opportunity, for that purpose is used the “Collaboration Opportunity Characterization” module which allows the definition, with greater precision, of the collaboration opportunity. Once the characterization is done, the user accesses the “Profile & Competency Management” module in order to search for partners using the before-characterized collaboration opportunity.

This scenario proves that the proposed collaborative tools can support the process of choosing partners by allowing users to look for competencies, resources, evidences, standards and processes required for a specific collaboration opportunity in order to make a more informed decision process. This advantage is confronted to the traditional process carried out in the “Business Links” module so we can realize that while the traditional process lets user just to look for products or services, the collaborative process go beyond and includes detailed competency-based search.

5.2 WWest Mexico study Case Scenario

WW Energy ST Mexico S.A. de C.V. (WWEST MEXICO) is an international green company based in Mexico with strategic alliances with the most advanced green energy producers worldwide. These alliances allow the company to offer the most advanced green energy production methods.

The company WWest Mexico is dedicated to develop customized engineering projects for energy saving and generation, using the most advanced technology of green energies and renewable sources, like the solar photovoltaic and thermal energy, Aeolian energy and induction lamps among others.

WWest Mexico is mainly focused on providing solar energy to rural communities, urban areas with insufficient supply of electrical energy, portable solar generators for: construction sites, emergency lights, telecommunication towers, energy-backup equipment, security cameras and speed radars. Also induction plasma lamps and LED illumination for the energy saving in public and private buildings.

5.2.1 Products and Services Description

The company offers two solar equipments for electrical energy generation, the equipments are known as PLUS and PREMIUM respectively. The difference between them is the amount of international certifications accomplished and the Kilowatt per hour (KWh) cost, being the PREMIUM the most advanced and the one that accomplish more certifications and have the lower KWh cost.

Also, the company offers the service of engineering in energy-saving Projects, this service consists on a complete and customized solution for companies that want to save energy or simply reduce their dependency on the energy network. The products are imported from USA and Canada and some components used in the implementation are purchased in the national market, none of the commercialized products are made by the company.

In the case of the service, it is performed entirely by employees of the company and rarely, depending on the size of the project, is needed to make use of outsourcing in order to get work done.

5.2.2 Business model

As Figure 5.4 depicts, the business model of WWest Mexico is based-on the leverage that their specialization in services and products of power generation represents over their competitors.

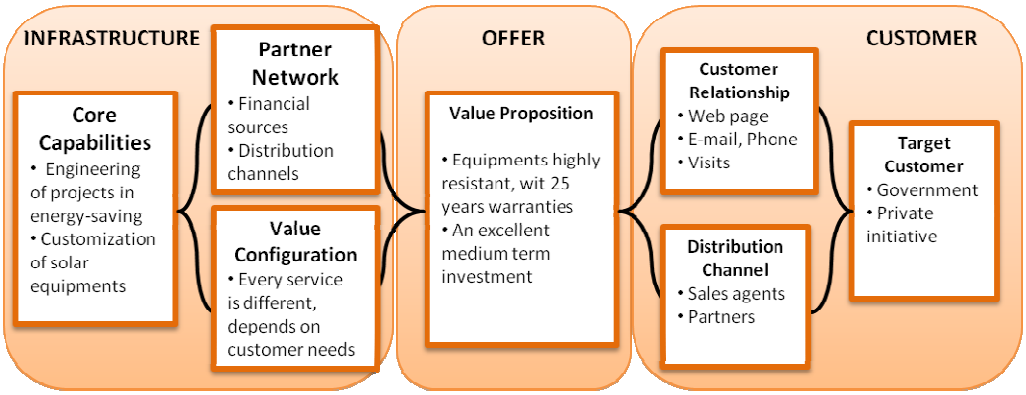

Figure 5.4 WWest Mexico Business Model Description
(using Osterwalder (2004) Business Model Ontology)

WWest Mexico infrastructure includes the core capabilities, these consist on the engineering applied to the energy-saving projects and the skills and experience used to customize the solar equipments depending on the project specifications. Another component of infrastructure is the partners network, it is mainly focused on obtain new distribution channels and financial sources. The Value configuration is the infrastructure component that translates the core capabilities from an internal feature to a value proposition for customers; in this case the value configuration consists on offer customized services that are configured based-on customer needs.

The next part of the business model is the offer, in this part is defined the value proposition of the company, in the case of WWest Mexico consists on offering highly resistant equipments and representing an excellent medium-term investment in solar powered generators.

The first customer-related component of the business model is the customer relationship which is supported by using a Web page to show company and products/services information to customers; also the e-mail and phone calls are the most used ways of communication with clients following the physical visits to the customer. The distribution channels are considered to be the sales agents and the commercial partners.

Both customer relationship and distribution channels are considered to target customers like the government and the private initiative.

