The Enterprise Architecting Framework Applied to the Supply Organization of a Sourcing Management Center of Excellence

By

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BS in Electronic Systems Engineering, ITESM, 2001

Submitted to the MIT Sloan School of Management and the

Engineering Systems Division

in Partial Fulfillment of the Requirements for the Degrees of

Master of Business Administration and
Master of Science in Engineering Systems

In conjunction with the Leaders for Manufacturing Program at the

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ABSTRACT

The basis to develop this thesis was performed after executing an internship in ABB Inc. The main objective of the study was to design the organization to operate the procurement function at a new manufacturing campus.

The enterprise architecting roadmap was applied to decompose the complex problem of designing an organization into bulding blocks that could be easily developed. For this purpose, two enterprise architecture tools were applied: stakeholder analysis and enterprise relevant views. Once the basic building blocks of the enterprise were defined, different analytical tools were applied to design the details of each one. The analytical tools applied to this project were process mapping, total cost modeling, organization design and information technology selection.

The outcome of the study was the detailed definition of the following building blocks of an enterprise: processes, process costs, organization and information technology. The conclusions of the thesis generalize the applied concepts to companies that are in the situation of starting new operations.

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1. Introduction

The present thesis is the result of a joint effort between ABB Inc. and the MIT Leaders for Manufacturing program. It was developed after conducting a 6.5-month internship at ABB Mexico, having as a main objective to design the organization and processes to operate the procurement function at a new manufacturing campus.

At the time the internship was held, there was little undergoing operation in San Luis Potosi; therefore, part of the work could not be based on experimental research, but on analytical activity. The objective of the internship was to aid in developing a vision of the future supply organization and the objective of the thesis is to present an example of how the Enterprise Architecting roadmap applies to the creation of a startup organization.

1.1. Problem Statement

The particular issue that started the need for an internship was the establishment of a new engineering, sourcing and manufacturing campus in Mexico that would service not only the domestic market but also the US and Canada markets. This implied a major change in the sourcing and international trade operations for ABB Mexico, formerly focused on the domestic market. It was important for ABB to design the organization and processes that would deliver the expected supply and logistics functions while taking advantage of the benefits and meeting the obligations of the government trade programs.

1.2. Aim and scope

The conclusion of this project allowed answering the following questions:

- What are the required processes to be deployed in order to operate the supply function for the new campus?
- What is the organization that will better serve ABB supply objectives?
- What are the metrics that better support ABB's strategic objectives in Mexico?

- What are the obligations that ABB must comply in order to take full advantage of the benefits of Mexican international trade programs?

1.3. *Enterprise Architecting Framework*

Designing the operation of a newborn organization is a task that requires consideration of several factors such as company strategy, political factors, interests of stakeholders and flow of information, just to mention a few. Understanding these factors and the relationships among them is a topic that, traditionally, could not be classified under a specific branch of knowledge: it is neither plain process engineering nor social sciences studies. However, a branch of knowledge that studies how to analyze and build complex systems is called Systems Architecting. Systems Architecting was initially defined by Eberhardt Rechtin in the 1980's and is now an important research field within the Engineering Systems Division of MIT.

Enterprises, being a conglomerate of resources that have a common business purpose, fall under Rechtin's (1991, p. 7) definition of system as "a set of different elements so connected or related as to perform a unique function not performable by the elements alone. The most important and distinguishing characteristic of a system, therefore, is the relationships among the elements." The task of the system architect is, in consequence, to understand these relationships and reduce the original chaos and complexity into concepts that can be further developed. Figure 1 is a conceptual map of the main entities and interrelationships must be considered in order to architect an enterprise.

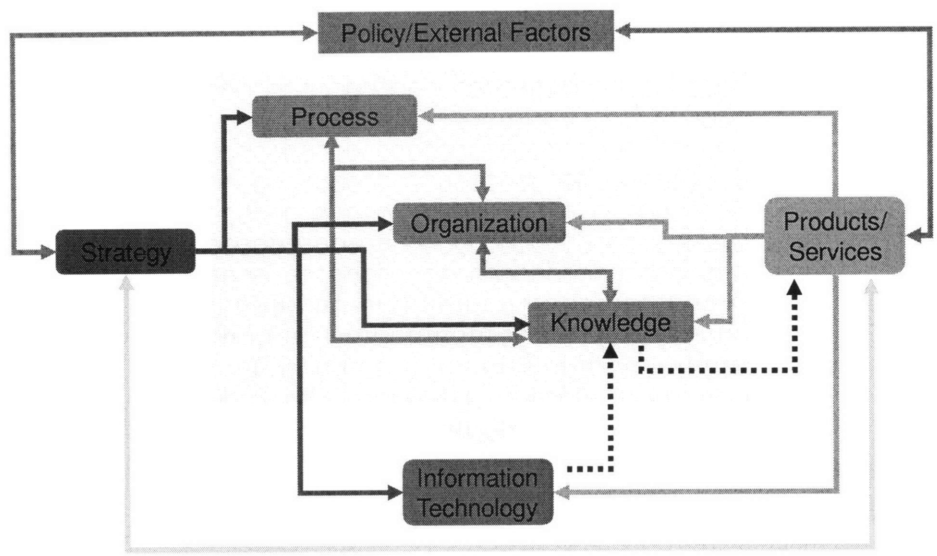

Figure 1. Key Interrelationships of Enterprise Architecture (Nightingale & Rhodes, 2008)

Once the architect identifies the basic building blocks of the enterprise, the architecting task must be complemented with specific analytical tools such as process mapping, logistics analysis, organizational design and information technology selection.

1.4. Structure of the thesis

The thesis is divided in several chapters, which follow an adaption of an Enterprise Architecting Process Roadmap proposed by Nightingale and Rhodes (2008, ESD38J). Chapter 2 reviews the strategic motivation to architect a new enterprise; it covers both the strategy of ABB Inc since its inception in 1988 and also the strategy of ABB in Mexico. Chapter 3 covers the scope and boundaries of the new enterprise from the internal point of view. Chapter 4 describes the Government Policy that regulates the activities defined as part of the scope of the enterprise. Chapter 5 is a description and analysis of the current state of the enterprise by utilizing analytical tools of the enterprise architecting framework. Chapter 6 is the future state vision of the enterprise; it contains a literature review of the tendencies in processes and supply chain management of world-class companies. The concepts in this chapter are developed in detail in Chapters 7 to 0. Chapter 7 defines the processes that transform inputs into the required enterprise outputs. Chapter 8 proposes a methodology to understand the logistics costs related to the operation of the enterprise. Chapter 9 defines the organization that executes the processes in the new enterprise. Chapter 10 describes the information technology required to support the business processes, and details a software selection process. Chapter 11 presents the conclusions to the thesis and reflects on the application of the framework to companies that are in the situation of opening new operations. Figure 2 depicts the structure of the thesis.

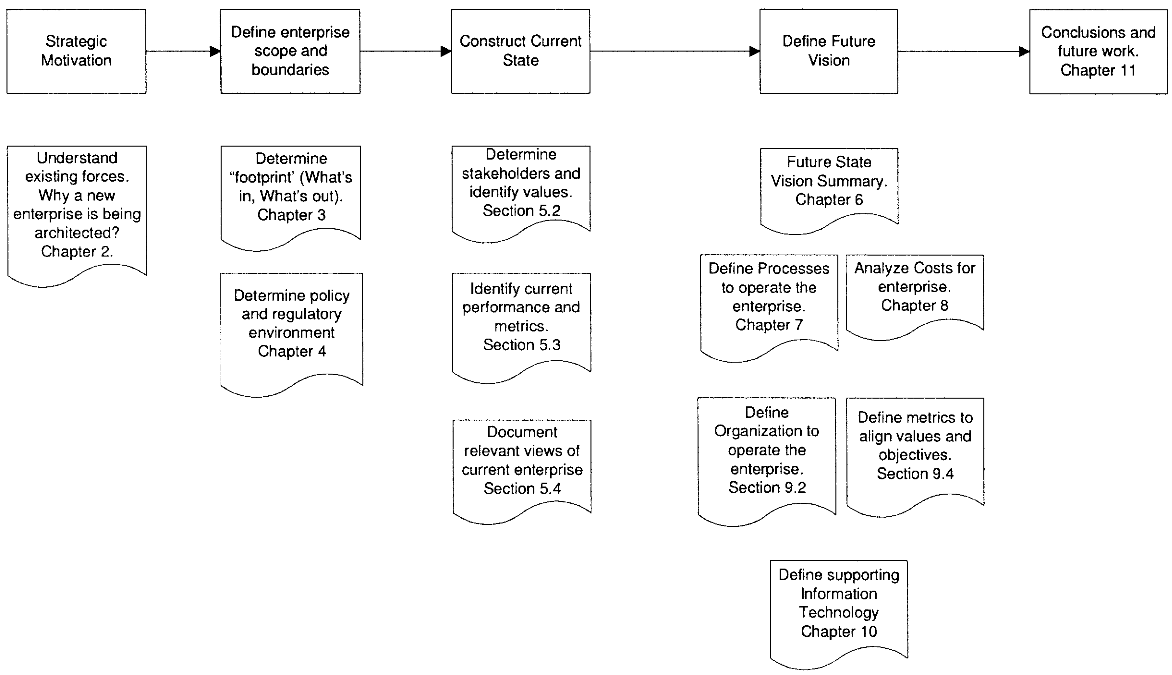

Figure 2. Enterprise Architecture Process Roadmap and Thesis Structure

2. ABB. Business Strategy and Organization Evolution

2.1. *Chapter Introduction*

This chapter focuses on the evolution of ABB as an enterprise and the changes in its business strategy and organizational structure. The objective is to understand the historical context that steered ABB to the creation of a new campus in Mexico.

2.2. *ABB Inc*

"ABB is a leader in power and automation technologies that enable utility and industry customers to improve their performance while lowering environmental impact. The ABB Group of companies operates in around 100 countries and employs more than 110,000 people."[1]

The ABB group originated in 1988 as the merger of the Swedish company Asea and the Swiss company Brown Boveri; it was originally composed of 700 companies, 2,500 factories in 25 countries, produced revenues of $18 billion and employed about 160,000 people. Percy Barnevik, former Asea's CEO for 8 years, became first ABB's CEO and followed an expansion strategy based on acquisitions and joint ventures. In order to manage the complex set of different companies, Barnevik created a three dimensional matrix structure, where the members of the executive committee had clear responsibility over both a business segment and a geographical region. The first dimension of the matrix consisted of eight business segments responsible for global strategy for products, marketing, production and R&D. The second dimension was composed of geographical regions, where each region was responsible for national operation – government relations, customer services and union negotiation –. The third dimension was composed by the enabling processes – financial, legal, human resources, technological, etc – provided by the headquarters to support the other two dimensions of the matrix. By 1996, the

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[1] *The ABB Group Website*. Retrieved January 20, 2008, from http://www.abb.com/cawp/abbzh252/A92797A76354298BC1256AEA00487BDB.aspx?v=7182A&e=us&m=6D4A

group had grown from a mainly European company to a global group of 215,000 people with orders of $34 billion.(Strebel & Govinder, ABB(A) The Barnevik Era, 2004)

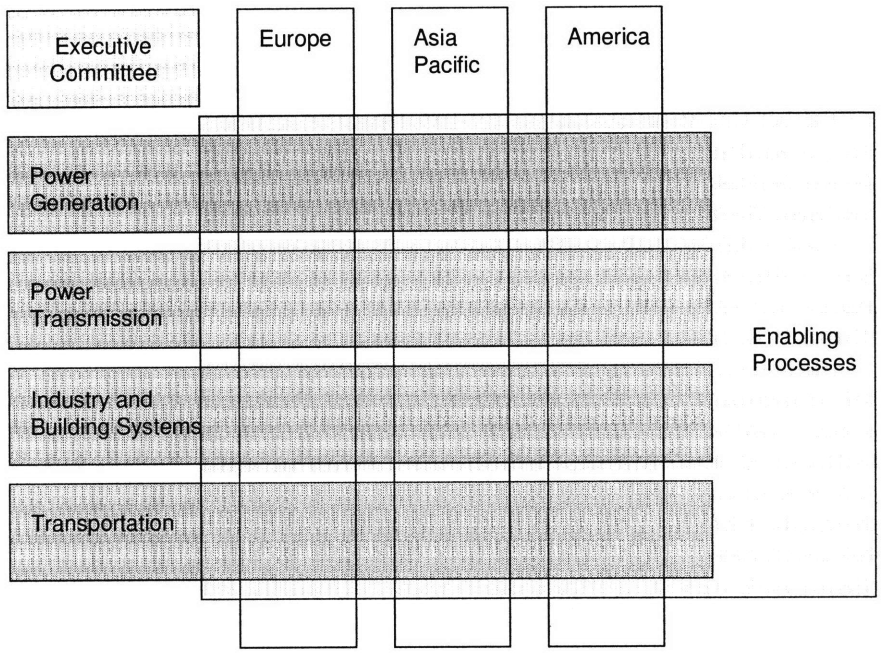

Figure 3. Three Dimensional Matrix Enterprise of ABB until 1996

In 1996, Barnevik stepped down and Goran Lindahl became CEO for the next four years, bringing a new vision for both business strategy and enterprise structure. Regarding the business strategy, Lindhal's goal was to steer ABB from heavy-industry toward a high-margin, technology-driven and knowledge-based company. Regarding the enterprise structure, he removed the geographical dimension from the matrix and also reorganized the business segments by breaking the original Industrial and Building division into automation; oil, gas and petrochemicals; and products and contracting.(Strebel & Govinder, ABB (B) The Lindahl Era, 2004)

In addition to the changes in strategy and organization, Lindahl faced a European economic recession which led him to cut about 10,000 jobs in Europe. On the other hand, he decided to take advantage of the 1997 Asian economic crisis by making major investments in the region to capitalize on low prices. However ABB's flagship Asian project, the Bakun dam – which intended to be the second largest dam in the world – got cancelled, leaving the company with losses of $102 million. In order to keep up to the high-margin strategy, Lindhal divested the least profitable business such as the locomotive arm, the nuclear power generation division and the Alstom power generation joint venture. When Lindhal stepped down in 2000, ABB was back to 160,000 employees and orders for $25 billion but still showing profits.(Strebel & Govinder, ABB (B) The Lindahl Era, 2004)

Jorgen Centerman assumed the CEO position in January 2001, having as a main business strategy to transform ABB from a product-centric company into a customer-centric, solutions-based company. Centerman reorganized the enterprise structure again by replacing the industrial divisions with four customer segments – utilities; process industries; manufacturing and consumer industries; and oil, gas and petrochemicals -, and adding two product based divisions – automation technology and power technology -. The product based divisions would be the upstream platform to provide products for the customer segments that would actually interact with the clients. In addition to the changes in strategy and structure, Centerman had to deal with inherited moves started by his predecessors: entering ABB into the NYSE listing which meant a switch to US GAAP; a share buyback initiative; and a lawsuit against the US ABB subsidiary Combustion Engineering (CE) based on asbestos products supplied by CE prior to ABB acquisition. These problems reduced investor's confidence in the group causing a fall in share prices. Additionally revenues decreased, so ABB increased its short term liabilities in order to continue operation; interest expense started to eat profitability. By the end of 2001 ABB was still a 160,000 employees company, but orders fell to $19 billion and a net loss of $729 million was reported.(Strebel & Govinder, ABB (C) The Centerman Era, 2004)

Jurgen Dormann assumed as CEO in September 2002 having as a main goal to bring order back to the group. He redefined ABB's core businesses as "power and automation technology for utility and industry customers", and decided to keep the customer-centric, solutions based approach. All businesses that did not fit into the new, stretched portfolio were divested to utilize the capital gains to reduce debt. When Dormann stepped down in 2004, ABB was still unprofitable, but the liabilities were considerably reduced and the business strategy was clearly defined.(Strebel & Govinder, ABB (D) The Dormann Era, 2004)

