Continuous Improvement at a Multinational Company - Dealing with Uncertainty in the Global Supply Chain and Analyzing Implementation Dynamics

By

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B.S. Engineering in Mechatronics, Universidad Panamericana, 2007

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 Global Operations Program at the Massachusetts Institute of Technology

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Abstract

This thesis explores the problem of global supply chain flexibility in the context of a multinational commonly that we refer to as Company X. Company X faces competitive markets, increasingly demanding customers, and internal challenges due to the global extension of previously local business processes. Company X aims not only to produce goods to meet customers' requirements but also to improve the performance of its fundamental business processes. Considering this reality, this thesis explores two main initiatives to accomplish sustainable continuous improvement: 1) maximize flexibility in the Global Value Chain while minimizing waste and variance, and 2) develop a methodology to ensure the successful implementation of improvements.

For the optimization of the Global Value Chain, the objective was to enable the company to grow its business as global opportunities present themselves. For this purpose, this thesis proposes a new planning process that both enables assessing the risk on supply and deliveries due to the variability of lead times and includes real options analysis in the planning processes for Region A. As a result, this Dynamic Strategic Global Sourcing Plan will make possible the creation of a plan that captures benefits from increases in project value and insures against losses from decreased project value.

In addition to the strategic and tactical work for the optimization of the Value Chain, it is a reality that large-scale transformation requires a deep understanding of the human side. The company's culture, values, people, mindset and capabilities must be changed to ensure a successful implementation of the improvements. On this line, a unique iterative perspective on managing the human side of change that can be adapted to a variety of realities was developed during the course of the research. This technique is iterative and adaptable because transformation is not a one-time event but an ongoing process and the company is a multinational corporation facing different situations on its locations.

Overall, the aim and tasks of the thesis deal with sustaining continuous improvement in a dynamic Global Value Chain environment. The Dynamic Strategic Global Sourcing Plan will enable Company X to respond effectively to changes and the Change Management Process will ensure the implementation of the processes needed to make that effective response possible.

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1 Introduction

1.1 Company Overview

With annual sales of US$20.8 billion in 2011 and more than 57,000 employees worldwide, the multinational commonly where the research was done, hereafter referred as Company X, is a diversified consumer product goods (CPG) corporation that combines technology with the human side (culture, values, people, behavior, etc.) to constantly improve in essentials for a better life.

Company X global brands are sold in more than 175 countries, connecting consumer products and innovation with environmental stewardship to provide professional, health care and personal care products.

1.2 Thesis Motivation

Company X faces competitive markets, increasingly demanding customers, and internal challenges due to the global extension of previously local business processes. Thus, it aims not only to produce goods to meet customers' requirements but also to improve the performance of its fundamental business processes at a local, regional and global level.

The globalization of the value chain requires changes on the way the business is organized and operates because the activities are scattered internationally. This transformation requires adjustments on the operational side, management infrastructure, and mindset and capabilities. Embedded in the global value chain, enterprise's global supply chain is a "backbone process" to meet company's global growth and strategy for now and in the future. For this reason, Company X has recently made a transition from local to a regional/global procurement system. To illustrate, Figures 1.1, 1.2, and 1.3 show how the company has recently changed the supply mix between domestic and import goods, for a group of raw materials, from 2002 to the first semester of 2012.

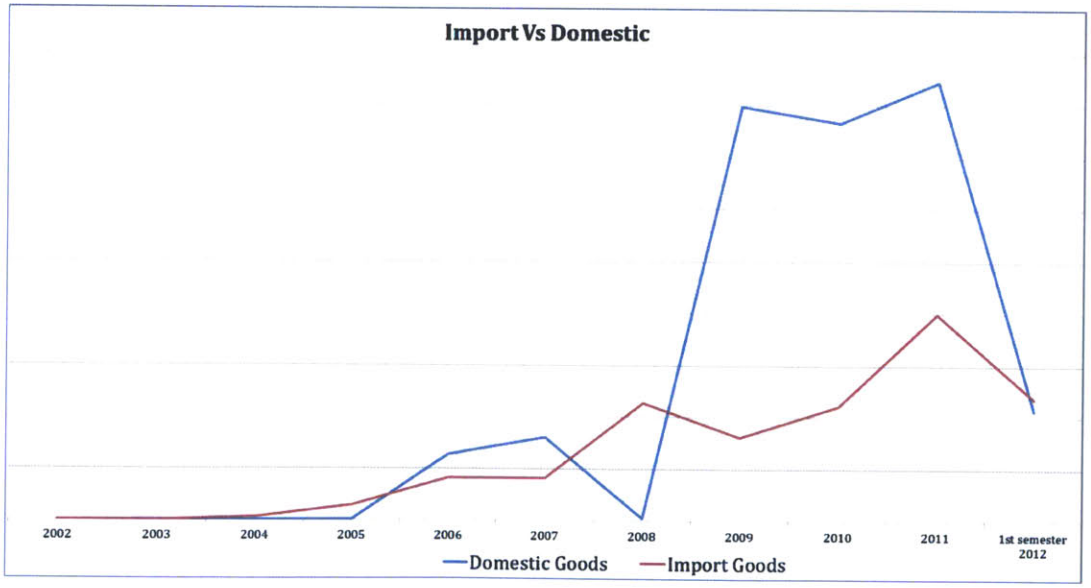


Figure 1.1 – Quantity of domestic and import goods from 2002 to the first semester of 2012
Note: actual values have been removed to protect proprietary data

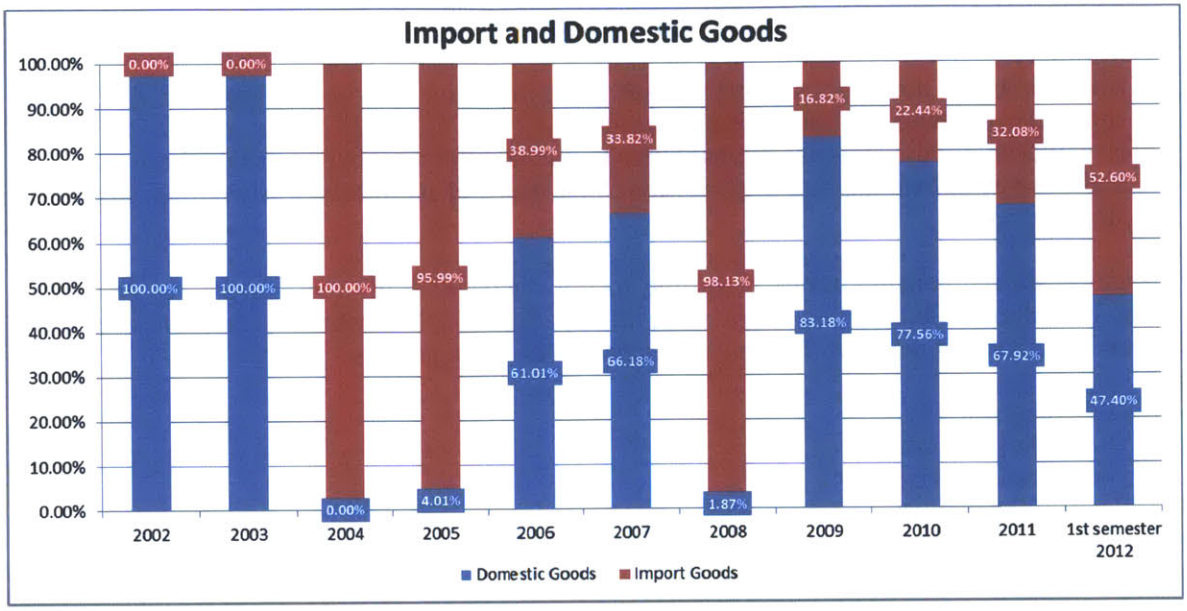


Figure 1.2 – Import and domestic goods from 2002 to the first semester of 2012

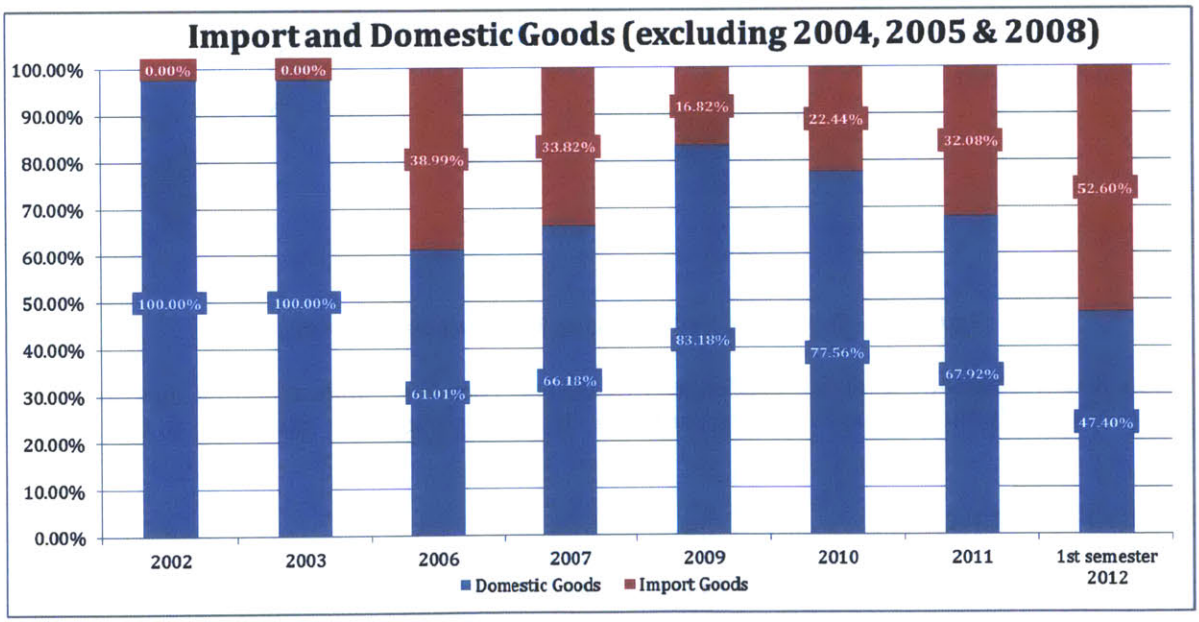


Figure 1.3 – Import and domestic goods from 2002 to the first semester of 2012 (excluding 2004, 2005 & 2008)

Moreover, turning a local value chain into a global value chain (including global supply chain) presents new challenges (RSM McGladrey and The Manufacturing Institute, 2007):

1. Adequate supply chain management to minimize waste and variance and maximize flexibility.
2. Acceleration of continuous improvement and innovation activities to respond quickly to changes in demand and competitors' actions.
3. New workplace dynamics and capabilities to manage and sustain operational improvement and the way individuals and organization think, feel, and act to ceaselessly pursue customer satisfaction.

Furthermore, special considerations arise due to the region of study that consists of emerging markets, hereafter called Region A (Blanco, 2008). Figure 1.4 illustrates common countries considered as emerging markets. The challenges proper of the region are:

1. Political instability
2. Fluctuating regulations
3. Poor inventory visibility
4. Poor infrastructure
5. Lack of demand data
6. Cultural diversity

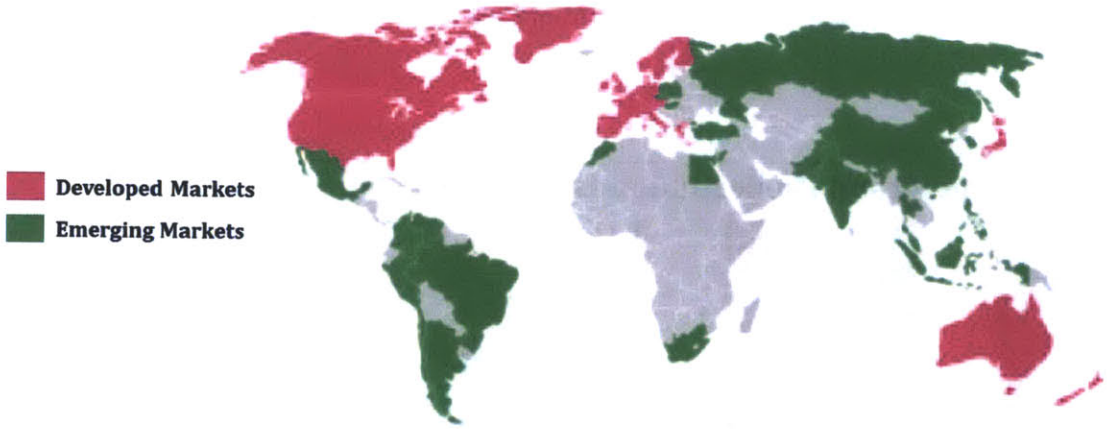


Figure 1.4 – Developed and Emerging Markets (Blanco, 2008)

Company X is not exempt from the challenges mentioned. Therefore, understanding how to deal and solve effectively these issues will create a major source of competitive advantage to Company X.

1.3 Problem Statement

Company X's transformation is not a one-time event but an ongoing process. On this line, this thesis will work on two main initiatives Company X can work on to accomplish a sustainable continuous improvement and, in turn, gain competitive advantage. The first initiative consists of an approach to include uncertainty on global supply chain planning in order to maximize flexibility and minimize waste and variance. The second proposal comprises an iterative and adaptable perspective to

manage the human side of change by matching the ever changing needs of the organization with the ever changing needs of the employees to ensure the successful implementation of improvements at a local, regional and/or global level.

1.4 Thesis Structure

The remainder of the thesis structure is as follows:

Chapter 2 outlines a description of the change, from local to global, of the supply chain and the challenges Company X is facing due to this transformation.

Chapter 3 describes the Dynamic Strategic Sourcing Planning proposed.

Chapter 4 depicts an analysis of process improvement dynamics and the change management process for the implementation of the initiatives.

Chapter 5 explores a case of study for the implementation of the Dynamic Strategic Sourcing Planning following the change management process suggested.

Chapter 6 contains the conclusions of the study and suggestions for future research activities to extend the reach of this project.

2 Supply Chain

2.1 From Local to Global

It is a reality that CPG's business environment is global. This global expansion of the value chain, including the supply chain, offers many gains in global efficiency such as being responsive to local markets, integrating and coordinating the global operations to achieve better economies of scale and scope, and transferring knowledge from one location to another. Nonetheless, the global extension of business processes gives rise to numerous obstacles in the form of internal changes, increased complexity, wider competition and local/global conscience. In the end, the effects of global expansion, due to the gains and obstacles, are significant on key factors that generate sustainable growth like, for instance, company's competitive advantage, its ability to grow the business as global opportunities presented themselves, and its capacity to insure against losses from decreased project value, just to mention a few.

As a consequence of the internationalization efforts of CPG industry, Company X changed dramatically its supply chain during the last ten years. As an example, Figure 2.1 presents the transformation of the supply for a group of raw materials for a specific region. As expected, this transformation at Company X was primarily driven by the pursuit of key benefits such as unifying regional/global purchases, reducing monopolistic behaviors from local suppliers, looking for options with the same quality and lower price, among others.

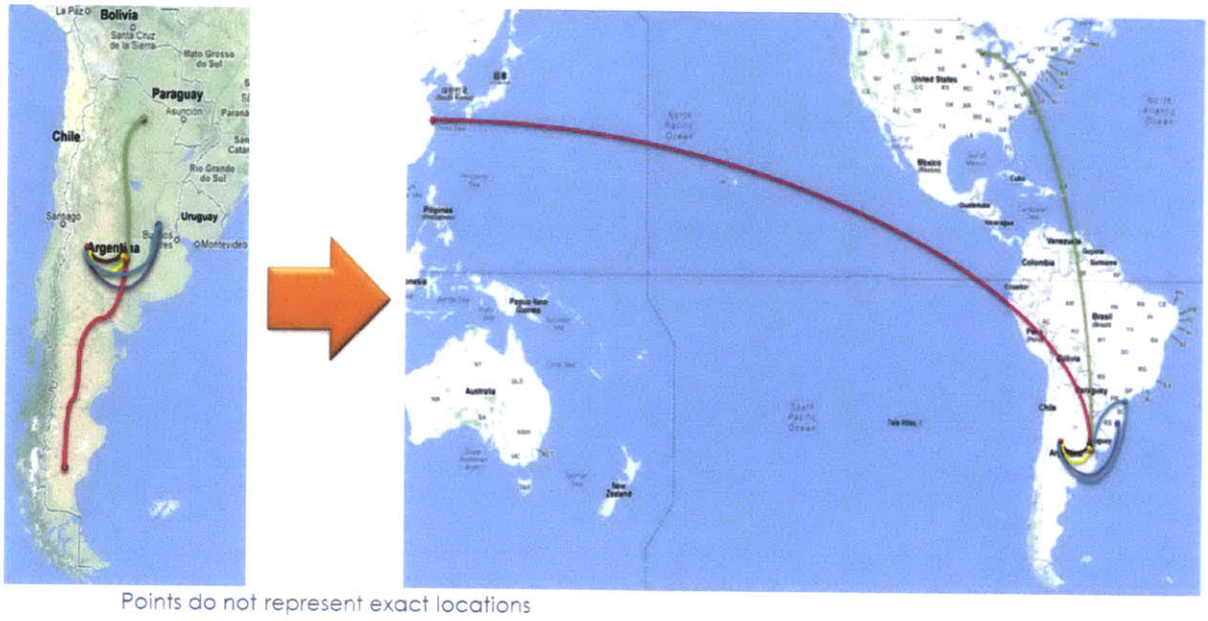


Figure 2.1 – Supply Chain transformation from local to global in 10 years (2002-2012)

However, this modification produced unintended consequences that are intrinsic from going global. The main effects Company X is facing are longer lead times; cultural, language, and time zone differences among stakeholders; and higher vulnerability to governments' decisions and regulation.

2.2 Lead Times

One of the main changes from moving the supply of a product from local to global can be seen on the lead times. This difference in lead times is mainly due to a variation in distance and an increase in activities for bringing the materials such as import/export processes, compliance with regulatory procedures, and others. It is important to consider both factors because if we consider only one factor at a time we are not looking the whole picture that Company X deals with.

In terms of the variation in distance, the majority of the new suppliers are further from the delivery point than the local suppliers and, in consequence, it takes longer time to transport the material from its origin to its destiny. On the other hand, a small number of suppliers are closer, in kilometers, than the previous suppliers; however, this does not necessarily mean that lead times are shorter because getting new supplier's materials requires additional processes, primarily from regulatory and legal nature.

Furthermore, the majority of the additional activities, from going global, that Company X does to get the materials to its destination are non-value added but necessary and their duration depend not only on Company X time to do the tasks, but also on the time that all the institutions involved take to complete these activities. To clarify, Figures 2.2 and 2.3 show examples of how generic supply process changed from local to global by land and by sea, respectively. From these figures, it can be seen the increase in complexity and time on the supply and delivery processes due to the global extension of the value chain.

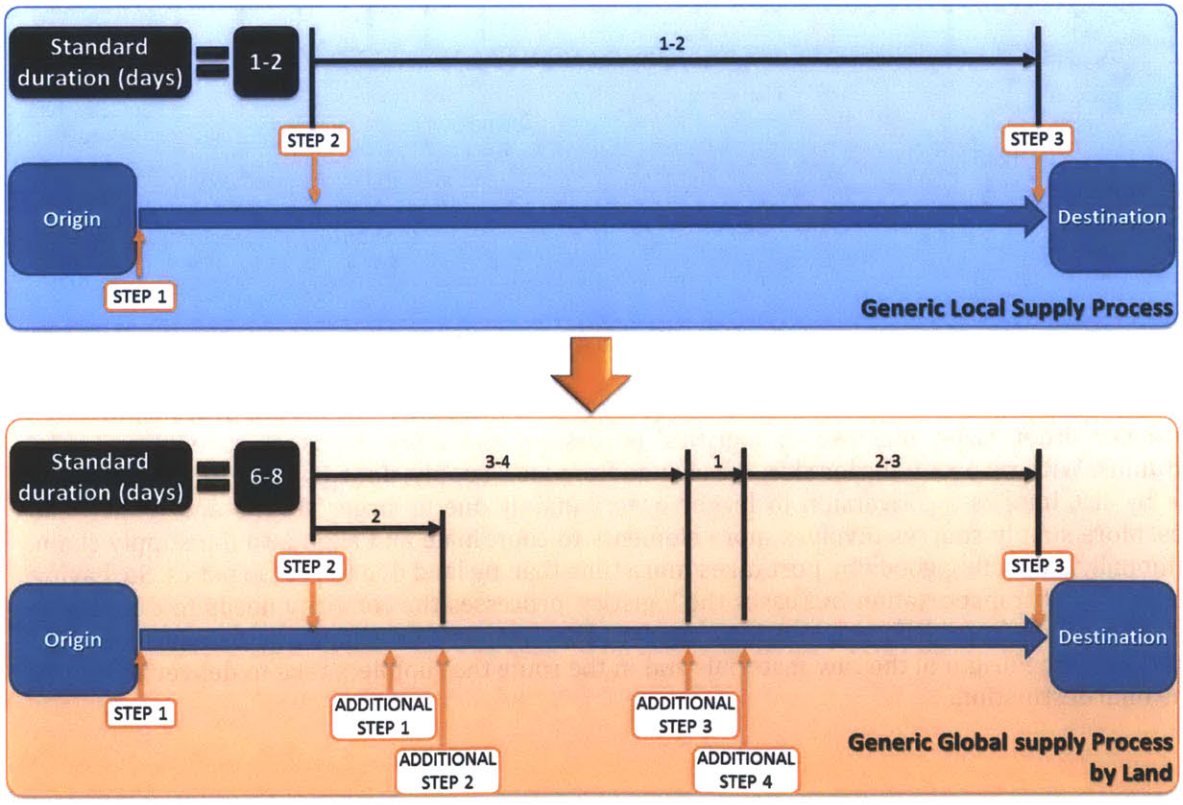


Figure 2.2 – Generic Local Supply Process to a Generic Global Supply Process by land

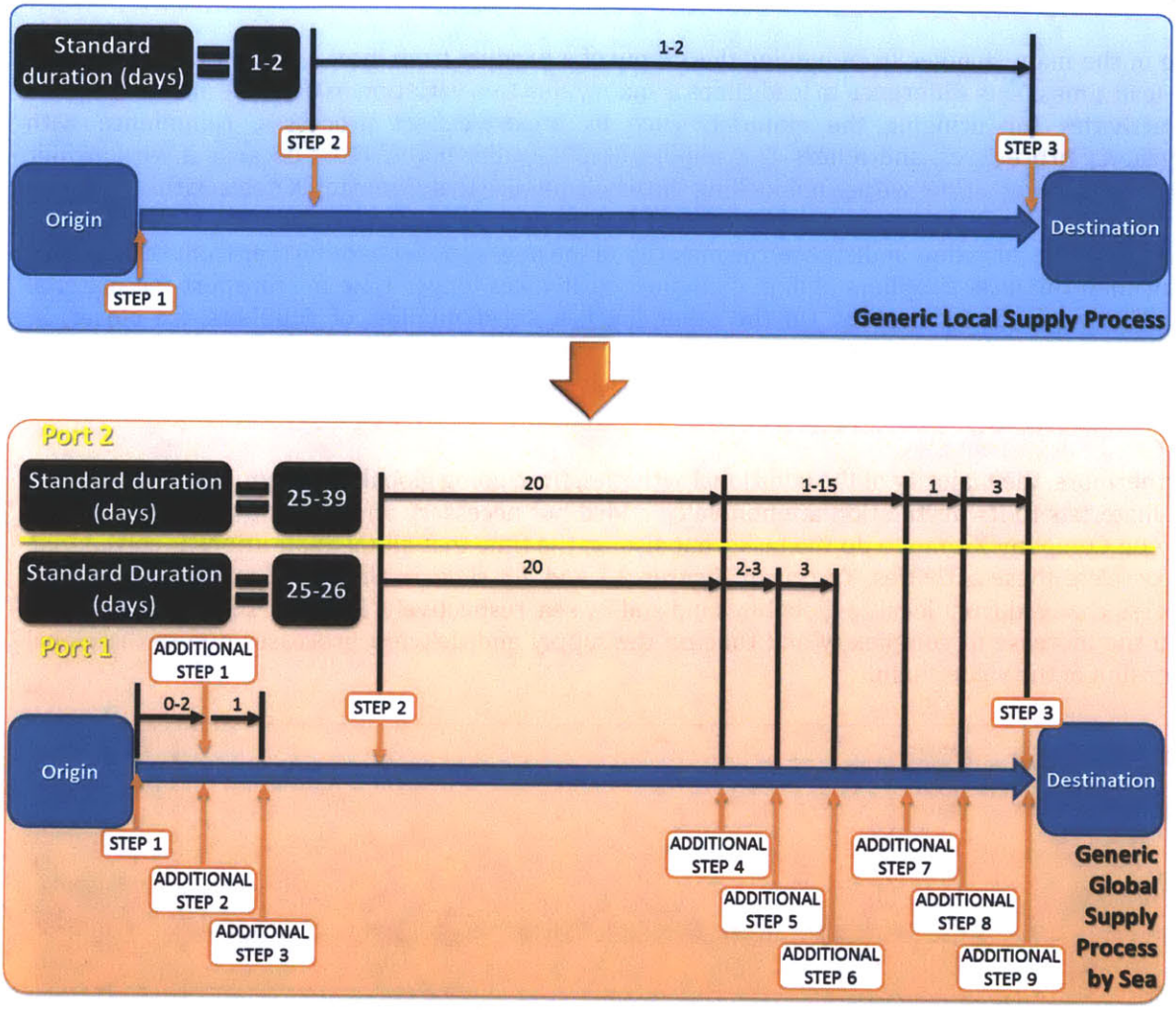


Figure 2.3 – Generic Local Supply Process to a Generic Global Supply Process by sea

In addition to longer lead times, other consequences of having different modes of transportation are bigger order sizes, increase in logistics' processes, and more exposure to environmental conditions. With respect to order size, the change from local supply, done by land, to global supply, done by sea, implies a conversion to bigger orders mainly due to larger vessels and longer lead times. More supply sources involves more elements to coordinate and align into the supply chain. Additionally, importing goods by port takes more time than by land due to port logistics. So, having more modes of transportation increases the logistics' processes the company needs to do. Finally, importing goods from different locations exposes the company to delays due to environmental conditions at the origin of the raw materials and in the route the suppliers take to deliver the goods at the final destination.