5.2.3 Porter's Five Forces Analysis

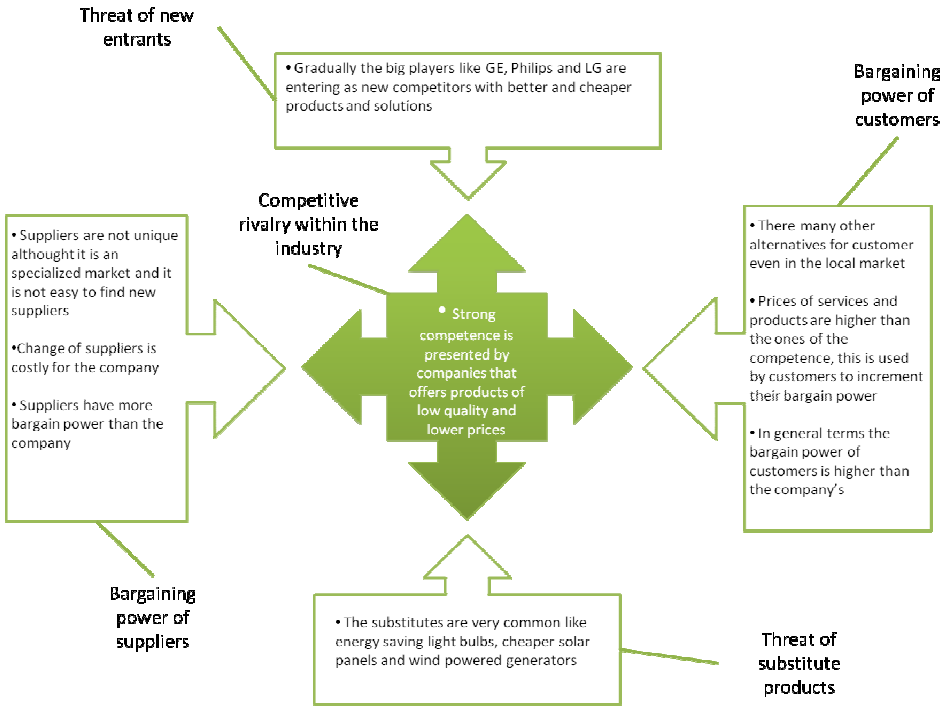

Figure 5.5 WWest Mexico Analysis of Porter's Five Forces

The five forces analysis, depicted in Figure 5.5, reveals that the company have little bargain power over its customers and over it suppliers, in the contrary, the suppliers have strong bargain power over the company because it does not reach a high volume of purchases. New entrants like Philips, LG and GE are developing and commercializing new products to compete in the market or energy-saving and solar generators, however, this threat could be capitalized as opportunities to increase revenue by using those new products as part of the solutions offered by the company.

Substitute products like energy-saving light bulbs are a constant threat especially when clients are small companies that prefer not to make a considerable investment although the benefits could be more substantial in the medium-term, and instead choose to make a lower investment acquiring energy-saving light bulbs or cheaper solar panels. But when clients are government agencies or large enterprises the medium-term benefits of acquiring WWest Mexico's products and services are preferred over the lower investment of other products cheaper but not attractive in the medium-term perspective.

According to the analysis, the company does not have a strong bargain power neither with customers nor suppliers, but unlike suppliers, customers are not unique, they can be gained by identifying and developing the competencies most required by them. The suggested strategy for this company is to look for new customers through the collaborative process integrated to the incubation model.

5.2.4 Supply Chain and Customer Relationship Management Efforts

WWest Mexico does not have any supply chain management software system; instead of that, their relationships with suppliers are carried out using manual registers and e-mail, phone calls or physical visits as forms of contact.

Occasionally the company search in expos or internet for new suppliers, but due to the specialized nature of the market it is difficult to find new ones.

About the customer relationship management efforts, the company has a Web page designed to show clients the latest technologies and products offered by the company. Besides the Web page, e-mail, phone calls and personal meetings are the preferred ways of communication with clients.

5.2.5 Collaboration Scenario

In this scenario, the company WWest Mexico needs to find partners in order to create a Virtual Enterprise and carry out the service called Implementation of Solar Equipment which is already offered by the company and is wanted to be carried out in collaboration with other partners.

In this subsection we are going to show the differences between the traditional and the collaborative way of carry out the process of selecting partners for a business opportunity.

In the traditional way, the user accesses the Business Links module of the EMPRENDETEC Web Portal system in order to search for companies using parameters like business line, business area, company's name and products or services; once defined the search criteria the company executes the search and then obtain a result list of the companies that fulfilled the criteria, each company is briefly described including contact information.

If WWest Mexico is interested in one or more companies in the result list then WWest must contact the selected companies and ask for more information in order to decide which of them are going to be required to become suppliers of WWest Mexico.

On the other hand, in the collaborative way the company must first characterize the service, in this case the one called Solar Equipment Implementation, as a collaboration opportunity. The user must access the "Collaboration Opportunity Characterization" module in order to characterize the Solar Equipment Implementation service especially in the resource and raw material components.