Fred Kindle assumed the role of CEO in September 2004, having as a main mandate not to restructure ABB but to bring the company back to profitability. By focusing on the core businesses defined by his predecessor, Kindle was able to increase the number of orders received in 2007 to $34 billion with $3.8 million in profits. Regarding organization, he maintained the two product-centric divisions defined by Centermann – Power Products and Automation Products – and created two service-centric divisions – Power Systems and Process Automation –. Robotics is the only division that maintained product manufacturing and customer services under a single head. Regarding the enterprise structure, members of the executive committee have direct responsibility over a business division while regional and country managers are not part of the executive committee. Figure 4 depicts the five major divisions of ABB as defined by Kindle:

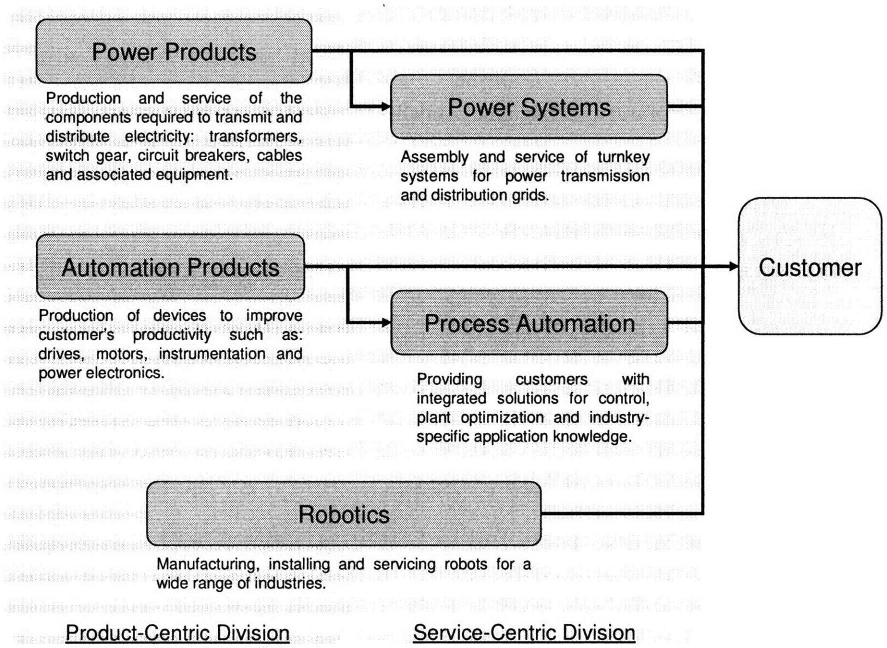

Figure 4. Business Divisions of ABB in 2007

On 2005, the year of the turnaround, ABB's Annual Report (2005, pp. 4-5) stated, "Operating performance is strong and we are reaping the rewards of our focus on execution, our emphasis on cost and risk management, and increasing operational excellence." Moreover, the report also mentions a key component of cost reduction: "We directly benefit from our global operations and supply footprint which allows us to lower the cost of our products."

Despite the success of focusing on business execution, cost and risk management and organic growth strategy, Kindle announced his departure from ABB due to "irreconcilable differences about how to lead the company"[2](The ABB Group Website) in February 2008.

2.3. ABB Mexico

Long before the existence of ABB as a single entity, Brown Boveri established a control cabinet plant in Mexico in 1947; Asea started production of electric motors, relays and control cabinets in 1962. After the merger in 1988, ABB continued the operations in Mexico having, at the time of this study, the following operations:

- Medium and High Voltage Control Cabinets assembly plant
- Warehouse and logistic management of spare parts
- Service and sales offices in different cities
- Robotics test labs

Until 2006, ABB Mexico focused on servicing clients within Mexico, having as main customers the state companies for oil and energy: Petroleos Mexicanos (PEMEX) and Comision Federal de Electricidad (CFE). However, Kindle's emphasis on global operations and cost reduction led ABB North America to follow on its Low-Cost-Country strategy by establishing a new campus for Engineering, Sourcing and Manufacturing Operations in Mexico (ESMOM). The objective of the new campus is to supply products and services not only to the Mexican market but to the US and Canada markets.

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[2] *The ABB Group Website.*

Retrieved February 29, 2008, from http://www.abb.com/cawp/seitp202/11833c3d0f8702e1c12573ee001f539c.aspx

2.4. Chapter Summary

This chapter gave us insight about the evolution of ABB as an enterprise since its inception in 1988. Throughout the years, ABB business strategy periodically changed its industry scope and its organizational structure, leading the company to uncertainty about its core business and consequently to a poor performance. However, under Kindle's direction, ABB focused on two core businesses – power and automation – and aimed to the basic levers to profitability: increase revenue and reduce costs. The focus on cost reduction led the company to emphasize its Low-Cost-Country-Sourcing program, which eventually led to the establishment of Engineering, Sourcing and Manufacturing Operations in Mexico. For ABB Mexico's operation, formerly focused on the domestic market, a focus on exportations implied a major change both in internal process execution and in organizational structure.

3. Enterprise Scope and Boundaries

3.1. *Chapter Introduction*

"Architecting usually begins with generating an abstract mental or paper description – a model – of the system and its environment" (Rechtin, 1991, p. 4). While Chapter 2 covered the evolution of ABB and the strategic motivation to establish a new campus in Mexico, present chapter focuses on describing the scope and boundaries of the San Luis Potosi (SLP) Supply Organization. The sponsors of the initiative defined two requirements for the enterprise: process scope and organizational scope.

3.2. *Process Scope*

Process scope refers to the activities that the ABB Supply Organization would be executing and the expected inputs and outputs of the enterprise. Three main processes would be executed:

1. Assess and select reliable suppliers located in Mexico for both the new campus and the plants operating in the US and Canada.
2. Manage the logistics processes to import components to Mexico and export finished goods to the US market.
3. Manage the logistics processes to export parts and components sourced by Mexican suppliers to plants in the US and Canada.

Figure 5 depicts the inputs and outputs of the process scope for the ABB Mexico Supply Organization.

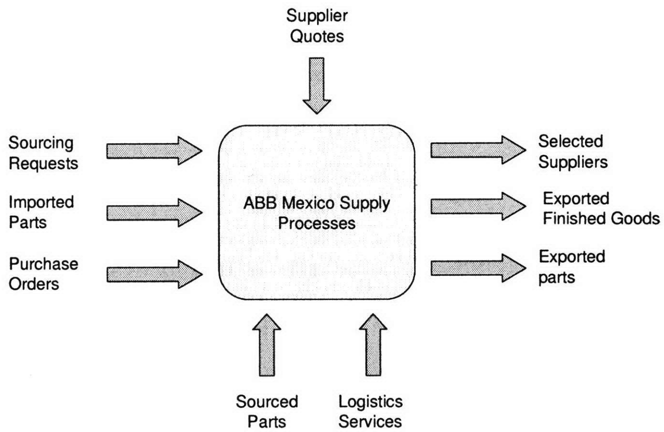

Figure 5. Process Scope of ABB Supply Organization

It is important to notice that the enterprise outputs are services dependent on the internal processes; therefore, the architected enterprise should be both process and service centered.

3.3. Organizational Scope

Organizationally, the new campus defied a common practice across ABB divisions. The SLP Supply Organization would be shared by all five divisions; implying a shift from a functional, vertically-integrated organization to a process-centered, horizontally-integrated matrix organization. Figure 6 depicts the structure of ABB SLP as proposed by Project Management.

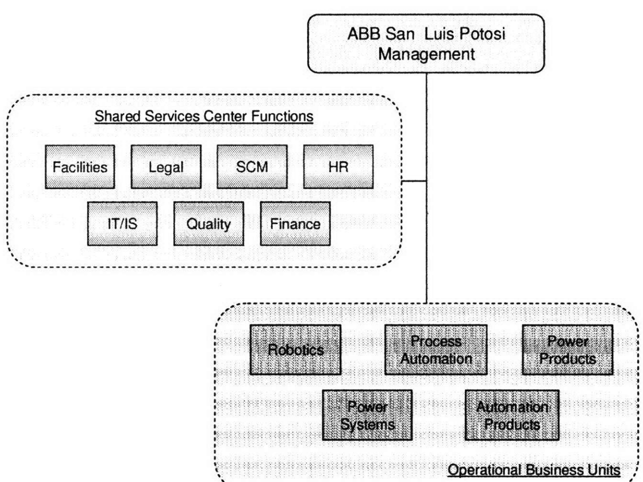

Figure 6. SLP organization with shared services functions

Although Figure 6 illustrates the shared functions rationale, it is not clear from the process point of view since it mixes units that run enabling processes with units that run core processes. In this case, Supply Chain Management and Quality Management are units that execute core processes for the enterprise. Figure 7 is a rearrangement to show a process-centered, matrix organization.

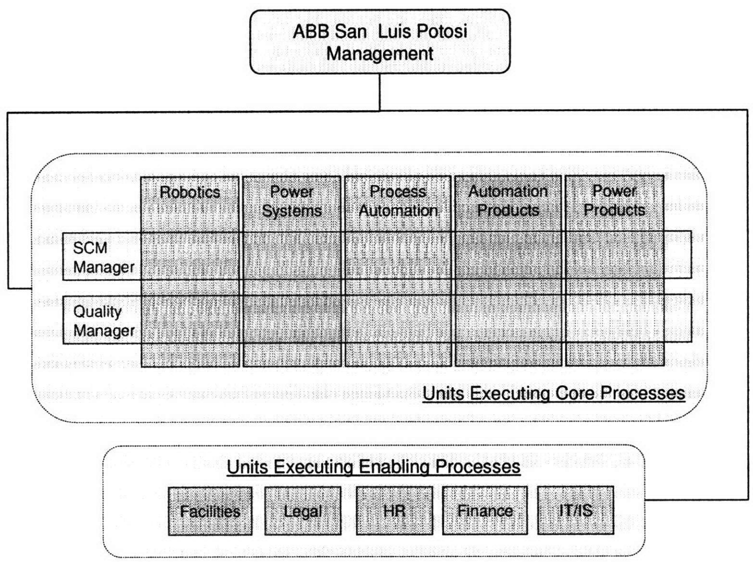

Figure 7. ABB SLP Organization as a process oriented enterprise

3.4. *Chapter Summary*

This Chapter presented insight on the scope and boundaries of the SLP Supply Organization as defined by Senior Management. From the process point of view, the new organization would be responsible for finding suppliers and shiping components and finished goods. From the organization point of view, the organization would be shared amond all five business divisions of ABB. Next chapter describes boundaries of the organization that are set by Mexican Government.

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4. Policy and Regulatory Environment

4.1. Chapter Introduction

As the Program Manager defined the enterprise scope, it became clear that certain boundaries fell within the government role. According to Rechtin(2000, p. 69), governments have four roles that affect the way in which enterprises respond to change:

- Government as a provider of National Defense
- Government as a regulator
- Government as a buyer and a client
- Government as an agent to assist foreign trade with other governments

In order to develop the logistics processes for the enterprise, a key point to understand is the role of Mexican government both as a regulator and as an agent to assist foreign trade. This chapter analyzes the boundaries, benefits and obligations that Mexican government uses to regulate the international commerce operations by means of a trade program called IMMEX.

4.2. Foreign Trade Programs of Mexican Government

Mexican law authorizes companies to operate their trade activities with different customs regimes (Ley Aduanera, Article 90):

1. Definitive – Import and Export
2. Temporary – Import and Export (IMMEX and Strategic Fiscal Zone programs)
3. Fiscal deposit
4. Products in transit
5. Repair and transforming in a Fiscal Region

When executing paperwork operations at a Mexican Customs Office, the customs broker representing a Company must inform to the Authority about the chosen customs program to apply for the traded goods.

For the purpose of this thesis, only the definitive and temporary customs programs are compared in Table 1.

Trade Activity \ Regime	Definitive	Temporary
Importation	Import goods from other countries to be utilized in Mexico. Importer pays Value Added Tax	Import goods from other countries to be transformed or repaired in Mexico and then exported to other countries. Importer does not pay Value Added Tax
Exportation	Export goods from Mexico to be utilized in other countries. Importer does not pay Value Added Tax	Export goods from Mexico to be transformed or repaired in other countries and then imported to Mexico. Importer does not pay Value Added Tax

Table 1. Comparison of definitive and temporary trade programs

From the fiscal point of view, the main difference between these programs is that definitive importation must pay full taxes while temporary trade operations waive certain taxes. The main tax waived by utilizing a temporary importation program is Value Added Tax (Ley del IVA, article 9), which in Mexico represents 15% of the invoice value of the traded goods. Exportations – products or services – never pay Value Added Tax (Ley del IVA, article 29).

In chapter 2 we learned that until 2006 ABB Mexico had focused its market in Mexico, having a limited exportation activity. This type of trade activity is suitable for a definitive importations program and in consequence, there was no internal expertise on how to utilize the temporary importations program. The next subsection focuses on explaining the temporary importation program that ABB was planning to utilize in the new campus.

4.3. Temporary Importations Program – IMMEX

4.3.1. Trade Promotion Policy Instruments

According to Torres(2007), developing countries have created trade promotion policy instruments that allow them to:

1. Develop disadvantaged regions
2. Generate income and employment
3. Attract investment

These objectives are usually pursued by providing incentives to companies operating within these instruments. The incentives may be classified in three types:

1. Fiscal Incentives, such as tax breaks and exemptions
2. Regulatory Incentives, such as flexible rules on importation and labor
3. Infrastructural Incentives, such as easy access to communications infrastructure or availability of skilled labor

These instruments have with different names in different countries, for example: free trade zones, foreign trade zones, duty free zones, export processing zones, enterprise zones and special economic zones. In the case of Mexican Laws, there are two programs that fall under this category: IMMEX and Strategic Fiscal Zone. The author researched the operation of both programs however, at the time of this study, the Strategic Fiscal Zone instrument was not completely regulated, so the thesis focuses on the description of the IMMEX program.

4.3.2. Benefits

The main fiscal benefit of the IMMEX program is that allows the temporary importation of inputs consumed in the production of exported products, with the exemption of value added tax, general imports tax and other compensatory fees (Ley del IVA, article 9).

These taxes have to be paid in two situations:

- If finished products enter the domestic (Mexican) market
- If the inputs stay in the country for a period longer than 18 months.

On the other hand, when products are re-exported, taxes have to be paid in accordance with international agreements, NAFTA in this case.

Equipment utilized in the production process is waived from importation taxes and allowed to stay in the country as long as the program is valid for the company. (Decreto IMMEX, article 4)

This program arose as a Decree in November 1st, 2006 and is the merger of former PITEX and Maquila programs (Decreto IMMEX, General Considerations), which have been operating in Mexico for more than 40 years.

4.3.3. Requirements

In order to obtain the permit to operate this program, a company must file an application to the Central Customs Office, providing certain documentation. The main requisite is to have a commitment to export at least US $500,000.00 per year or at least 10% of total company revenue (Decreto IMMEX, Article 11).

In order to operate of this program, companies must file every month a report to the National Institute of Population, Geography and Statistics (INEGI) containing information regarding the amount of international trade executed. In addition, government must keep track of the temporary importation activity, by certifying that the imported components are exported as part of a finished good within the time limit allowed by the law (18 months). Companies must achieve this requirement by keeping an accurate inventory management system carefully described in the law (Ley Aduanera. Annex 24) and analyzed in Chapter 10. Failure to meet any of these requirements may deem a suspension of the permit to operate this program.