2.3 Cultural, language, and time zone differences

Cultural, language, and time zone differences are a reality in global value chains that should be recognized as a major topic on the transformation process from local to global (Cook, 2006). It is important to get a sense of the culture and basic language skills of the place where the company is thinking to expand business activities because its ability to develop relationships on these new locations will determine how successful the globalization of the value chain will be.

From the cultural perspective and defining culture as beliefs, symbols, norms, and values prevalent among people in a society, the prevailing value emphases may be the main feature to capture and characterize cultures (Hofstede, 2001; Schwartz, 1999) because they express shared conceptions of what is good and desirable in the culture. Moreover, cultural value emphases shape and justify policies, norms, and everyday practices. Thus, it is critical for Company X to identify those prevalent values of the culture where it is migrating because any aspect that is incompatible with them is likely to generate tension, elicit criticism, and, in turn, affect enterprise efforts to establish any presence on that location.

Regarding language, although many companies that establish communication with Company X in non-English and non-Spanish speaking countries have English-speaking and Spanish-speaking employees, problems arise when interactions with key personnel that do not always have sufficient command of English and/or Spanish to engage in lengthy or detailed exchanges are necessary. In general, this situation occurs in technical discussions where people were hired for their technical abilities and not their education; and usually they tend not to have any training in a foreign language. To illustrate, Figures 2.4 (Geocurrents, 2012) and 2.5 (Nationalencyklopedin, 2007) provide a quick glance of the different languages around the world.

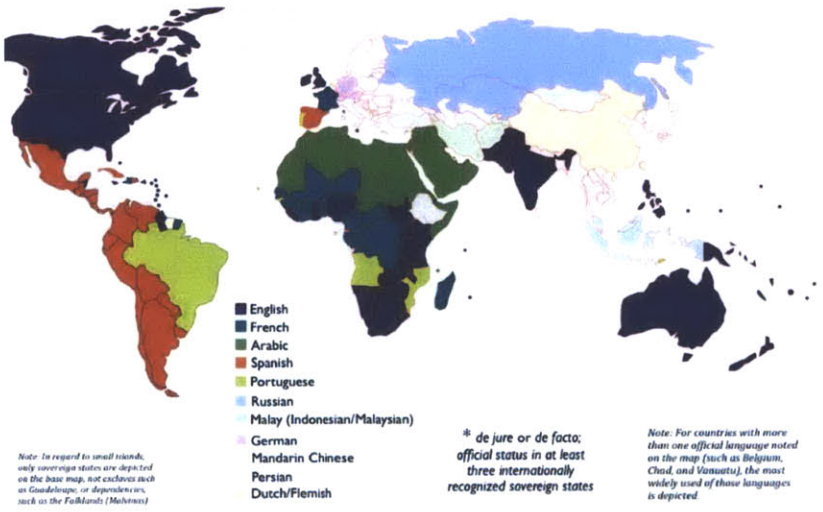


Figure 2.4 – Map of the world's main languages

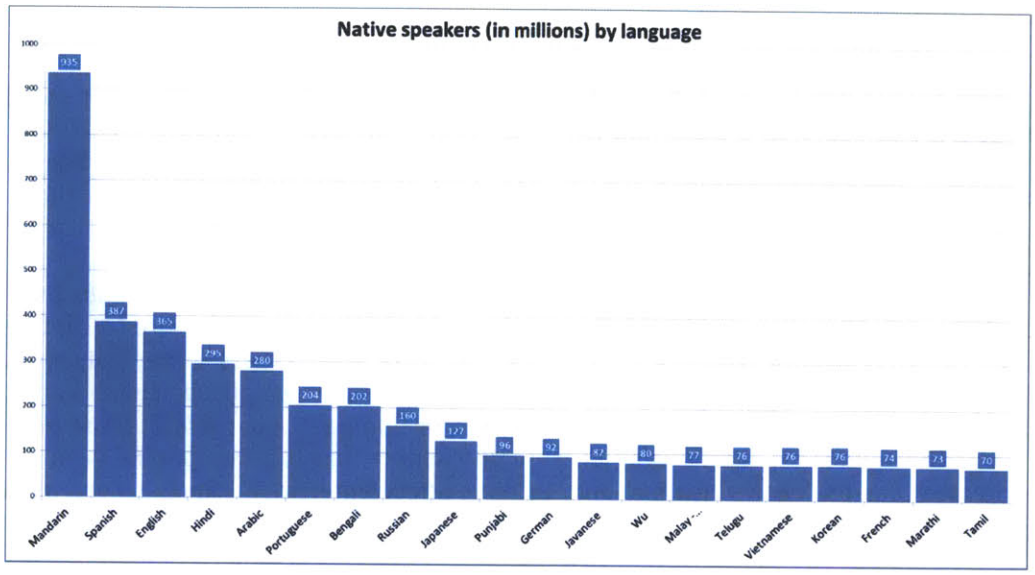
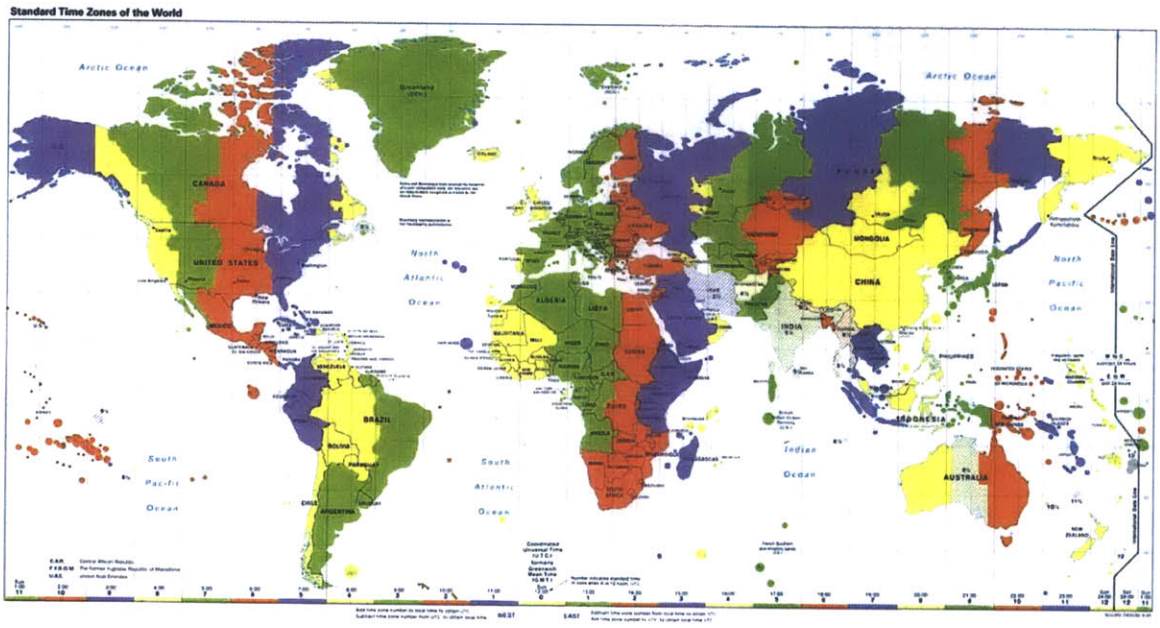


Figure 2.5 – Top 20 of languages based on number of native speakers

Finally, time zone differences play an important role when employees of Company X need to coordinate agendas with peers, partners, and suppliers from different locations. However, these complications –for example, take more time to solve issues due to the different work schedules, pay extra-time, change labor schedule if regulation permits it, different holidays' schedules among countries, etc.- can be justified due to the benefits of having a 24-hours work schedule on topics where it is possible; especially on the CPG industry where things change quickly. The different time zones Company X deals with –for all the activities of the Value Chain- are all the standard time zones, shown in Figure 2.6.



Source - University of Texas - http://www.lib.utexas.edu/maps/world_maps/timezones_ref00.pdf

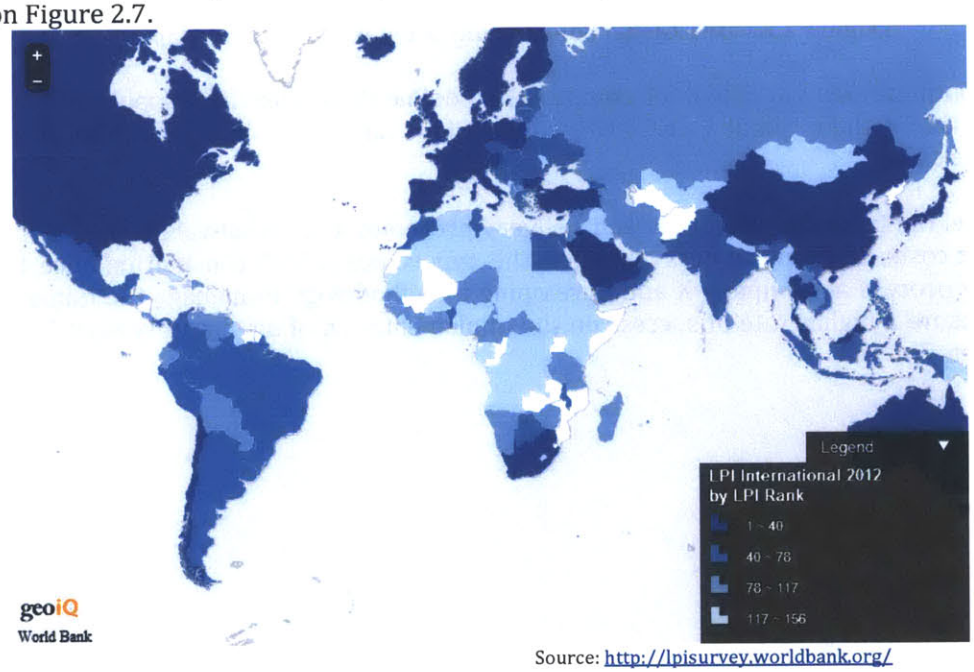
Figure 2.6 – Standard Time Zones of the World

Altogether, the cultural, language, and time zone differences are important aspects a company needs to consider to ensure a successful transformation from local value chain to global value chain.

2.4 Governments and Regulation

The efficiency of Global value chains depends on government services, investments, and policies (The World Bank, 2012). Governments play an important role on building local infrastructure, developing a regulatory regime for logistics, and implementing efficient customs clearance procedures, i.e. governments can facilitate trade through investments in both "hard" and "soft" infrastructure. Good indicators about countries' trade logistics performance are: the Logistics Performance Index (LPI) by the World Bank and the Global Connectedness Index (GCI) by DHL (Ghemawat and Altman, 2012).

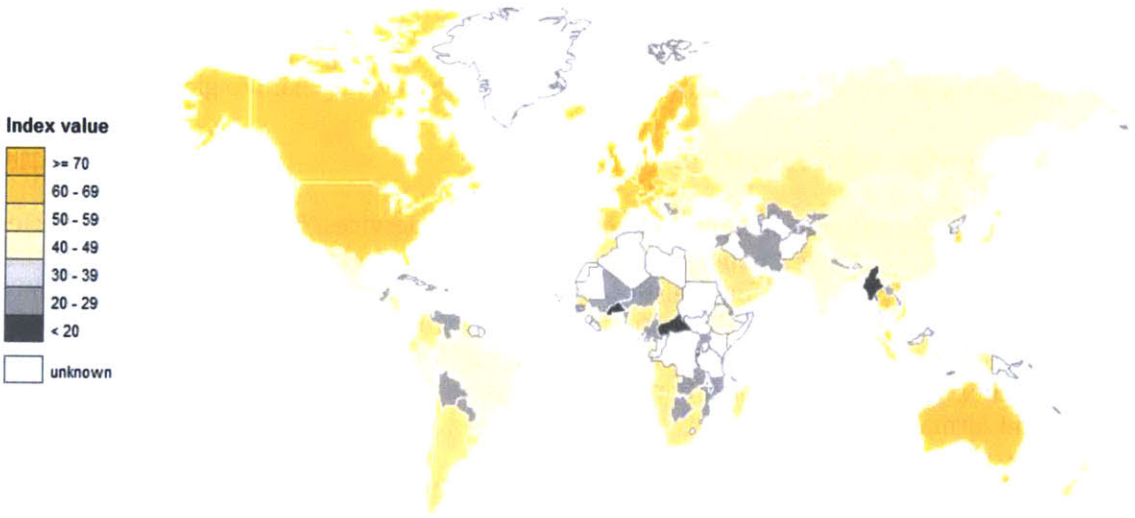
The LPI provides a global benchmark to measure logistics performance among countries. This indicator helps countries identify the challenges and opportunities they face in their trade logistics performance and what they can do to improve. A world map of the LPI International 2012 rank can be seen on Figure 2.7.



Source: http://lpisurvey.worldbank.org/

Figure 2.7 – Logistics Performance Index International 2012 Rank

The GCI refers to the depth and breadth of a country's integration of 140 countries with the rest of the world. The 140 countries studied represent 99% of the world's GDP and 95% of its population. Besides, the GCI also depicts the actual extent and direction of globalization around the world, which is less globally connected today than it was in 2007. Figure 2.8 illustrates the rank for the 140 countries studied at the GCI.



Source: http://www.dhl.com/en/about_us/logistics_insights/global_connectedness_index_2012/gci_results_noflash.html

Figure 2.8 – DHL Global Connectedness Index 2012 World Map

In general, both indexes are useful for companies to define their objectives, goals, strategies, and execution plans of their global value chain considering countries political conditions and their impact on the chain.

On the whole, the fact that the supply and delivery processes at a global value chain imply more tasks, hidden costs, and stakeholders highlights the importance of both considering uncertainty on the planning process at Company X and developing a methodology to manage the human side of change to ensure a higher rate of success on the implementation of any improvement in the local and global set.

3 Non-Deterministic Supply Planning Process

In our everyday lives we see events that confirm what the Roman scholar Pliny the Elder said: "The only certainty is that nothing is certain." Changes are ubiquitous and the CPG industry is not exempted to them. Consumer behavior in the CPG industry has changed dramatically over the course of the years, and this situation directly affects Company X.

As explained in Chapter 1 and 2, challenges arose due to Company X's globalization as a response to fulfill the constant variations in customers' needs. The consequences of the new challenges make more plausible the importance to anticipate and plan for a range of possible futures as an intelligent method to deal with uncertainty (De Neufville and Scholtes, 2011).

It is important to mention that uncertainty does not necessarily mean only bad things could happen. Unexpected events can produce gains and losses. Thus, Company X should not only worry about downside risks, but also about upside potential when considering uncertainties in its planning process.

3.1 Current Planning Process – Base Case

The current planning process for any department in Company X, as in the majority of the companies, uses only point forecasts to evaluate the "viability" and "value" of a project and produces single number results. This planning process ignores the major uncertainties the project is likely to encounter. In the end, the company makes a decision based on expected results that are completely different from the reality of what the company will experience from making that decision.

This discrepancy between what actually happens to a project and the result from the current planning process used to evaluate and choose alternatives is mainly because the current process does not recognize two important facts: assumed conditions constantly vary and management will make adjustments during the course of the project in response to new circumstances. Furthermore, the analysis carries an error called the "flaw of averages" (Savage, 2009) and the analysts are not conscious of this huge mistake.

The "flaw of averages" means that generally it is incorrect to calculate the average value of a project by using the average value of the parameters due to the asymmetry between gains and losses. Mathematically speaking, this is because the models are non-linear and/or involve some discontinuity. In turn, the "flaw of averages" can produce a significant loss of potential value of the project because using the average conditions neglects to both insurance against losses in value and capture benefits from possible increases in project value. An illustration of the "flaw of averages" can be seen on Figure 3.1, which is an example from Sam Savage showing how using the average can mislead the evaluation process just as the statistician in the figure who drowned in a river that was, on average, three deep feet might have thought it was safe.

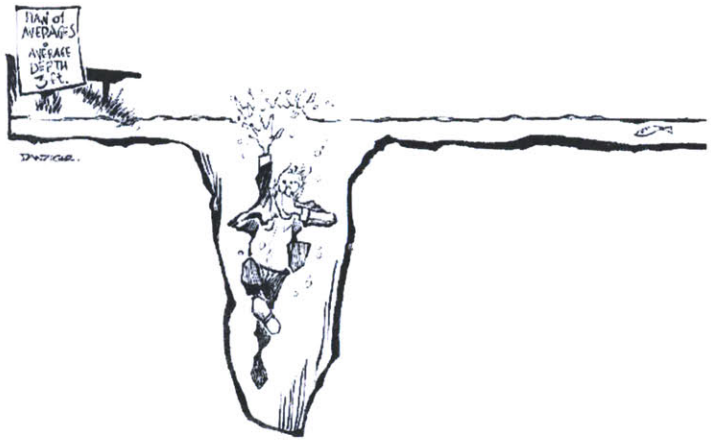


Figure 3.1 – Flaw of Averages

Regarding the planning process for the global supply chain, it generates the production plan, production schedule, and material plan in each mill (Azrielant, 2011). Figure 3.2 describes the general planning process at a typical mill in Company X. As noted, the process relies heavily on point forecasts to elicit important decisions. In fact, the objective of the first step is to produce "reliable" and "accurate" single-number forecasts. This planning process based on precise forecasts produces a production plan, production schedule, and material plan that do not consider the range of uncertainties around the forecasts and the possible asymmetry of any distribution due to assumptions and flaws stated on previous paragraphs.

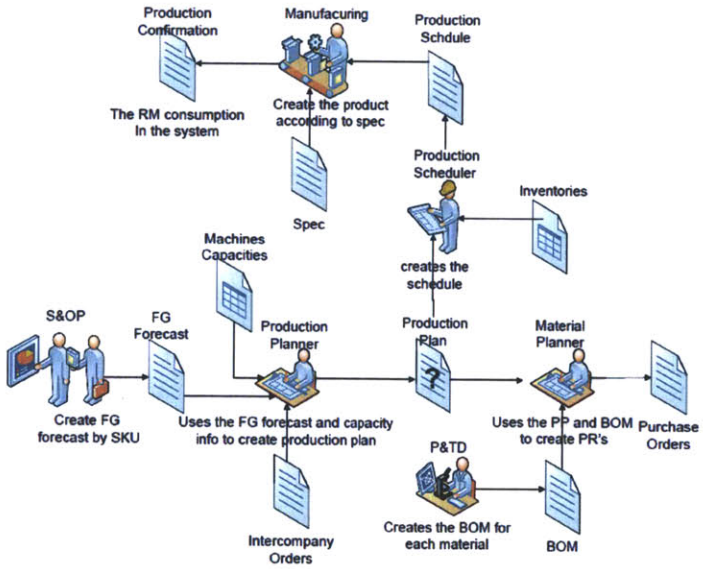


Figure 3.2 – Planning Process at a typical mill (Azrielant, 2011)

All things considered, the current planning process for the global supply chain leads to suboptimal systems that have not captured the unreliability of the point estimations, so Company X needs to adopt a new planning paradigm that considers the range of circumstances that might occur and examine the entire distribution of consequences.

3.2 Dynamic Strategic Global Sourcing Planning Process

The proposed planning process for the global supply at Company X, called "Dynamic Strategic Global Sourcing Planning", recognizes uncertainties, both risks and opportunities, and includes strategies for dealing with them into the plans (De Neufville, 2000). This planning process is dynamic because it acknowledges uncertainty and the importance of having a plan that is adaptable over time to actual situations. It is also strategic due to the fact that it is built for both short and long term goals.

The Dynamic Strategic Global Sourcing Planning Process employs two key methodologies to global sourcing activities: Decision analysis and Real Options. Decision analysis is a structured method for considering uncertainties and evaluating the possible different results from all the choices evaluated at any decision stage. Real Options refers to the applications and theoretical extensions of the theory of financial options to the assessment of options associated with non-financial projects and activities. In this sense, an option is the right, but not the obligation, to take an action some time in the future.

The current planning process differs from the Dynamic Strategic Global Sourcing Planning process in that the latter adjusts over time to reality. This feature allows Company X to respond actively to the actual market circumstances and serve better to customers. An Excellent analogy for this new process is the one that Dr. Richard de Neufville uses to explain Dynamic Strategic Planning in general: *"Doing dynamic strategic planning is comparable to playing chess: the planner thinks many moves ahead, but only commits to one move at a time, retaining the flexibility to adjust the game plan according to the events as they unfold."*

Essentially, the Dynamic Strategic Global Sourcing Planning contemplates three main tasks: acknowledge and understand uncertainties, conduct the dynamic analysis of the global sourcing situation, and build a flexible dynamic global sourcing plan.

3.2.1 Acknowledge and Understand Uncertainty

The constant changes in the world impact directly on consumer behavior at the CPG industry shaping new customer needs and, in turn, new production and supply requirements for companies within the industry. Therefore, acknowledging and understanding the major uncertainties that surround any forecast is the necessary starting point for a new dynamic strategic planning process.

It is worth noting that understanding the uncertainties is as important as acknowledging them. The simple task of acknowledging uncertainties is not enough to consider them into the planning process on a proper way. A common and good approach to understand and define the magnitude and pattern of uncertainties is to look at historic data in similar situations. For circumstances where no historical data is available, an effective method is to look at comparable situations that have enough data to describe the uncertainties. Ultimately, the goal is to characterize the distribution of the uncertainties to be able to estimate the likelihood of the different outcomes.

In particular, for the situation described in chapter 2 that Company X is facing, it is useful to begin grouping the uncertainties in types for the managers to tailor effective risk-reduction and opportunity-exploitation approaches. Although uncertainty and risk are not the same, the majority of authors equate risks with uncertainties and most of the literatures are found under the risk management for supply chains. That said, the categorization exposed in the next paragraph says it

is intended for risks but it can easily be intended for uncertainties. In this paper and in the work done for Company X, the categorizations are used for uncertainties.

Several categorizations exist for sources of risks in supply chain. Some literatures consider only a few categories, like the one that encompasses all the risks sources in supply chains in three groups: Environmental risk sources, network-related risk sources and organizational risk sources, shown in Figure 3.3 (Jüttner et al, 2003). Environmental risk sources contain any uncertainty from the supply chain environment interaction. Organizational risk sources lie within the boundaries of the supply chain parties. Network-related risk sources arise from suboptimal interactions between organizations within the supply chain.

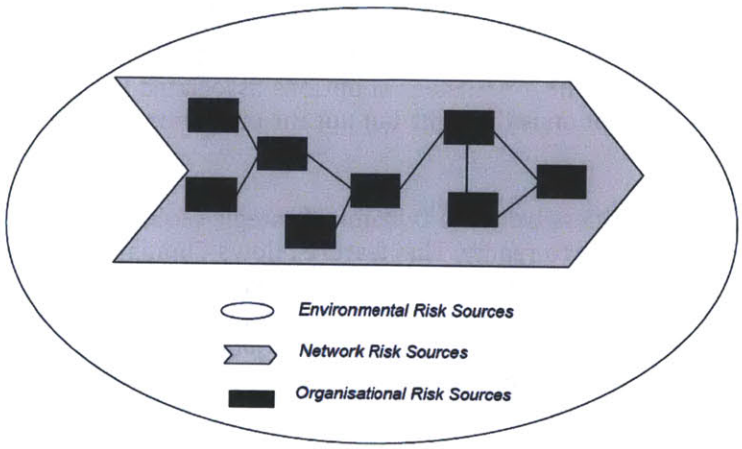


Figure 3.3 – Risk Sources in Supply Chains (Jüttner et al, 2003)

Other papers select more groups to classify the uncertainties and their drivers. A useful set of categories for managers includes delays, disruptions, forecast inaccuracies, systems breakdowns, intellectual property breaches, procurement failures, inventory problems, and capacity issues (Chopra and Sodhi, 2004). To clarify, Figure 3.4 show the risk categories and their drivers.

Category of Risk	Drivers of Risk
Disruptions	▪ Natural disaster ▪ Labor dispute ▪ Supplier bankruptcy ▪ War and terrorism ▪ Dependency on a single source of supply as well as the capacity and responsiveness of alternative suppliers
Delays	▪ High capacity utilization at supply source ▪ Inflexibility of supply source ▪ Poor quality or yield at supply source ▪ Excessive handling due to border crossings or to change in transportation modes
Systems	▪ Information infrastructure breakdown ▪ System integration or extensive systems networking ▪ E-commerce
Forecast	▪ Inaccurate forecasts due to long lead times, seasonality, product variety, short life cycles, small customer base ▪ "Bullwhip effect" or information distortion due to sales promotions, incentives, lack of supply-chain visibility and exaggeration of demand in times of product shortage
Intellectual Property	▪ Vertical integration of supply chain ▪ Global outsourcing and markets
Procurement	▪ Exchange rate risk ▪ Percentage of a key component or raw material procured from a single source ▪ Industrywide capacity utilization ▪ Long-term versus short-term contracts
Receivables	▪ Number of customers ▪ Financial strength of customers
Inventory	▪ Rate of product obsolescence ▪ Inventory holding cost ▪ Product value ▪ Demand and supply uncertainty
Capacity	▪ Cost of capacity ▪ Capacity flexibility

Figure 3.4 – Risk Categories in Supply Chains and their drivers (Chopra and Sodhi, 2004)

Both groupings above allow Company X to acknowledge and understand uncertainties with a more structured approach. However, a proposed combination, in this thesis, of both categorizations will permit the management to be able to devise more effective risk-reduction and opportunity-exploitation strategies because this framework will help them to identify the drivers of each type of uncertainty and see if it arises due to the environment, organization, and/or network, as seen in Figure 3.5. From the interviews conducted with Company X employees, new drivers where identified and classified according to the grouping format proposed. These new drivers are highlighted in Figure 3.5

	Environment	Organization	Network
Disruptions	Natural Disaster War and Terrorism Seasonality (snow, hurricanes, storms, etc.) Political instability	Labor Dispute Dependency on a single source of supply Changes in Standards and Processes	Supplier bankrupcy Dependency on a single source of supply Capacity and responsiveness of alternative suppliers New standards in the network
Delays	Excessive handling due to border New regulations	Capabilities, competencies and mindset of the labor	High capacity utilization at supply source Inflexibility of supply source Poor quality or yield at supply source Excessive handling due to border crossings or change in transportation modes New regulations learning curve
Systems	Information infrastructure breakdown Disruptive software upgrades	Information infrastructure breakdown ERP implementation	Information infrastructure breakdown System integration or extensive systems networking Lack of IT renewal for new requirements
Forecast	"Bullwhip effect" Futures market that limit actual sales	"Bullwhip effect" Inaccurate forecasts Attrition of knowledgeable employees	"Bullwhip effect" Forecasts without capacity constraint consideration
Intellectual Property	Global outsourcing and markets Non-standard process for global intellectual property	Different Company X's trademarks among countries	Vertical integration of supply chain Different supplier's rights among countries
Procurement	Exchange rate risk Percentage of a key component or raw material procured from a single source Change regulations about currency for commercial transactions	Industry wide capacity utilization Long-term versus short-term contracts Non-complete visibility of regional needs	Exchange rate risk Percentage of a key component or raw material procured from a single source Industry wide capacity utilization Long-term versus short-term contracts Lack of knowledge about suppliers' financial health
Receivables	Financial strength of customers Changes in requirements such as electronic receipt	Challenging cost center distribution	Number of customers Financial strength of cutomers Multiple receivables agreements
Inventory	Product value Demand and supply uncertainty Lack of trust that impedes inventory visibility	Inventory holding cost Product value Legacy safety stock level	Rate of product obsolescence Demand and supply uncertainty Lack of inventory visibility
Capacity	Import requirements for machines Local and regional people do not fulfill company's requirements	Cost of capacity Capacity flexibility Correlation with workforce's skill and mindset level	Non-updated capacity levels Lack of transparency about capacity levels

Figure 3.5 – Proposed Risk Categorization for Company X

Once the planning team has categorized the uncertainties and identified how much Company X contributes to their existence, the second part is to evaluate the impact of these uncertainties on the global sourcing process.