Characterization of a Collaboration Opportunity from WWest Mexico:

- *Collaboration Opportunity name: Implementation of Solar Equipment*
- *Competencies:*
  - *Requirement analysis of customer needs*
  - *Equipment design*
  - *Integration of components for customization of solar powered generators*
  - *Equipment installation*
  - *Training on use of solar generators*
  - *Maintenance and supervision of installed solar powered generators*

- *Capacities:*
  - *Maximum number of fulfilled projects per month: 5*

- *Evidences*
  - *Customer references*
  - *Success stories*
  - *Staff of engineers Certified in Energy and Environmental Management (CEEM)*
  - *Certified equipment*
  - *25 years warranty on solar powered generators*

- *Processes*
  - *Leads management*
  - *Proposal presentations*
  - *Purchase process*
  - *Components integration process*
  - *Solar Equipment customization based-on client needs and environment*

- *Resources*
  - *Name: Electronic & Mechanical Engineer*
  - *Type: Human Resource*

  - *Name: Customer Relationship Management system*
  - *Type: Information Technologies*

  - *Name: Web page*
  - *Type: Information Technologies*

  - *Name: Warehouse*
  - *Type: Physical*

- *Raw material*
  - *Aluminum (per roll)*
  - *Screws 1 ½ inches*
  - *Wire*
  - *Tube*
  - *Electronic inverters*
  - *Solar panels*

- *Standards*
  - *ISO-9000 (in process of implementation)*

Once the service was characterized it is time to search for new suppliers, then the user enters to the Partners Search and Suggestion module and load the previously characterized service, the next step is the definition of the search criteria that is going to complement the characterized service. After the search is executed the system throws a result list with the companies that matches at least one of the defined requirements for the raw material and resources described in the collaboration opportunity characterization. Figure 5.6 depicts the result list displayed after the search was executed in the Partners Search and Suggestion module.

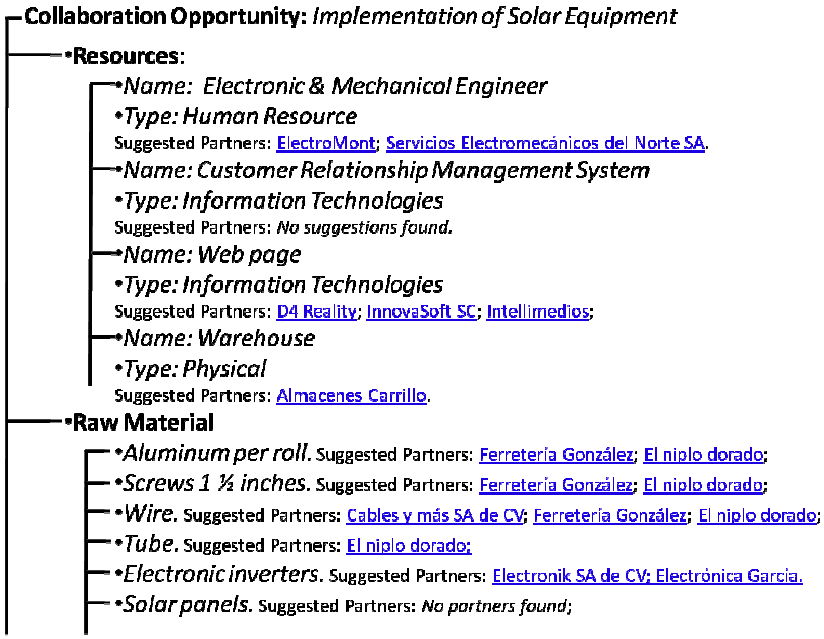

Figure 5.6 Result List of Suggested Suppliers for the Implementation of Solar Equipment Service

5.2.6 Conclusions

This case scenario shows us how the traditional process results inefficient and slower than the collaborative process, we can observe that the traditional process in the EMPRENDETEC system requires to dedicate a lot of time in contacting companies to know more about them asking for information about its products, services, competencies and even their history. As a result we realize that the traditional process is obsolete and difficult because of the time spent and the lack of information available for the decision-making process.

On the other hand, the collaborative tools make the process of looking for new suppliers easier, more accurate and fastest than the traditional way. This is because of the competency-driven definition of collaboration opportunities and the competency-based search for partners. It is important to notice that the search based in competencies allows the user to focus only in those components of the collaboration opportunity that he needs to outsource or just buy; in this case the user simply needs to find new suppliers for the resources and raw material used in the service Implementation of Solar Equipment.

This study case demonstrates that it is possible to integrate successfully the incubation process with the collaboration process, this can be verified with the search results of the collaboration opportunity, in these results we can see that there are nine companies suggested to fulfill some of the requirements in resources and raw material, each one of these companies can be consulted instantly to retrieve information about the resource/raw material that matches with the search criteria or the requirements of the collaboration opportunity.

The next Table 5.1 shows the strengths and weaknesses of both collaborative and traditional processes observed in this case scenario.

Table 5.1 Strengths and Weaknesses of the traditional and the collaborative processes

Process	Weakness	Strength
Traditional (Business Links)	• Time-consuming • High efforts to retrieve company's information • Search criteria limited to products/services	• Does not need to characterize any collaboration opportunity • Simplicity
Collaborative (Proposed)	• Requires the characterization of a business opportunities • Requires a trust-based relationship between participants	• Competency-based search (broader window of business opportunities) • Deeper searches • Expand company's marketable assets • Support the competency-driven collaboration between companies • Ability to fulfill bigger business opportunities

5.3 Power Engineering Services and Solutions Study Case Scenario

Power Engineering Services and Solutions (PESS) S.A. of C.V. is a company whose main objective is to offer the best specialized services to the power industry. PESS personnel have extensive experience in areas like mechanical, electrical, instrumentation and control in power industry projects.

PESS provides innovative services and integral solutions, has a bilingual, multidisciplinary team, with proven effectiveness in the field. Reduce costs of operation and inferior response time to competition, generating therefore strong synergy resulting in direct customer benefits. Right now the company is in the Post-Incubation phase of the ITESM business incubator.