4.4. *Chapter Summary*

In this chapter, we analyzed two government roles that affect the way an enterprise adapts to change. First, by emitting laws and signing agreements with foreign governments, the Mexican government is allowing companies established within its territory to export their production to other countries. Second, by acting as a regulator, a government may influence several aspects of the enterprise, such as strategy, operational processes and information technology. It affects the strategy by encouraging the company to export certain amount of its production in order to have access to tax exemptions. It affects the internal processes of the company by requiring specific actions to comply with paperwork and, finally, it affects the information technology by defining the requirements of an inventory management system.

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5. Current State

5.1. Chapter Introduction

While chapters 3 and 4 defined the scope and boundaries of the enterprise, this chapter describes the current state of the enterprise at the beginning of the internship. The central point of the chapter is stakeholder theory, which allows the enterprise architect to understand the forces and interests driving the enterprise's direction.

5.2. Stakeholder Theory

According to Freeman(1984, p. 46), "a stakeholder in an organization is any group or individual who can affect or is affected by the achievement of an organization's purpose". The strength to which a stakeholder influences an enterprise is called salience. Mitchell, Agle and Wood(1997, p. 869) define salience as "the degree to which managers give priority to competing stakeholder claims", which is determined by the combination of three main attributes: Power, Legitimacy and Urgency. The following table summarizes the definitions and bases of these attributes.

Attribute	Definition	Bases
Power	A relationship among social actors in which one social actor, A, can get another social actor, B, to do something that B would not otherwise have done.	• Coercive. Force/threat • Utilitarian. Material/Incentives • Normative. Symbolic influences
Legitimacy	A generalized perception or assumption that actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, vales, beliefs and definitions	• Individual • Organizational • Societal

Urgency	The degree to which stakeholder claims call for immediate attention	• Time sensitivity. The degree to which managerial delay in attending to the claim or relationship is unacceptable to the stakeholder • Criticality. The importance of the claim or the relationship to the stakeholder

Table 2. Key attributes in the Theory of Stakeholder Identification[3]

5.2.1. Stakeholder Network Model

Grossi(2003, p. 64) describes a graphical representation of stakeholders known as a network model. A stakeholder network model represents the key stakeholders with circles and their relationships with lines. The size of the circles represents the stakeholder salience as perceived by the person performing the analysis, while the thickness of the lines represents the relevance of the relationships to the value creation process of the enterprise. Figure 8 is a network model for ABB San Luis Potosi Supply Organization.

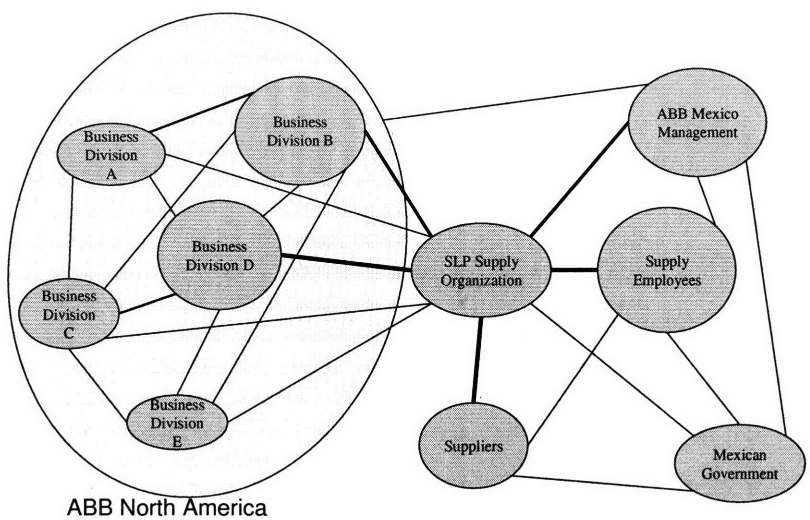

Figure 8. Stakeholder Network Model of ABB San Luis Potosi Supply Organization

[3] Mitchell, Agle and Wood, pg 869.

There are three main aspects of Figure 2. The first aspect is the clusters of stakeholders drawn in opposite sides of the figure. The left side of the figure clusters the five major divisions of ABB North America, which directly managed the new campus initiative. The right side of the figure maps stakeholders located in Mexico. In general, stakeholder interactions were stronger depending on their geographic location.

The second aspect is the stakeholder salience represented by the size of the circles. On the left side of the figure, two stakeholders are bigger than the rest for different reasons. On the onde hand, Business Division D is more salient because of its Power attribute; it exerts its power by being the primary source of funds to support the new organization. On the other hand, Business Division B is more salient because of its Urgency attribute. Division B would open the first production line in the SLP campus and, for this reason, required support to find local suppliers in a time sensitive and critical base.

The right side of the figure maps stakeholders that individually may appear as more salient than stakeholders on the left side; however, the combined salience of the divisions was actually steering the direction of ABB SLP Supply Organization. A Legitimacy attribute determines the salience of both ABB Mexico Management and Supply Employees. The Legitimacy attribute is an exchange relationship, where the stakeholder provides the enterprise with critical resources, and in exchange expects its interests to be statisfied. In this case, ABB Mexico Management provided the ABB SLP Supply organization with resources to execute their work – offices, computers, telephones- and in exchange expected business results. Supply Employees provided the enterprise with their work, and in exchange expected a fair salary. On a different situation, Mexican Government determined its salience by its Power attribute. Mexican Government had a coercive base, such as penalties for not complying with the law, that could be as big as cancelling the trade program for ABB in Mexico.

The third aspect is the thickness of the lines, which represents the relevance of the relationship to the value creation process of the enterprise. Division B and D have thick lines linking to the Supply Organization because they provide the input to the system: specifications, volumes and target prices. In a matrix organization, the divisions also provided the commodity team leaders for the standing requests for quotations. The supply employees have a thick link because they execute the processes that transform the system inputs into the services provided. Suppliers add value by providing quotes and components that ABB utilizes to assemble its final products. Finally, ABB Mexico Management provided the enabling processes for the supply function.

5.2.2. Stakeholder Values

After identifying the stakeholders, it is necessary to understand the interests of the key groups in the value creation process: internal customers, employees and suppliers. These interests are required to understand the enterprise's current performance and to define the future state. The information is gathered by asking the stakeholders to complete a survey where they define their relevant values, and then rank these values according to their perceived current performance. Once the surveys are completed, the results are averaged and plotted in a graph, where the x-axis represents the relative importance of a stake, while the y-axis represents the perceived performance of the enterprise.

The first group is the internal customers. Supply Chain Managers and Purchasers are the internal customers and trigger the supplier selection processes. Figure 9 represents the key interests of this group:

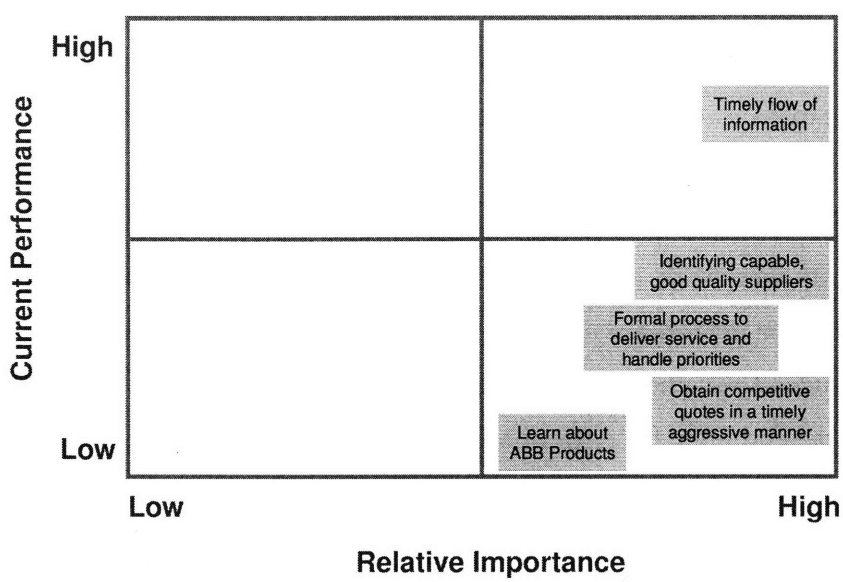

Figure 9. Key values of enterprise internal customers

The second group is the enterprise suppliers. Suppliers start the relationship with ABB by providing quotes to the ABB Mexico Supply Organization and, later on, they provide the parts and components that ABB utilizes to assemble its final products. Next figure represents the key values of this group:

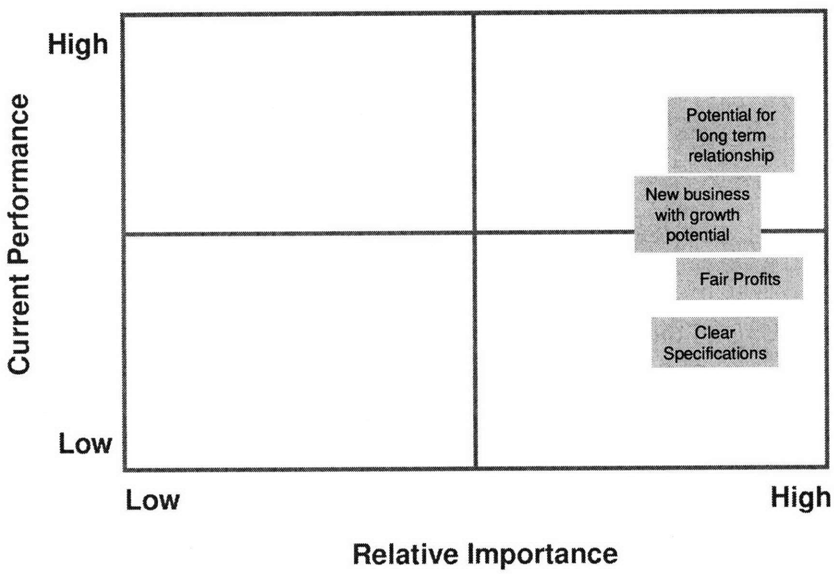

Figure 10. Key values of enterprise suppliers

Timely Payment was a very important value for the suppliers; however, its current performance could not be measured because at the time of the study there were no standing purchase orders. The delivery of this value should be measured again once the enterprise starts purchasing from Mexican suppliers.

The third group is the employees of the enterprise. This group actually transforms the system inputs into the required services. Next figure represents their key values:

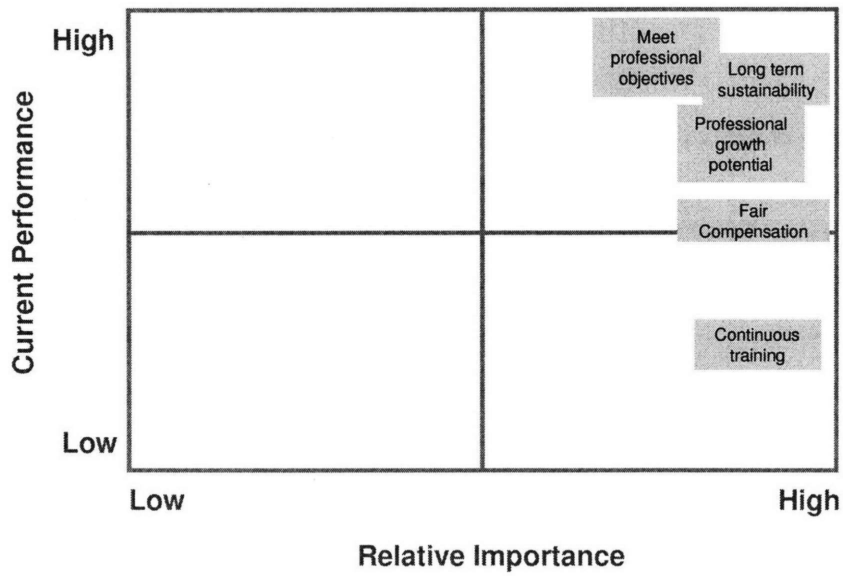

Figure 11. Key values of enterprise employees

A commonality among all the graphs is that all interviewees ranked their values on the high importance end of the spectrum; an interpretation can be that if a value is worth to mention it, it is because of its importance. Following is a list of considerations regarding the responses of each stakeholder group:

- Customers. Most of the values fell under the medium to low current performance, meaning that the expectations for delivery are higher than the actual results. Nevertheless, more than just reporting a perceived low value delivery, it is necessary to find the root causes of it. Chapter 7 analyzes the causes for delays on retrieving quotes from suppliers.
- Suppliers. The values of this group will change as the enterprise evolves; at the time of this study, there were no parts being sourced and most of the suppliers were having the initial contacts with the organization.
- Employees. Most of their responses fell on the upper right quadrant; however, the one value that the enterprise needs to improve is Continuous Training.

5.3. *Enterprise Metrics*

"Metrics are a system of parameters or ways of quantitative and periodic assessment of a process that is to be measured, along with the procedures to carry out such measurement and the procedures for the interpretation of the assessment in the light of previous or comparable assessments."[4] In order to make metrics work, an internal link to the rewards system of the company must be present. For example, sales representatives usually have a low fixed salary, and the rest of their compensation is the result a function of the revenues in a period. In a different situation, employees that do not work for a profit center may have their annual bonus linked to their department metrics. Chapter 9 discusses this topic in more detail.

At the time of this study, the only metric measured for the ABB SLP Supply organization was the "Annual Savings Target". This metric consisted in the aggregation of the differences between the current cost of the parts with potential to be sourced in Mexico, and the quotes obtained from Mexican suppliers. Both the current and the new costs referred only to the unit cost, not the total spend.

5.4. Internal Views of the Enterprise

An enterprise must be holistically evaluated in order to understand all the aspects that influence the outputs of the system. This section analyzes the most relevant views of the enterprise architecture roadmap for the ABB SLP Supply Organization.

5.4.1. Process View

The process view refers to the core, enabling and governing processes by which the enterprise creates value for its stakeholders. Core processes are those that transform the inputs of the enterprise into the products or services offered; typical core processes in most companies are product development, order fullfilment and order to cash. Enabling processes are those that support core processes, such as financial management, hire&development of human resources and information technology management. Governing processes are those that define the strategy

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[4] *Wikipedia*. Retrieved March 20, 2008, from http://en.wikipedia.org/wiki/Metrics

and direction of the company, mainly for long term goals, such as brand management or mergers and acquisitions.

The relevant processes during the course of the internship were core processes related to supplier selection and to goods distribution. Although the low-cost-country supplier selection process had been present for a long time in ABB US, it was evident that each Supply Manager had different ideas about how to perform each activity. The cause of these different ideas is a lack of process documentation and standardization across different divisions.

5.4.2. Organization View

Being a group that grew through acquisitions – as already discussed in chapter 2 –, ABB has a very diverse structure across its divisions. The commonality is that each division is vertically integrated having its own functional silos for the core activities; in this case, Supply Chain Management was a core process available within each division, as Figure 12 shows.

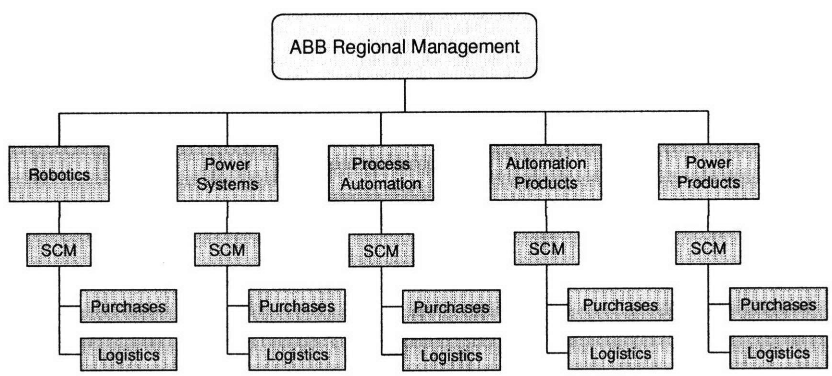

Figure 12. Current State Divisional Vertical Integration

Regarding organizational structure, ABB Mexico tended to be more hierarchical than flat - and as a result, bureaucratic - having as main characteristics:

- A top-bottom management approach, where the information flow had to follow the hierarchical path, causing delays in information delivery and, consequently, in the decision making process

- Employees and individuals work independently, rather than collaborating as team members.