Keeping in mind that the objective of the planning team is to perform an effective analysis, the analysts should select a set of uncertainties that have significant planning consequences that need to be analyzed more in depth, which will be called drivers. The fewer drivers needed to complete a compelling dynamic analysis of the global sourcing the better because the number of scenarios increases exponentially with the number of drivers. The planners can use single-variable sensitivity analysis tools such as the Tornado diagrams, explained in Appendix A, and multivariable sensitivity analysis tools to select the drivers. The single-variable sensitivity analysis means the application change one input at a time, whereas the multivariable sensitivity analysis changes all inputs simultaneously. These tools are a valuable complement to expert judgment.

The third and final step to acknowledge and understand uncertainties is to characterize the drivers according to the probability of their occurrence and their variability over time. For this task, planners need to analyze historical trends and identify trend-breakers.

The objective of examining historical data is to understand the past behavior to estimate future possibilities. For this purpose, planners should assess the quality of the data and acquire a thorough appreciation of the pattern.

For the quality of the data, analysts should first understand the procedures and definitions followed to record the data they are planning to use. For example, which date is recorded at the column "Ordered date"? Is it the date at which the purchase order was created? Or is it the date when the supplier was notified? This step will ensure that the data used is appropriate for planning and will serve for the standardization of the global IT-Systems and recording procedures at Company X.

For Company X planners to acquire a thorough appreciation of the pattern and be able to characterize the uncertainties with the data selected, the planning team should use t-test, ANOVA, or multiple regression analysis as a primary statistic. For a second statistic, they can use chi-square test as a resource for the probability distribution fitting, which is the procedure of selecting a statistical distribution that best fits to the data selected of the variable analyzed by the planning team.

A tool was developed, during the research, to assist the planning team in the probability distribution fitting procedure using chi-square test as a complement to the primary statistic tests Company X has tools for. This tool is explained in detail in Appendix B. This probability distribution fitting Excel tool makes the selection of the statistical distribution that best fits the data as easy and straight-forward as possible and, in turn, to ensure the implementation of this critical step of the Dynamic Strategic Sourcing Planning Process.

The structured and scientific practice of acknowledging and understanding uncertainties allows Company X planners to develop valid models of random processes they deal with such as the global sourcing model. Therefore, after this essential step, they are able to perform a thorough dynamic analysis of the global sourcing process.

3.2.2 Dynamic Analysis of the Global Sourcing Process

For Company X, any change in the global supply chain affects the production plan, production schedule, materials plan, and delivery plan. Sooner or later, these alterations affect the bottom line of the company in different ways such as lost sales, low profit margin, and high level of inventories, among others. Therefore, the dynamic analysis of the global sourcing should involve examining all the possible decisions to maximize Company X value chain's flexibility while minimizing waste and variance.

As exposed previously, planners define the production plan, production schedule, and material plan based on point forecasts. For this task, they use a model to make any decision regarding the global supply chain. The existing model, considered as the base case, and the characterization of uncertainties are the basis for developing the dynamic analysis of the global sourcing process. The objective of the dynamic model is to obtain a distribution of possible results by using Monte Carlo simulation, invented in the late 1940s by Stanislaw Ulam, while he was working on nuclear weapon projects. It was named, by Nicholas Metropolis, after the Monte Carlo Casino, where Ulam's uncle often gambled (Metropolis, 1987).

Monte Carlo simulation provides an efficient and useful mean of quantifying the consequences of the uncertainties included in the model. It does this by sampling possible scenarios to cover all contingencies in proportion to their likelihood, calculating and storing the results for each scenario, and presenting the result in useful ways.

For adoption purposes, an Excel application to perform the dynamic analysis of the global sourcing process was built using the existing model that Company X planning team uses. This application samples Y uncertainty distributions N times and calculates the results for Z number of orders by running a Monte Carlo simulation using Excel's data table feature. The number of iterations, uncertainty distributions and orders are defined by the user up to a limit at which it was considered not efficient for the Monte Carlo simulation to last.

For the number of iterations, uncertainty distributions, and orders, planners face a trade-off between the time needed to run the Monte Carlo simulation and achieve a good representation of the distribution of the uncertainties. The higher the number of iterations, inputs, and outputs, the longer it takes to the computer to perform the simulation and the better the representation of the uncertainties. However, Company X planning team's time to make a decision depends on urgency (sometimes is less than 5 minutes, while in other occasions it could be more than 30 minutes), so they must limit the time needed by the computer to run the simulation by defining a maximum number of samples. For this reason, planners need to decide when an estimate of the distribution of the uncertainties is considered good, check the iterations required to achieve this representation, estimate the time needed to run a simulation with the number of iterations, Y uncertainties, and Z orders in question, and choose the best option when considering all this information.

Figure 3.6 illustrates how the representation of a normal distribution, with a mean of C6 in the figure, changes for four different numbers of iterations: 100, 250, 500, and 1000. This representation was done using the Excel's data table feature and normal distribution function. All the graphs presented in Figure 3.6 have the same twelve classes, so they are completely comparable. It is clear, from this example, how a higher number of iterations produces a better representation of the distribution of uncertainties. To illustrate, the probability of having samples above C9 is 5.00%, 3.60%, 3.60%, and 3.00% for 100, 250, 500, and 1000 iterations, respectively.

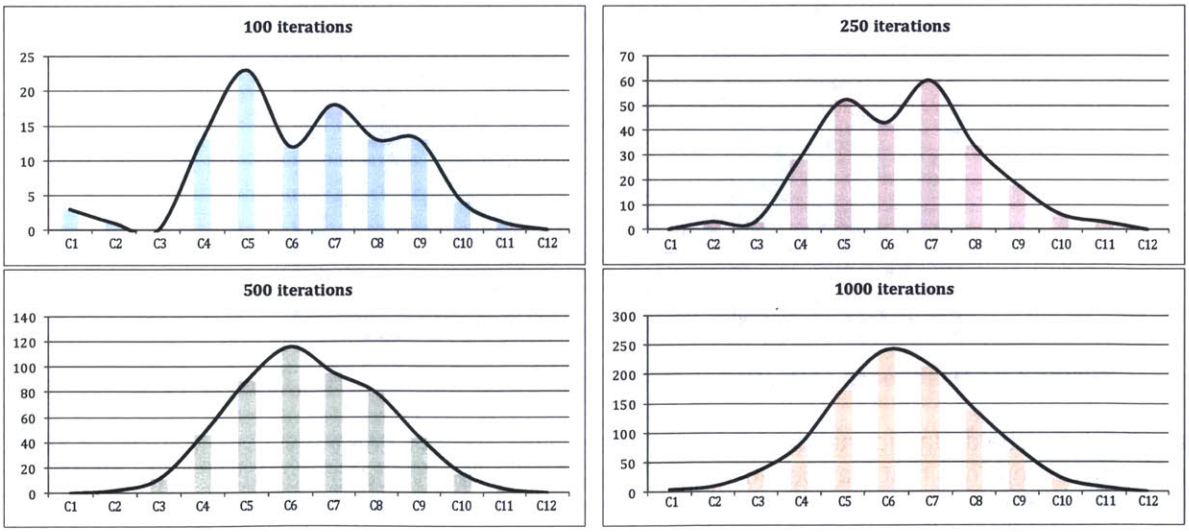


Figure 3.6 – Normal Distribution representation for different number of iterations

With respect to the time needed to run a simulation, the tests conducted during this research with a model consisting of 100 distributions of uncertainties and 100 orders at the same time yielded a time of 0.00018 seconds per iteration in the computers where the tests were done. Figure 3.7 compares the total time needed for different iterations based on the time per iteration obtained from the tests. This comparison clearly shows the benefits from running a simulation with only 100 samples; however, considering also the information in the previous paragraph, the decision of using only 100 samples might not be a good decision. Thus, the trade-off between better representation and time needed is an important aspect that could affect the implementation of this new dynamic analysis proposed, which is why different forms to overcome this and other implementation issues are analyzed in the next chapters.

Number of Distributions of Uncertainties	100	100	100	100
Number of Orders	100	100	100	100
Iterations	100	250	500	1000
Time per iteration	0.00018	0.00018	0.00018	0.00018
Total Time needed (seconds)	180	450	900	1800
Total Time needed (minutes)	3	7.5	15	30

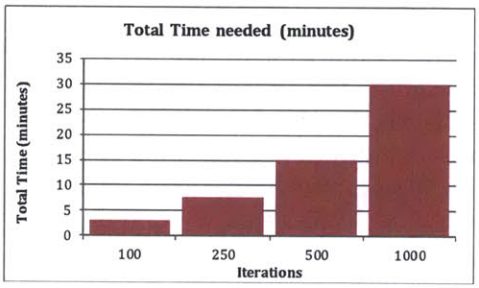


Figure 3.7 – Comparison of Total Time needed for different number of iterations

For the possible results for the orders, three categories were defined to reflect the main consequences of orders delivery time and identify the situations where the real options will be more valuable. Figure 3.8 presents an example of the output of the dynamic analysis tool. Category 0 (green color) means that although the uncertainties will affect the lead times, the materials will arrive in the initial expected period of time. Category 1 (orange color) refers to the situation where the materials will arrive in a different range of time from the initial expected arrival period, but the order will be produced with no problems on production schedule and materials availability. Finally, Category 2 (red color) is the occasion when the order cannot be produced on schedule due to a lack of materials as a consequence for late arrival.

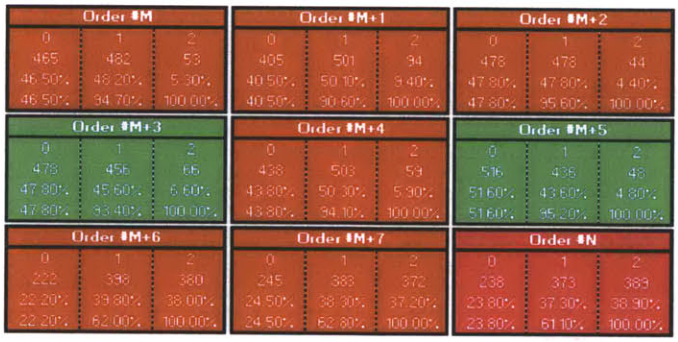


Figure 3.8 – Dashboard of the Dynamic Analysis of the Global Sourcing Process Tool

As a result from the dynamic analysis of the global sourcing process, Company X planning team can identify the real options that may be most useful and add the most value to the global sourcing plan. Hence, the dynamic analysis enables the planners to develop a well-grounded Dynamic Strategic Global Sourcing Plan.

3.2.3 Dynamic Strategic Global Sourcing Plan

The Dynamic Strategic Global Sourcing Plan can increase expected value of the Global Sourcing Process. It does this by configuring the Global Sourcing Process, using real options, to perform better over the range of possible future circumstances. Real options enable Company X to avoid future downside risks and take advantage of new opportunities and, in turn, improve the expected value.

The main real options, studied and explained in the literature about this topic, Company X can consider are six: abandonment, deferral, scale, stage, switch use, and unlocking (Fichman et al., 2005; Tiwana et al., 2007, Hult et al., 2010). An abandonment option means that a project or investment can be terminated completely before it achieves its life without losing the remaining funds. This is different from the switch use option that allows redeploying investments or projects. A deferral option enables to postpone a project or investment. A scale option permits the expansion of a project or investment. A stage option makes possible to do a project or investment in incremental steps. Finally, an unlocking option refers to the situation when an investment or project creates the opportunity for future investments or projects previously not possible.

From the types of options explained previously, the best real options for Company X planning team will be the stage, scale, deferral, and unlocking options because they are easier to implement in the supply chain considering the raw materials are in transit and cannot be used for other purposes (switch use option), such as some important raw materials that fulfill specific purposes, and abandonment is not an option given that the product must be produced.

When including the real options into global sourcing plans, Company X planning team is building insurance into plans in the form of flexibility because these options will reduce downside exposure while simultaneously increase upside opportunities. As in the dynamic analysis of the global sourcing process, Monte Carlo simulation is a useful procedure for building the Dynamic Strategic Global Sourcing Plan because it provides a means of validating the use of real options in the global supply chain.

Company X planners can introduce real options into the global sourcing plans by defining rules in the dynamic model that will decide when and how to exercise the options. These rules are included in the model using "If, then" statements and should emulate what Company X would decide when dealing with a similar situation. For each iteration, Monte Carlo simulation calls on the rules, consults whether the conditions are met, and exercises the option in the cases where the conditions were fulfilled. The planners will be able to analyze the iterations where the options were exercised due to the fact that Monte Carlo simulation records the results for each repetition. In the end, the real options will lead to a different distribution of possible developments than in the dynamic analysis of the global sourcing process and, in turn, create the Dynamic Strategic Global Sourcing Plan. An example of this new distribution of future developments and a comparison with the dynamic analysis can be seen in Figure 3.9 and Figure 3.10, respectively.

Figure 3.9 – Dashboard of the Dynamic Strategic Global Sourcing Plan

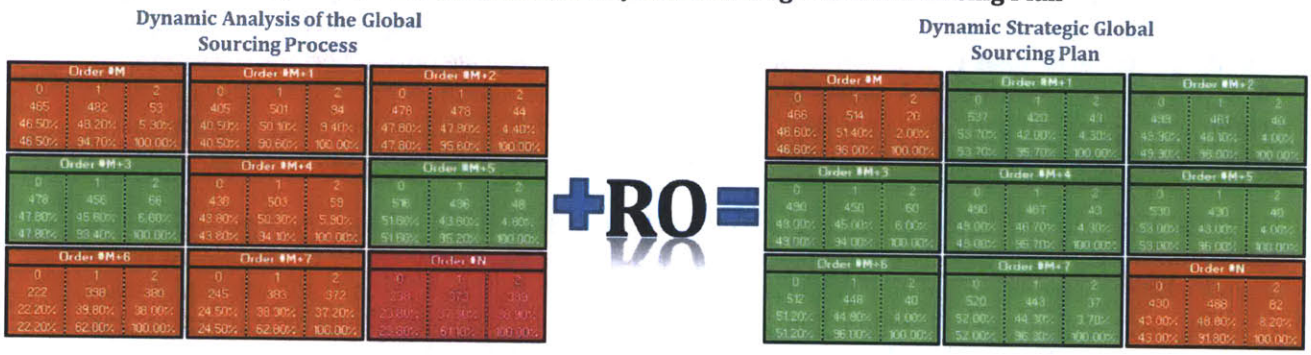


Figure 3.10 – Comparison of Dynamic Strategic Global Sourcing Plan and Dynamic Analysis of the Global Sourcing Process Dashboards

From the figures above, it can be seen that the Real Options Approach will permit Company X to increase the value for a specific production schedule by introducing flexibility into the supply chain. Based on the results for the example illustrated in Figure 3.9 and Figure 3.10, Company X will be able to solve quickly problems on Orders #M+1, #M+2, #M+4, #M+6, #M+7, and N by introducing flexibility into the supply chain. This flexibility is introduced into the process by using the rules for exercising Real Options, such as deciding when to accelerate delivery of specific orders, agreeing with import authorities the orders authorizations' prioritization, defining receiving schedule on distribution centers, among others. As expected, the Real Options help moving orders from Category 2 (red color) to either Category 1 (orange color) or Category 0 (green color) and from Category 1 to Category 0. Categorization based on orders delivery time is explained in the previous section. In the end, this flexibility in the supply will emulate, in advance, the decisions management would make on specific situations so that planners can elaborate a reliable dynamic plan that, in turn, will introduce benefits for Company X such as waste reduction.

To sum up, the Dynamic Strategic Global Sourcing Plan enables Company X to be prepared for a broad range of uncertainties, respond to these changes as effectively as possible, and increase company´s competitive advantage. It does this by including real options and committing to actions only one period at a time to adjust to conditions as they develop. Thereupon, the Dynamic Strategic Sourcing Plan henceforward must replace the prevalent single-number plan. The implementation methodology explained in the following chapters increases the success rate of this replacement by much.

4 Change Management and Process Improvement Dynamics

Stories about transformation programs that failed to achieve the desired outcomes despite having well-defined strategy and tactical plans are common around the world. Usually, these unsuccessful transformations point to people's initial resistance as the main cause for failure and have very low or no understanding of the human side of change by which managers can engage people at all levels in the company's initiative. It is true that people have initial resistance to change; however, people will implement the transformation if they believe that doing so will benefit them. Nonetheless, there is no methodology that harnesses people engagement and creates sustainable change momentum. Thus, a perspective that considers the human side of change is proposed to support the implementation of Company X continuous improvement efforts.

The development of the unique perspective for change management, proposed in the following sections of this chapter, involved studying Company X culture, values, people, skills, and behaviors, and both learning and compiling the change management methodologies used in successful and failed transformations. The perspective, presented in this thesis, for change management can be adapted to different situations with the caveat that it was constructed with a heavy focus on a region of Company X and considering Company X conditions as a multinational.

4.1 Change Management

Change Management is a process to engage individuals and the organization to move from the current state to the desired future state by adjusting an organization's people processes, practices and behaviors to sustain the change over the long haul. In the existing literature exists a common change life cycle even though the names and phases of these different change management processes are not the same. To clarify, Figure 4.1 shows that the change life cycle is practically the same between two well-known change management processes despite the fact that the number and definition of the steps are not (Franklin, 2011; DeAnne et al., 2007).

'Business change life cycle' (Franklin, 2010)	Change Management Process (DeAnne et al., 2007)
1. Understanding the change	1. Defining the change
2. Planning and preparing for change	2. Creating a share need 3. Developing a shared vision
3. Implementing the change	4. Leading the change 5. Engaging and mobilizing stakeholders 6. Creating accountability
4. Embedding the change	7. Aligning systems and structures 8. Sustaining the change

Figure 4.1 – Comparison of two well-known change management processes

For explaining purposes, this document follows the 'business change life cycle' (Franklin, 2011). It is important to mention that the sequence used to explain the change management perspective proposed in this thesis is not a rigorous order; rather, it is an iterative process that the company needs to revise and update regularly to adapt to individual and organizational feedback.

4.1.1 Understanding the change

It is critical to have clarity of the purpose, scope, outcomes, and implications of the change. It will allow elucidating the change to the whole company taking into consideration the expected barriers for the implementation. This explanation and expectation clarity will make the change salient, credible, and legitimate to the people in the organization. Hence, the person in charge of the transformation should define the initiative as clearly as possible and embed change management beginning with the design of the initiative.

A useful tool for assessing reasons of the change due to influences from the environment in which the company operates is the PESTLE analysis. PESTLE stands for Political, Economic, Sociological, Technological, Legal, and Environmental. This exploration permits the analyst to include exogenous factors to the company into the process of understanding the need for the change and to be able to explain them to employees that are not fully aware of the marketplace. A sample interview questionnaire for this analysis is displayed in Appendix C.

For the analysis of the impacts, it is recommended to the change leader to use job/role analysis and planning, career anchor analysis, cultural diagnostic, and system dynamics for modeling specific problems up front. Sample forms and questionnaires for these frameworks are shown in Appendix C. Using these tools will allow the person who is in charge of the transformation to identify unintended consequences that may affect the overall result of the implementation and analyze potential countermeasures.

Job/role analysis and planning is a dynamic process that allows executives and managers to figure out how roles in their organizations are changing, and to communicate those changes to future job holders. Moreover, this process enables job holders to rapidly define and redefine their changing role as the network around them changes to adapt (Schein, 1992). That said, this analysis will help the change leaders to understand more clearly how the jobs/roles he or she is analyzing relate to various others, what their expectations are, who the key stakeholders are, what they expect of the jobs/roles, what changes the change leader anticipates and how they will affect the stakeholders and their expectations, and what the implications are for the jobs/roles.

A person's career anchor is a self-concept that consists of self-perceived talents and abilities, basic values, and, most important, the evolved sense of motives and needs as they pertain to the career (Schein, 1996). The career anchor is a need that operates as a genuine constraint on career decisions. The anchor is the thing that the person would not give up if he or she had to make a career choice. Knowing the career anchor of the persons involved in a change will help to develop a better human resource planning for the desired future state. Together, career anchors analysis and job/role analysis and planning, make possible to match ever changing needs of the organization with the needs of the employees and, in consequence, do a better change management since the design of the transformation.

The cultural diagnostic focuses on identifying the core values, beliefs, behaviors, and perceptions that should be considered for successful change to occur. Besides, this analysis helps to identify sources of leadership and resistance. A useful tool for this cultural analysis is the culture web (Johnson, 1992). The culture web analyzes the core set of beliefs and assumptions which delineate an organization's view and its environment and their relation with company's control system, organizational structure, symbols, rituals, power structures and stories and myths. Figure 4.2 illustrates the cultural web.

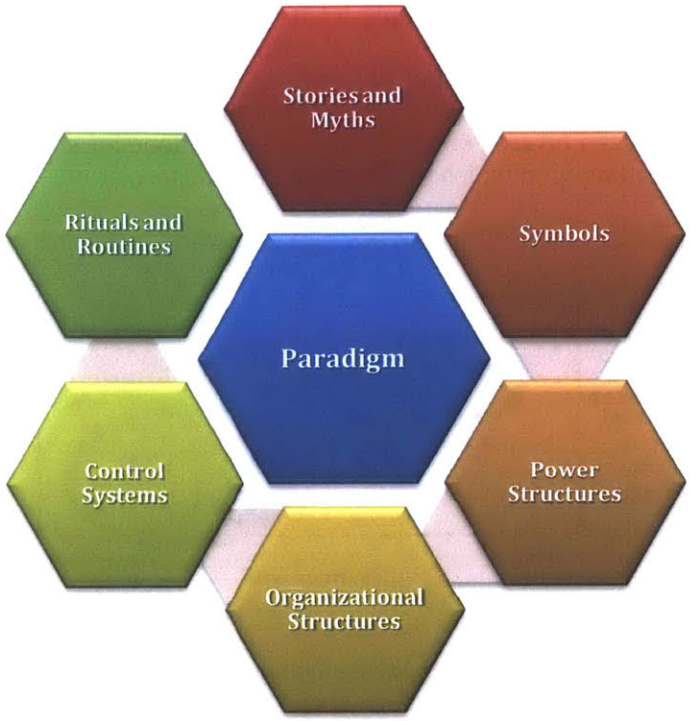


Figure 4.2 – Cultural Web

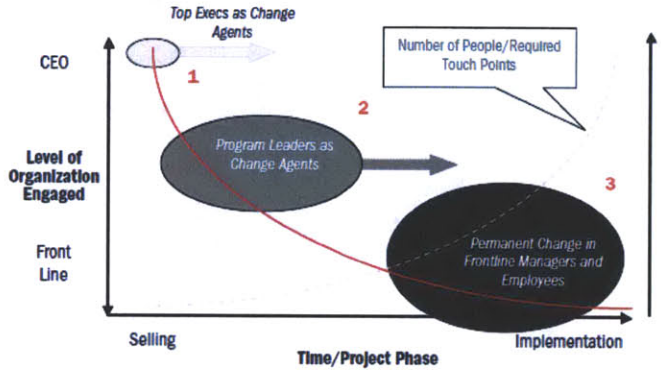
System dynamics, created by J.W. Forrester in late 1950s, allows complex system simulation through stock and flow metaphors (Forrester 1989). These stock and flow structures provide a method for following and observing quantities of items flowing through the model because the stocks accumulate and discharge quantities through inflow and outflow. Although System Dynamics is based in mathematics, physics and engineering, it also draws on cognitive and social psychology, economics and other social sciences (Sterman, 2000). System Dynamics modeling and simulation techniques make possible the development of new understandings and mental models related to the dynamic complexity surrounding the initiative under study.

From the understanding of the change process, the change leader can articulate a formal and complete case for change and start planning and preparing the change process while developing the strategic and tactical plans of the transformation. This understanding of the change should be continuously revisited as the change program progresses.

4.1.2 Planning and preparing for change

Planning and preparing for change encompasses forming collective ownership of the change and creating and communicating a customized written vision statement for various audiences. The collective ownership and the vision statement will generate a clear picture of the desired state to all the organization and, therefore, build alignment.

Collective ownership means more than just an agreement that the change is critical for the company. It is accepting responsibility for making the change happen on people's areas of control. This ownership can be created by understanding the various perspectives of whether the transformation is necessary and involve people from those perspectives to discuss the need for change, identify issues, and craft solutions. The ownership will be reinforced by indicators, incentives, and rewards throughout the change process. Figure 4.3 depicts the importance of the ownership created since this analysis for all the change management process of the initiative (DeAnne et al., 2004). As it can be seen on the figure, the work done for achieving the commitment of the people is the foundation upon which to delineate the transformation.