The company is located in *Pabellón Tec suite 38-5 Garza Sada Avenue, Monterrey, Nuevo León*; the legal representative is Mr. Raúl Reyes.

5.3.1 Services description

In this section there are described all the services that PESS offers to its customers.

- *Service of Calibration and Assembly of Devices*

    - *Device Calibration and assembly in any plant (pressure switches, temperature, level switches, etc.)*
    - *Device assembly and installation, as per the assembly diagrams provided by the OEM.*
    - *Reporting and information package, generated with detailed information on tests and results obtained during the calibration process.*
    - *Wiring on Control and Power systems*
    - *Correct gauge certification on all wiring provided by the OEM.*
    - *Wiring and Cable Pulling, as per Design.*
    - *Connection and identification of wiring in terminal boards and junction boxes.*
    - *"AS BUILT" Documentation in Hardcopy, Spreadsheet and .pdf formats.*
    - *Terminal Boards and Junction Box Engineering Documentation of all point to point connections, drawing in graphical form all referred wiring and wiring specifications, by doing this, in a more comprehensible information access for O&M personnel.*
    - *Release of Graphical interface showing the basic engineering of the related systems, the information can be accessed through any dedicated HMI or a single workstation.*

- *M&D solution for Power Plants*

    Benefits of the PESS M&D Center

    - *Maintenance database for benchmarking*
    - *Database of historian of the equipment*
    - *Better practices for Predictive Maintenance*
    - *Database of the technology used*
    - *Access to process data of specific equipment via Web 100% uptime reliability Emergency Response Team for Mechanical outages and inspections*

    Competitive advantage of the PESS M&D Center

    - *Better Control and Monitoring of Indicators of Acting Projects*
    - *Can read data from any database, txt or ASCII*
    - *On-line reports. Instant Web-based interface*

- *Personalization of the system to the client (i.e. Integration with SAP)*
- *Notification of alerts and incidents to cell, e-mail, pager.*
- *Customizable service. Can provide Monitoring ONLY or Advanced Diagnostics as a monthly service*

- *Control's Loop Check*

  - *Independent testing of each control system connected from the Control Panel to the field device.*
  - *Elaboration of reports for each checked loop, containing fundamental information like the test condition, date and personnel that performed the job.*

- *Machinery, Systems and Auxiliary Equipment Commissioning*

  - *Functional tests to the different power and control systems, a series of simulations can be performed if the conditions of operation and time frame do not allow testing. Reducing the problems and risks that could show up during the plant start.*
  - *Release of specific reports over the performed tests, compiling a technical memory of this phase of the project. Plant personnel find this tool, very useful during the normal operation of the facility.*

- *Technical Consulting on Turn Over, Start Up and Commissioning*

  - *Supply of specialized personnel in commissioning and equipment start up.*

- *Plant Customization*

  This service focuses in taking care of the typical problems in Power Plants, a series of solutions are designed to present and record information that facilitates tracing, detection and prevention of problems in the plant processes.

  - *Design and release of procedures, operation manuals, schematic diagrams and P&IDs for each plant. (printed and digital presentation).*
  - *Drafting and design of specific basic engineering of each plant in spreadsheet format and graphical interface, allowing the integration of any additional information customized to the owner's need. Hyperlinks in digital format are a splendid feature, most plant operators appreciate as the information as report*

of calibration, data sheets, configurations, etc. is available anywhere, anytime.

- *Creation, modification and improvement of system operation screens, in actual HMI.*
- *Evaluation of areas of opportunity and critical to performance in the power plant.*

〉 *Execution of Preventive, Predictive or Corrective Maintenance*

- *Specialized labor for mechanical, electrical and instrumentation work for all planned and emergency maintenance outages.*
- *Elaboration of technical reports with detailed documentation of all tasks and modifications performed by PESS or others during a project scope.*

〉*Technical Consulting on Negotiation of long term Service Contracts (LTSA's)*

- *Technical assistance during the Contract negotiations over OEM´s Long Term Service Agreement. Obtaining an experienced third party approach over contractual mistakes, omissions and ambiguities usually produced by lack of technical advice.*

〉 *Maintenance, O&M Training*

- *Qualification and training directed to the personnel in charge of the operation and maintenance of power plants. Didactic materials are included, theoretical classes and practices. The training focus on specific needs of each plant, using the plant facilities and equipment.*

〉 *Special Services*

- *Vibration Analysis and Machinery Diagnostics.*
- *Bore scope and remote visual inspection on turbo machinery.*
- *Flushing of hydraulic and Lubrication circuits.*

〉 *Improvements and Redesign to Existing Systems*

Evaluation of systems operating in the plant, allowing improvements and redesign that proves to be a cost reduction and risk impact in machinery life. Examples:

〉 *Quality monitoring systems on hydraulic fluid parameters.*
〉 *Retrofit of "stand alone" monitoring systems into Human Machine Interface (HMI).*

〉 *Decommissioning of Obsolete Power Plants*

〉 *Dismantling/Relocation of equipment in obsolete plants.*

〉 *Project Control and Management*

〉 *Planning, coordination and execution of projects related to Outages and Start up jobs.*

5.3.2 Business Model

PESS business model is based-on the highly specialized engineering skills and resources they offer to their customers, also the fact that the company is focused on a highly specialized market and that the government represents their bigger customer. Figure 5.7 depicts the business model for PESS.