On the other hand, ABB organization in the US, despite also being hierarchical, tended to have more characteristics of a flat organization, with team focus and a quick flow of information.

5.4.3. Information Technology View

In a similar case as the organization and processes, there were different IT systems within ABB. For example, the ERP system in ABB Mexico organization was different to the ERP in certain business divisions in the US; however, there was an effort in ABB North America to unify the ERP systems. On a different end, ABB North America counted with a knowledge system to capture information regarding ABB suppliers; nevertheless, the use of this system was not standardized. The employees hired in SLP to perform the supply selection process did not receive training on it – at least not during in the six and a half months of the internship –.

5.4.4. Knowledge View

The internal knowledge of ABB SLP Supply Organization was composed of two main elements:

- Knowledge about supplier capabilities
- Knowledge about internal processes

As we already mentioned in the Process View, the relevant processes of the organization were those related to learn about supplier's capabilities. Learning about supplier's capabilities was of utmost importance in order to be able to make informed decisions about the best alternatives for sourcing. However, not only the resulting knowledge of executing the processes was being obtained, but also the knowledge about processes was being generated as the organization operated. One of the most relevant elements of the internal knowledge of procurement organizations, as we will see in the following chapter, is the understanding of Total Spend. Total Spend will be thoroughly discussed in Chapter 8.

5.5. Chapter Summary

This chapter covered different aspects of the current state of the enterprise. The first section described the main stakeholders for the SLP Supply Organization along with their interests. By analyzing the responses of the internal customers of the organization, we learned that two key values of this group were not being met as expected: identification of capable suppliers and obtention of competitive quotes in a timely aggressive manner. The second section described the metrics utilized to measure the performance of the organization; here we learned that the only metric in place for the organization failed to cover the most important values of each stakeholder group. The final section described the status of the enterprise from four points of view: organization, process, information technology, and knowledge. The remarkable take away of the views is the fact that the structure set by management for the ABB SLP Supply Organization was a clear departure from prior structures of the current enterprise and that the processes and internal knowledge of the organization were in process of being developed.

6. Future State Vision

6.1. Chapter Introduction

Past chapters analyzed the external environment and current state of the SLP Supply Organization. This chapter presents the tendencies, from the point of view of experts in their fields, of process-oriented procurement organizations and sets the expectations for the future state of the ABB SLP Supply Organization.

6.2. Tendencies in Process Oriented Enterprises

A key characteristic of world-class organizations is their business process orientation. Hammer (2007) states that redesigning business processes "can lead to dramatic enhancements in performance, enabling organizations to deliver greater value to customers in ways that also generate higher profits for shareholders". He defined a process implementation roadmap that helps managers to assess current state of processes in their organizations, and plan process-based transformation efforts. His assessment framework consists of five process characteristics – design, performers, owner, infrastructure and metrics – and defines four levels of maturity of the internal processes in the enterprise. Given that the ABB SLP Supply Organization is in its early stages, only the first two levels of maturity are relevant for this study; these levels are shown in the following table:

		Maturity Level 1	Maturity Level 2
Design	Purpose	The process has not been designed on an end-to-end basis. Functional managers use the legacy design primarily as a context for functional performance improvement.	The process has been redesigned from end to end in order to optimize its performance.
	Context	The process's inputs, outputs, suppliers, and customers have been identified.	The needs of the process's customers are known and agreed upon.
	Documentation	The documentation of the process is primarily functional, but it identifies the interconnections among the organizations involved in executing the process.	There is end-to-end documentation of the process design.
Performers	Knowledge	Performers can name the process they execute and identify the key metrics of its performance.	Performers can describe the process's overall flow; how their work affects customers, other employees in the process, and the process's performance; and the required and

			actual performance levels.
	Skills	Performers are skilled in problem solving and process improvement techniques.	Performers are skilled in teamwork and self management.
	Behavior	Performers have some allegiance to the process, but owe primary allegiance to their function.	Performers try to follow the process design, perform it correctly, and work in ways that will enable other people who execute the process to do their work effectively.
Owner	Identity	The process owner is an individual or a group informally charged with improving the process's performance.	Enterprise leadership has created and official process owner role and has filled the position with a senior manager who has clout and credibility.
	Activities	The process owner identifies and documents the process, communicates it to all the performers, and sponsors small-scale change projects.	The process owner articulates the process's performance goals and a vision of its future; sponsors redesign and improvement efforts; plans their implementation; and ensures compliance with the process design.
	Authority	The process owner lobbies for the process but can only encourage functional managers to make changes.	The process owner can convene a process redesign team and implement the new design and has some control over the technology budget for the process.
Infrastructure	Information Systems	Fragmented legacy IT systems support the process.	An IT system constructed from functional components supports the process.
	Human Resource Systems	Functional managers reward the attainment of functional excellence and the resolution of functional problems in a process context.	The process's design drives role definitions, job descriptions, and competency profiles. Job training is based on process documentation.
Metrics	Definition	The process has some basic cost and quality metrics.	The process has end-to-end process metrics derived from customer requirements.
	Uses	Managers us the process's metrics to track its performance, identify root causes of faulty performance, and drive functional improvements.	Managers use the process's metrics to compare its performance to benchmarks, best in class performance, and customer needs and to set performance targets.

Table 3. Process Maturity Assessment (Hammer, 2007)

6.3. Tendencies in Procurement Organizations

As companies face globalization, the role of procurement organizations has to evolve from a basic level of maturity, where the main goal of the organization is to issue purchase orders in a reactive environment, to a role where the organization becomes part of the competitive advantage of the enterprise (Beckman & Rosenfield, 2008, p. 242). The following table summarizes the different levels of maturity:

Level of Maturity	Role	Typical Activities	Value Measures	Results for the Organization
Beginner	Administrator	• Issue POs. • Make it safe and easy to buy things. • Reactive Environment.	Tolerable Level of complaints.	• Understand Total Spend. • Price at or below market.
Basic	Advisor	• Shop the world. • Have basic commodity knowledge. • Understand costs and technology. • Make good, but primarily reactive, decisions aligned with enterprise needs.	Period-to-period price takedowns.	• Understand total spend and market opportunities. • Price at or below market.
Competitive	Process Enabler	• Influence suppliers to get preferred treatment. • Understand costs, availability, market trends, and risk. • Primarily reactive environment.	Period-to-period price takedowns.	• No surprises. Excellent price – better than market – and assurance of supply.
Leader	Contributing Partner	• Process focused, tool-enabled environment. • Worldwide access to suppliers for materials and services. • Decisions are well thought out and holistic in context. • Primarily proactive environment.	Total economic value.	• Better total costs.
World Class	Competitive Differentiator	• Create clear and defined competitive advantages for enterprise enabled by automated tools and processes. • Proactive environment.	Total economic value created.	• Leader in market.

Table 4. Procurement Organization Maturity Model (Beckman & Rosenfield, 2008, p. 243)

A very important aspect of world-class procurement organizations is the type of relationships that are established with the suppliers. The next section describes the characteristics of world-class supplier relationships.

6.4. *Tendencies in Supplier Relationships*

Traditionally, a supplier delivers components to a customer company by means of a contract. In this model, the contract specifies quality tolerances, expected leadtimes, total volume to be purchased and, of course, the price to be paid to the supplier. Contracts are revised from time to time, with the customer company usually requesting the supplier to improve any of these variables or else, bring the component to an open auction where the contract can be granted to a different company.

Japanese companies changed the traditional model by implementing *keiretsu*, where both the supplier and the parent company work together towards a long-term relationship, which targets cost savings, quality improvement and fast innovation. This type of approach requires both companies to develop tight relationships were information is intensively shared and joint improvement activities are conducted. The most important aspect of the relationship is the commitment of the parent company to provide support to the supplier, by periodically sending production or quality engineers to aid in the continuous improvement process.

According to Liker and Choi(2004), there are two main reasons that have prevented companies to replicate the Japanese *keiretsu* model. First, as global sourcing became easier, many companies jumped to the conclusion that the immediate benefits of low-wage costs surpassed the benefits of long-term relationships. Second, the availability of internet-based auctions eased the procees of getting suppliers to compete among themselves for a contract. In summary, most companies do not appreciate the fact that Japanese companies maximize profits, but not at expense of their suppliers.

Liker and Choi (2004) state six steps followed by Japanese companies that develop better supplier relationships; the following figure summarizes these steps:

Conduct joint improvement activities
• Exchange best practices with suppliers.
• Initiate kaizen projects at suppliers' facilities.
• Set up supplier study groups.

Share information intensively but selectively
• Set specific times, places and agendas for meetings
• Use rigid formats for sharing information.
• Insist on accurate data collection.
• Share information in a structured fashion.

Develop supplier's technical capabilities
• Build suppliers' problem solving skills.
• Develop a common lexicon.
• Hone core suppliers' innovation capabilities.

Supervise your suppliers
• Send monthly report cards to core suppliers.
• Provide immediate and constant feedback.
• Get senior managers involved in solving problems.

Turn supplier rivalry into opportunity
• Source each component from two or three vendors.
• Create compatible production philosophies and systems.
• Set up joint ventures with existing suppliers to transfer knowledge and maintain control.

Understand how your suppliers work
• Learn about suppliers' businesses.
• Go see how suppliers work.
• Respect suppliers' capabilities.
• Commit to coprosperity.

Figure 13. Supplier Partnering Hierarchy (Liker & Choi, 2004)

6.5. Chapter Conclusions

This chapter presented a review of the tendencies in process oriented enterprises, procurement organizations, and customer-supplier relationships. The following chapters will develop and apply several of the concepts mentioned here for each of the future state relevant views of enterprise architecting.

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7. Future State Process View

7.1. Chapter Introduction

If the reader asked an employee of a company to describe the place where she works, she may be tempted to present the information contained in any of the following documents: an income statement, a product brochure or a vision statement. Certainly, none of these documents describe the activities that an enterprise executes[5]. Process Mapping is the language that describes the tasks executed in an enterprise. According to Beckman and Rosenfield (2008, p. 257), process mapping is "a visual representation of workflow that shows the stream of activities involved in converting a set of inputs to a desired set of outputs". Although any language, such as English, can describe a set of activities to complete a task, process mapping is a visual alternative that allows the identification of redundant activities, making it easier to execute an improvement process. Process mapping is useful either "to improve the 'as is' processes or to specify the 'to be' processes"(Booth, 1995).

Chapter 3 briefly described three different sets of processes that fell within the scope of the enterprise:

- supplier selection
- outbound logistics for sourced parts
- inbound/outbound logistics for goods manufactured in the new campus (IMMEX)

This chapter will focus on developing the Supplier Selection Processes and the Inbound/Outbound Logistics (IMMEX), based on the concepts outlined in section 6.2. The objective is to clearly define the inputs, outputs, suppliers and customers of each process, and leave documentation that will be useful for the process' performers.

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[5] Hammer, Michael. Rationale explained during a lecture of the 15.769 Operations Strategy course in MIT.

7.2. *Process Mapping Conventions*

The process maps developed for ABB followed a cross functional approach, showing not only the tasks to complete a process, but also the functional units – departments or positions – that execute each task. Table 5 contains the symbol convention for the process maps generated during the internship.

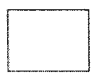
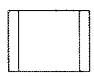
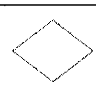
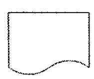
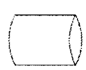
Process Symbol	Description
	Process. Represents a single step activity executed in the process. It contains verbs and nouns.
	Predefined Process. Represents a sub-process that is defined in a different process map.
	Decision. Represents a step where a decision has to be made. The outcomes are usually two – yes or no -.
	Document. Represents a step that results in a document.
	Data. Represents a step that involves storing information in a computer system.

Table 5. Symbol convention for Process Mapping

7.3. *Supplier Selection Process*

The supplier selection process is well known and standardized within ABB; in fact, the company is currently realizing savings by bringing low cost country sourcing to the US and Canada plants. However when the processes were deployed in SLP, a few fine-tuning actions were required to eliminate delays. Figure 14 depicts the supplier selection process as originally implemented in SLP:

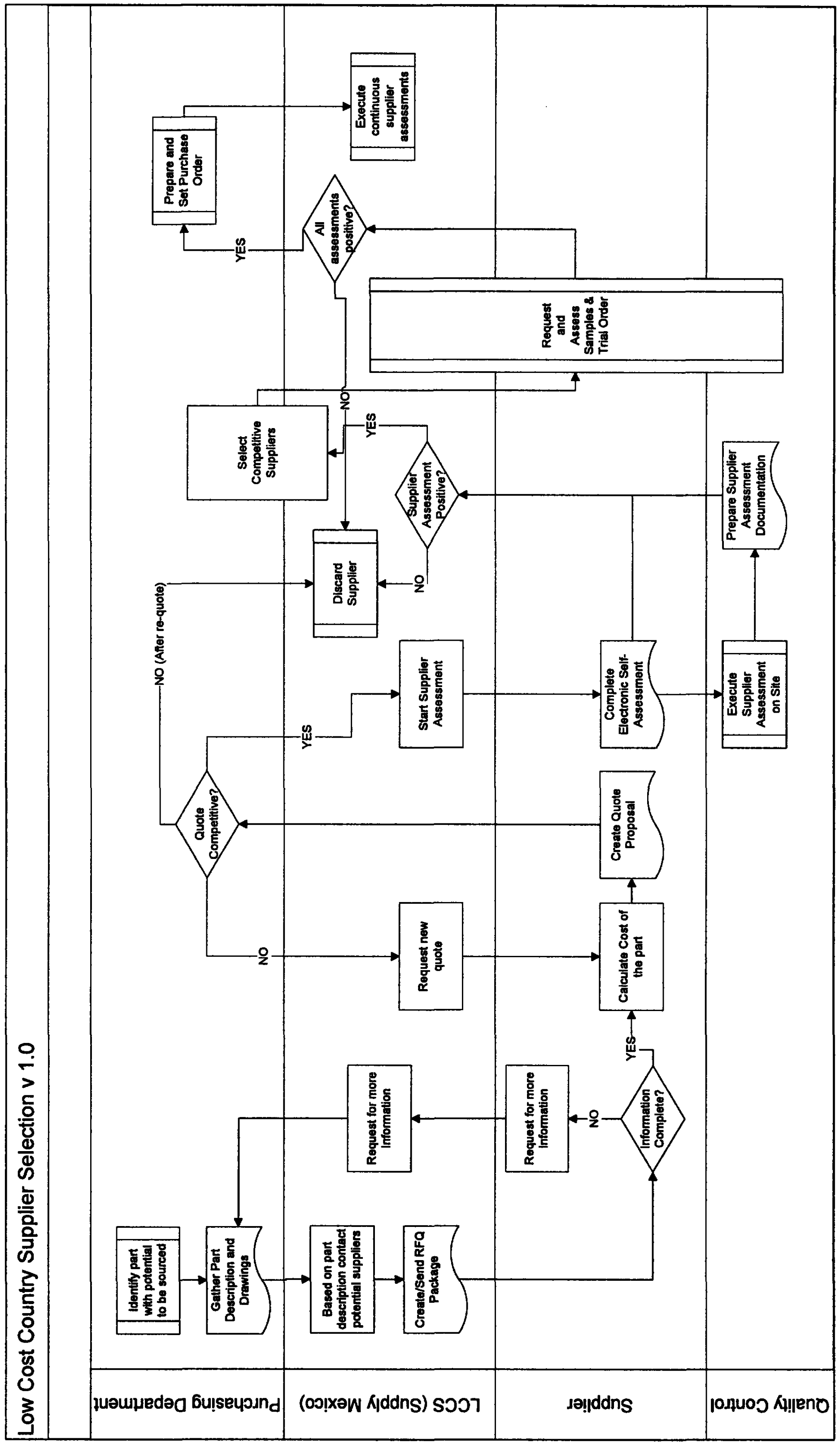


Figure 14. Initial Supplier Selection Process

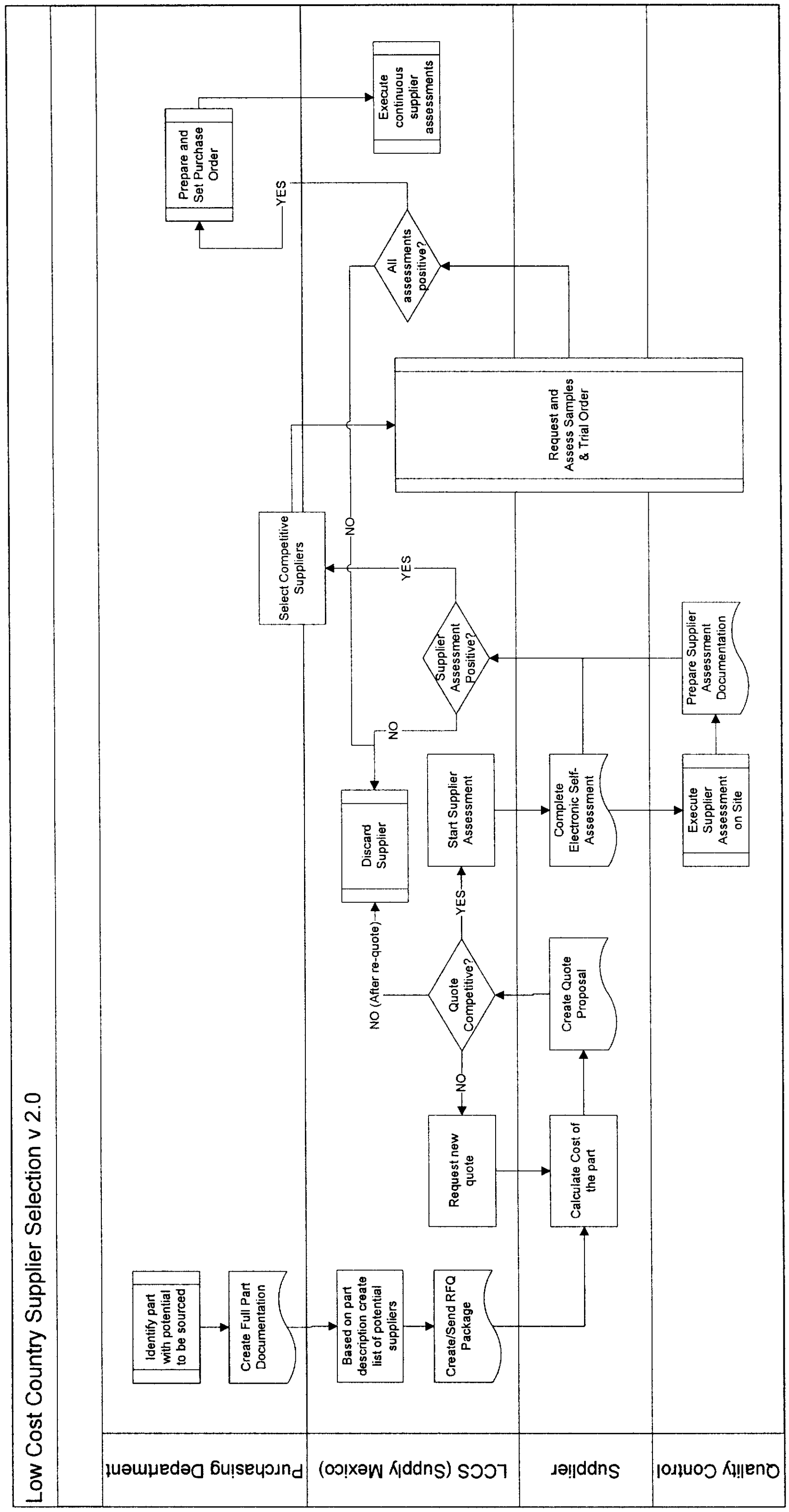


Figure 15. Reviewed Supplier Selection Process

As the team of sourcing specialists executed their normal activities, a few issues arose and were addressed early on:

1. Definition of the documents that compose a part specification. The second step of the process, a task executed by the purchasing department, did not specify clearly which documents should be gathered before requesting the sourcing team to find a supplier. The outcome was that during the initial contact with the supplier, many questions arose with respect to the part's specifications. These questions could not be solved by the sourcing team and had to be forwarded to the purchasing department, causing a delay in the collection of quotes.
2. Target price not included in required documentation. Upon reception of the supplier quotes, the sourcing specialists did not have any information regarding the target price of the parts being quoted. In many cases, they had to send the quotes back to the Purchasing Department in order to decide which suppliers continued in the selection process and which supplier would have to re-quote. It was at this point when the sourcing team had access to the target prices.
3. Process Ownership. The process owners were the managers of the purchasing departments, and all pertained to Business Division D. From the divisional, vertically integrated organization point of view, this was the structure that made most sense, since all the divisions were habituated to be vertically integrated, having their own sourcing specialists. Nevertheless, for the expected organizational structure, the arrangement entailed a problem: process owners prioritized their own commodities over the commodities of the other business divisions.

The first two issues were solved by calling a meeting with the internal sponsors of the group – Division D managers – and raising the problem. The solution was to define a simple rule of operation stating that "No Request for Quotation will be sent to a supplier if the sourcing specialist does not have, at least, the following documentation: Full description consisting of drawings and specifications; annual consumption and spend; current and target prices." The objective of this rule was to reduce the interactions between the sourcing specialists and the purchasing department, in order to accelerate the selection process. Figure 15 represents the modified process.

Solving the third issue required alignment across divisional stakeholders. As stated in Chapter 3, an architectural requirement was to share the Supply organization among divisions. Therefore, the process owner should be the sourcing specialist itself, and not the process client – in this case, division D managers-.[6] However, bringing the process ownership to the sourcing specialists is a task that required understanding of the interests of each divisional manager. The common interest for all of the divisional managers was to find suppliers in Mexico, both for the new campus and for the US and Canada plants. However, the division D managers were concerned about being the only division providing budget for the sourcing organization. The solution was to propose a mechanism to allocate the budget of the organization based on the amount of savings found for each division. Once the main barrier to agreement was settled, two new rules of operation were added to the Supply organization:

1. The supply organization will operate as a Shared Services organization, being able to receive requests for quotes from any business division.
2. The supply organization will be able to group requests for quotes from different divisions with the objective of reaching synergy and stronger negotiation power over suppliers.

7.4. Temporary Importation Process

7.4.1. Benchmarking as a source of Process Mapping

Defining the temporary importation process for IMMEX was a challenging task for three reasons. First, it was not in ABB Mexico's expertise the operation of this program. Second, the law explains part of the process but tends to be cryptic, and third, the process would not be tested until after completion of the internship. Therefore, in order to be able to create a reliable process

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[6] In Spanish, there is a popular saying that states that "in a trial, one can not be both the judge and the plaintiff".

map for IMMEX operation, the author applied benchmarking, a management tool to document best practices. Figure 16 depicts the benchmarking process as defined by Camp (1995, p. 17).

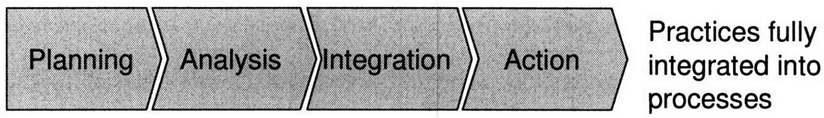

Figure 16. Benchmarking Process

The *planning stage* consists of defining the process to be benchmarked, identifying the comparative companies and determine the data collection method. In this case, two LFM partner companies agreed to share their IMMEX processes with ABB, and a standard set of questions was defined for the interviews. The *analysis stage* consisted in bringing together the results of the interviews and elaborating the IMMEX process map. The *integration stage* consisted in communicating findings to the organization. The *final stage, action*, would be executed by the Supply Organization after completion of the internship.

7.4.2. Temporary Importation Process Maps

After completing the benchmarking activity, the top level IMMEX process definition depicted in Figure 17 was generated. Next, sub-processes 1.2 and 3 were exploded into Figure 18 and Figure 19.

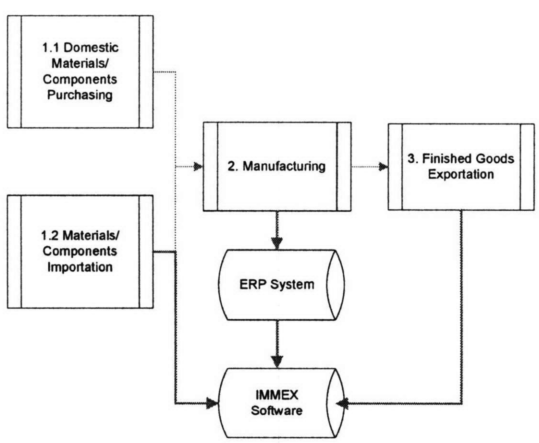

Figure 17. Top Level IMMEX Process Definition

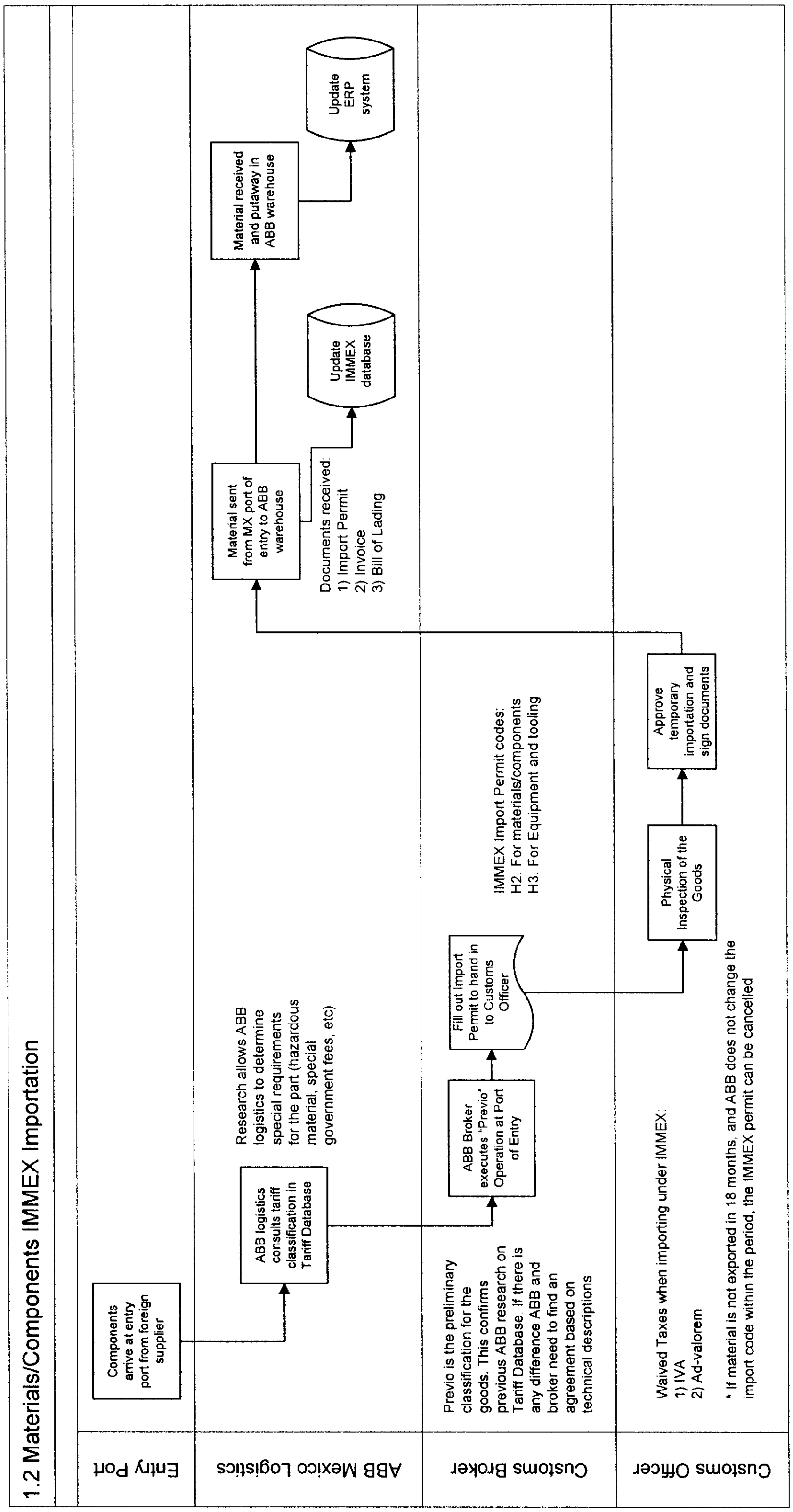

Figure 18. IMMEX importation process

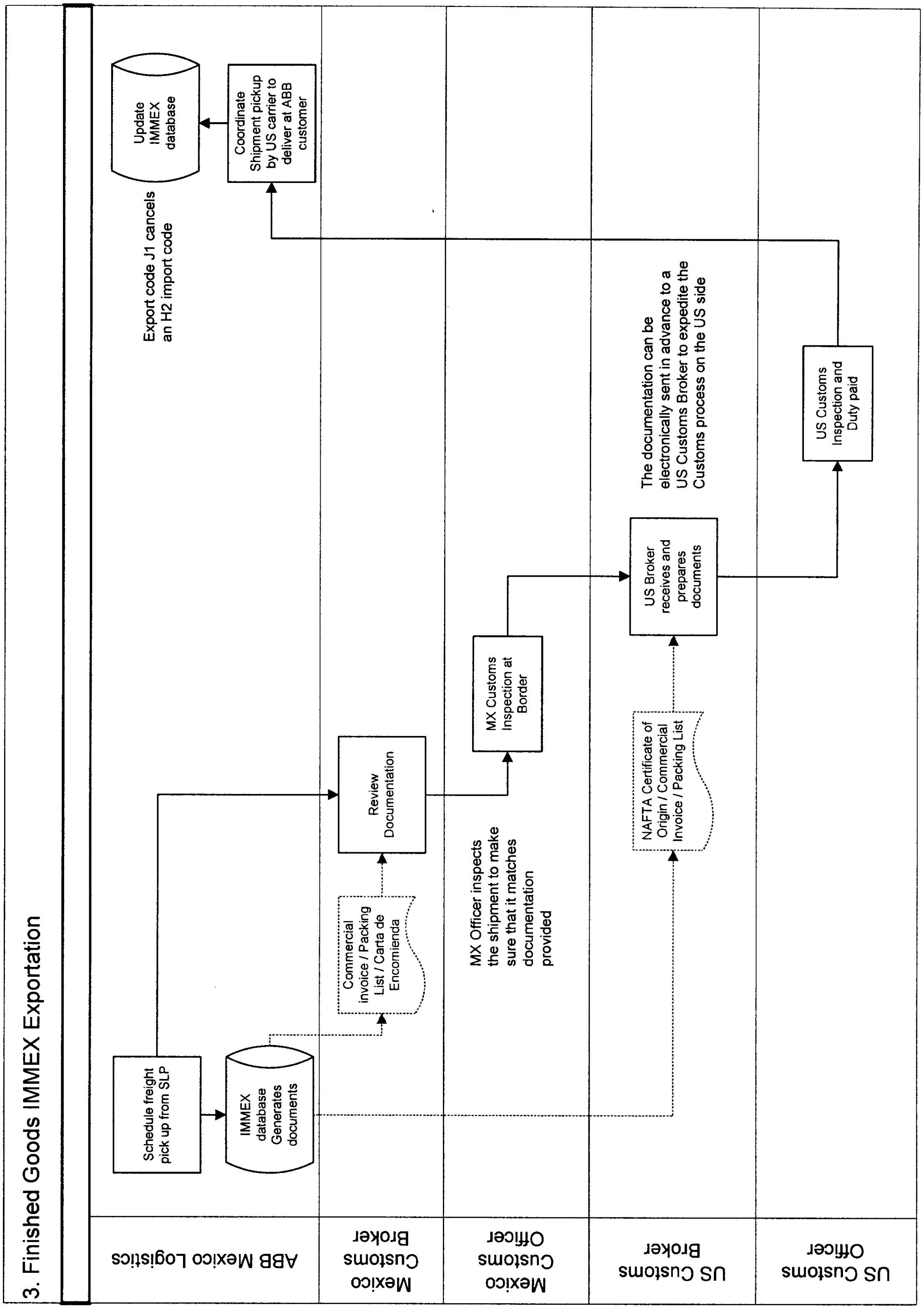

Figure 19. IMMEX Exportation Process

The most important step on the IMMEX process is the control of temporary importations. As already mentioned in Chapter 4, parts and components are imported free of Value Added Tax but can stay in the country for a maximum of 18 months. At the end of this period, goods must either leave the country or change its customs status by paying the waived taxes. For this reason, companies operating this regime must have a tight control of its import permits and inventory. Mexican Government defines a specific computer system that can be utilized to fulfill this obligation.