Source: Booz Allen Hamilton

Figure 4.3 – Main Owners during Change Management Process

The written vision statement allows individuals to see that the change is headed in the right direction according to company's strategic goals. This statement needs to be customized without changing the core to reflect different perspectives, concerns and objectives and to develop a shared vision across the organization. The customized written statement should be built following the Stockdale Paradox, illustrated in figure 4.4 (Collins, 2001), to increase its impact in guiding behavior and decision-making because it will be written in terms that matter to the people in the company.

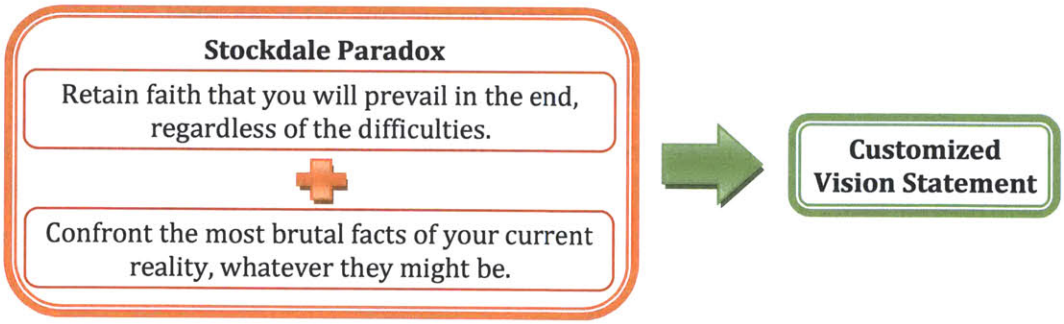


Figure 4.4 – Stockdale Paradox

Finally, the change leader can elaborate a work breakdown structure for the change management process for the implementation and sustainability of the transformation that considers all the input received from the people during building ownership and creating shared vision tasks. This

breakdown structure should be incorporated in the project management plan and continuously revisited to include new challenges and strategy variations during the course of the transformation. This task identification, with their priorities and interdependencies, is the base for the implementation of the transformation.

4.1.3 Implementing the change

This critical process requires the senior executives to play an active role, mainly at the beginning of the change process, in embracing the new behaviors, engaging in the transformation, and advocating that other employees do so as well. Later, as transformation affects different levels of the organization, change efforts must include engaging and mobilizing individuals and groups who could influence the change either positively or negatively. Moreover, the change leader and executives should provide the necessary resources and build indicators for measuring results and holding people accountable. Thus, ownership must be cascaded to ensure a successful implementation, as seen in Figure 4.3 and Figure 4.5.

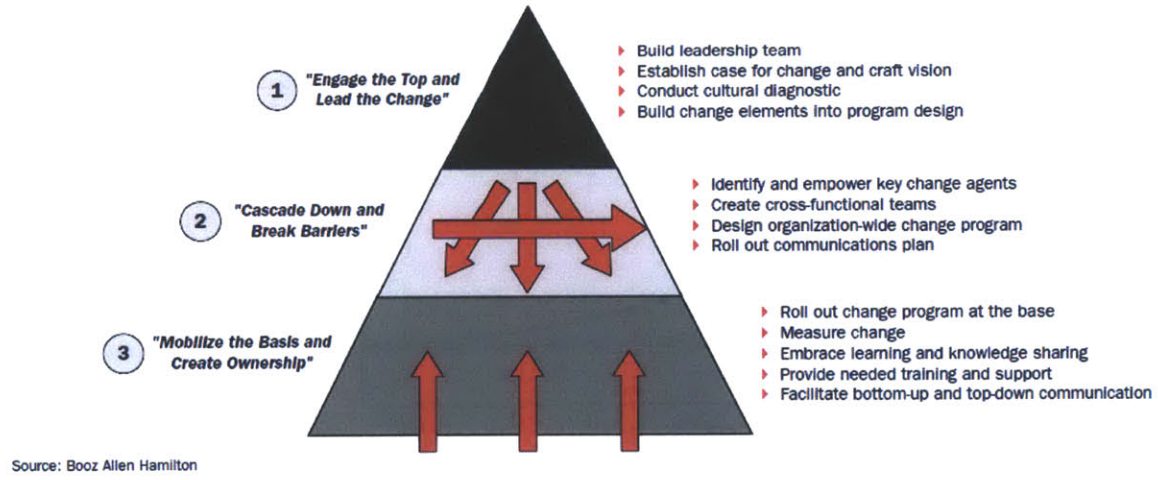


Figure 4.5 – Ownership Cascade

Implementation depends heavily on the bottom of the organization. These employees must receive training to perform the new tasks, change their behaviors, and persuade people to adopt the new behaviors, skills, culture, among other aspects that the change involves. To run the change process as smoothly as possible, the change leader should name change managers and teams including people from all levels of the organization to facilitate communication, ensure a common core vision of the change, encourage knowledge sharing, measure progress, solve problems effectively without affecting other areas, and adapt the change management process when needed.

Change leaders can perform a stakeholder mapping to decide who will be part of the change teams and bring on board the people who can affect the change process the most. The stakeholder map may use as an input the job/role planning analysis, cultural web analysis, and the work breakdown structure. The objective of this analysis is to build a list of the stakeholders, think about potential contributions they can make to the change process, and outline mitigation activities to overcome resistance to change from these stakeholders.

Furthermore, timing of providing the necessary resources for the implementation is crucial. In this sense, change leaders should be aware of when and where the multiple resources are needed to

ensure a successful implementation because providing them either early or late can affect the transformation. Figure 4.6 exposes very clearly the importance of making the resources and ideas available on time when learning by doing and constrained resources are present on process improvement dynamics (Morrison, 2003). Based on information from Morrison (2003) and Morrison and Repenning (2011), the patterns shown Figure 4.6 describe the following dynamics. Blue and black patterns show how the organization returns to the original conditions of support personnel collaboration just enough to get tasks done at just the rate needed mainly due to process degradation and stabilization of experience collaborating. Green pattern describe a sustained improvement value at a higher level since worker ideas for improvements are permanently better because support personnel collaborate with them on such a high proportion of tasks. The only difference among the possible results is when the additional resources were introduced. Thus, timing of providing resources for continuous improvement is an important aspect companies should be aware of because different moments for supplying additional resources can lead to complete opposite results, in spite of supplying the same number of resources.

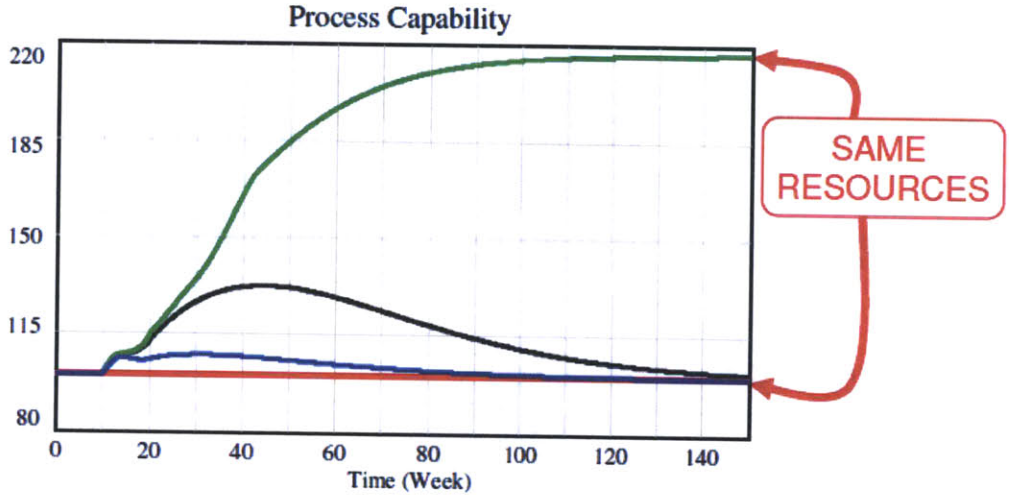


Figure 4.6 – Process Capability response to new ideas and resources available at different times

Implementing the change is a day to day activity that change leaders must monitor constantly and adjust the plan and definition for the change as soon as new issues unfold. Change leaders should define indicators to monitor the implementation objectively and keep change momentum on the organization. The indicators will form the dashboard that change leaders will use to make well-informed decisions and control the change management process to ensure a successful implementation of the transformation.

Once the transformation has been implemented, the change becomes "business as usual". Yet, it has not achieved its full potential. Hence, it is imperative to embed the change into business processes, management infrastructure, and people mindsets and capabilities to make this transformation sustainable and achieve continuous improvement in the institution.

4.1.4 Embedding the change

Change leaders must guarantee alignment and consistency among transformation objectives, the way individuals and organization think, feel, and act at to pursue customer satisfaction, and the

metrics, system, and processes the company uses to manage and sustain performance. This alignment and consistency will enable a sustainable change.

The company must align its management infrastructure to maintain and manage properly the change. This means that the organization's metrics, systems, and processes should drive and support the behaviors needed in the transformation. It is important because keeping the old management infrastructure will revert the behavior to what is measured and rewarded and, in turn, the results achieved during the implementation will be lost.

Furthermore, change leaders need to foresee required competencies, skills, and behaviors in order to align mindsets and capabilities with the desired future state to embed the change successfully, as illustrated in Figure 4.7. Retention programs, workforce development and strategy, and performance management are key enablers for embedding the change by both reinforcing the required competencies, skills, and behaviors and aligning company's management infrastructure.

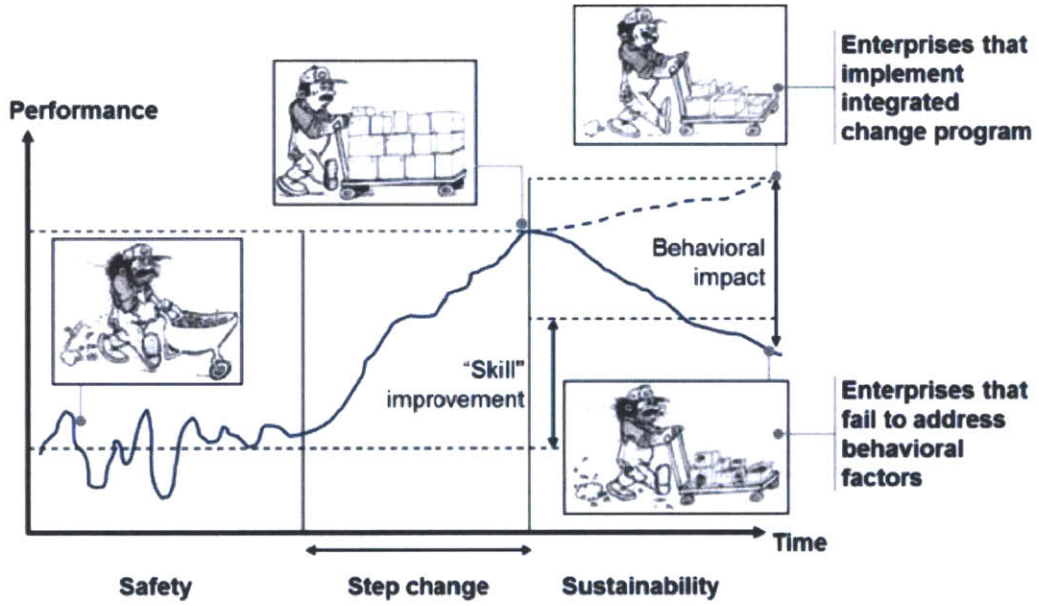


Figure 4.7 – Impact of Competencies, Skills, and Behaviors on Embedding the Change

All in all, managing the change process and the "soft" side of change are two essential responsibilities that must be identified and incorporated in project management plans from the start and be constantly revisited to ensure a successful implementation of the transformation and its sustainability. In addition, change leaders must be aware of company's conditions and process improvement dynamics to adapt the change management and ensure positive results.

4.2 Process Improvement Dynamics

Process Improvement Dynamics provide the foundations to better understand how the coevolution of actions, beliefs, and structures can affect the implementation of useful change of any type. Two main complications present in process improvement implementations are the priority of corrective actions over preventive actions and the resource allocation problem.

4.2.1 Priority of Corrective Actions over Preventive Actions

From research done by Repenning and Sterman (2002) and Morrison (2003), at least four reasons were identified of why managers usually choose the corrective approach over the preventive approach: 1) sunk cost trap, 2) saliency of process outputs, 3) delay on improvements, and 4) uncertainty on preventive actions.

Managers often prefer to correct current problems and recoup past investments for the reasons that accounting systems report the value of current problems either directly or indirectly, company's performance management usually focuses on punishing and rewarding actions based on past values, and preventing future problems does nothing about the lost value generated by current problems. Yet, it is important to mention that the investments affected by current defects are sunk costs and the predominant decision of managers is just an escalation of commitment to a losing course of action.

Performance management systems usually force the corrective approach because process outputs are more tangible than process problems. For executives is easier to see a stock of defective products or claims due to bad service than it is to see process problems. This reality strengthens the saliency of process outputs and generates the behavior of focusing on correcting them before thinking of any process improvement.

The delays between the beginning of the implementation of an improvement and the point where the benefits are more tangible are long and variable, causing the worse-than-before dynamics, shown in Figure 4.8. Moreover, the delays between the impact of the short term solution and their effects on the system are also long, producing better-than-worse dynamics shown in Figure 4.8. These dynamics and the saliency of process outputs induce the employees to prefer the short term over the long term when making a decision.

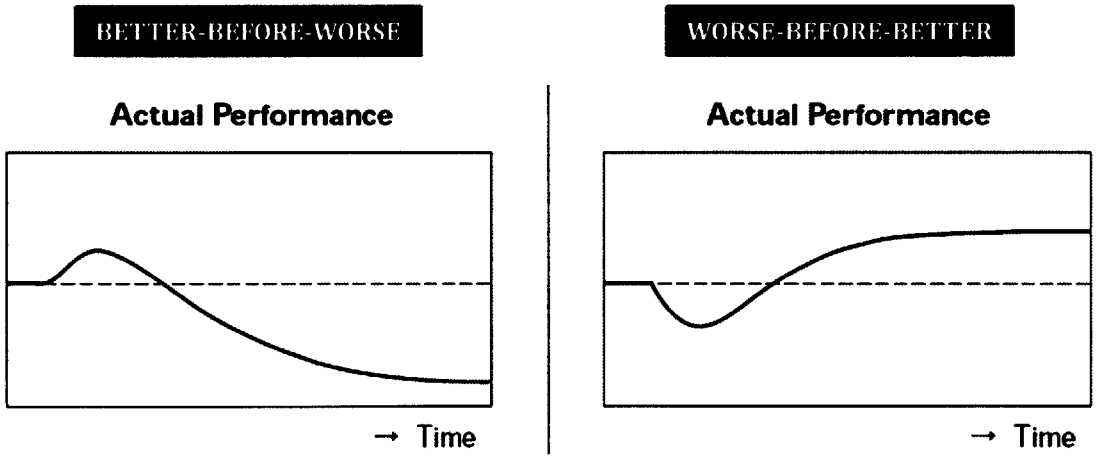


Figure 4.8 – Better-before-worse and Worse-before-better Dynamics (Repenning and Sterman, 2001)

Finally, the uncertainty of the final result and impacts of process improvements and how measurable and tangible are the results of the corrective approach encourage the managers to prefer the certain "gain" to the uncertain yield of problem prevention.

For the reasons described above in detail, executives and managers must avoid the fundamental attribution error. The fundamental attribution error consists of attributing a problem or behavior in the organization to the workforce rather than the system in which they are embedded. Moreover, the fact that corrective actions, such as overtime or cutting corners, produce immediate gains gives the idea to the manager that the root cause has been eliminated and confirms the fundamental attribution error leading the manager to think that he or she intervened appropriately.

In conclusion, whether an organization improves continuously or stagnates is thus determined by the state of the preventive actions. However, the majority of companies sacrifice preventive solutions over corrective actions that trap them in a vicious cycle of declining capability. The reason is that companies' metrics and systems are focused more on preferring the certain and immediate tangible benefits of corrective actions and avoiding short term costs of preventive solutions.

4.2.2 Resource allocation problem

Companies very often have limited resources to meet customers' demands and improve its processes. These two goals seem to be in conflict and managers face this apparent dilemma of not affecting the throughput while implementing improvements. Morrison (2012) develops a system dynamics model to analyze the improvement dynamics under constrained resources, shown in Figure 4.9. This model enables the understanding of the resource allocation decision.

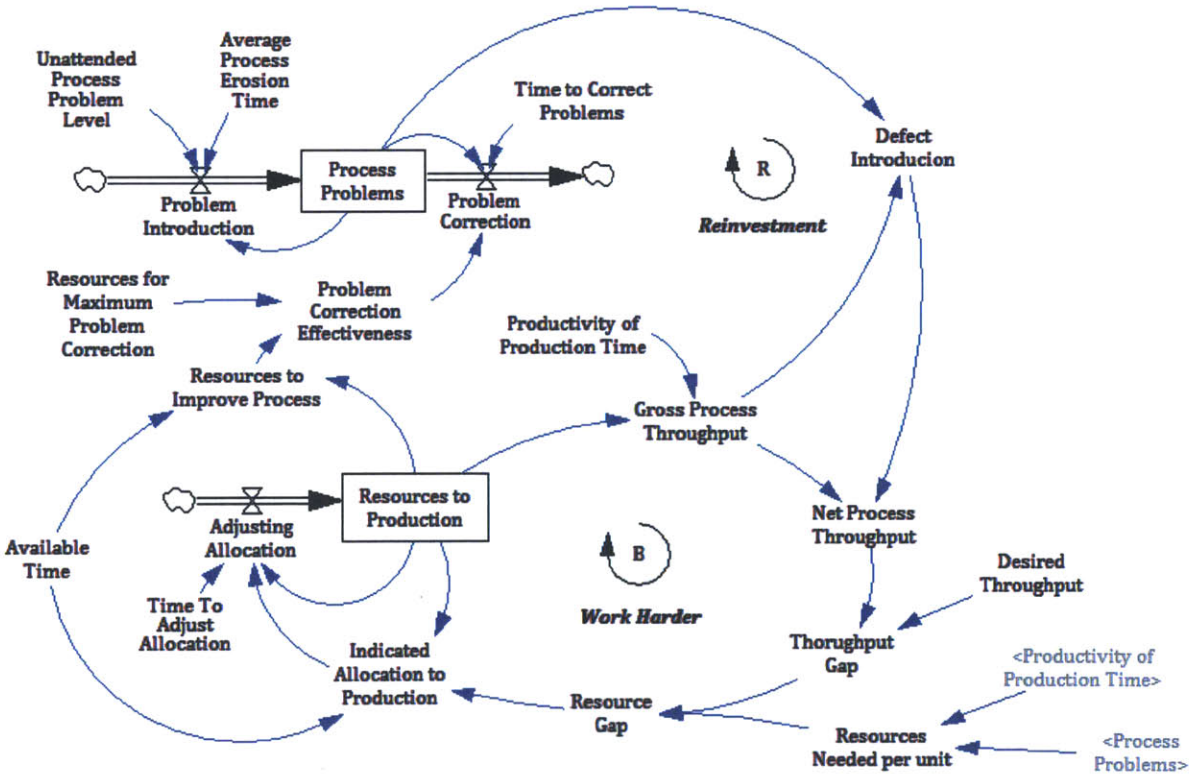


Figure 4.9 – Process Improvement Dynamics under Constrained Resources (Morrison, 2012)

From the model in Morrison (2012), change leaders can obtain two main learnings, for future implementations of transformations, of process improvement dynamics under constrained resources:

1. Allocating more resources to produce primary output will indeed increase the output in the short run, but at the expense of compromising process capability. In the long run, repeating this decision will trap the company into a vicious cycle called the capability trap. The capability trap is a downward spiral of eroding process capability, increasing work hours, and reducing the time dedicated to improvement.

2. Systems with the resource allocation problem have tipping points, which are thresholds of stretch goals beyond which performance rapidly deteriorates.

Altogether, the change management process proposed in this thesis and the process improvement dynamics are holistic frameworks that enable change leaders at Company X to understand what to expect when implementing and embedding the transformation, manage properly the change process and engage the stakeholders in the initiative. In doing so, these frameworks will ensure a successful implementation and accomplish sustainable continuous improvement in Company X.

5 Case of study: Embedding the Dynamic Strategic Sourcing Plan at Company X

The aim of this case study is to provide the analysis for the successful implementation and sustainability of the Dynamic Strategic Sourcing Plan as a continuous improvement initiative at Company X in a pilot region, hereafter called Region A. For this purpose, the change management process proposed in the previous chapter is used and the process improvement dynamics are analyzed to draw insightful recommendations to Company X. It is important to mention that only general results are displayed to protect proprietary data and information.

5.1 Change Management

The goal of this section is to consider the human side of change for the adoption of the non-deterministic supply planning process in Company X. Tools and frameworks are used to develop a thorough understanding of the change, prepare a complete plan for this transformation, conduct an appropriate preparation for the change, propose useful tasks for the implementation phase, and identify required adjustments to make the initiative sustainable.

5.1.1 Understanding the change

The initiative and its implications were analyzed using the following frameworks: PESTLE analysis, Job/role analysis and planning, Career anchor analysis, Cultural Web, and System Dynamics. These methods enabled an in-depth understanding of the change and defining the initiative as clearly as possible. For this investigation, interviews were conducted with Region A personnel at Company X.

The PESTLE analysis outlined the different macro-environmental factors that highlight the need for Company X to adopt the Dynamic Strategic Sourcing Plan in Region A to deal effectively with uncertainty. Chapters 1 and 2 expand on key findings from this analysis.

A summary of the most interesting findings that introduce uncertainty into the chain can be found in Figure 5.1. From the political point of view, the countries that form the region present political instability due to disagreements among political institutions. Some governments are making decisions to protect the local economy based only on political considerations. On the economic side, Region A faces an increase in cost beyond what was expected because countries with heavy production activity have high inflation rates and high volatility in foreign exchange rates. The socio-cultural sphere highlights changes in consumers' buying behaviors such as increase in price sensitivity due to economic conditions in the countries. The technological study notes how powerful customers and suppliers that operate with specific IT systems require companies to adopt some technologies for delivery and supply purposes, and Company X is not exempt from this behavior. In the legal area, an increase in trading regulations produces an increase in paperwork, tasks, and lead time. Finally, supply chain carbon footprint concerns are increasing, and this will cause modifications to the supply chain that need to be considered in future plans.

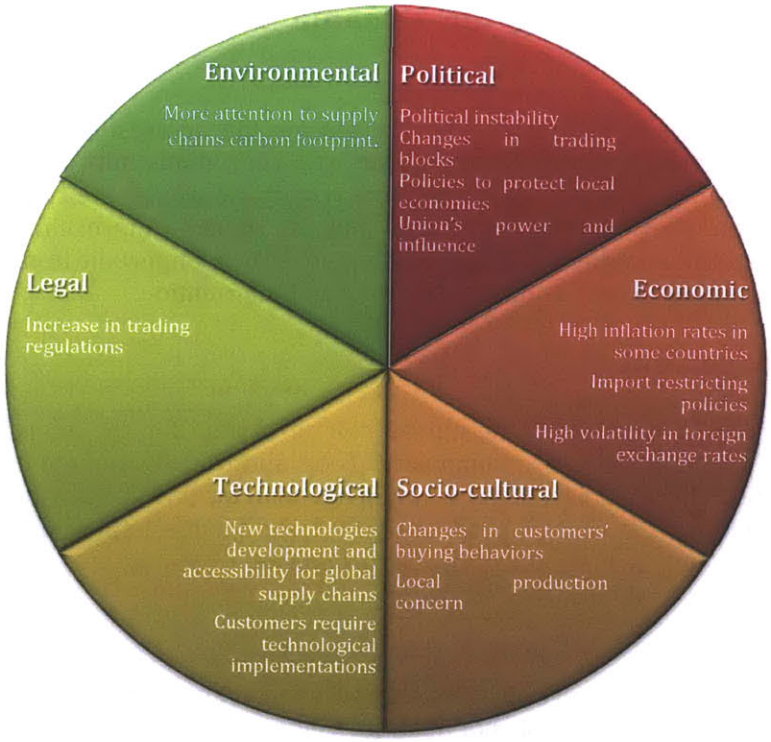


Figure 5.1 – PESTLE Analysis

The adoption of the Dynamic Strategic Sourcing Plan implies different benefits and impact for different roles. For this reason, the job/role analysis and planning is used to acquire a deep appreciation of how to make the change attractive to all the stakeholders based on their needs and initiative's benefits and costs. Some of the roles that were analyzed are: Mill planners, Import/Export leaders, Procurement leaders, Production leader, and Supply leader, among others. Figure 5.2 exemplifies the key stakeholders network developed for Job Position H to illustrate how the stakeholders network was built and analyzed for all key positions at Company X Region A.

For the planners, the job/role planning and analysis provided the conclusions that they need to become familiar with modeling and simulation of uncertainty and stop looking at forecast accuracy as the goal of their job. For procurement personnel and managers, the analysis showed they must communicate this non-deterministic model, mainly the assumptions and outputs, as simply as possible to all stakeholders to make it understandable and not just a black-box model. Lastly, people who are responsible for managing the warehouses and employees that are part of the finance department should be included when defining the real options for the model and comprehend all the real options in which they participate for Company X to be able to exercise these real options when needed.