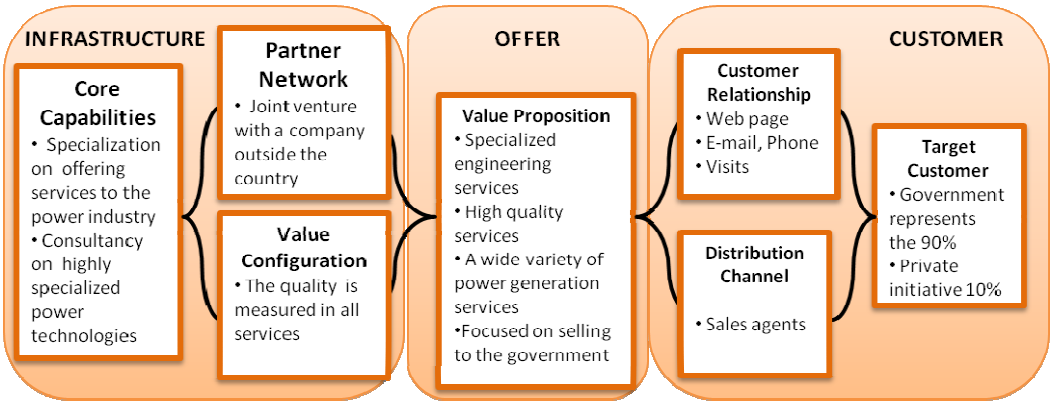

Figure 5.7 PESS Business Model
(using Osterwalder (2004) Business Model Ontology)

In order to make an attractive value proposition to customers, the company develops as core capabilities the specialization on power generation services for the power industry and the consultancy on highly specialized power technologies. The quality in services is constantly oversee with the purpose of improve it every time a service is started.

Another element of importance in infrastructure is the Partner Network, in this topic the company is currently in a joint venture with an enterprise outside Mexico, the information of that company is not revealed because it is not of relevance for this study. This joint venture serves the company as a way to share information about new technologies and best practices.

One of the priorities for the company is the quality assurance, and because of that, the most important subject of the value configuration is the fact that the quality is measured and improved in every service carried out by the company. As is expected, all the infrastructure components make possible for the company to offers to its customers a value proposition based-on the specialized products and services on which they are focused, also the wide variety of services and the high quality of them are two important factors that gives shape to the value proposition.

On the customer side of the business model the relationship between the company and its customers is carried out using a Web page, e-mails, phone calls and physical visits. The Web page is used mostly to show the services catalog and to keep clients updated with the information of newest products and services offered.

PESS uses their own sales force as a way to reach their customers therefore using it as a distribution channel for the products and services offered.

The target market of PESS is in the 90% the Mexican government, especially the Federal Electricity Commission, and the remaining 10% is compounded by the private initiative.

5.3.3 Porter's Five Forces Analysis

The company is in a highly specialized market, thus the forces are particularly strong in aspects like the suppliers bargain power and the competitive rivalry within the industry. The Figure 5.8 depicts the five forces that affect the company.

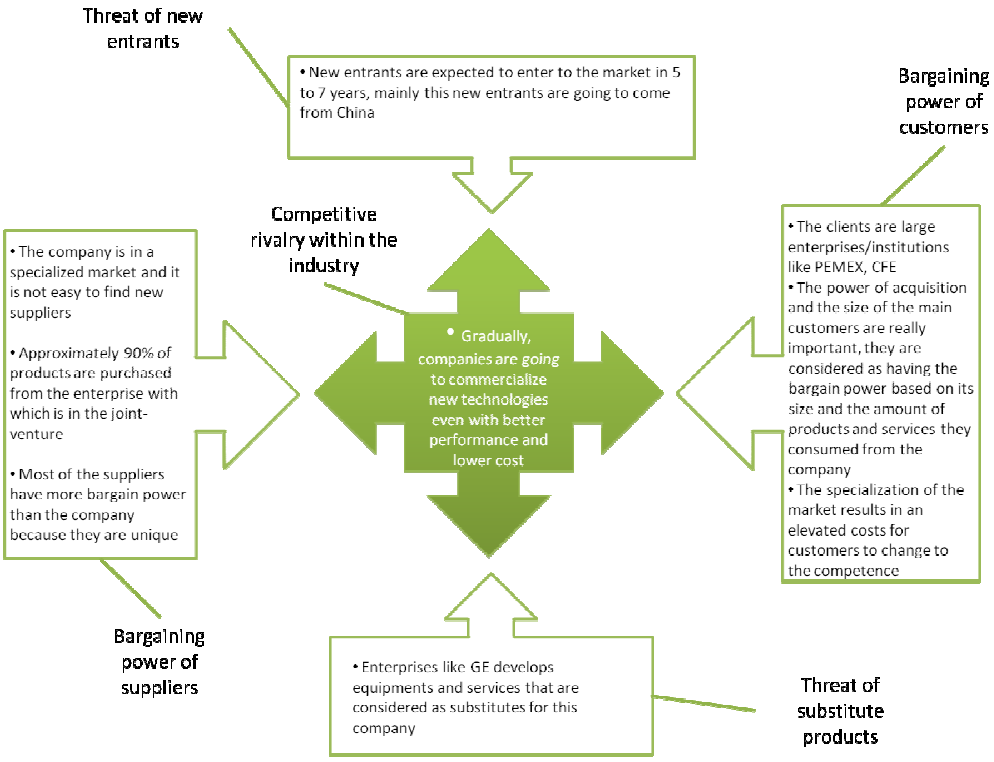

Figure 5.8 PESS Analysis of Porter's Five Forces

The analysis of the forces affecting the company throws as conclusion facts like the strong bargain power of the suppliers due to the difficulty of find new ones caused by the highly specialized products that company requires. Almost 90% of the products are acquired from the enterprise with which the company is in a joint venture, this represents a noteworthy dependence from one single supplier that could be risky for the company.