7.5. Chapter Summary

The present chapter described the main processes that were mapped and analyzed during the internship. Two sets of processes were described, those related to Supplier Selection and those related to Temporary Importations under IMMEX. The methodology to map the processes was different in each case. On the one hand, Supplier Selection processes were mapped by observing the daily tasks of the Supply employees and by talking to the more experienced Commodity Leaders in the ABB US organization. On the other hand, the Temporary Importations process required the application of benchmarking, since this was not an expertise of the current state enterprise.

8. Future State Knowledge View

8.1. Chapter Introduction

In section 5.3 we discussed the fact that sourcing decisions were made by considering savings in part's cost; however, as we already learned in section 6.3, one of the main knowledge elements of mature procurement organizations is their understanding about Total Spend in the supply chain. This chapter describes a methodology to analyze Total Spend by comparing the three transportation alternatives that the organization was considering to ship goods: Truck Load (TL), Less Than Truck Load (LTL) and Rail.

8.2. Total Cost comparison of different transportation modes

In order to be able to select the best transportation mode for the components to be shipped from Mexico to a plant in the US, it was important to consider not only the transportation cost per unit, but also the inventory costs. The costs considered in this approach were:

1. Transportation Cost
2. Ordering Cost
3. Safety Stock Holding Cost
4. Cycle Stock Holding Cost
5. In-transit Stock Holding Cost

8.3. Continuous Review Policy

Given that ABB could not afford having stock outs in a newborn operation, a safe inventory policy was selected. The Continuous Review (s, Q) Policy reviews the inventory levels everyday and, whenever the inventory on hand in the warehouse falls below a reorder point s, an order is triggered to the supplier by the amount Q.

The following assumptions were used in applying the model:

- The customs and duties costs are irrelevant to the comparison since these are the same in all three transportation modes.
- The goods are purchased under the Ex-Works (EXW) Incoterm, in consequence, ABB holds responsibility for the in-transit stock.
- Demand is assumed to be normal, and can be described by its average and standard deviation.
- A required service level is set by ABB
- The cost of holding inventory is assumed to be the WACC (Weighted Average Cost of Capital)

8.3.1. Reorder Point and Safety Stock

Simchi-Levi et al. (2003, p. 59) define the reorder point *s* as consisting of two components: the average demand during lead-time and the safety stock. The following formula represents these components:

$$s = L \times D + z \times \sigma_D \times \sqrt{L}$$

Equation 1. Reorder Point s in a Continuous Review Policy

Where:

- L is the replenishment lead-time from the supplier to the ABB plant in the US. It adds up the production lead-time and the transportation lead-time.
- D is the average daily consumption of the component at the ABB plant in the US
- Z is the safety factor associated with the required service level. In Excel, it can be found by applying the formula NORMSINV (service level in percentage).
- σ_D is the standard deviation of the consumption of the component (and also the forecast error) at the ABB plant in the US

However, it is common to observe that, in addition to the demand, lead time also behaves as a random variable. Silver, Pike and Peterson (1998, p. 283) mention an adjustment to take care of this variation, assuming independent increments:

$$s = L \times D + z \times \sqrt{L \times \mathrm{var}(D) + D^2 \times \mathrm{var}(L)}$$

Equation 2. Reorder Point s considering variability in lead time

Where:

- Var(D) is the variance of the consumption of the component at the ABB plant in the US
- Var(L) is the variance of the replenishment lead time from the supplier to the ABB plant in the US. It considers both the production lead-time and the transportation lead time.

Following, an example of the application of the theory is explained. An undisclosed component to be sourced from Mexico has a daily demand of 27 units and a standard deviation of 18 units. Partly, since the coefficient of variation is lower than 1, the use of the normal distribution to develop safety stock calculations may be considered reasonable. The following figure depicts the lead times and standard deviations of the replenishment period, under the three different transportation modes.

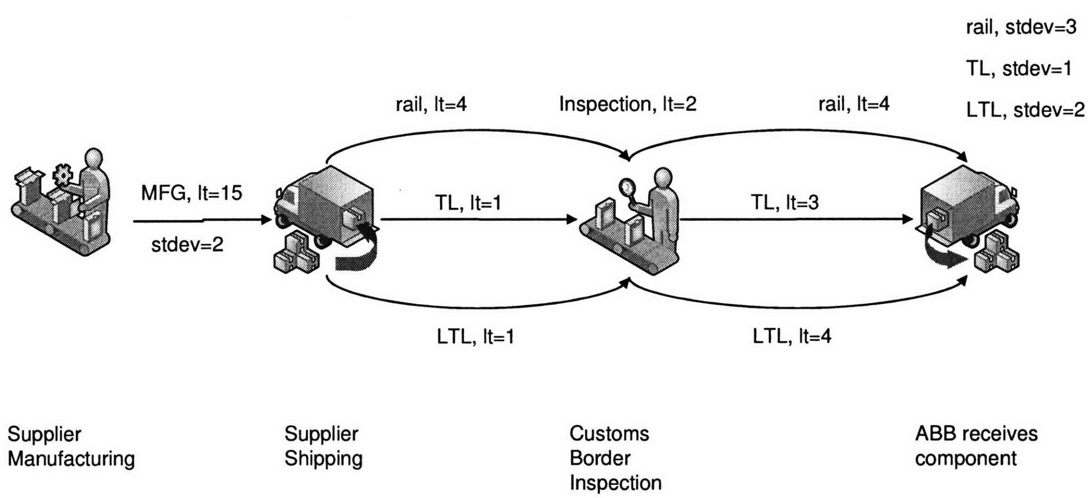

Figure 20. Lead Times and Standard Deviations of Replenishment

In order to find the total days of the replenishment cycle for each option, the lead times and standard deviations were added[7]. In this case, production lead-time and inspection at the border

---

[7] Standard deviations cannot be added directly. If time increments are independent, it is necessary to add the variances and then square root the result.

were the same for the three alternatives. The following table shows the results, along with the calculations for reorder point and safety stock; it utilizes a 95% service level, a unit price of $30.55 and a holding cost of 15%.

	TL	LTL	Rail	
Total Average Lead Time	21.00	22.00	25.00	days
Total Standard Deviation in Lead Time	2.24	2.83	3.61	days
Safety Stock	169	188	218	units
Reorder Point	729	774	885	units
Safety Stock Holding Cost	$ 774	$ 860	$ 999	dlls

Table 6. Reorder Point and Safety Stock for each transportation alternative

8.3.2. Optimal Order Quantity

Once that the reorder point and the safety stock are known, the next step is to calculate the order quantity that is triggered to the supplier. One approach is the Economic Order Quantity, introduced by Ford W. Harris in 1915, which consists of a simple illustration of the trade-offs between ordering and storage costs (Simchi-Levi, Kaminsky, & Simchi-Levi, 2003, p. 47).

$$Q^* = \sqrt{\frac{2AD}{vr}}$$

Equation 3. Economic Order Quantity

Where:

- A is the ordering cost incurred each time the warehouse triggers and order to the supplier
- D is the annual demand
- v is the unit cost of the purchased component
- r is the inventory holding cost, which in this case will be assumed to be the WACC applied by the finance department to any investment project

For ABB Mexico, the ordering cost *A* was derived from real costs of operation, as suggested by Silver, Pike and Petersen(1998, p. 46), and included the following costs:

- Cost of time utilized by buyer to place an order and handle incoming invoices

- Cost of time utilized by warehouse personnel to receive and handle a shipment
- Telephone, IT, office space and printing costs of placing an order

Next table shows the EOQ parameters for the undisclosed part number being analyzed:

Cost per unit (v) dlls	Holding Cost (r/WACC)	Order Cost (A) dlls	Demand (D) units per year
$30.55	15%	$30.77	9,600

Table 7. EOQ Parameters

Nevertheless, the Economic Order Quantity does not incorporate the transportation costs. To solve this problem, two different approaches were taken and are explained in the following sub sections.

8.3.2.1. Optimal Order Quantity for Truck Load and Rail

Swenseth and Godfrey (2002) detail the derivation of the EOQ Inverse Model, which provides a constant charge per shipment to the original EOQ formula. The resulting EOQ adds the TL charge to the cost of placing an order, which is depicted by the following equation:

$$Q^* = \sqrt{\frac{2D(A + F_x W_x)}{vr}}$$

Equation 4. EOQ Inverse Model

Where:

- F_x is the TL freight rate per pound at the full TL shipping weight
- W_x is the full TL shipping weight

In plain words, F_x times W_x is nothing else than the standing quote for a full container. Since both TL and Rail carriers handle full containers, the approach was valid for both options. The following table shows the calculated EOQ, based on the parameters of Table 7:

	Container Cost dlls	Q (units)	Cycle Stock Cost
TL container	$ 4,150	4,185	$ 9,590
Rail container	$ 2,075	2,970	$ 6,806

Table 8. EOQ Calculated for TL and Rail

8.3.2.2. Optimal Order Quantity for Less than Truck Load

LTL carriers provide quotes where the freight rate decreases as the shipping weight increases, which derives from the economies of scale faced by the carrier and the decrease in consolidation costs. In this case, a LTL quote for an undisclosed destination in ABB NA of an undisclosed carrier reads as follows:

range (pounds)	SLP to Laredo	Laredo to Final Destination	Rate	Type
Minimum charge			**$ 100.00**	Fixed
0 - 500	$ 0.25	$ 0.33	**$ 0.58**	Per pound
501 - 1000	$ 0.20	$ 0.26	**$ 0.46**	Per pound
1001 - 5000	$ 0.10	$ 0.13	**$ 0.23**	Per pound
5001 - up	$ 0.07	$ 0.09	**$ 0.16**	Per pound
TL rate			**$ 4,150**	Fixed

Table 9. Nominal LTL freight rate

The problem of EOQ with range rates is the difficulty of inserting this information into the formula. The best alternative to solve this problem is to define an optimization model and, supported by MS Excel Solver, find the optimal order quantity after considering the different ranges. The objective function of the model is to minimize a subset of the Total Cost, defined by the following objective function:

MIN: Transportation Cost + Ordering Cost + Cycle Stock Holding Cost

These three Costs depend on the weight of the Order Quantity, which is the variable modified by the Solver engine. The Ordering Cost and Cycle Stock Holding Cost components of the objective function are straightforward to calculate, and will be explained in the following sections.

However, the Transportation Cost is a discontinuous function given by the values in Table 9, where the rate depends on the Order Quantity selected.

After running MS Excel Solver to solve the objective function, with a weight of 7.5 lbs/unit, the following results were obtained:

	Q (units)	Q (pounds)	Cycle Stock Cost
LTL service	667	5,003	$ 1,528

Table 10. Optimal Order Quantity for LTL freight

8.3.3. Cycle Stock Holding Cost

The cycle stock holding cost represents the costs of carrying inventory over a period. It depends directly on the Optimal Order Quantity (Q), since the average inventory over a period is Q/2. The following equation represents the cycle stock holding cost:

$$CycleStockHoldingCost = \frac{Qvr}{2}$$

Equation 5. Cycle Stock Holding Cost

Once the Optimal Order Quantities were calculated for the three transportation alternatives, the Cycle Stock Holding Cost was calculated having as common parameters v and r, which were defined in subsection 8.3.2. The following table summarizes the results:

	TL	LTL	Rail	
Cycle Stock Holding Cost	$ 9,590	$ 1,528	$ 6,806	dlls

Table 11. Cycle Stock Holding Cost

8.3.4. In-transit Stock

Since the components are purchased under the EXW incoterm, it is important for the company to accrue the in-transit inventory costs into the transportation mode decision. The in-transit holding cost is defined by:

$$In\ transit\ holding\ cost = AnnualDemand(D) \times \left(\frac{daysInTransit}{daysInYear} \right) \times unitCost(v) \times carryingCost(r)$$

Equation 6. In-Transit holding cost

The following table shows the in-transit cost for each transportation alternative, over a period of a year:

	TL	LTL	Rail	
Total TransitTime	6.00	7.00	10.00	days
In Transit holding cost	$ 723	$ 844	$ 1,205	dlls

Table 12. In-Transit Inventory Holding Cost

8.3.5. Ordering Cost

The order cost depends directly on the Optimal Order Quantity, since it represents the amount spent when placing each order. It is defined by the following equation:

$$OrderingCo\ st = \frac{AD}{Q}$$

Equation 7. Ordering Cost

Once the Optimal Order Quantities were calculated for the three transportation alternatives, the Ordering Cost was calculated, and it is shown in the following table:

	TL	LTL	Rail	
Optimal Order Quantity	4,185	667	2,970	units
Orders Per Year	2.3	14.4	3.2	orders
Ordering Cost	$ 71	$ 443	$ 99	dlls

Table 13. Ordering Cost

8.3.6. Transportation Cost

The transportation costs depend on the number of orders per year, for the TL and rail services, while it depends both on the order quantity and the number of orders per year for the LTL service. Next table represent the transportation costs:

	TL		LTL		Rail	
Optimal Order Quantity		4,185		667	2,970	units
Orders Per Year		2.29		14.39	3.23	orders
Container Cost (TL and rail)	$	4,150			$ 2,075	dlls
Price Range (LTL dlls per pound)			$	0.16		dlls
Transportation Cost	$	9,519	$	14,031	$ 6,706	dlls

Table 14. Transportation costs

In addition to the rate of $0.16, a 20% Fuel Surcharge is required for the LTL service.