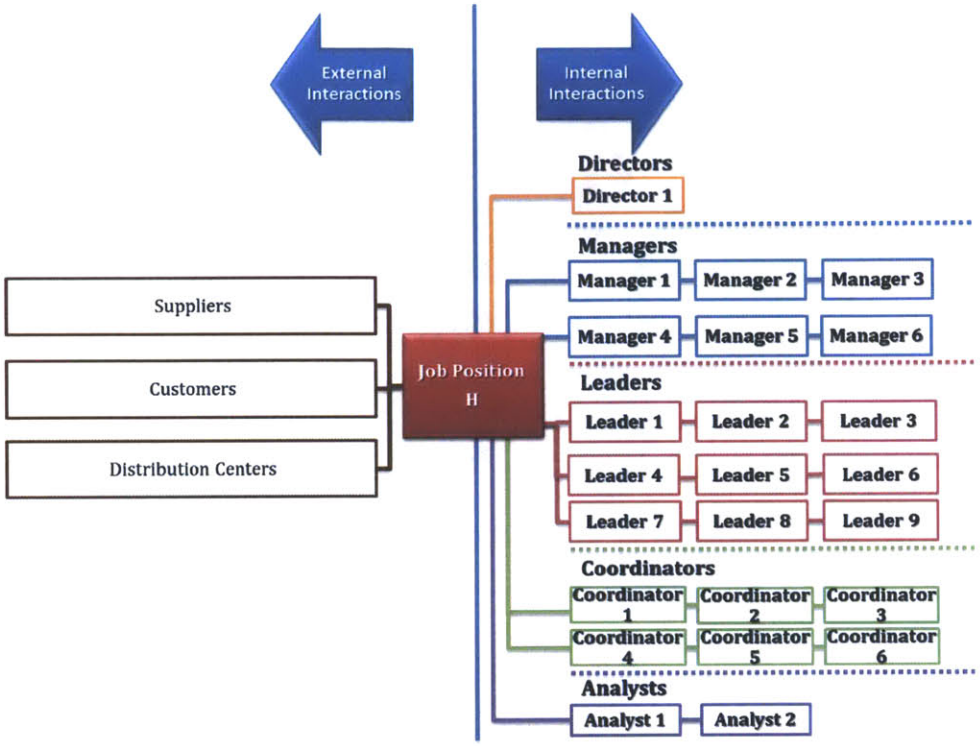


Figure 5.2 – Key Stakeholders Network

Career anchors analysis allows aligning Company X's long term needs for people development with the employees' professional development needs. On this line, the career anchors that best suit the sustainability and improvement of the Dynamic Strategic Sourcing Plan are Autonomy/Independence anchor, Life-Style anchor, General Managerial Competence anchor, and Pure Challenge anchor. These anchors match extremely well with Company X results driven culture, organizational policies, and expected performance from the people who occupy the key positions for the elaboration of the Dynamic Strategic Sourcing Plan.

In respect of the culture audit, the cultural web helps to discover the current culture and to compare it with the desired culture for the sustainability of the Dynamic Strategic Sourcing Planning. Figure 5.3 displays a summary of the results of this culture analysis.

The analysis of comparing the current culture with the desired culture, to ensure the adoption of the Dynamic Strategic Sourcing Plan, pointed key suggestions for some elements of the cultural web. For the stories and myths part, it would be useful to incorporate stories about how not recognizing uncertainty into company's plans decreases the company's ability to respond effectively to changes in the projects such as communicating how Company would have benefited from including flexibility in previous plans versus the reality on those situations. In terms of symbols, incorporating real options lingo into day to day operations will create awareness of the dynamic strategic planning process. In power structures, a well-respected individual should be the one who leads the transformation from deterministic to non-deterministic supply planning. The control systems need to be adapted to reward the increase in project value in the dynamic plan compared to the value of the fixed plan. Finally, the rituals and routines should put more emphasis on analytic decisions than on pragmatic decisions.

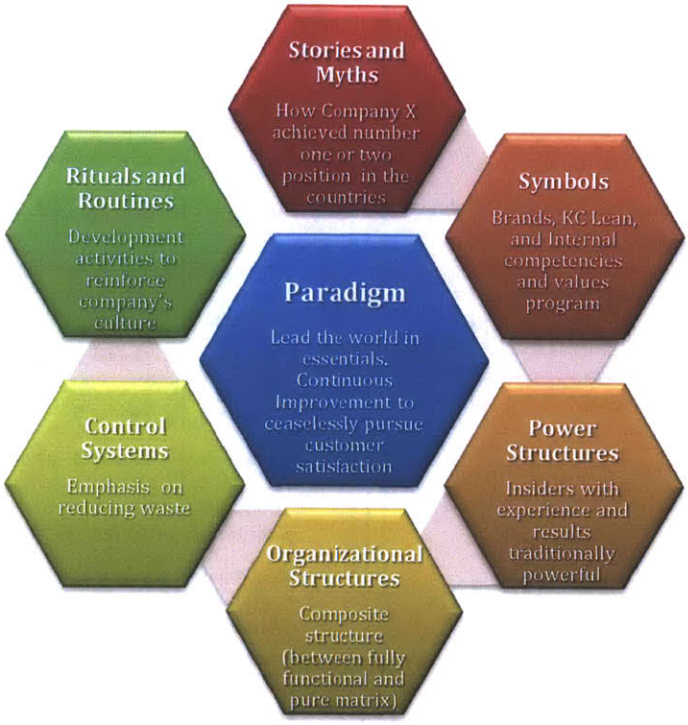


Figure 5.3 – Cultural Web of Company X Region A

In light of the preceding analyses, it can be concluded that replacing single point sourcing plans with dynamic sourcing plans is needed due to changes in environmental factors and internal requirements of maximizing global supply chain and minimizing waste and variance. For this reason, Company X needs to do adjustments in key job positions and in cultural aspects. People in key job positions require training to perform the new tasks and support on changes in reports demanded by stakeholders. With respect to the culture, Company X must eliminate the idea that accuracy in plans is a must and start measuring and rewarding dynamic plans that enable the company to prepare and respond better to what happens in the uncertain world where it operates. It is worth noting that the conclusions presented in this section are the result of revisiting this part of the change management process when doing progress in the next steps to include important aspects previously not considered.

5.1.2 Planning and preparing for change

Once the need and the impacts were understood as much as possible, the next step focuses on creating collective ownership and developing multiple customized written vision statements aligned with the core vision and adapted to key divisions and country offices' language and continuous improvement objectives.

To create collective ownership, the Dynamic Strategic Global Sourcing Plan Excel tool, presented in Chapter 3, was developed using the current tool of the deterministic model as a base and testing each new feature with the end users. Using the current deterministic Excel model allowed a quick

adoption from end users due to the fact that they were familiar with the presentation and form of use. Additionally, testing each new feature and adjusting it immediately based on end users feedback enabled adoption of each new feature separately and sequentially. Figure 5.4 illustrates the general sequence of the Dynamic Strategic Global Sourcing Excel Tool Development. This sequential adoption enabled a better understanding of both the purpose of each feature and the benefits of having a Dynamic Strategic Global Sourcing Plan. In the end, one planner of Region A became the owner of the tool, and he will use it on a regular basis as a pilot implementation. The result of this pilot will serve to facilitate the changes in culture and management infrastructure identified during the phase dedicated to understand the change.

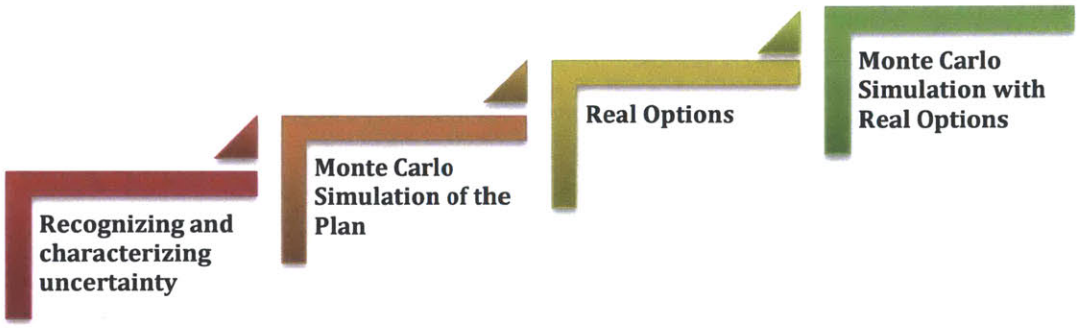


Figure 5.4 – Sequence of Dynamic Strategic Global Sourcing Excel Tool Development

The tool development served also to educate personnel from different divisions and offices in the Dynamic Strategic Global Sourcing Planning process. During these interactions, the employees were asked the advantages and disadvantages of using the dynamic model and its alignment to the strategy of their division, office and company in general. This input was useful to develop a shared core vision with customized message according to the target audience. The core vision and customized written statements were revisited with members of the target audience until achieving impactful statements. An example of the core shared vision and different vision statements can be seen in Figure 5.5. The vision statements shown in Figure 5.5 were developed at different levels such as Company X Region A, Region A's country offices, and country office's divisions to confront the reality that each of them were facing, in order to demonstrate that a viable and possible future exists for them and provide an explanation of what they need to do to make that future a reality.

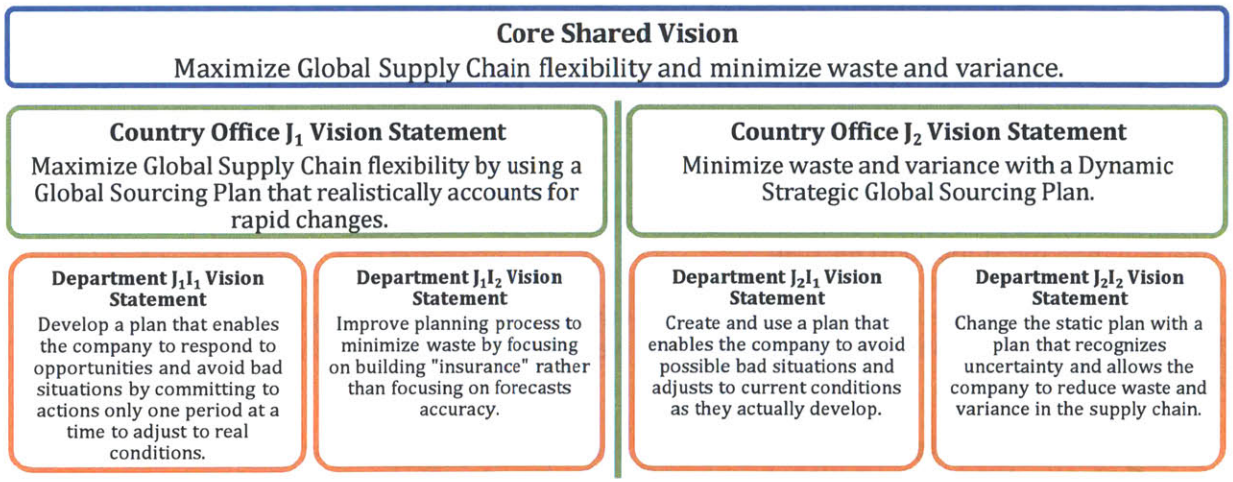


Figure 5.5 – Core Shared Vision and Customized Vision Statements

Finally, a work breakdown structure was developed to organize and define the necessary tasks for the change management process for the implementation and sustainability of the Dynamic Strategic Global Sourcing Planning Process. An extract of the work breakdown structure built at this point can be seen in Figure 5.6. The work breakdown structure provides the details for a proper definition of indicators to measure and control the human side of change effectively along with providing direction to all stakeholders involve.

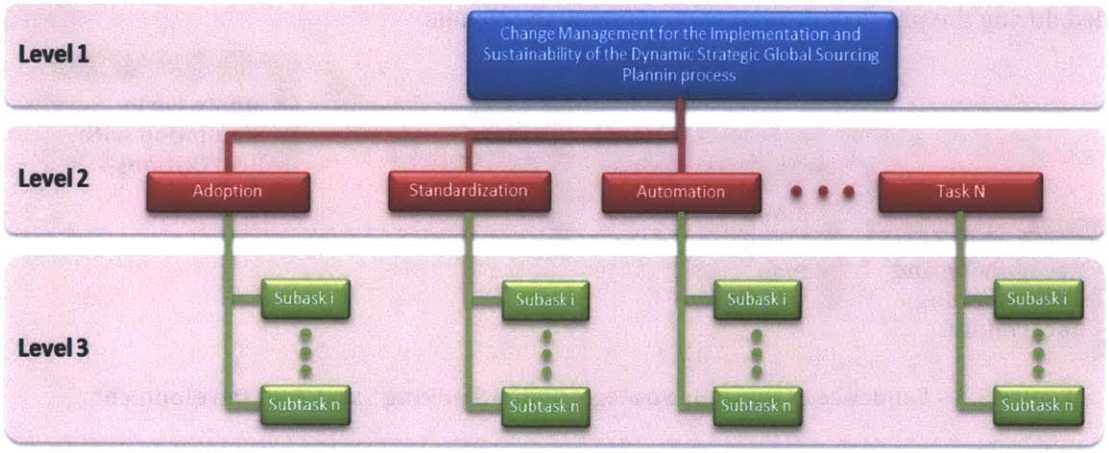


Figure 5.6 – Work Breakdown Structure for Change Management

At this point, the pilot implementation was possible because we had a good understanding of the change and made an exhaustive preparation and planning.

5.1.3 Implementing the change

The first, and essential, task for the pilot implementation was to engage the top level managers of Operations Research and Supply Chain for Region A. In doing so, they played an active role supporting the Excel tool development, communicating how important it is for Company X Region A to deal effectively with uncertainty, and advocating that managers and leaders get involved and support this initiative as well.

A stakeholder map was built using information from the multiple interactions with several employees across Region A. This stakeholder network made possible to identify good candidates to be the owners of the Dynamic Strategic Sourcing Planning Excel Tool. One person was selected as the owner of the tool after a long deliberation with managers and executives. This Company X employee will be the insider responsible for implementing the dynamic planning process as a replacement of the static sourcing plan.

During the pilot implementation with the owner of the tool, several obstacles to making good use of the dynamic strategic sourcing planning process were found. These obstacles can be classified as following:

1. **Lack of knowledge:** In general, Company X employees know little or nothing about Monte Carlo simulation, uncertainty characterization, and real options.

2. **Unclear rules to exercise real options:** There was no clear definition on how and when the options were supposed to be used and the way they can contribute to cut possible losses and increase gains.

3. **Stakeholder opposition:** Groups and individuals think the tool will affect other initiatives and the implementation of the dynamic planning process will undermine some tasks proper of some job positions.

4. **Different agendas and priorities:** It is common in business that multiple initiatives are running to solve problems the company is facing. This was not different in Company X and some activities were delayed until being able to agree or meet with key stakeholders.

The identification of the obstacles and knowing the desired future state enabled to propose countermeasures to overcome the current problems as best as possible in a holistic way. Activities such as training, explanation, expectation clarity, prioritization of ideas, among others were done to achieve a successful pilot implementation. Moreover, each task and subtask from the work breakdown structure was monitored and actions were taken to correct the situation when needed.

From this pilot implementation, key actions were defined for the Dynamic Strategic Sourcing Plan to be implemented in a larger scale and become this transformation into a "business as usual" activity.

5.1.4 Embedding the change

For Company X Region A to sustain the Dynamic Strategic Sourcing Planning Process some metrics, capabilities, and systems need to be aligned with this initiative to both be consistent with each other and generate the behaviors needed for the new process to achieve its full potential.

Metrics used for the performance management to measure and control forecast accuracy, speed in delivering plans, and point recommendations, just to mention a few of the critical metrics studied, need to be modified. The forecast accuracy indicators need not to be as important as they are now for the planners not to invest more time than needed to develop reasonable forecasts. This is because the dynamic model will consider a broad range of possibilities and not just one. The speed demanded to analysts to deliver results for a plan should be adjusted for the planning team to be able to run enough simulations with a proper number of iterations and achieve a reliable range of possible outputs due to a good representation of uncertainties. Finally, the managers must avoid rewarding planners for doing single point plans. Managers should encourage analysts to present them the possible outputs and be able to define both real options and clear rules for exercising those options. These modifications to the metrics will ensure a proper embedding of the dynamic global sourcing plan.

For the capabilities, required trainings and levels were defined per role. These capabilities were categorized as either technical or soft to separate if they will directly improve a process or they will directly influence the way people think, feel and act. Furthermore, each capability was matched with a training program to ensure that Company X Region A has the means to prepare its employees. Figure 5.7 and Figure 5.8 exemplify the technical and soft capabilities defined for job positions and the comparison of capabilities levels among the job positions, respectively. From these figures, it can be seen that different sets of capabilities and levels are required based on the job position.

Job position 1H							
TECHNICAL CAPABILITY	AREA	LEVEL	TRAINING	SOFT CAPABILITY	AREA	NIVEL	TRAINING
Technical capability 30	Area 1	Required	A	Soft Capability 30	Area 1	Novice	P
Technical capability 31	Area 1	Required	B	Soft Capability 31	Area 1	Medium	Q
Technical capability 32	Area 1	Required	C	Soft Capability 32	Area 1	Medium	R
Technical capability 33	Area 1	Required	D	Soft Capability 33	Area 1	Advanced	S
Technical capability 34	Area 1	Required	E	Soft Capability 34	Area 2	Medium	T
Technical capability 35	Area 1	Required	F	Soft Capability 35	Area 2	Medium	U
Technical capability 36	Area 1	Required	G	Soft Capability 36	Area 2	Medium	V
Technical capability 37	Area 1	Required	H	Soft Capability 37	Area 2	Novice	W
Technical capability 38	Area 2	Required	I	Soft Capability 38	Area 3	Medium	X
Technical capability 39	Area 2	Required	J	Soft Capability 39	Area 3	Medium	Y
Technical capability 40	Area 2	Required	K	Soft Capability 40	Area 3	Medium	Z
Technical capability 41	Area 2	Required	L	Soft Capability 41	Area 4	Advanced	AA
Technical capability 42	Area 2	Required	M	Soft Capability 42	Area 4	Intermedio	AB
Technical capability 43	Area 2	Required	N	Soft Capability 43	Area 5	Advanced	AC
Technical capability 44	Area 2	PERA	O	Soft Capability 44	Area 5	Advanced	AD

Figure 5.7 – Technical and soft capabilities for Job Position H

TECHNICAL CAPABILITY	AREA	Level required per job position					
		Division 1	Division 2				
		Job position 1H	Job position 2H	Job position 2J	Job position 2K	Job position 2L	Job position 2M
Technical capability 1	Area 1	PERA	PERA	PERA	PERA	PERA	PERA
Technical capability 2	Area 1	PERA	PERA	PERA	PERA	PERA	PERA
Technical capability 3	Area 1	N/A	N/A	N/A			
Technical capability 4	Area 1						
Technical capability 5	Area 1						
Technical capability 6	Area 1						
Technical capability 7	Area 1	Unit program	Unit program	Unit program	Unit program	Unit program	Unit program
Technical capability 8	Area 1	Unit program	Unit program	Unit program	Unit program	Unit program	Unit program
Technical capability 9	Area 1	Unit program	Unit program	Unit program	Unit program	Unit program	Unit program
Technical capability 10	Area 1	Unit program	Unit program	Unit program	Unit program	Unit program	Unit program
Technical capability 11	Area 1	Unit program	Unit program	Unit program	Unit program	Unit program	Unit program
Technical capability 12	Area 1	Unit program	Unit program	Unit program	Unit program	Unit program	Unit program
Technical capability 13	Area 1	Unit program	Unit program	Unit program	Unit program	Unit program	Unit program
Technical capability 14	Area 1	Unit program	Unit program	Unit program	Unit program	Unit program	Unit program
Technical capability 15	Area 2	Advanced	Advanced	Advanced	Advanced	Advanced	Advanced
Technical capability 16	Area 2	Advanced	Advanced	Advanced	Advanced	Advanced	Advanced
Technical capability 17	Area 2	Advanced	Advanced	Advanced	Advanced	Advanced	Advanced
Technical capability 18	Area 2	Medium	Advanced	Advanced	Advanced	Advanced	Advanced
Technical capability 19	Area 2						
Technical capability 20	Area 2	N/A	N/A	N/A			
Technical capability 21	Area 2						
Technical capability 22	Area 2						
Technical capability 23	Area 2		Advanced	Advanced	Advanced	Advanced	Advanced
Technical capability 24	Area 3	Basic	Advanced	Advanced	Medium	Medium	Novice
Technical capability 25	Area 3	Advanced	Advanced	Advanced	Medium	Medium	Novice
Technical capability 26	Area 3	Medium	Advanced	Advanced	Medium	Medium	Novice

Figure 5.8 – Technical Capabilities Level for different Job Positions

Finally, the ERP system of Company X Region A needs to be modified to allow running and obtaining the Dynamic Strategic Sourcing Plan directly from it, to eliminate the process of downloading data, to introduce the data into the Excel tool, and to draw conclusion from this last tool. It is true that the Excel tool allows quick adoption and understanding of the new process, but the modification of the ERP system is what will make this dynamic planning sustainable and able to be adopted in other regions of Company X.

All things considered, the replacement of the current point plans in Company X for the dynamic strategic plans is an essential and possible transformation. This change will foster continuous improvement in the organization, generate more resources for other important initiatives, and therefore, increase Company X competitive advantage.

5.2 Process Improvement Dynamics

The examination of process improvement dynamics in Company X Region A was conducted to understand how the coevolution of actions, beliefs, and structures can affect the implementation of the Dynamic Strategic Sourcing Planning Process. On this line, a problem that was identified and studied using system dynamics is how the attrition of employees in key positions at the mills impacts the resource allocation for the improvement and, in turn, affects the implementation of the dynamic planning process.

In Company X Region A, managers recognize the difficulty of retaining qualified personnel in key positions at the mill. Although this situation can be considered an exogenous factor caused by the dynamics between the scarcity of talented people and the increase in companies looking for these persons, in reality it is more endogenous than it is thought. Yet, the analyses of the dynamics that cause the lack of talent are out of the scope of this research. This research focuses only on the effects of losing employees in key positions on Company X's continuous improvement efforts, in particular the adoption of the dynamic strategic sourcing plans. The intent is to show that this problem should not only be on HR department's agenda, but in all departments' main priorities.

The starting point was to obtain the stock and flow diagram of the career path the employees at the mills expect to follow. An illustration of this career path can be seen in Figure 5.9Figure 5.9. This initial model shows an ideal situation without attrition, with an unconstrained number of people at each level, and in which people are well-prepared to make the switch from one position to another, among others. The distinction between Position j and Position j to be Position j+1 is made to include the behavior, in terms of career advancement, that occurs when an employee remains too much time in a specific position.

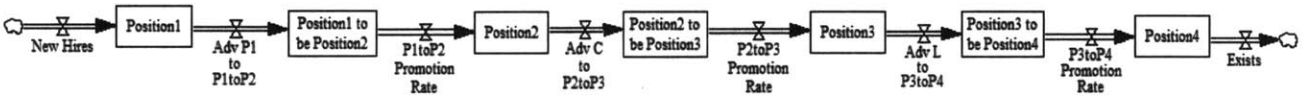


Figure 5.9 – Expected Professional Growth of Personnel from a division in Company X Mills

The model was extended to include attrition in all job positions to reflect a more realistic situation and compare it to the current talent lost. The outflow from each position that contains the word "leaving" is to consider all the employees that will no longer be part of the department regardless of the reason. Moreover, the promotion rates between positions consider the maximum number of employees per position, based on the organizational structure, to avoid a situation of promoting more employees than the maximum allowed at the Mill. Hence, this stock and flow diagram models people development and talent lost dynamics in a specific mill, hereafter referred as Mill G, of Company X Region A. This model can be seen in the upper part of Figure 5.10.

In the following paragraphs, two scenarios will be considered for the attrition values: 1) all the attrition values equal a desired attrition for each position, and 2) the attrition at each position is the real attrition value of Company X Region A Mill G for that position. For illustrative purposes, the desired attrition value for all positions will be equal to zero in this document. The reason for running two scenarios with different attrition values is to show how attrition affects the implementation of continuous improvement initiatives of Company X.

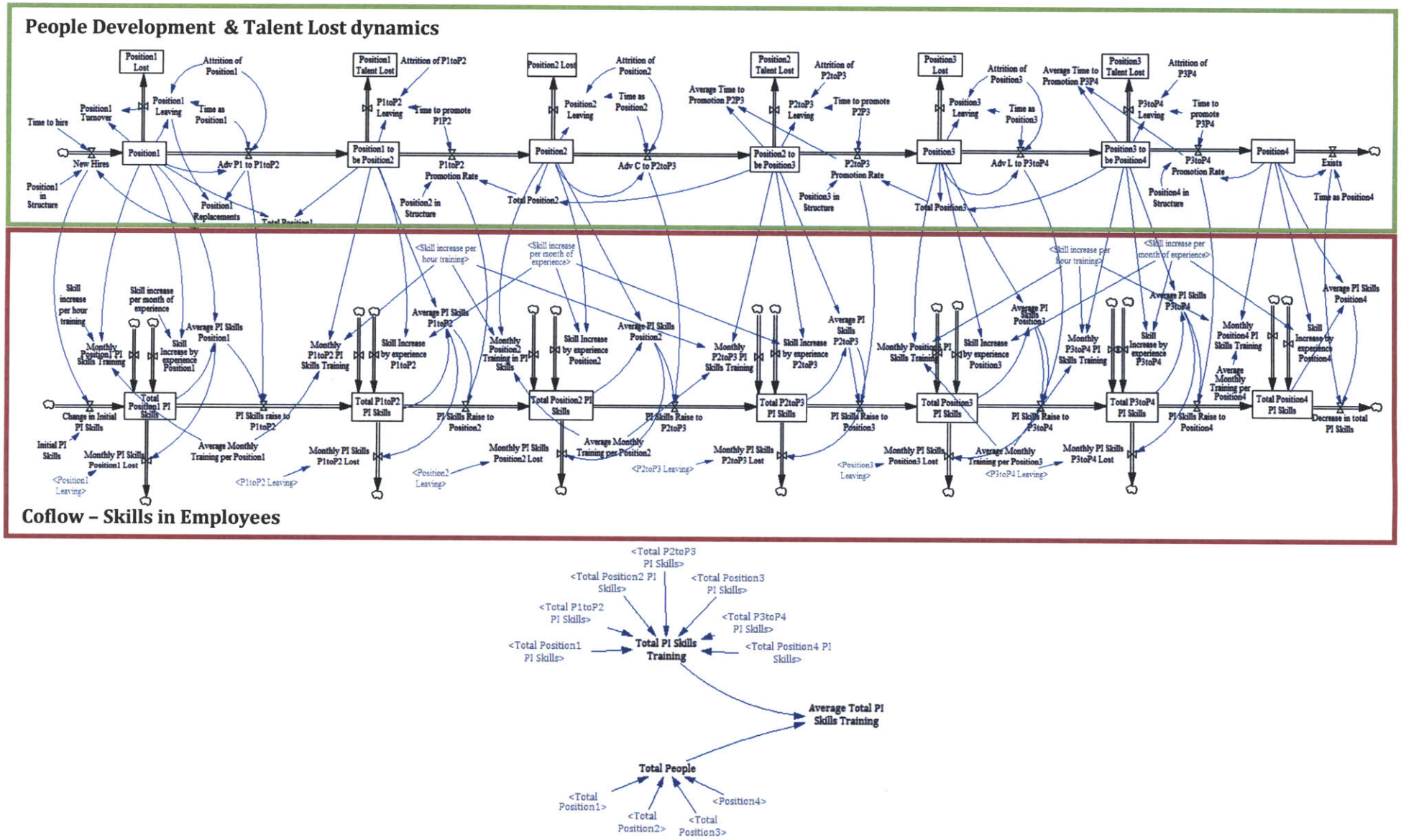


Figure 5.10 – System Dynamics Expected Professional Growth of Personnel in Company X Region A Mills

Once the model was built, the next step was to define the parameters according to Company X reality and do the necessary formulations for the system to be in steady state equilibrium. In equilibrium, the total inflow for each stock equals its total outflow so the level of the stock remains constant. A complete description of the equilibrium formulas for the stocks can be seen in Appendix D. Figure 5.11 and Figure 5.12 plot the equilibrium value of the people at any position and the talent lost for the model with attrition of zero and real attrition values at Company X Region A Mill G.