In the case of customers' bargain power it is important to say that almost their entirely clients portfolio are government agencies, especially one (CFE) that represents nearly the 80% of their total sales revenue, this force in particular.

The analysis reveals that the substitute products are developed for General Electric (GE), a giant of the electronic equipment, and threat is important because of the magnitude and global presence of the company behind the substitute products.

In the case of the force exerted by new entrants, the company identified that the Chinese producers of electronic equipment are going to enter to the market competition in the next 5 to 7 years, this time windows open the chance for PESS to adapt their business model to compete with those new entrants expected in 5 to 7 years or even sooner.

The fifth force is the inner force of the industry; this force reveals that companies within the industry are developing new products more efficient and cheaper than the existing ones; the tendency of this market is to improve the value-cost relation in order to offer better products at a lower cost.

Finally, the analysis reveals that the company should follow a strategy to find new suppliers for the 10% of products that are not acquired to the company with which the joint-venture is performed.

5.3.4 Supply Chain and Customer Relationship Management Efforts

PESS manages their supply chain manually this means that all the contacts are made using phone calls, e-mails or physical visits and no system is used to manage the relation with suppliers just a list of them with their general contact information.

The remaining 10% of products, those that are not bought in the joint venture, are actually bought-by-emergency to the supplier that offers the required quantity of product and the most competitive price. Bought-by-emergency means that since the company has not any stock of those products, they are bought when they are needed and usually the purchase operation must be done in a short period of time, that is why it is used the term emergency.

In the case of the customer relationship management efforts the company is already using CRM software called V-Tiger, it is mostly used for leads and clients management; for the relationship to customers it is used a Web site with the aim of keep customer updated with the latest of products and services offered by PESS.

5.3.5 Collaboration Scenario

In this scenario we are going to assume that the company PESS have already filled its profile in the “Profile & Competency Management” module, this means that all the services offered by the company were registered in that module. Also in this scenario is considered the event in which another company invites PESS to take part in a Virtual Enterprise.

In this scenario the traditional process consists on registering the company in the EMPRENDETEC directory and wait for other enterprises to enter the “Business Links” module and search for companies based-on general parameters like business line, business area or company’s name, then select the company and invite it to become a supplier or a participant in a Virtual Enterprise.

In the collaborative process the company already characterized all its services in the “Profile & Competency Management” module and one of the companies in the EMPRENDETEC Web Portal system perform a search that matches in one of the seven parameters of the service called Hydraulic clutch installation offered by PESS and, as mentioned earlier, already registered as a service of the company.

The competency-driven characterization of the service is presented as follows:

- *Service name: Hydraulic clutch installation*
- *Competencies:*
  - *Clutch installation*
  - *Support engineering*
  - *Clutch adaptation and customization*

- *Capacities:*
  - *Specialization in turbo generation*
  - *Knowledge of hydraulic systems*
  - *Knowledge on arrow alignment*

- *Evidences*
  - *Success stories*
  - *Letters of recommendation*
  - *Certifications*

- *Processes*
  - *Requirements analysis*
  - *Selection of the adequate clutch*
  - *Purchase order*
  - *Dismantling*
  - *Clutch installation*
  - *Customer satisfaction survey*

- *Resources*
  - *Name: Project engineer*
  - *Type: Human Resource*

  - *Name: Service engineer*
  - *Type: Human Resource*

  - *Name: Workshop*
  - *Type: Physical*

〉 *Raw material*
- 〉 *Hydraulic clutch*
- 〉 *Screws 2 inches*
- 〉 *Washers*

〉 *Standards*
- 〉 *ISO-9000*

The structure of characterization is identical to the one used in the "Collaboration Opportunity Characterization" module, is precisely this structure that allows the "Partners Search & Suggestion" module to match parameters of a collaboration opportunity with a company's profile and competency definition.

As mentioned at the beginning of this section, a company registered in the EMPRENDETEC Web Portal system performed a search for partners in order to create a Virtual Enterprise and fulfill a collaboration opportunity.

The collaboration opportunity matches the Hydraulic clutch installation service specifically in the process called Clutch installation; Figure 5.9 depicts the results of the partners' search made by the company that was looking for partners.