8.4. Final Results

The final comparison among the three transportation alternatives is shown in the following table:

	TL		LTL		Rail	
Transportation Cost	$	9,519	$	14,031	$	6,706
Ordering Cost	$	71	$	443	$	99
Safety Stock Holding Cost	$	774	$	860	$	999
Cycle Stock Holding Cost	$	9,590	$	1,528	$	6,806
In-transit Stock Holding Cost	$	733	$	855	$	1,222
Total Annual Logistics Cost	**$**	**20,687**	**$**	**17,718**	**$**	**15,833**
Annual demand		9,600				
Logistics Cost per unit	**$**	**2.15**	**$**	**1.85**	**$**	**1.65**
Unit Cost EXW	$	30.55				
Total Unit Cost at Destination	**$**	**32.70**	**$**	**32.40**	**$**	**32.20**
Optimal Order Quantity (units)		4,185		667		2,970
Orders per year		2.3		14.4		3.2
Safety stock level (units)		169		188		218
Reorder point (units)		729		774		885
Frequency of shipments (weeks)		22.7		3.6		16.1

Table 15. Comprehensive Comparison among LTL, TL and Rail

In this case, the best alternative is the rail service, which despite having a high cycle stock holding cost, significantly reduces the transportation cost.

8.5. Chapter Summary

This chapter covered an important element of the knowledge of the ABB SLP Supply Organization. Being able to compare total spend versus part cost is a requirement for procurement organizations, that allows making educated decisions regarding the best sourcing alternatives for each part. The proposed methodology to calculate Total Spend followed an example to determine the best alternative to ship goods from San Luis Potosi to a plant in the United States. The relevant costs for this task were transportation cost, inventory holding costs and ordering costs.

9. Future State Organization View

9.1. Chapter Introduction

This chapter describes the methodology followed to propose an organization to operate the Supply Processes as well as the best performance indicators. Two key points from section 6.2 were applied to this section:

- The process's design drives role definitions and job descriptions
- The process has end-to-end metrics derived from customer requirements

The chapter starts by analyzing the skillset of the employees in the organization, continues by proposing an organization chart and finalizes by proposing the best metrics to meet the organization objectives.

9.2. Human Resource Requirements

A job analysis methodology was followed to determine the organization that would better support the execution of the required processes. Based on the job analysis methodology proposed by Gomez-Mejia (2007, pp. 57-59), the following activities were executed for each evaluated job – Sourcing Specialist and Logistics Specialist –:

1. Work Flow Analysis (review Chapter 7)
2. Knowledge, Skills and Abilities (KSA) Analysis
3. Definition of the Job Description

The KSA Analysis was performed by creating a KSA matrix, which lists in one edge the Job Tasks and in the other, the KSA required to perform the taks. Then, the extent to which each KSA is relevant to execute each task is rated with a 1(very low importance) to 5(very high importance) scale. The information required to execute the KSA analysis was obtained mainly by the observation and daily interaction with the Sourcing Specialists, and by the author performing some of the job activitites by himself[8].

9.2.1. Sourcing Specialist Job Analysis

While section 7.3 focused on the work flow of the sourcing process, this section focuses on determining the knowledge, skills and abilities (KSA) required to succesfully perform such process. The resulting matrix for the Sourcing Specialist is presented in next table:

	Knowledge, Skills and Abilities					
Job Task	Technical Expertise	Communication and Interpersonal	Decision Making and Initiative	Negotiation	Planning	Analytical and Problem Solving
Locate vendors of materials	5	4	3	1	3	2
Create RFQ Package	3	3	2	1	1	1
Track Progress of RFQs	1	5	3	2	5	2
Analyze and Negotiate quotes	5	5	5	5	2	4
Analyze supplier assessment	5	2	5	2	2	5
Request samples/trial orders	5	5	3	2	2	3
Track progress of samples/trial orders	2	3	3	3	5	3
Set purchase orders	3	5	3	5	5	1
Track purchase order progress	1	5	3	3	5	3
Maintain records of quality and delivery of purchased goods	4	3	1	2	5	3
	34	40	31	26	35	27

Table 16. Task by KSA Matrix for Sourcing Specialist

The following insight can be extracted from the previous matrix:

- Communication and Interpersonal Abilities were ranked highest, which makes sense since employees in this position must interact with suppliers, commodity team leaders,

[8] The author executed the supplier selection process in order to obtain quotes for LTL, TL and Rail transportation modes.

quality engineers and peers. Moreover, most of the time they have to visit suppliers facilities, make phone calls to track progress of different sub-processes and communicate progress to commodity leaders.

- Planning Abilities are ranked second since timelines must be followed in order to meet deadlines. Employees in this position must coordinate cross-functional teams and keep track of each commodity being sourced.
- Technical Expertise refers to the specific industry knowledge that employees require to execute these tasks. Employees in this position must be able to understand technical drawings and specifications and must also be knowledgeable on the production processes of different commodities.
- Negotiation ability ranked low because the skill appears as very important only in two of the job tasks: Analyze and Negotiate Quotes, and Set Purchase Orders. However, these tasks are basic to the success of the overall low-cost-country initiative, so the employees in this position must be strong in negotiation skills as well.

Based on previous findings, the following job description was elaborated:

Job Title: Sourcing Specialist

Job Duties and Responsibilities:

1. Finds and keeps a record of potential suppliers for the required manufacturing processes.
2. Executes the Request for Quotation process with several suppliers; Creates RFQ packages containing component specifications, instructions for the supplier and deadlines for the supplier; Keeps record of progress of the standing RFQs sent to suppliers and assures the reception of quotes to meet deadlines.
3. Negotiates proposed quotes to obtain savings for the organization.
4. Analyzes the results of supplier quality assessments and determines whether the supplier is capable of soucing components to ABB or not.
5. Requests samples and trials orders and keeps track of the progress and quality of these orders.
6. Sets Purchase Orders and keeps track of quality and delivery of components.

Job Knowledge, Skills and Abilitites:

1. Technical Expertise. The employee must be knowledgeable in the specific processes to be sourced (e.g. metal- mechanic or electrical/electronic).
2. Communication and Interpersonal abilities are required to obtain information from different sources and to communicate results to managemet. Employees in this position are the face of the organization with suppliers.
3. Planning skills are required to keep track of standing RFQs, samples and trial orders
4. Negotiation skills are required to bring savings to the organization.
5. Analytical abilities are required to organize and understand the incoming information.

Figure 21. Job Description for Sourcing Specialist

9.2.2. Logistics Specialist Job Analysis

While section 7.4 focused on the work flow of the temporary importation process, this section focuses on determining the knowledge, skills and abilities (KSA) required to succesfully perform such process. The resulting matrix for the Logistics Specialist is presented in next table:

	Knowledge, Skills and Abilities					
Job Task	Technical Expertise	Communication and Interpersonal	Decision Making and Initiative	Negotiation	Planning	Analytical and Problem Solving
Assess and select transportation suppliers	3	4	4	5	5	4
Schedule freight pick up of goods (inbound/outbound)	4	4	3	3	5	3
Generate documentation for Customs Broker and Customs Authority	5	4	1	1	3	2
Track progress of inbound/outbound transportation	3	3	5	3	5	5
Resolve potential delays in delivery and resolve customer complaints	3	3	5	4	3	5
Monitor spending to ensure that expenses are inline with budget (transportation, customs and duties)	4	2	4	3	5	3
Prepare documentation for government audits	5	3	1	1	4	2
	27	23	23	20	30	24

Table 17. Tasks by KSA matrix for Logistics Specialist

The following insight can be extracted from the previous matrix:

- Planning skills are in the highest rank of this set of tasks, which makes sense since logistics processes are most about planning.
- Technical expertise refers to the knowledge required about transportation modes, transportation lead times, inventory planning and, of course, laws and regulations that apply to international trade activities.
- Analytical and problem solving appear also in the high end, since employees in this position must deal with delays in transportation; they must be able to analyze the problems and propose alternate solutions. This characteristic is related closely to their ability to communicate and the decision-making ability, which ranked next on the line.

Based on previous findings, the following job description was elaborated:

Job Title: Logistics Specialist

Job Duties and Responsibilities:

1. Assesses and selects transportation suppliers based on quotations and service levels.
2. Ensures the on-time delivery of inbound components from suppliers and outbound finished goods from manufacturing site; schedules the pick up windows frames for the transportation suppliers and keeps track of transportation lead times.
3. Resolves delays on transportation and resolves internal customer complaints about delivery.
4. Generates documentation for the importation/exportation activity, as required both by the Customs Broker and the Customs Authority.
5. Maintains an up to date database of importation and exportation activity to present documentation to government oficials during audit processes.
6. Monitors spending to ensure that expenses are inline with budget.

Job Knowledge, Skills and Abilitites:

1. Planning skills are required to develop transportation tactics and long-term strategies.
2. Technical expertise. The employee must be knowledgeable in different transportation

modes, inventory planning and importation/exportation programs of Mexican government.

3. Analytical and Problem Solving skills are required to support most of the work in this job, and must be accompanied by outstanding communication and decision-making abilities.

Figure 22. Job Description for Logistics Specialist

9.3. Organization Structure

The short-term organization chart of the enterprise – Supply Organization –, as proposed to ABB Program Management, is depicted by the following figure.

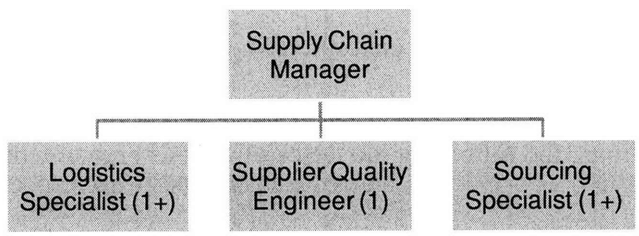

Figure 23. Short-term Supply Organization for ABB SLP

In addition to the two job descriptions analyzed in section 9.2, the author proposed to hire a Supplier Quality Engineer. The reason to suggest this position into the team was that during the supplier assessments, the team had to rely on getting time from a Manufacturing Quality Engineer from a different location to perform the supplier quality assessments. This mechanism delayed the approval or rejection of potential suppliers. But the most important reason to propose this position is the fact that, in the near future, the objective of the Supply Organization was not only to provide sources of components and materials, but to establish long-term supplier relationships as the one described in section 6.4. This objective would be targetted by the additional position.

Next figure presents a short job description of this position:

Job Title: Supplier Quality Engineer

Job Duties and Responsibilities:

1. Ensures process and infrastructure quality of selected suppliers.
2. Measures quality of supplied parts; keeps a record of supplier quality delivery.
3. Helps ABB suppliers to develop from a low level of quality to world-class supplier.

Job Knowledge, Skills and Abilitites:

1. Masters different Quality Systems (ISO 9000, ISO 14000).
2. Masters different Production Systems (Six Sigma, Lean Manufacturing).
3. Has Technical Expertise in the industry processes, materials and components.

Figure 24. Job description forSupplier Quality Engineer

9.4. Organization Metrics

Metrics –or indicators- are, according to Franceschini (2007, p. 10), the communication protocol of an enterprise health state to the outside world, and have three basic functions:

- Control. Indicators enable managers and workers to evaluate and control the performance of the resources which they are responsible.
- Communication. Indicators communicate performance not only to internal workers and managers for purposes of control, but also to external stakeholders for other purposes. Poorly developed or implemented indicators can lead to users feeling frustrated and confused.
- Improvement. Indicators identify gaps (between performance and expectation) that ideally point the way for intervention and improvement.

As discussed in section 5.3, the only metric measured in the ABB Supply Organization, at the time of the study, was the "Annual savings target". However, in section 6.2 we learned that metrics should cover the end-to-end process and must be based on customer requirements. Therefore, the "annual savings target" single metric had four oportunities:

1. Opportunity A. The metric is calculated based on unit cost, and not on landed cost (including transportation or inventory costs).
2. Opportunity B. "Annual Savings" may be an effective metric during the initial phase of low-cost-country-sourcing, since the lower labor costs in Mexico reduce the cost of sourced parts when compared to supplier costs in the US or Canada. However, after first-time savings that can be large, the task of obtaining further savings depends on the ability of the enterprise to develop long-term relationships with the suppliers. Moreover, during the starting phase the indicator is risky since the team may be tempted to select those suppliers that offer the highest savings, while quality or delivery are poor!
3. Opportunity C. "Annual savings" measures financial results, which from the senior management perspective are the logical thing to measure; however, it does not measure process performance, which would allow operation managers to improve process performance. For example, if the SLP Supply Organization meets the annual financial target during a year, then senior management is pleased and assumes a perfect operation. What if the team spent twice as much time as required because of delays or rework?
4. Opportunity D. "Annual savings" is not tied to the compensation of the team members, either as a variable compensation or as an annual bonus. Moreover, the indicator applied only to the SLP Supply Organization, while the rest of the people involved in the process did not see it as a performance indicator of their work.

9.4.1. Countermeasures for Opportunity A

The basic countermeasure for considering unit costs when calculating savings is to invite managers to utilize a methodology as the one proposed in chapter 8, which adds transportation and inventory holding costs to the unit cost of the part. In addition to the model proposed in this thesis, Morita (2007) developed a Total Cost Model for Making Sourcing Decisions for ABB, which includes other costs such as risks and changes in assets and liabilities. Senior Management can force operative managers to utilize this type of models by disregarding any savings that do not follow a Total Cost Model.

9.4.2. Countermeasures for Opportunity B and C

Kaplan and Norton (1992) introduced the concept of Balanced Scorecard, which allows managers to look at the business from four important perspectives. The following figure represents the model and the suggested metrics for the SLP Supply Organization:

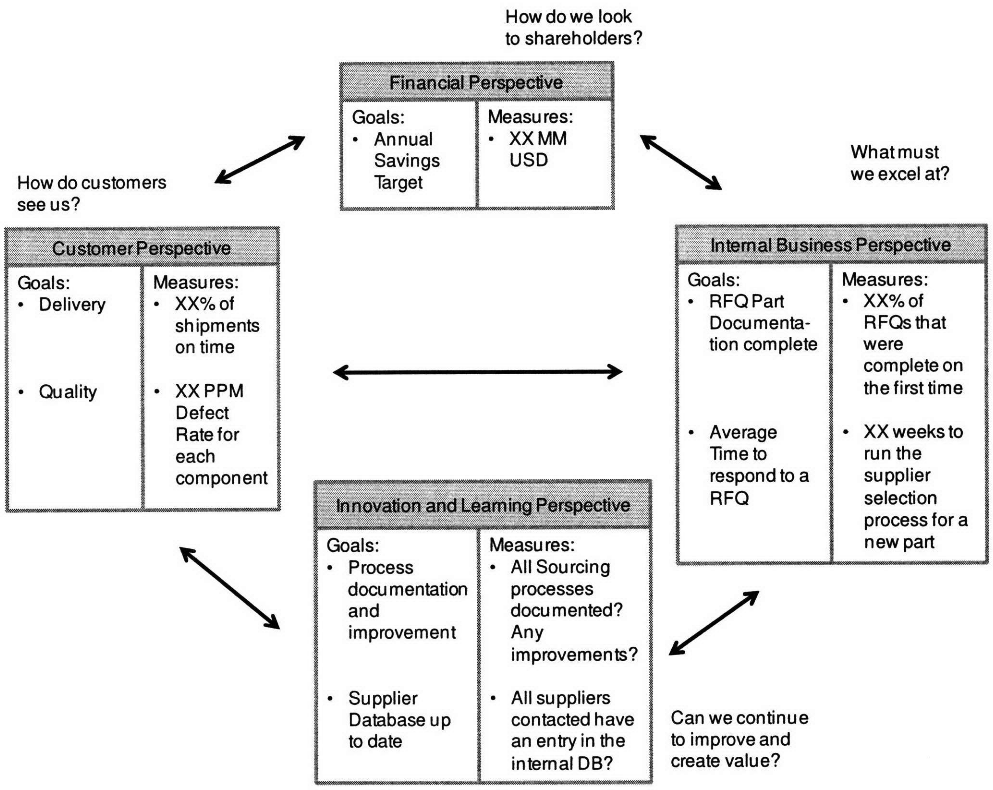

Figure 25. Balanced Scorecard for SLP Supply Organization[9]

During the internship, the author implemented a simple way of keeping record of the metrics suggested for Internal Business Perspective. During a period where the author took the team-leader role for the Sourcing Specialists Team, the team members created a Gannt chart for each commodity in the RFQ process. The objective of the Gannt chart was to keep track of the duration of each step in the Supplier Selection Process, and to document any possible delays. Nevertheless, the internship ended before recording a significant amount of data.