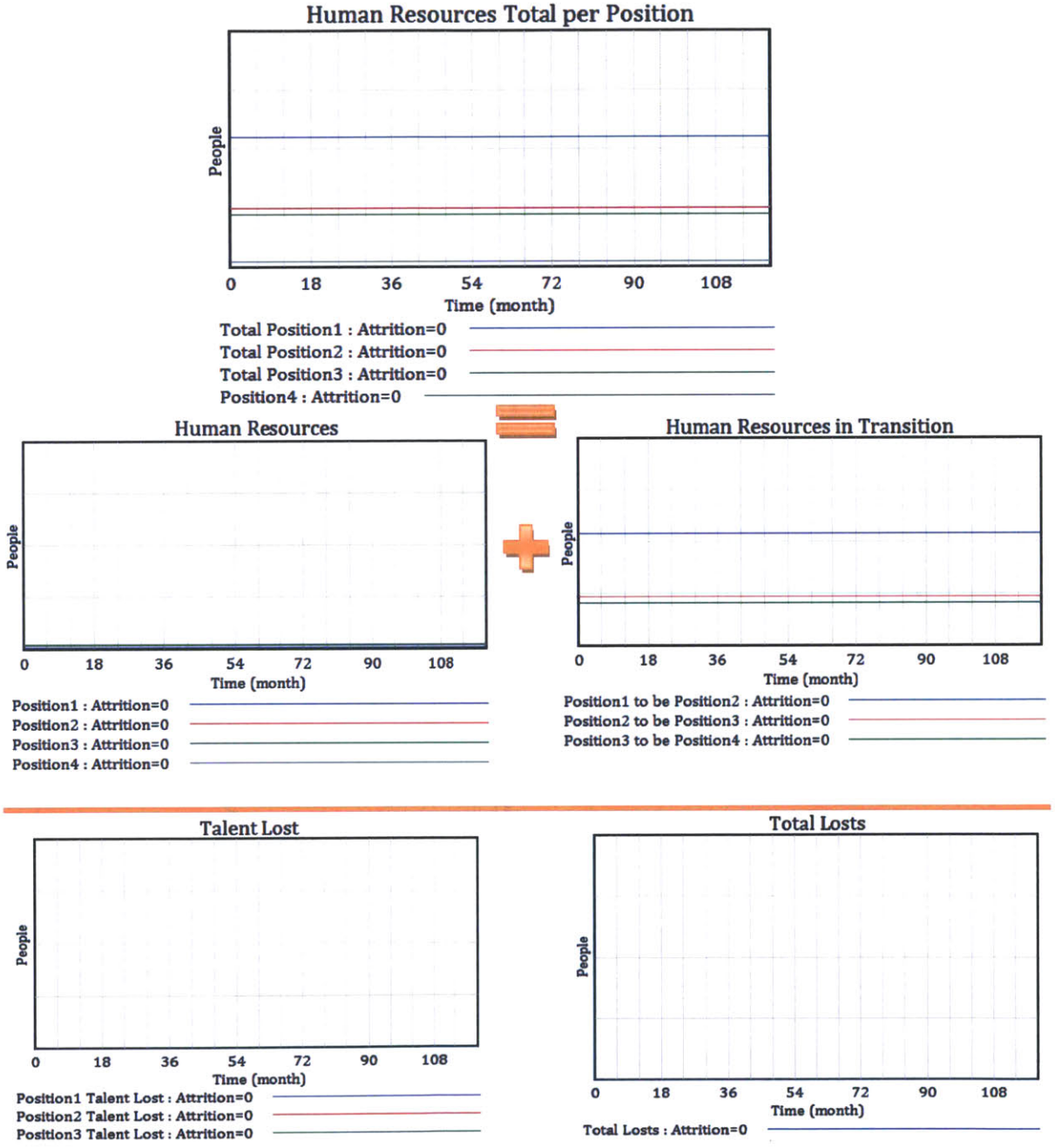


Figure 5.11 – Steady-state Equilibrium Stocks and Rates for People Development and Talent Lost with Desired Attrition. Note: actual values have been removed to protect proprietary data

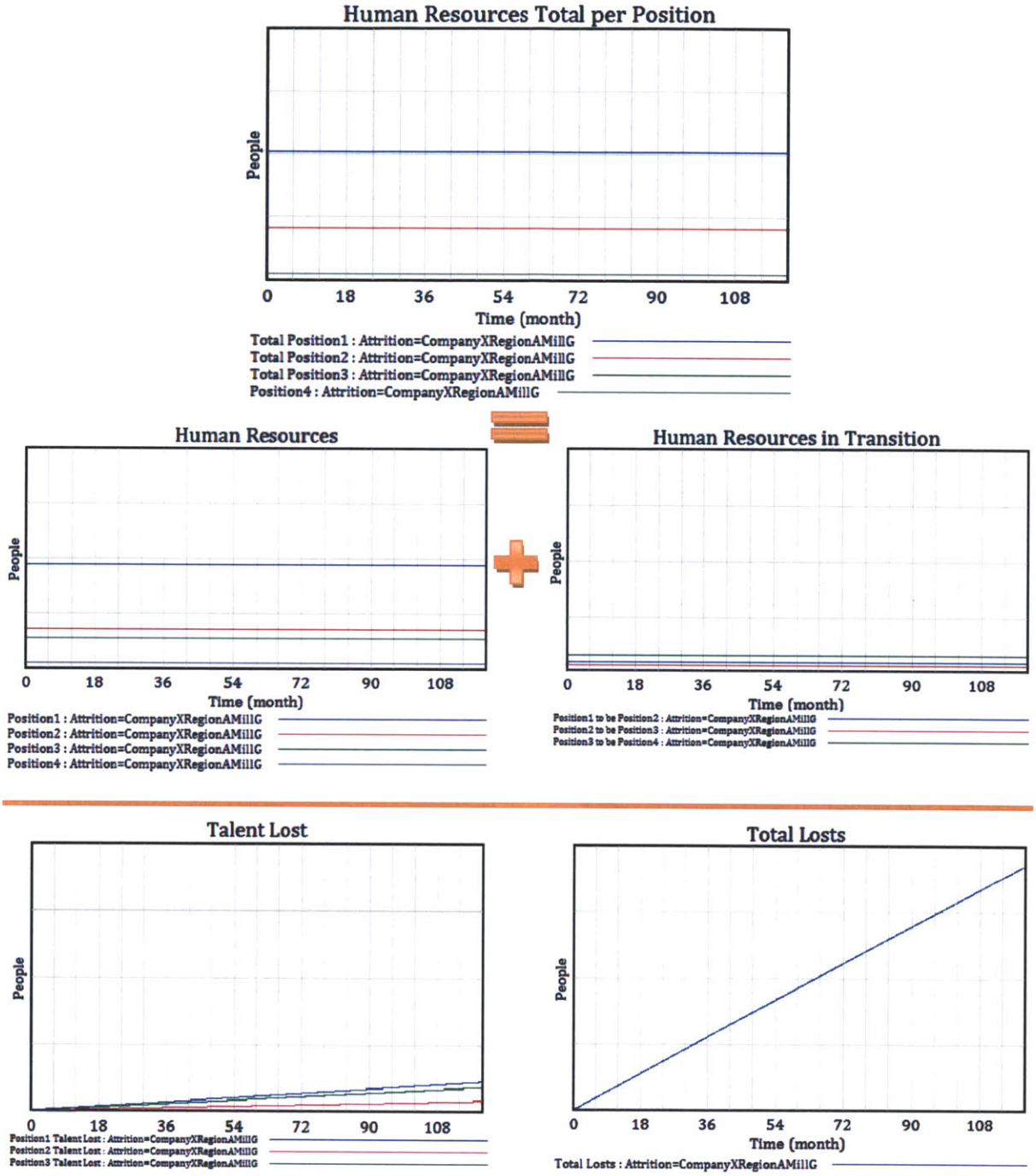


Figure 5.12 – Steady-state Equilibrium Stocks and Rates for People Development and Talent Lost with Company X Attrition values. Note: actual values have been removed to protect proprietary data

Comparing the equilibrium runs with attrition values of zero and Company X Region A Mill G real data, the total people per position decreases for the run with the real values, except for the managers. Moreover, the mix of the people at the position and the employees who are well-

prepared to occupy the next position in the structure changes also. Figure 5.13 shows the graphs that make explicit the changes mentioned. These changes will have significant impacts on the overall process improvement skills the employees from Company X Region A Mill G have. In consequence, the implementation of continuous improvement initiatives is affected for these changes in employees' dynamics. For example, the resource allocation problem between production and improvement activities increases because the employees need more time to solve problems due to the lack of training and experience.

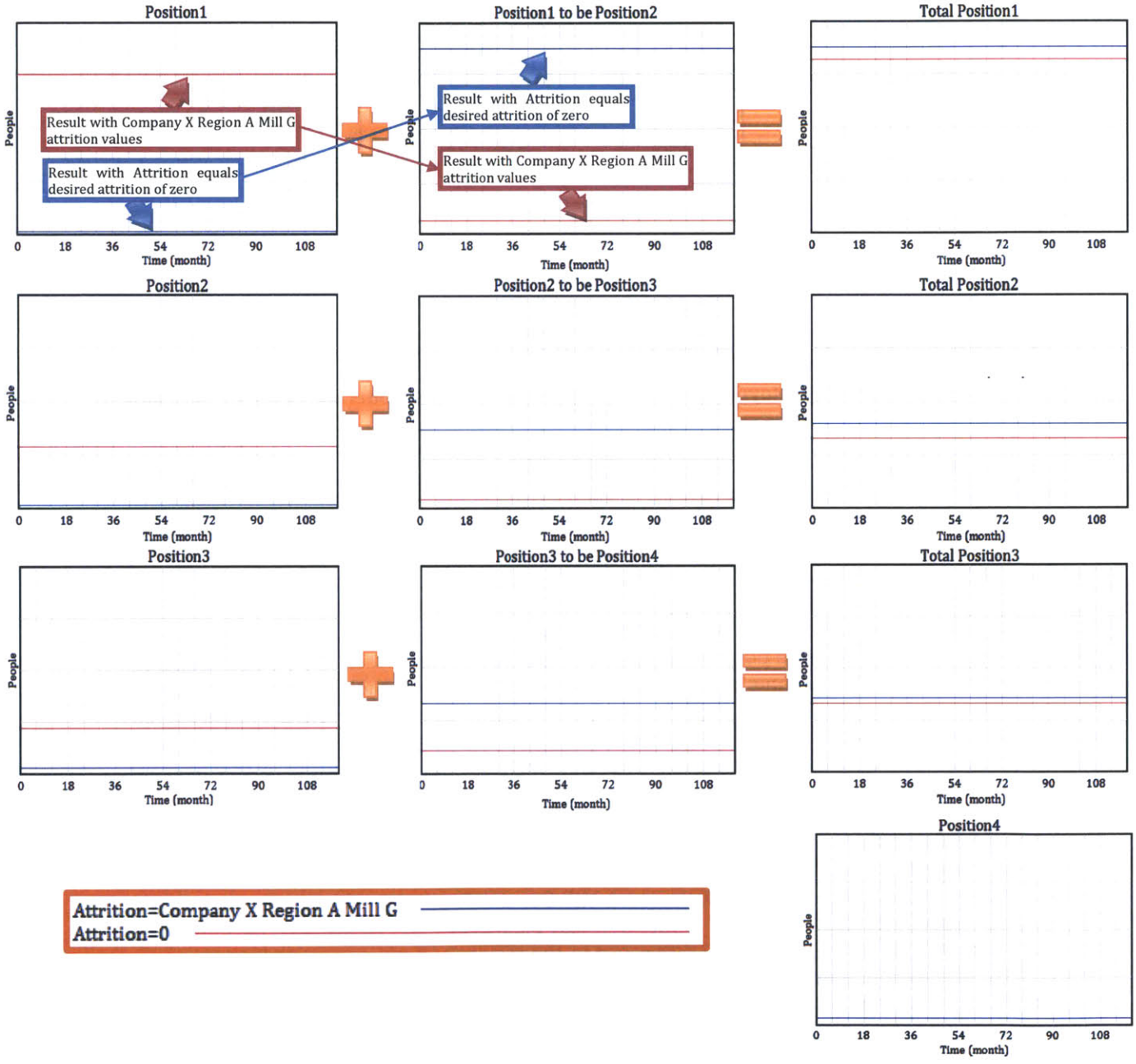


Figure 5.13 – Runs Comparison between Results with Desired Attrition and Results with Company X Region A Mill G Values. Note: actual values have been removed to protect proprietary data

It is important to mention that the model and the input parameters were verified and validated by Company X employees. To illustrate this verification and validation, Figure 5.14 compares the result from the model at month 33 with real data from Company X Region A Mill G for the same period of time. The fact that the model gives an approximate value of the talent lost for division R increased its credibility to employee's eyes and, in turn, its saliency. The problem became more salient because the model proved to be a useful tool to test policies for the issue in question and see the results of those initiatives in seconds and not in months.

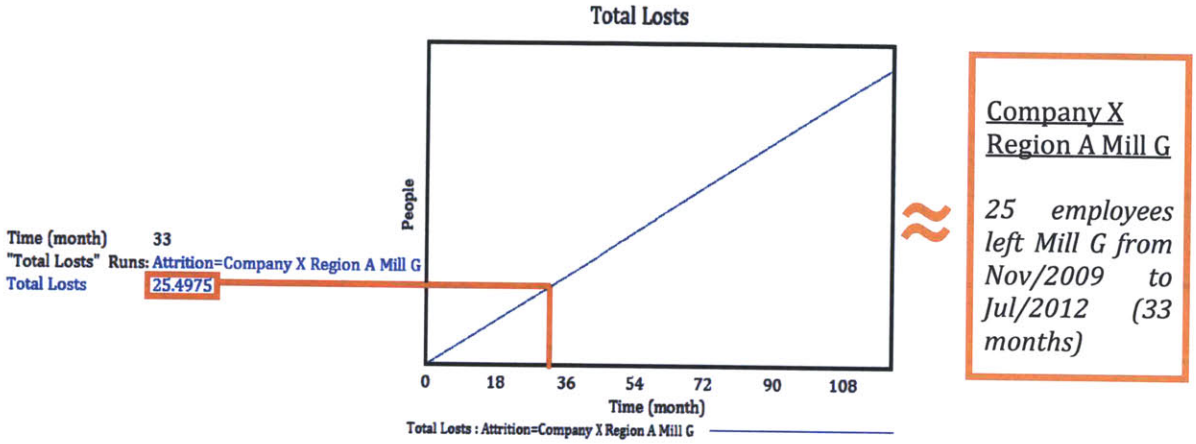


Figure 5.14 – Comparison of Employees Lost between System Dynamics Model and Company X Region A Mill G

For the model to be able to quantify the impact of the changes in employees' dynamics on continuous improvement skills, it was needed to keep a track of the skills developed throughout all the time the employees are in the company as an attribute of the fundamental stock that is people. A coflow was used for this purpose. From Sterman (2000), we know that coflows are "structures that keep track of various attributes of the units in a stock and flow network".

Figure 5.10 displays the coflow structure used to account for the PI Skills of Mill G employees. In this coflow structure, as each job position increases in number of employees, the Total PI Skills for that position increases. On the same line, as the number of employees of a job position is reduced to any of the two outflows, the Total PI Skills for the position decreases. All the Total PI Skills stocks are a function of Skills increase by hiring/promotion, Skills increase by training, Skill increase by experience, Skill lost by employees leaving, and Skill lost by either promotion to the next job position or leaving the system.

The necessary formulations for the coflow to be in steady state equilibrium can be seen in Appendix D. The result from the equilibrium runs with the attrition of each job position equal to both their desired attrition value and to Company X Region A Mill G real values can be seen in Figure 5.15 and Figure 5.16, respectively. It is important to mention that Figure 5.15 and Figure 5.16 have the same scale for the reader to be able to see the difference in the results of both scenarios. Looking at the results of the simulation, they confirm the initial guess that the change in the position mix between early employees and experienced employees due to attrition has significant impacts in the process improvement skills of the employees.

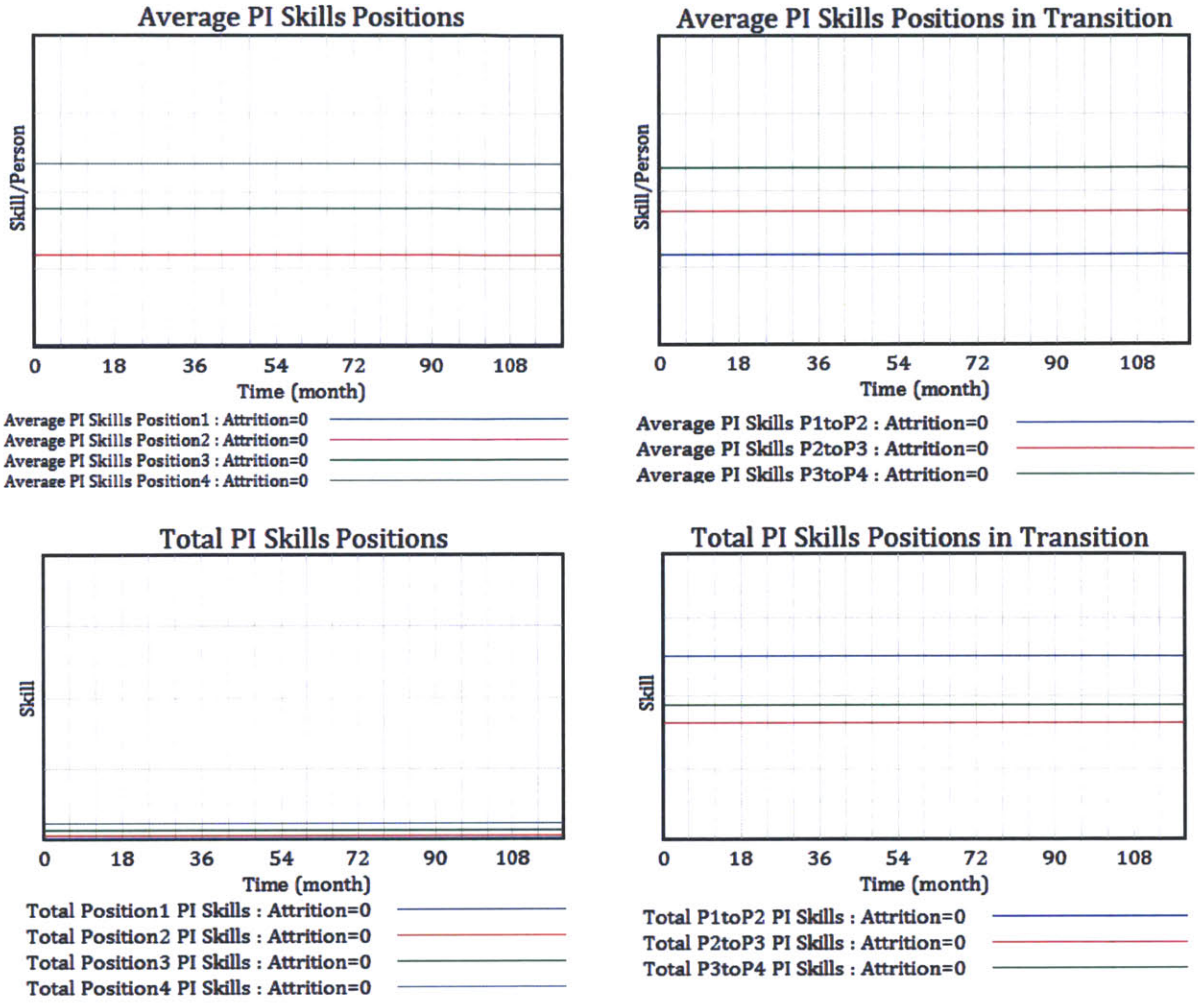
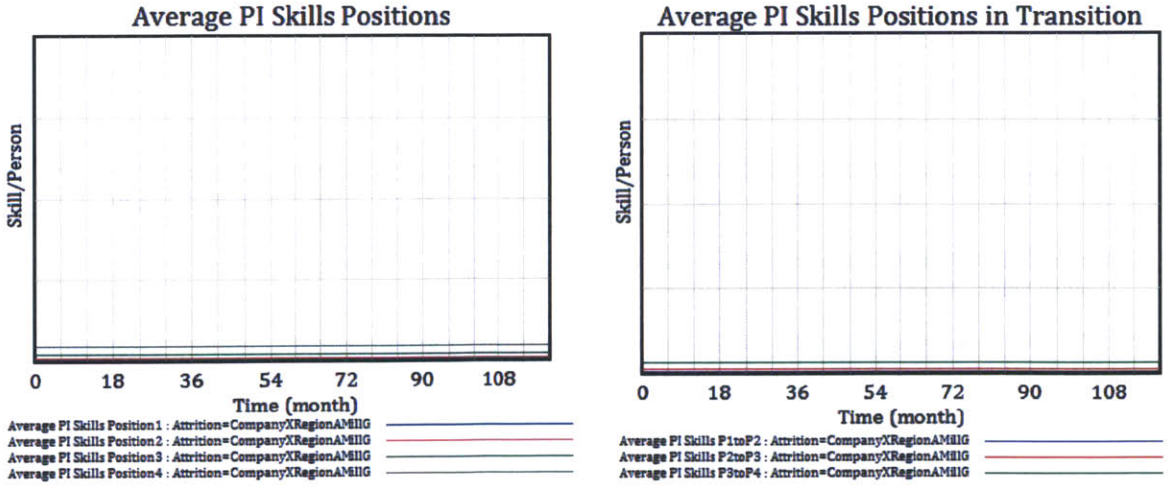


Figure 5.15 – Steady-state Equilibrium Stocks and Rates for PI Skills with Desired Attrition. Note: actual values have been removed to protect proprietary data



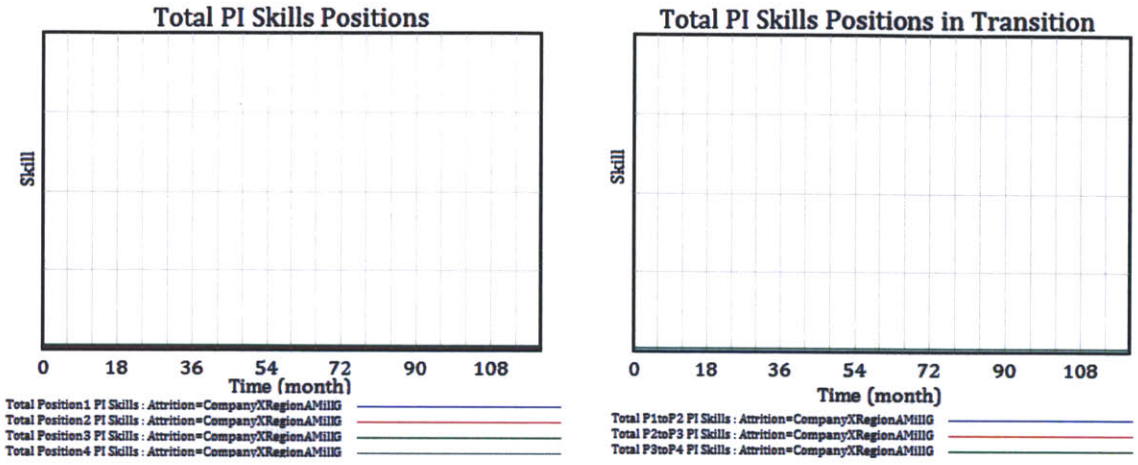


Figure 5.16 – Steady-state Equilibrium Stocks and Rates for PI Skills with Company X Region A Mill G Values. Note: actual values have been removed to protect proprietary data

When conducting a detailed comparison between scenarios, the biggest difference in total PI skills, from the run with desired attrition and the run with real attrition, is on the job positions where the employee is in transition between positions in structure. This finding exposes that losing well-prepared individuals is reducing the total process improvement skills at Company X by a factor of 1/35 with a desired attrition of zero for the ideal situation, shown in Figure 5.17.