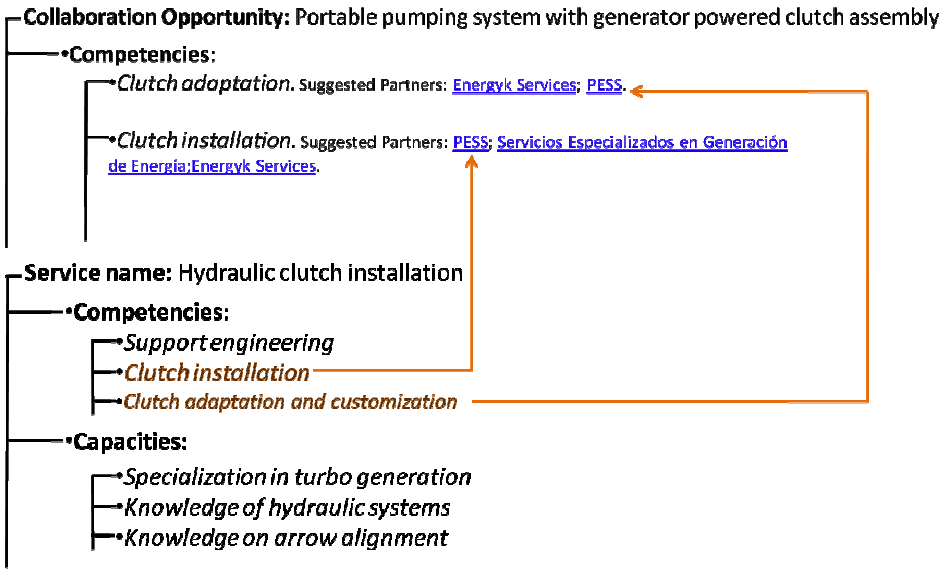

Figure 5.9 Matches of PESS Competencies with the Collaboration Opportunity called Portable Pumping System with Generator Powered Clutch Assembly brokered by another Company

As can be seen in Figure 5.9 shows only the result of the competencies matches for the collaboration opportunity, this is because the two displayed competencies are the ones that match the competencies offered by PESS. After reading about PESS and comparing it with the other suggested companies, the company invites PESS through an e-mail to take part in the Virtual Enterprise that is going to be created in order to fulfill a Collaboration Opportunity. The VE creation process used in this thesis work ends after the invitation was sent.

5.3.6 Conclusions

Once again the collaborative process and its corresponding toolset proved to be more effective and faster than the traditional process in the EMPRENDETEC Web Portal system. In fact, in the traditional process PESS does not have the same chances to be invited to a business opportunity than in the collaborative process, this is because in the traditional process the search is performed using only five parameters including the one that finds directly in the name of the companies, besides, the traditional process just allows users to search by services and products in contrast to the collaborative process that allows users to perform the search using components of the collaboration opportunity like competencies, resources, processes, evidences, raw material and standards just to name some of them.

This case scenario proved that the collaborative process is able to generate business opportunities for companies within the incubator, this is achieved by promoting SMEs competencies as if they were products or services. In this particular case, PESS was invited to take part in a Virtual Enterprise because of the matches of two competencies in a PESS service with another two competencies in the collaboration opportunity.

CHAPTER 6: Results, Conclusions and Further Research

Previous chapters described the business process integration of two different models, on the one hand is a business incubation model which in this case is the ITESM business incubation model and on the other hand the Virtual Enterprise creation process developed by the ECOLEAD Project. This chapter presents the main results of the work, drawing several conclusions and presenting a further research that could be performed to extend the integration to other collaborative tools.

6.1 Results

The main results of this research work are based-on the objectives stated on Chapter 1, and can be summarized as follows:

- The research was mainly focused on the enterprise incubation model of ITESM and the Virtual Enterprise creation process developed within the ECOLEAD project, also concepts like Virtual Organization Breeding Environments, Business Process Modeling, Business Process Integration and Enterprise Application Integration and their related technologies were addressed in order to complement the theoretical background of this research work.

- A Review and an analysis were carried out with three of the processes proposed by the ECOLEAD project for Virtual Enterprise creation in order to design the business process integration between those processes and the ITESM business incubation process.

- The business process integration was achieved using Business Process Modeling Notation and Business Process Integration.

- A prototype tool was developed by integrating three processes of the VE creation process, the Profile & Competency Management (Ermilova & Afsarmanesh, 2006; 2007; 2008), Collaboration Opportunity Characterization (Concha et al., 2008) and the Partners Search & Suggestion (Baldo et al., 2007), with the ITESM business incubation process.

The main contribution of this thesis work is the achievement of a successful integration of a collaborative process that supports incubating companies to promote their competencies as marketable services or products and as a result gain access to more business opportunities that can be converted in more sales.

Also, the three study cases in Chapter 5 showed the integration being used as the process is described in Chapter 3. The integration not only proved to be possible but also beneficial for the companies in the incubator.

6.2 Conclusions

At the beginning of this thesis work a discussion was opened around the hypothesis and some research questions were asked in order to address this hypothesis, in this section the discussion concludes by answering those questions and taking as foundation all the work developed in this thesis.

- Is it possible to integrate the VE creation process with the enterprise incubation process?

In Chapter 3, the ITESM business incubation process was integrated with the VE creation process, this integration was done using Business Process Modeling Notation and afterward Business Process Integration methodology. This chapter proved that it is possible to integrate the VE creation process with the ITESM business incubation process.

- What are the characteristics of a VE creation process integrated to the ITESM business incubation process?

The integrated processes can be seen now as one merged process that enables incubating SMEs to collaborate; this process preserve the characteristics of the VE creation and the business incubation processes. The proposed VE creation process consists of three sub-processes: (1) Profile & Competency management, (2) Collaboration Opportunity Characterization, and (3) Partners Search & Suggestion.