[9] Adapted from Kaplan, R. S., & Norton, D. P. (1992)

9.4.3. Countermeasures for Opportunity D

Gomez-Mejia (2007, p. 301) defines an employee's compensation with three components: base compensation, pay incentives and indirect benefits. Base compensation is the fixed pay an employee receives on a regular basis in the form of a salary; pay incentives are programs designed to reward employees for good performance; and indirect benefits encompass a wide variety of programs, such as health insurance, vacation or retirement plans. Employees in SLP Supply Organization received two of these components: base compensation (65% of total) and benefits (35% of total).

Following the standards in the US, where on average 75% of firms offer some form of variable pay, with an average of at least 10% of total compensation (Gomez-Mejia, Balkin, & Cardy, 2007, p. 305), ABB Mexico should link the results of the Balanced Scorecard proposed in previous section to an annual performance bonus to the employees. More than that, all the employees that contribute to the Sourcing process should have part of their annual bonuses tied to the indicator. In section 7.3, the process diagrams included the following personnel in the process:

- Purchasing Department employees are the ones that start the Supplier Selection process by sending the complete documentation to create the RFQs. As it was discussed in section 7.3, a cause of delay for the entire process was the inadequate documentation of specifications.
- Quality Assurance employees are responsible for analyzing samples and trial orders of potential suppliers. Sometimes the QA process was delayed due to tasks of higher priority.

By creating a link of the Supply Organization Balanced Scorecard to all the involved in the process from start to end, employees develop a sense of urgency and commitment to the success of the SLP Supply Organization objectives.

9.5. Chapter Summary

This chapter described the organization of the enterprise, by creating the job descriptions for the primary positions, proposing an organization chart and proposing the metrics to measure performance. The primary tool to create the job descriptions for the main positions in the organization was the tasks by Skill-Knowledge-Ability matrix. The organization chart added a position that was not originally proposed, but that will be key to develop low-cost-country suppliers. The metrics for the organization were based on a Balanced Scorecard methodology, and a mechanism to link the metrics to the compensation of the employees was suggested.

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10. Future State Information Technology View

10.1. Chapter Introduction

"Information Technology is an important enabler of effective supply chain management" (Simchi-Levi, Kaminsky, & Simchi-Levi, 2003, p. 266). ERP systems and IT in general, allow the stakeholders of a supply chain enterprise to share information across the value chain, which results in faster response to changes in the environment, reduction of costs and, in some cases, a competitive advantage.

As already discussed in the Current State Chapter, ABB has a commercial ERP system that supports most of its core processes. However, IMMEX operation requires companies to have a specific computer system to assure that goods imported temporarily free of taxes will either return to a foreign country as part of a finished good or apply for a change of customs regime by paying the waived taxes. This chapter briefly describes both the requirements of the system and the software selection process implemented by the author while at ABB Mexico.

10.2. IMMEX Software Description

The main objective of the IMMEX inventory system is to keep track of component's temporary importation, making sure these components are exported before the 18 month period allowed by the program expires. A secondary objective of the system is to create the required documentation to manage the exportation process. Figure 19 in Chapter 7 depicted how the IMMEX system provided documents that are sent both to the MX Customs Broker and the US Customs broker.

The system must contain the following elements, as described in the law (Ley Aduanera, Anexo 24):

1. Catalogs
    a. General business information
    b. Materials and Components
    c. Final Products

2. Customs Module
    a. Temporary Importations
    b. Exportations and other outputs (scrap, change of customs program, donations, etc.)
    c. Fixed Assets Module
3. Process Module
    a. Bill of Material Explosion
    b. Part consumption (using FIFO)
4. Reports Module
    a. Input Report of Temporary Imports
    b. Output Report of Temporary Imports
    c. Balance of Temporary Imports

Sections 1 and 4 are reports that the Customs Authority must have access to, when executing an audit to the company. The IMMEX system must be directly linked to the ERP system, since the Bill of Materials allows the proper consumption of components when a finished good is produced. The basic information inflow of the system is depicted in Figure 26.

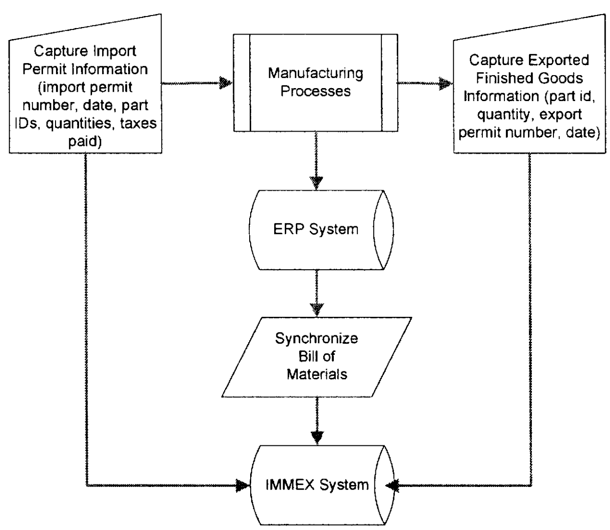

Figure 26. Basic Information Inflow of IMMEX System

The key subsection of the system is "3.b Parts consumption (using FIFO)". This section must discount part number amounts from the Import Permits captured in the internal database, when these parts are exported as part of a finished good. Figure 27 depicts the internal logic of this portion of the system.

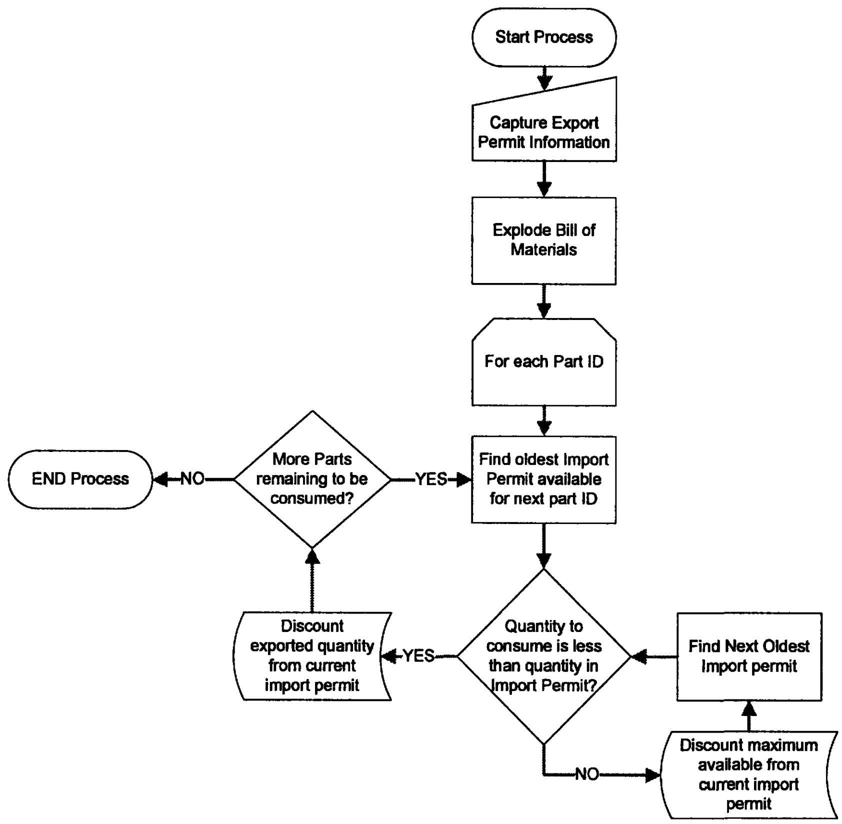

Figure 27. Internal FIFO Logic of IMMEX System for Parts Consumption

Despite its simplicity, the IMMEX system requires periodical updates, since the documentation sent to the customs brokers must be up to date with changes in the law. These changes can be as frequent as every month, and are commonly related to Tariff Codes being either exempted of certain taxes or charged with new taxes. Mexican Government publicizes changes in all its laws in a daily publication called "Diario Oficial de la Federacion", which is usually read by attorneys, lawyers and government bureaucracy[10].

[10] And MIT interns

10.3. Software Selection Process

The first decision to make regarding the IMMEX system was to decide whether to buy it or to develop it in house. Beckman and Rosenfield (347) recommend analyzing two dimensions regarding an IT investment: (1) is the supported process core or enabling and (2) is the context stable or evolving. Next table summarizes the decision guidelines:

	Core Business Process	Enabling Business Process
Stable	Modify standard packages, ensuring support with the evolving core	Implement standard packages
Evolving	Build custom software in house or with a third party developer	Consider outsourcing the process to and organization for which it is core

Table 18. Categories of IT investment(Beckman & Rosenfield, 2008, p. 348)

Supporting the IMMEX operation is an enabling process, since it is not part of the competitive advantage of the company. In addition, it exists within an evolving context, since changes in laws are frequent. For these reasons, the best alternative was to consider outsourcing the process to a company specialized in this market niche. Nevertheless, the in-house development option was evaluated, but from the cost perspective, it was too expensive since it required dedicated personnel keeping track of changes in the law and then implementing these changes in the system.

In order to make an informed decision, the author designed a process to evaluate software vendors, which was executed by a cross-functional selection committee of ABB personnel. The selection process, as opposed to the one depicted in Figure 15, would base the decision on other aspects aside of low cost. Figure 28 depicts the four steps of the selection process:

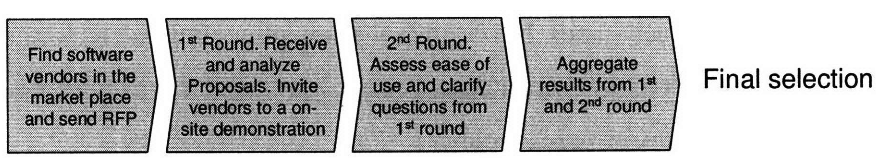

Figure 28. Software Selection Process

The first step consisted in finding vendors in the market place. This part was completed both by doing internet searches and by benchmarking with international companies established in the region. Since the IMMEX operation is not a core process in any company, Supply Chain Managers were willing to share their experience about IMMEX software when cold-called by phone.

The second step consisted in elaborating a Request For Proposal document and sending it to the suppliers. The document requested vendors to answer a set questions grouped in five different aspects:

- Vendor Profile. Company size, annual revenues, number of employees, number of implementations of the IMMEX software, and a few contacts in companies that were utilizing their solution
- Functional Description. A questionnaire to assess if the proposed solution met the minimum requirements set by the law. The full description of the system specifying the contents of each module and report was listed in a spreadsheet, and vendors had to mark one of four options (system surpasses requested capability, system fulfills capability, system partially fulfills capability and system does not have the capability). If the requested capability was either exceeded or partially fulfilled, a clear explanation had to be attached.
- Technical Description. A questionnaire developed in conjunction with the IT department in ABB Mexico. It evaluated features such as technological platform, user security, support and maintenance, training, and documentation.
- Additional Features. In this section, vendors were free to list and describe any additional features – value added – of their software, such as linking to customs broker interfaces, automated download of updates regarding changes in the law, etc.
- Financial Proposal. Upfront payment, warranty and costs of different service level agreements.

The cross functional team created a balanced scorecard to weight the different variables; based on the results obtained from this scorecard, four suppliers were invited to execute an on-site demonstration.

The third step consisted in the evaluation of the on-site demonstration. All suppliers were provided with an agenda specifying the topics to cover and the questions to be answered. The objective was to directly assess features such as ease of use, and to answer any questions that arose as a result of the analyses performed in the second phase.

The fourth step consisted in aggregating the results and perceptions of both rounds of selection. The selected supplier was in a medium range in cost, while it met the functional and technical requirements. Additionally, it offered a difficult to measure added value: the country manager of the company was a former director of the Customs Authority in Mexico and had valuable contacts in Mexican Government.

10.4. Chapter Summary

This chapter described the importance of understanding the requirements of a business process in order to be able to make a decision regarding the supporting Information Technology. The Enterprise Architect must make sure that the selected solution fits within the objectives of the enterprise. In addition, knowing that a computer system is both a long term investment and a long term relationship with a vendor, it is imperative to analyze different factors other than price. In fact, this should be the approach taken to establish a relationship with any supplier for the enterprise.

11. Conclusions

11.1. Application of the Enterprise Architecture Framework to startup enterprises

In the globalized business environment of today's world, companies are facing new challenges related to opening new manufacturing and sourcing sites in foreign countries. In addition to the initial decisions to make – selecting a location or starting the construction –, the challenge of defining the operation emerges. Some of the questions that must be answered are: What are the processes to be executed? What is the organization that will support these processes? What will be the operation costs? What information technology will be required to support both the organization and processes? Unless the company is used to open new facilities periodically, the search for the answer to those questions can be quite overwhelming.

The enterprise architecting roadmap is a useful tool that allows the architecting team to consider all the different aspects needed to solve the architecting questions. The systems architecting origin of this framework states that everything is interrelated, and the decisions made regarding a building block of the system have an effect on the other building blocks. The architecting team must, in consequence, not only consider the internal details of each building block, but also their interrelationships.

There are four steps in this roadmap, and are summarized as follows: strategic motivation; scope and boundaries; current state and stakeholder analysis; and future state vision. The strategic motivation of the company and its context is the first aspect to understand, and gives the architect a general idea of why the decision to create a new enterprise arose. The scope and boundaries of the enterprise allow the architecting team to focus on the specific components that must be covered by the design. The current state analysis provides three important aspects: the stakeholders interests and values; the current state metrics and performance; and the current state views of the basic building blocks. This analysis describes the company's position and is the base point for the future state view, allowing the architect to decide which building blocks require more attention to details, depending on the stakeholders' interests and on the enterprise's current performance. The future state vision is composed of the views that are of utmost importance for the enterprise to produce the desired outcomes.

Once the key building blocks for the new enterprise are defined, the architecting team must rely on different sources of knowledge and experience to design the details. In this case, the architected organization required the application of knowledge from different branches, such as: process mapping, logistics cost analysis, organization design and information technology.

In summary, the enterprise architecting roadmap is an excellent tool that allows the creation of a new operation, by providing a clear path to follow in order to consider all the pertinent details.

11.2. Future Work

One of the classic philosophers of our civilization, Heraclitus of Efesus, based his thinking on a well know aphorism: "everything is in a state of flux"[11]. Applied to the contemporary business environment, the aphorism should warn managers that the external conditions of the enterprise always change and, in consequence, the internal architecture should adapt to match the new requirements.

In this case, the EA framework applied to a startup organization, which spanned multiple organizational and country cross-cultural lines, and was a clear departure from prior structures of the current enterprise. However, as the ABB SLP Supply Organization matures, the study should be recasted to match new expectations and to reach further levels of maturity that will increase the value of procurement as a competitive advantage for ABB.

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[11] *Wikipedia.* Retrieved April 22, 2008, from http://en.wikipedia.org/wiki/Heraclitus

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