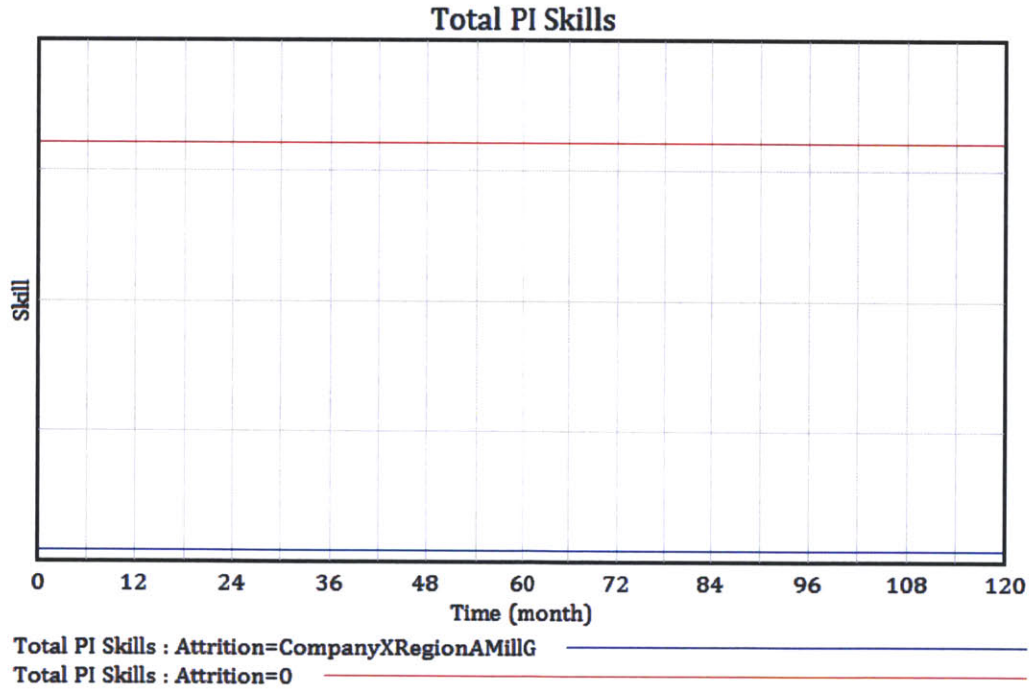


Figure 5.17 – Comparison of Total PI Skills Results with Desired Attrition and Company X Region A Mill G Real Attrition. Note: actual values have been removed to protect proprietary data

The final extension of the model was to include the effect of losing the skills into the production environment at the Mill. For this part, I used the model described by Morrison (2011) and introduced two main effects on Time to correct the problems and the Process Erosion Time. Table functions were used to capture the nonlinear relationships that will affect the two variables mentioned previously. On the table functions the relationship is specified as a table of values for the independent and dependent variables (Sterman, 2000). This part of the model and its equilibrium run can be seen in Figure 5.18.

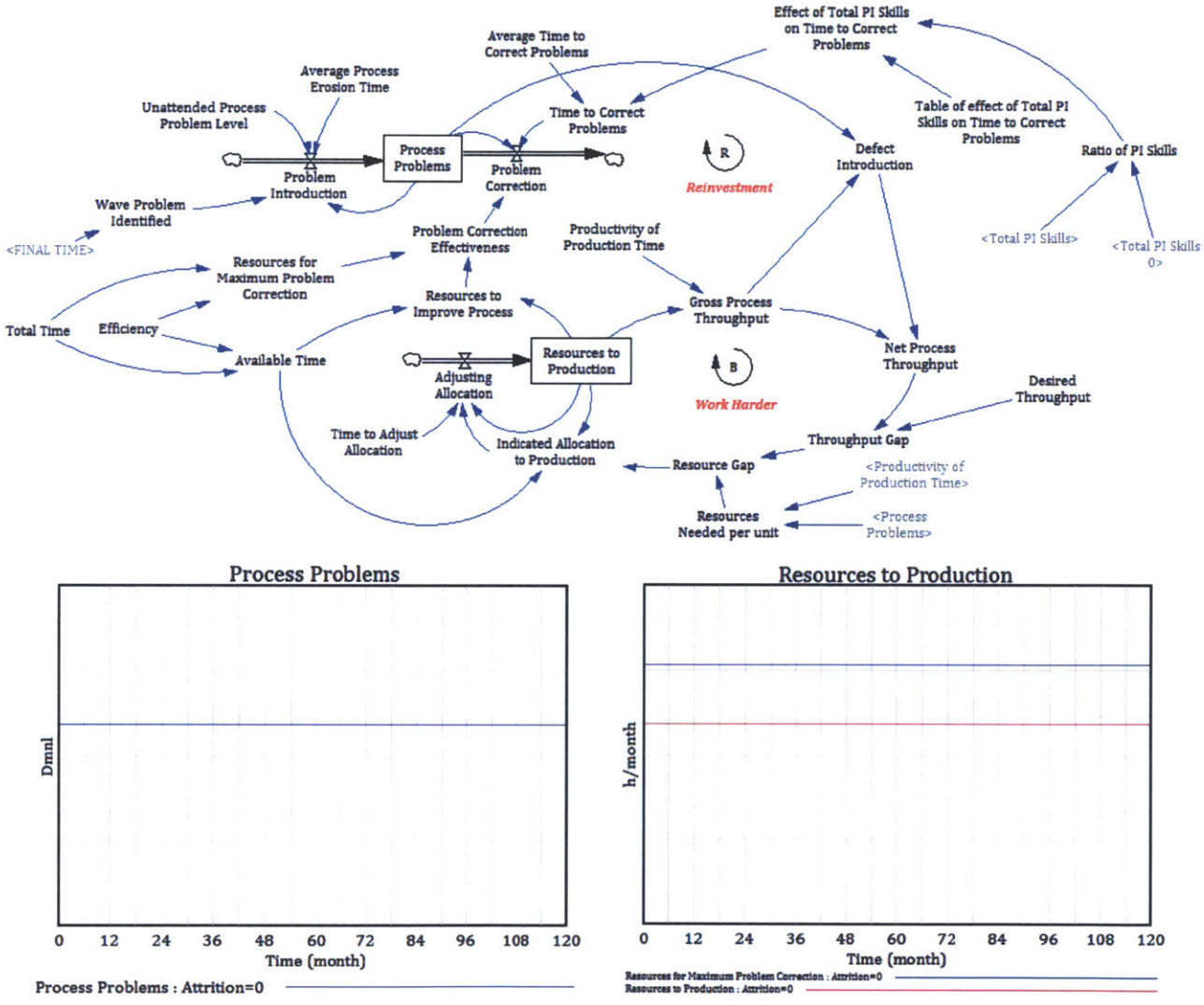


Figure 5.18 – Resource Allocation Dynamics Model

The first step for the table function was to normalize the input and output. To normalize the input a ratio between the Average Total PI Skills Training and Desired Average PI Skills Training was defined. The normalized output of both table functions will be factors that will multiply the average process erosion time and average time to correct problems. The following tasks to define the table functions involved identifying the reference point, identifying reference policies, and considering extreme conditions.

From interviews and the observed behavior in previous projects at Company X, the effect of the ratio of total PI skills on time to correct problems presents a huge decrease when the continuous improvement skills remain on the company, shown in Figure 5.19. When the PI skills from real attrition equal the PI skills from desired attrition the time to correct the problem is significantly lower than the actual average time to correct the problem by a factor of Z. For the case where there skills do not remain in Company X, the model uses the average time to correct problem the company used to take when there was not a structured approach to solve problems as it is now.

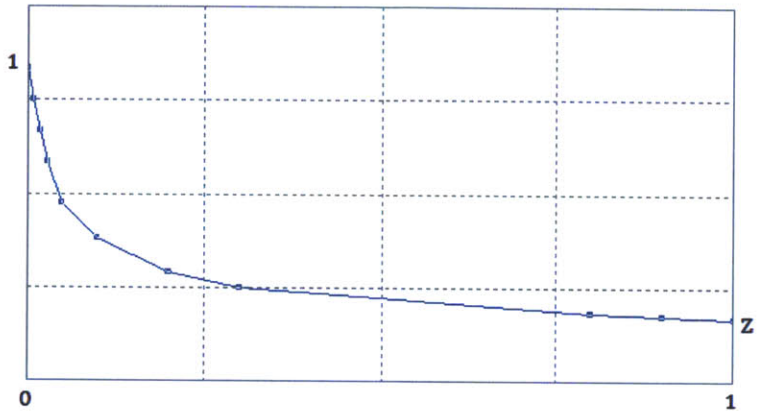


Figure 5.19 – Effect of the Ratio of Total PI skills on Time to Correct Problems

Once the effect of the change in total PI skills due to changes in attrition was defined, the simulation was run for both scenarios in attrition values. The main finding was that both process problems and the resources to production increased, shown in Figure 5.20. The increase in resources to production leaves fewer resources for the implementation of improvements, such as the Dynamic Strategic Global Sourcing Plan, and, in consequence, the mill got into the capability trap of eroding process capability, increasing work hours, and reducing the time dedicated to improvement.

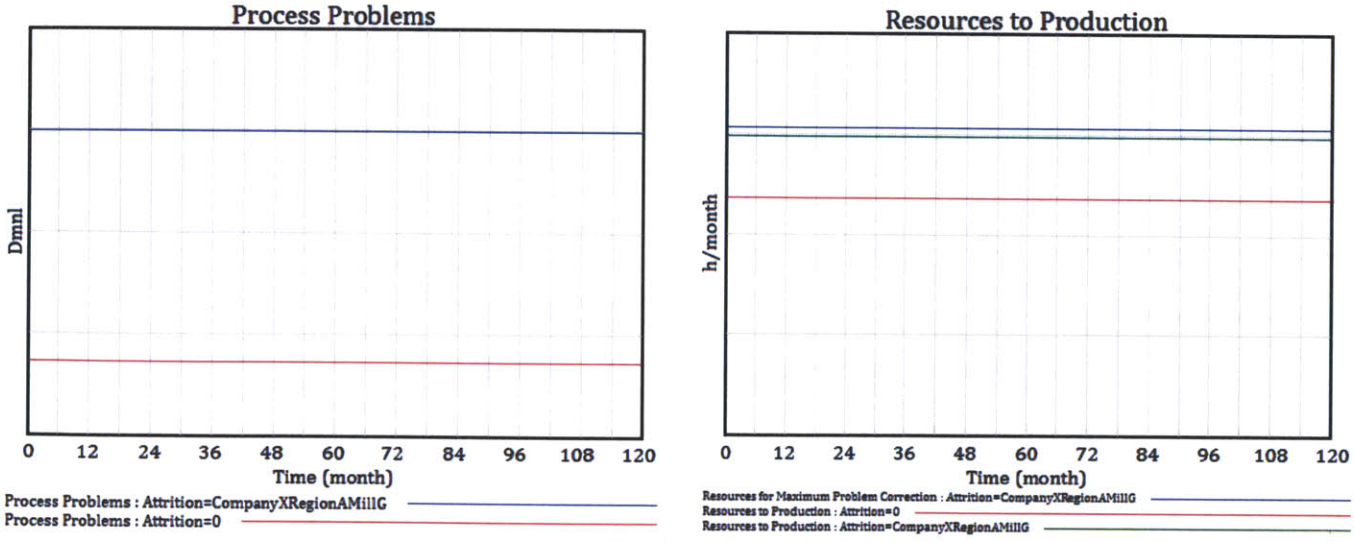


Figure 5.20 – Change in Process Problems and Resources to Production due to changes in Attrition

Once the system was in equilibrium, the continuous improvement problem introduction behavior consisting on identifying and solving a problem in a defined period of time every H months was simulated, shown in Figure 5.21.

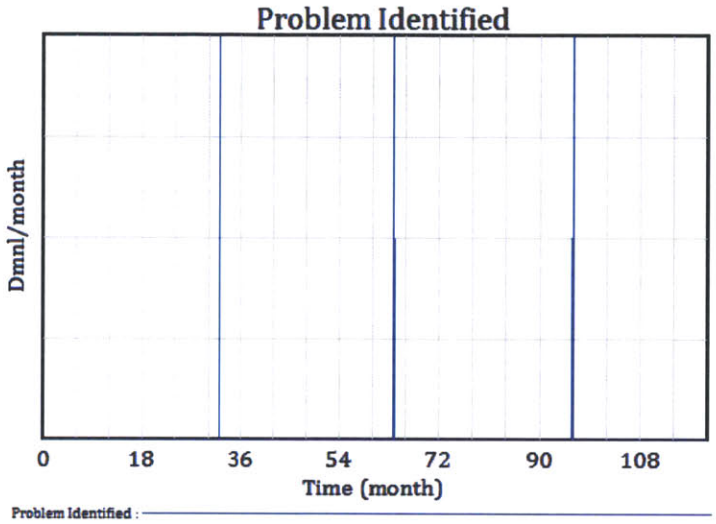


Figure 5.21 – Continuous Improvement Problem Introduction Pattern

The increase in problem introduction, generated by the continuous improvement problem identification activities, caused the following behaviors in the system, displayed in Figure 5.22. For the scenario when attrition equals the desired attrition value (red line), the system returns to equilibrium given that the time to correct the problems is below the average because Mill G's workforce has the skills to solve the problem quickly. In the case when attrition for each position has the real values (blue line), the system reaches the initial level in process problems after a long period of time due to the loss in skills when talented employees left the company.

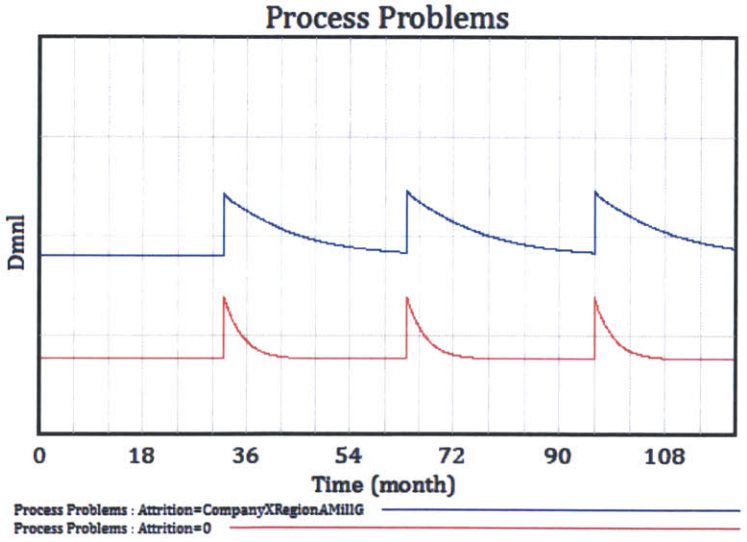


Figure 5.22 – Process Problems with Continuous Improvement Problem Identification for the two scenarios in attrition.

As expected, the increase in process problems affects the resources allocated to production, shown in Figure 5.23. For the desired attrition, the required resources for production increases suddenly after reaching a level when the resources needed decreases up to the initial level. For the current attrition values, production requires more resources for a longer period of time than the previous scenario.

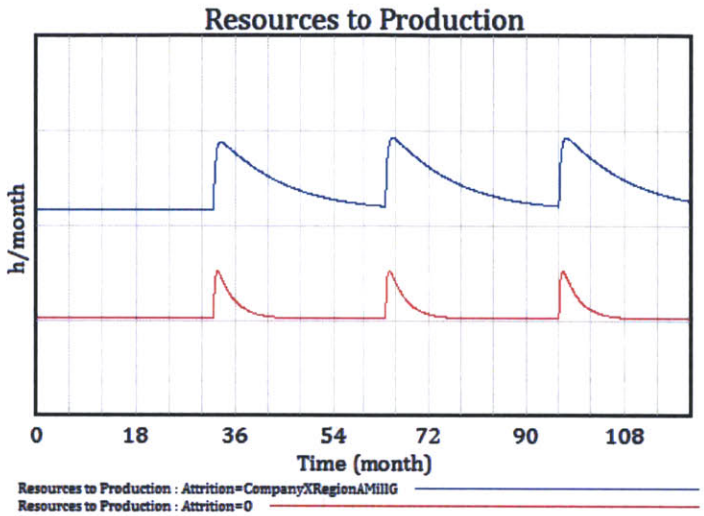


Figure 5.23 – Resources to Production with Continuous Improvement Problem Identification for the two scenarios in attrition.

In the end, based on the system dynamics model, the attrition of experienced employees in job positions is affecting significantly the success of the implementation of continuous improvement initiatives. This result confirms the importance of having skilled employee retention programs. Moreover, the system is also useful for company X to test different policies for employee retention and see which policy will solve the issue in a better way according to company conditions and dynamics.

All in all, the change management process and the process improvement dynamics proved to be excellent tools to increase the success rate for the implementation of the Dynamic Strategic Global Sourcing Plan and further continuous improvement initiatives. In addition, it has been demonstrated in this chapter that these techniques are adaptable to specific conditions for managing the human side of the change at Company X.

6 Conclusions and Future Suggestions

The globalization of Company X value chain has raised operational and management challenges where an effective method to deal with uncertainty in the value chain and an adaptable technique to manage the change process are needed. Although these methodologies could produce results in many areas of Company X, this research was focused on using and running a pilot implementation of the techniques in Company X Global Supply Chain.

The current planning process focused on forecast accuracy has demonstrated to be unsuccessful on enabling Company X to achieve the highest possible value on each project. Moreover, these single-number projections tend to mislead decision-makers to wrong and costly conclusions because of the flaw of averages. Thus, Company X needs a planning process that captures all the possibilities in the uncertain values and, therefore, provides a range of all probable outcomes. This Dynamic Strategic Plan will allow the organization to cut losses against possible risks and increase gains due to possible opportunities by committing only one action at a time as conditions unfold.

The process recommended in this thesis for replacing the current static planning process for the Dynamic Strategic Global Sourcing Plan at Company X involves three main activities: 1) acknowledgement, understanding, and characterization of uncertainty, 2) Monte Carlo simulation of the plan and analysis of possible outcomes, and 3) definition of rules for exercising real options and Monte Carlo simulation of the model including these rules. As a result, Company X will have a Global Sourcing Plan that will increase flexibility in the Global Supply Chain while minimizing waste and variance.

Despite all the benefits the Dynamic Strategic Global Sourcing Plan could bring to Company X, it is a reality that changing employees' behavior to perform dynamic plans instead of static plans constitutes an enormous effort. To address this problem with a structured approach, this thesis proposes a series of iterative processes to manage the human side of the change. The approach considers four main tasks: 1) understanding the change, 2) planning and preparing for the change, 3) implementing the change, and 4) embedding the change. It is worth noting that these tasks are part of an iterative technique, so they need to be revisited constantly to adjust the work done on each of them to current reality.

In the end, the proposed Change Management Process, customized for Company X, was a useful complement for the Dynamic Strategic Global Sourcing Plan to reach its full potential, by addressing the human side of the adoption of this new planning process, during the pilot implementation. Hence, the proposed Change Management Process and the Dynamic Strategic Global Sourcing Plan can potentially contribute to Company X continuous improvement, when fully implemented across Company X regions, by enabling it to respond effectively to changes in both the operational and human sides.

6.1 Recommendations for Further Research

Additional work has to be done to complement and improve the results driven by the Dynamic Strategic Global Sourcing Plan and the Change Management Process.

For the Dynamic Strategic Global Sourcing Plan, the recommendations for future work are:

1. Understand and characterize accurately the main uncertainties in the Global Supply Chain by conducting an exhaustive study of the variability of the main elements of the supply process such as seasonality, import process, transportation time by land and by sea, among others.

2. Examine and include correlation factors into the simulation to understand how a real option might affect other orders that are treated as independent in the simulation.

3. Standardize the process to define the rules for exercising the real options.

4. Use the Dynamic Strategic Global Sourcing Plan to support further initiatives in the Global Supply Chain, such as warehouse inventory reduction.

5. Automate the Dynamic Strategic Global Sourcing Plan.

In respect to the Change Management Process, key areas should be addressed to manage the human side of the change in a better form:

1. Explore and propose an adequate Knowledge Management Process for Company X.

2. Conduct a benchmark of all the tools and techniques Company X uses to address the "soft" side of the change.

7 References

Azrielant, Liron (2011). Design for implementation: redesigning a planning process in a multinational company / by Liron Azrielant, Institute Archives - Noncirculating Collection 3 | Thesis Mgt 2011 M.B.A.

Blanco, E.E. (2008). "Winning in Emerging Markets: Five Key Supply Chain Capabilities", MIT Center for Transportation & Logistics Research Paper.

Chopra, Sunil, and ManMohan S. Sodhi (2004). Managing Risk to Avoid Supply-Chain Breakdown. MIT Sloan Management Review, Vol. 46, No. 1. (2004), pp. 53–61.

Collins, James C. (2001). Good to great: why some companies make the leap--and others don't. New York, NY, HarperBusiness.

Cook, T. A. (2006). Global Sourcing Logistics: How to Manage Risk and Gain Competitive Advantage in a Worldwide Marketplace, AMACOM.

De Neufville, Richard (2000). Dynamic Strategic Planning for Technology Policy. International Journal of Technology Management, Vol.19, No.3/4/5, pp. 225-245.

De Neufville, Richard, and Stefan Scholtes (2011). Flexibility in engineering design. Cambridge, Mass: MIT Press.

DeAnne Aguirre, Louisa Finn, and Ashley Harshak (2007). Ready, Willing, and Engaged: A Practical Guide for Sponsors of Change. Booz & Company white paper.

DeAnne Aguirre, Gary Neilson, Paul Hyde, and Andrew Tipping (2004). Ten Guiding Principles of Change Management. Booz & Company white paper.

Fichman, R. G.,Keil, M.,&Tiwana, A. (2005).Beyond valuation: Options thinking in IT project management. California Management Review, 47(2), 74–96.

Forrester, Jay W. (1989). The Beginning of System Dynamics. System Dynamics Group, Sloan School, Massachusetts Institute of Technology.

Franklin, Melanie. (2011). Managing business transformation: A practical guide. Ely, Cambridgeshire, U.K. : IT Governance Pub.

Ghemawat, Pankaj, and Steve Altman (2012). DHL Global Connectedness Index 2012, DHL.

GeoCurrents (2012). Mapping International Languages, http://geocurrents.info/geonotes/mapping-international-languages

Hofstede, G. (2001). Culture's consequences: Comparing values, behaviors, institutions, and organizations across nations (2nd ed.), Beverly Hills CA: Sage.

Howell, David C. (1982). Statistical Methods for Psychology. Boston. Duxbury Press, p. 105.

Hult, G. T. M., Craighead, C. W. and Ketchen, Jr., D. J. (2010), Risk Uncertainty and Supply Chain Decisions: A Real Options Perspective. Decision Sciences, 41: 435–458

Jüttner, U., Peck, H., and Christopher, M. (2003). Supply Chain Risk Management: Outlining an Agenda for Future Research, International Journal of Logistics: Research & Applications, 6 (4), 197-210.

Metropolis, N. (1987). "The beginning of the Monte Carlo method". Los Alamos Science (1987 Special Issue dedicated to Stanislaw Ulam): 125–130

Morrison, J. Bradley (2003). Co-evolution of process and content in organizational change: explaining the dynamics of start and fizzle / by J. Bradley Morrison, Institute Archives - Noncirculating Collection 3 | Thesis Mgt 2003 Ph.D.

Morrison, J. Bradley and Repenning, N. (2011). Sustaining Employee Participation: The Challenge of Tipping Point Dynamics.

Morrison, J. Bradley (2012). "Process Improvement Dynamics Under Constrained Resources: Managing the Work Harder versus Work Smarter Balance." System Dynamics Review, 28: 329-350.

Nationalencyklopedin (2007). Världens 100 största språk 2007-The World's 100 Largest Languages in 2007, http://en.wikipedia.org/wiki/List_of_languages_by_number_of_native_speakers

Repenning, N. and J. Sterman (2002). Capability Traps and Self-Confirming Attribution Errors in the Dynamics of Process Improvement. Administrative Science Quarterly, 47: 265-295.

Repenning, N. and J. Sterman (2001). Nobody Ever Gets Credit for Fixing Defects that Didn't Happen: Creating and Sustaining Process Improvement, California Management Review, 43, 4: 64-88.

Savage, S. (2009). The Flaw of Averages, New York, NY, Wiley.

Schein, Edgar H. (1980). Developing your career : know your career anchors and develop your options. Cambridge, Mass., Alfred P. Sloan School of Management, Massachusetts Institute of Technology

Schein, Edgar H. (1992). Job/role analysis and planning: A workbook. Cambridge, Mass., Alfred P. Sloan School of Management, Massachusetts Institute of Technology.

Schein, Edgar H. (1996). Career anchors revisited: Implications for career development in the 21st century. Academy of Management Executive.

Schwartz, S.H. (1999). Cultural value differences: Some implications for work, Applied Psychology: An International Review, 48, 23-47.

Sterman, John D. (2000). Business Dynamics – Systems Thinking and Modeling for a Complex World. Boston, McGraw Hill Higher Education.

The World Bank (2012). Connecting to Compete 2012: Trade Logistics in the Global Economy.

Tiwana, A., Wang, J., Keil, M., & Ahluwalia, P. (2007). The bounded rationality bias in managerial valuation of real options: Theory and evidence from IT projects. Decision Sciences, 38(1), 157–181.

RSM McGladrey and The Manufacturing Institute (2007). Forging New Partnerships: How to Thrive in Today's Global Value Chain.

Appendix A. Tornado Diagram

The tornado diagram summarizes the impact of variations of the inputs in a model over the ranges specified by the modeler. This sensitivity analysis changes only one variable at a time and calculates the variations in the result of the model, i.e. while the variable analyzed changes over its range and the results are recorded in each iteration, the other inputs remain at their fixed values.

The tornado diagram sorts the effect of all the inputs from top to bottom by their size, going from higher at the top to lower at the bottom. As a result, the graph looks like a funnel, hence the name tornado diagram. This characteristic is useful because it allows to identify quickly those inputs, the ones with higher impacts, that need to be analyzed more in depth. To illustrate, Figure A.1 exhibits an example of tornado diagram.

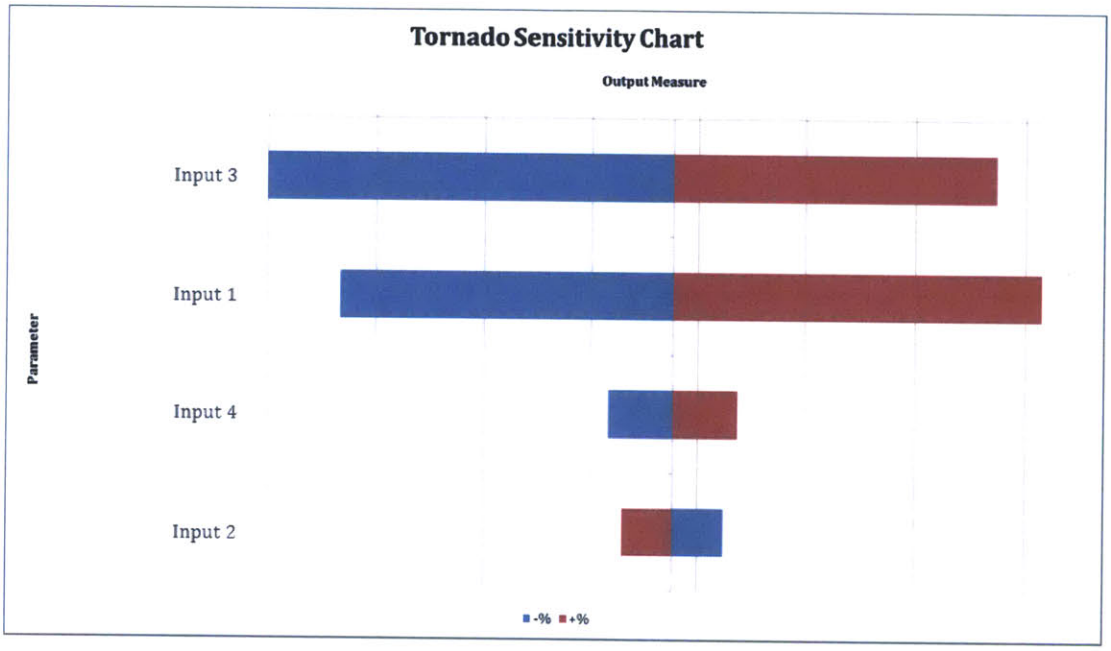


Figure A.1 – Tornado Diagram

Furthermore, it can be seen in Figure A.1 that tornado diagrams are also useful to detect asymmetries in gains and losses and, in turn, find variables on which the flaw of averages will cause more damage to the analysis. For example, input 3 has a shorter bar to the right, which means it produces unequal impacts for equal changes.