- Are the companies in incubation stages able to make a competency-driven characterization of their products and services and of the company itself?

It is important to notice that the three companies addressed in the study cases in Chapter 5 do not have any problems when they were asked to define themselves in a competency-driven description of their products and services. The main reason why companies have no problems with their company-based descriptions is because the ITESM incubation process motivates companies to adopt a competency-based definition instead of a traditional process or job-based definition.

- Is it possible to use a collaborative tool to support the provider's selection process of the SMEs in ITESM incubator?

Another interesting conclusion of this work is that the VE creation process integrated with the ITESM business incubation process supports the provider selection processes of SMEs in incubation, this was demonstrated in the case of study of WWest Mexico, this case consists on the characterization of a collaboration opportunity with the aim of find new suppliers for certain competencies, resources or raw material required by the collaboration opportunity.

- Is it possible to use a collaborative tool to make a competency-driven search for partners?

Finally, a collaborative approach enables a competency-driven search of partners who fulfill at least one of the competencies required by the PESS' collaboration opportunity. In this case the company was looking for partners to create a VE, the functionality is almost the same in case of looking for partners or suppliers.

6.3 Further Research

As mentioned earlier in this chapter, this work is an effort to help SMEs in promoting their competencies as well as their products and services, in order to achieve this objective two processes were integrated, the ITESM business incubation process and the VE creation process, the integration was successful, however some opportunities were found in the research work:

- The VE creation process can be expanded to address many other features like trust management, ontology management and an agreement and contract negotiation wizard, just to mention some of the features related to the VE creation process. Due to the limited issues addressed by this thesis an opportunity to implement all the features proposed by the ECOLEAD project seems to be an area of research to be explored.

- The business incubation model can be improved and adapted in order to take advantage of the collaboration capabilities developed in this work and the synergy that could be created by the companies within the incubator. At present the incubation model is focused in the traditional way of doing business, hence, all the support, information and services offered to companies are not of much help when companies try to collaborate between them.

- The VE creation process can be adapted to the characteristics and needs of incubating companies in order to make easier and more effective their collaboration efforts. Developing a Virtual Enterprise creation process focused on incubating SMEs will improve significantly their performance specially when defining their competencies, making their business plan and finally reaching the market.

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ANNEX 1. Screenshot of Emprendetec Web Portal system

Figure A1.1 Screenshot of Emprendetec web System

ANNEX 2. Screenshots of Collaborative tools developed in ECOLEAD

Figure A2.1 Profile & Competency Management System
(Ermilova & Afsarmanesh, 2006; 2007; 2008)

Figure A2.2 Collaboration Opportunity Characterization (Concha et al., 2008)

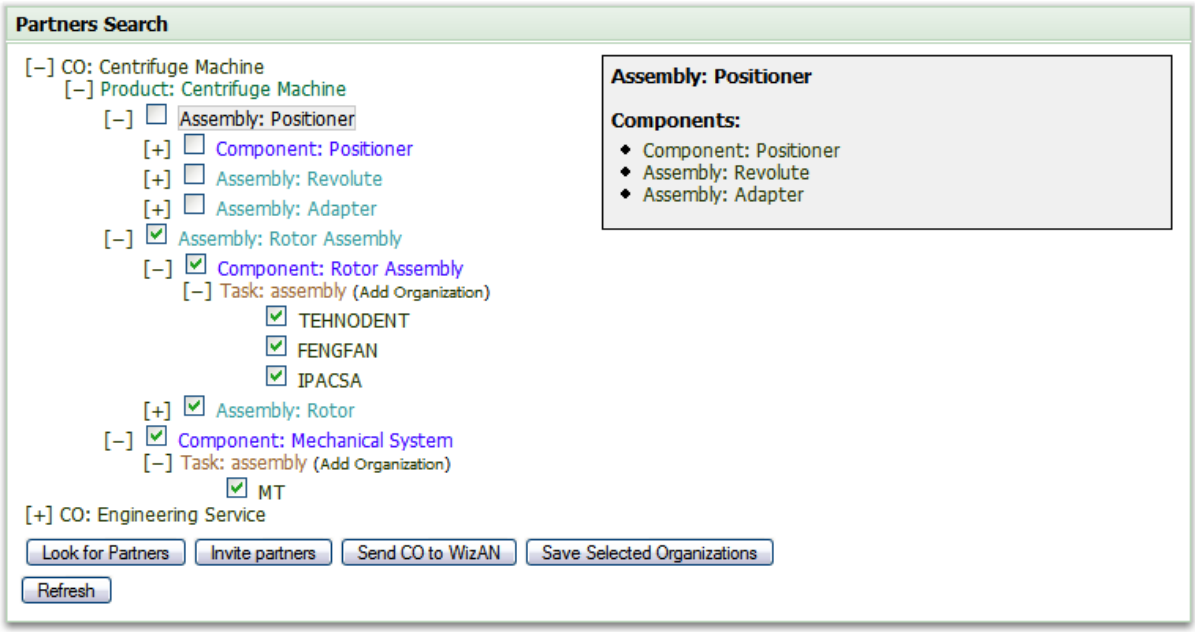

Figure A2.3 Partners Search & Suggestion (Baldo et al., 2007)