Appendix B. Excel Tool for Probability Distribution Fitting

The main purpose of the tool is to test several alternate distributions, eight for the version discussed here, to decide which distribution is followed by the data. This comparison helps to avoid "just-guess" syndrome and "assume-normal-distribution" syndrome, both behaviors extremely present in the CPG industry. This people's tendency results in analysis errors with serious unintended effects that lead to time and money loss.

As all the tools developed during the research, this tool was made having in mind user adoption at each and every step of the developing process. This appendix gives a general overview of the tool and describes the foundations of this tool.

General Overview

The probability distribution fitting Excel tool includes four tabs: Data Input & Dashboard, Histogram, Chi-square Test, and Q-Q Plot. It is important to mention that all the results shown in the figures of the distribution fitting tool are from random data generated for illustrative purposes and all the formulas used are discussed in detail in the next section.

The Data Input & Dashboard tab has four useful features for the user, shown in Figure B.1: Data Input, Descriptive statistics, Parameters for χ^2 test, and Distributions Comparison. As its name indicates, the Data Input is where the user introduces the data he or she wants to compare with the distributions considered in the tool. The descriptive statistics part shows the number of observations, mean, median, range, mode, standard deviation, and variance of the sample. This part allows an initial interpretation of the data such as central tendency, spread, among others; however, these results do not allow the user to reach conclusions regarding any hypothesis he or she might have about the distribution. The section of the parameters for χ^2 test refers to both the input that will be used to obtain the critical value of chi-square for the degrees of freedom and significance level considered and the critical value of chi-square itself. Finally, the distribution comparison dashboard presents a summary of the results of the chi-squared test used to define whether the data follow a specific probability distribution.

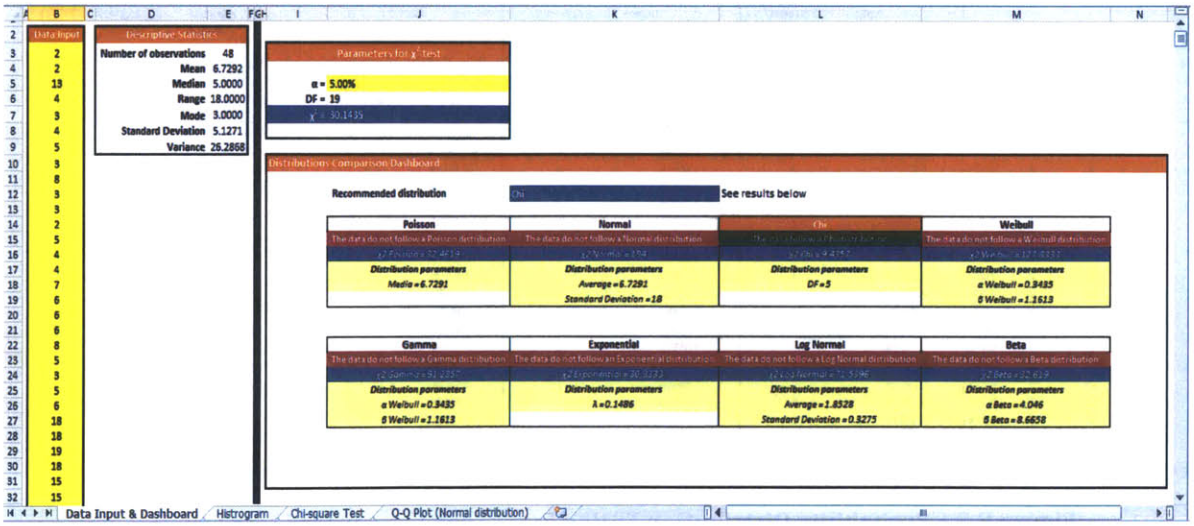
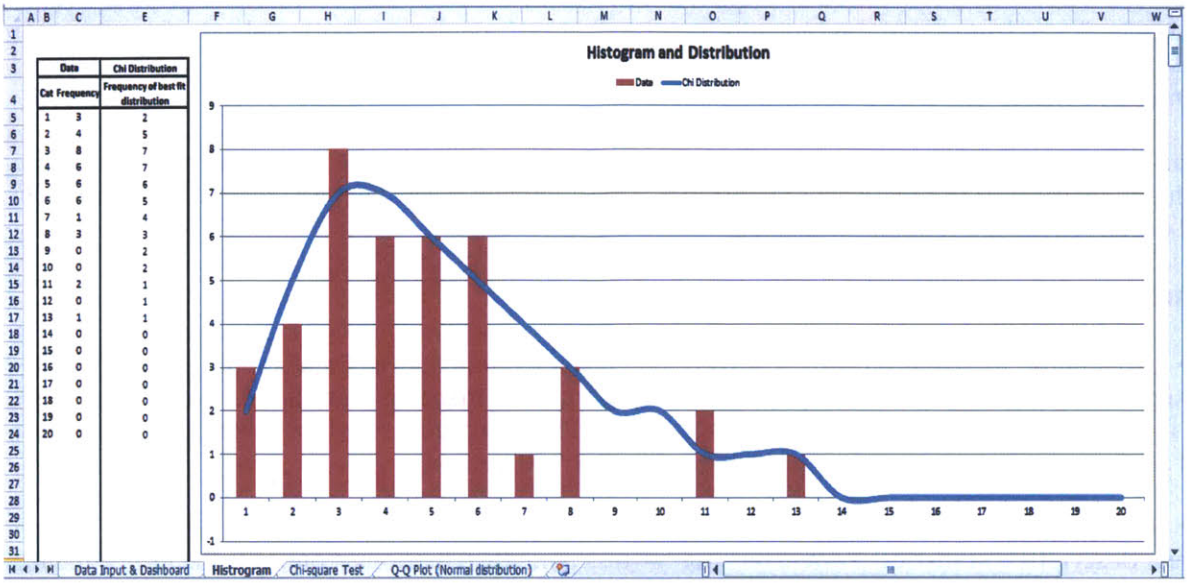


Figure B.1 – Probability Distribution Fitting Excel Tool: Data Input & Dashboard Tab

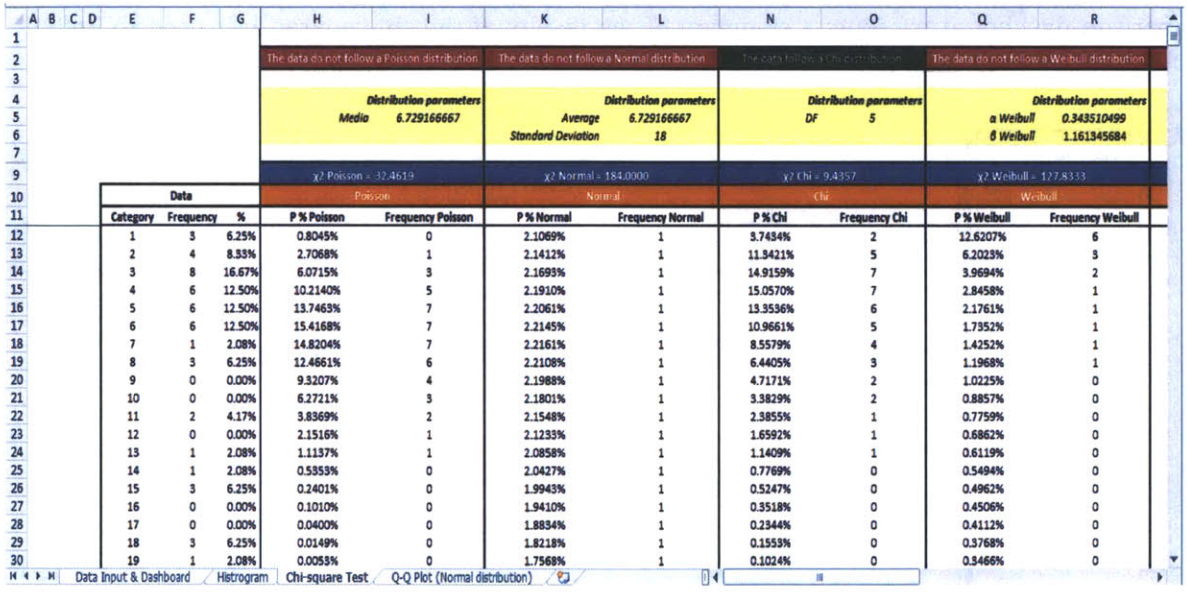
The histogram tab displays a plot that contains the histogram of the data and a representation of the distribution that best fits the data for the user to have a graphical demonstration of the match between the distribution and the data.



Data		Chi Distribution
Cat	Frequency	Frequency of best fit distribution
1	3	2
2	4	5
3	8	7
4	6	7
5	6	6
6	6	5
7	1	4
8	3	3
9	0	2
10	0	2
11	2	1
12	0	1
13	1	1
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0

Figure B.2 – Probability Distribution Fitting Excel Tool: Histogram Tab

The Chi-square Test tab contains all the computations done by the software to compare the data with the distributions. For each distribution, the user can see whether it follows the same form that the data, the parameters used to define the distribution, the value of χ^2, and the frequency for each category.



Data			Poisson		Normal		Chi		Weibull	
Category	Frequency	%	P % Poisson	Frequency Poisson	P % Normal	Frequency Normal	P % Chi	Frequency Chi	P % Weibull	Frequency Weibull
1	3	6.25%	0.8045%	0	2.1069%	1	3.7434%	2	12.6207%	6
2	4	8.33%	2.7068%	1	2.1412%	1	11.3421%	5	6.2023%	3
3	8	16.67%	6.0715%	3	2.1693%	1	14.9159%	7	3.9694%	2
4	6	12.50%	10.2140%	5	2.1910%	1	15.0570%	7	2.8458%	1
5	6	12.50%	13.7463%	7	2.2061%	1	13.3536%	6	2.1761%	1
6	6	12.50%	15.4168%	7	2.2145%	1	10.9661%	5	1.7352%	1
7	1	2.08%	14.8204%	7	2.2161%	1	8.5579%	4	1.4252%	1
8	3	6.25%	12.4661%	6	2.2108%	1	6.4405%	3	1.1968%	1
9	0	0.00%	9.3207%	4	2.1988%	1	4.7171%	2	1.0225%	0
10	0	0.00%	6.2721%	3	2.1801%	1	3.3829%	2	0.8857%	0
11	2	4.17%	3.8369%	2	2.1548%	1	2.3855%	1	0.7759%	0
12	0	0.00%	2.1516%	1	2.1233%	1	1.6592%	1	0.6862%	0
13	1	2.08%	1.1137%	1	2.0858%	1	1.1409%	1	0.6119%	0
14	1	2.08%	0.5353%	0	2.0427%	1	0.7769%	0	0.5494%	0
15	3	6.25%	0.2401%	0	1.9943%	1	0.5247%	0	0.4962%	0
16	0	0.00%	0.1010%	0	1.9410%	1	0.3518%	0	0.4506%	0
17	0	0.00%	0.0400%	0	1.8834%	1	0.2344%	0	0.4112%	0
18	3	6.25%	0.0149%	0	1.8218%	1	0.1553%	0	0.3768%	0
19	1	2.08%	0.0053%	0	1.7568%	1	0.1024%	0	0.3466%	0

Figure B.3 – Probability Distribution Fitting Excel Tool: Chi-squared test Tab

The Q-Q plot (normal distribution) tab exhibits a quantile-quantile plot to help the user to determine whether the data roughly follow a normal distribution. If the Q-Q plot shows the blue points form a straight line as the red one, the user will be able to decide that the data follows a normal distribution. This feature was included due to the "assume-normal-distribution" syndrome, which is highly permeated in the companies. With this plot, the user will see, very fast, how good is the assumption that the data follows a normal distribution and, in turn, make a well-informed decision in this manner.

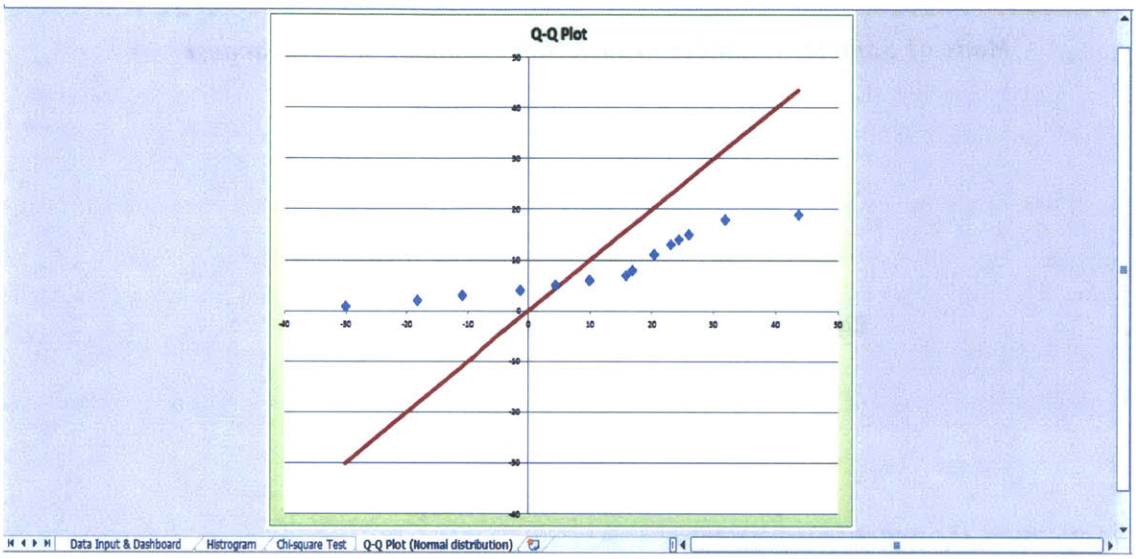


Figure B.4 – Probability Distribution Fitting Excel Tool: Q-Q Plot Tab

Now that a general idea of the tool has been developed, the next section explains the assumptions and calculations contained in each part of the tool.

Tool Foundations

As mentioned in the past section, the probability distribution fitting Excel tool provides the user the descriptive statistics of the data, critical value of chi-square, histogram of the data, chi-square test for all the distributions included in the tool, and a Q-Q plot for normal distribution.

In respect of the descriptive statistics, the tool shows number of samples, mean, median, range, mode, standard deviation, and variance. The formulas used for the descriptive statistics are:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

Equation B.1 – Mean of a sample

$$M = Value\ of\ the\ \left(\frac{n+1}{2}\right) th\ term$$

Equation B.2 – Median of a sample with odd number of observations

$$M = \frac{\left(Value\ of\ the\ \left(\frac{n}{2}\right)th\ term\ +\ Value\ of\ the\ \left(\frac{n+1}{2}\right)th\ term\right)}{2}$$

Equation B.3 – Median of a sample with even number of observations

$$R = Max\ (of\ sample\ data) - Min\ (of\ sample\ data)$$

Equation B.4 – Range of a sample

$$Mode\ of\ Sample = number\ m\ such\ that\ P(Sample = m)\ is\ largest$$

Equation B.5 – Mode of a sample

$$s = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

Equation B.6 – Standard Deviation of a sample

$$s^2 = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2$$

Equation B.7 – Variance of a sample

For the critical value of chi-square, two parameters are needed: significance level and degrees of freedom. The significance level, in this tool, refers to the percentage of values the user permits to the data not to follow a specific distribution. It is common practice to use a confident level of 5%, i.e. the difference between the observations and the values of the distribution in study is small enough that it would be seen at least 1 time in 20. The degrees of freedom equal the number of classes minus 1 for this tool because there is only one independent variable. In the end, the critical value of chi-square is found either by looking on tables or by using an Excel function for the significance level, defined by the user, and degrees of freedom in question.

$$DF = Number\ of\ classes - 1$$

Equation B.8 – Degrees of freedom for the goodness of fit test

The histogram in the Excel tool is a plot for the number of observations that fall within each class. In the chart where the histogram is displayed, there is a plot of the distribution that best fits the data according to the chi-square test. The classes are chosen by the tool based on the minimum and maximum values of the data.

The chi-square test in the tool is defined for the hypothesis presented in Equation B.9. That said, the tool uses chi-square formula, shown in Equation B.10, and then it compares this value with the critical value of chi-square to decide whether the null hypothesis cannot be rejected. A danger to avoid for the chi-square formula is that when the expected cell frequencies are small, the computed chi square does not fit the distribution of the statistic correctly. In this case, the result of significance testing is suspect. A conservative position is recommended for this issue that all expected frequencies should be at least 5 (Howell, 1982).

$$H_0 = The\ data\ follow\ the\ indicated\ distribution$$
$$H_1 = The\ data\ do\ not\ follow\ the\ indicated\ distribution$$

Equation B.9 – Hypothesis for Chi-square test

$$\chi^2 = \sum_{i=1}^{n} \frac{(Observed\ Value_i - Expected\ Value_i)}{Expected\ Value_i}$$

Equation B.10 – Chi-square formula

Finally, the Q-Q plot at the tool is a scatterplot of the data against the expected quantiles. For this Q-Q plot for normal distribution the tool first rearrange the data in ascending order. Then, the minimum value is the (1/n)th quantile and the maximum value is the ((i/(n+1))th quantile due to the fact that the 100 percentile of a normal distribution is infinity, and this value can never be assumed in observation. Next, the tool determines for each observation the corresponding quantile of the normal distribution that has the same mean and the standard deviation as the data using the function of Excel NORMINV, as in Equation B.11.

$$x'(i) = NORMINV(i/(n+1), sample\ mean, sample\ standard\ deviation)$$

Equation B.11 – Formula to determine the normal (i/(n+1))th quantile

Appendix C. Understanding the Change - Sample Forms and Interview Questionnaires

PESTLE Analysis

1. Political

1.1. What is the government structure in your country?

1.2. Could you explain me the decision power in the government of your country?

1.3. Could you talk to me about the political situation of the region and how can it affect the CPG industry?

1.3.1. How long is the government term in your country? Which are the most important elections in your country? When are the next most important elections in your country?

1.3.2. Are there any internal political issues in your country and in the region?

1.3.3. What can you tell me about the Inter-country and Inter-region relationships?

1.3.4. How easy do governments from other countries, mainly in the region, influence in your country's government?

1.4. What are the main policies that influence the CPG industry in your country and in the region (tax policy, fiscal policy, etc.)?

1.5. How often do companies lobby? Are there pressure groups that usually represent the CPG industry? If so, which are the most influential groups?

1.6. More questions regarding politics based on the answers from the previous questions.

2. Economic

2.1. How "good" are the prevalent economic factors (e.g. inflation rate, interest rates, foreign exchange rates, economic growth patterns)?

2.2. What are the projections for the economic indicators in your country?

2.3. What is the GDP per capita of your country?

2.4. What is the FDI (foreign direct investment) of your country?

2.5. What is the unemployment rate of your country? Of the region?

2.6. What is the income distribution of your country? Of the region?

2.7. How big are the import and export levels in the country? In the region?

2.8. What is the minimum wage in your state? In your country?

2.9. Into which income categories does the country fit? (See http://www.worldbank.org/data/countryclass/)

2.10. What is the current HDI rank of the country? What has been the HDI ranking of the country the last 5 years? (See http://hdr.undp.org/en/statistics/)

2.11. What are the export countries? What are the import countries?

2.12. Are there any agreements within countries in the region?

2.13. More questions regarding the economic situation of the country and/or the region.

3. Sociological

3.1. What can you tell me about the culture in your country? In the region?

3.2. What are the beliefs, symbols, norms, and values prevalent among people in this country?

3.3. Which are the main social taboos in your country? In the region?

3.4. What is the population age profile and growth rate of your country? Of the region?

3.5. Could you talk to me about the demographic indicators of your country (education, health, life expectancy, diversity, etc.)?

3.6. Are there any buying trends that affect the CPG industry in your country? In the region?

3.7. Who are considered role models in your country? In the region?

3.8. Which have been the main socio-cultural changes during the last five and ten years in your country?

3.9. Could you describe me the consumer buying patterns for the CPG industry in your country? In the region?

3.10. Are there any immigration/emigration patterns in your country? In the region?

3.11. Which role does the media plays in your society?

3.12. Other questions socio-cultural questions.

4. Technological

4.1. How have technological innovations affected the CPG market structure in your country? In the region?

4.2. Could you talk to me about the research and development activity in your country (institutions, funding,...)? In the region?

4.3. How do you evaluate the level of the information and communications infrastructure in your country? Why? In the region? Why?

4.4. Could you describe me the adoption patterns for new technology in the CPG industry in your country? In the region?

4.5. How is intellectual property managed in your country? In the region?

4.6. Could you give me an example of recent innovations developed in your country? In the region?

4.7. Are there any studies about technology adoption in your country? In the region?

4.8. More questions about technological issues.

5. Legal

5.1. Which current legislations regulate the CPG industry?

5.1.1. When did the last modification to these legislations take place? When do you think these legislations will change?

5.2. Which are the regulatory bodies in your country? In the region?

5.3. Where could I find about consumer law, labor law, employment law, safety standards, among others?

5.4. How does you country legislate?

5.5. More legal questions that the interviewer consider appropriate.

6. Environmental

6.1. What are the environmental concerns for the CPG industry in your country? In the region?

6.2. How important is the environment for the government of your country? In the region?

6.3. Are there any environmental regulations in your country? In the region?

6.4. How much are the consumers worried about the environment?

6.5. Which regulatory bodies protect the environment in your country? In the region? Which non-governmental institutions protect the environment in your country? In the region?

6.6. Other questions addressing environmental topics.

Job/Role Analysis and Planning

This form is taken from Schein (1992)

Step 1. Analyzing one's own present job/role

1. Basic Dimensions of the Job

1) List your basic responsibilities below

2) List your main resources for getting the job done

3) What skills, talents, attitudes, etc. do you need to get the job done?

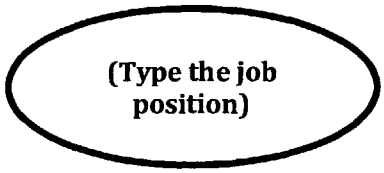
2. Job/Role Profile

Rate your present behavior in your present job on the 5 point scale next to each item where 1 is low and 5 is high.

	Rate
1. Degree to which I work in and with groups of various sorts (committees, task forces, meetings, etc.).	
2. Degree to which I operate as a consultant/catalyst in my day to day role.	
3. Degree to which I integrate the efforts of others who are technically more competent in their specialities than I am.	
4. Degree to which I have to rely on second hand information that is gathered by others.	
5. Degree to which I have to monitor the thinking and decision making of others rather than doing the thinking and decision making myself.	
6. Degree to which I facilitate the processes of management and decision making rather than making the decisions myself.	
7. Degree to which I identify the relevant problems and make sure that the right problems are worked on.	
8. Degree to which I am dependent on others (i.e. subordinates, peers, etc.) for total performance (rather than it being within my own control).	
9. Degree to which my level of responsibility (accountability) is greater than my direct degree of control.	
10. Degree to which I spend time considering the long range health of the organization rather than its day to day performance	

3. Current Role Network and Key Stakeholders

Put yourself into the circle at the center and then draw in all around you the members of your role set either by name or title. Draw an arrow from each of them to you and you to them, making the arrow more or less thick to represent how important those links are or how extensive the expectations of those people are. Think broadly about all possible categories of stakeholders: 1) Superiors; 2) Subordinates; 3) Peers; 4) Customers; 5) Suppliers; 6) Vendors; 7) Your spouse; 8) Your children; 9) Special friends or others in the community to whom you are connected.



4. Critical Stakeholders and Their Expectations

Go back over your diagram and pick out the five or six stakeholders whose expectations influence you the most.

Stakeholder 1 _____

Major Expectations

Stakeholder 2 _____

Major Expectations

Stakeholder 3 _____

Major Expectations

Stakeholder 4 _____

Major Expectations

Stakeholder 5 _____

Major Expectations

Stakeholder 6 _____

Major Expectations

If required, add more stakeholders and their expectations

5. Analyzing Role Ambiguity, Role Overload, And Role Conflict

Step 2. Analyzing changes in the environment

Take a five to ten year horizon as your frame of reference, but don't ignore trends that may have a more immediate impact.

Technological trends

Economic Trends

Political Trends

Socio-cultural Trends

Other Relevant Trends

Step 3. Analyzing the impact of the identified environmental changes on stakeholders and the job

For each of the major stakeholders you identified in Step 1, try to think through how the changing environmental trends you have identified will affect them, and how those effects will, in turn, change their expectations of you in your job/role.

Stakeholder 1 _____

Major Expectations

Stakeholder 2 _____

Major Expectations

Stakeholder 3 _____

Major Expectations

Stakeholder 4 _____

Major Expectations

Stakeholder 5 _____

Major Expectations

Stakeholder 6 _____

Major Expectations

Other stakeholders who may not have been identified as critical before, but whose expectations will become critical in the future

Step 4. Redefining the job/role

1. General impact on my job/role

Go back to your original analysis of your job in Step 1 and review your self-analysis in the light of your assessment of stakeholder changes. List below the main impacts you perceive.

2. Impact on job/role dimensions

Review the job/role dimensions in the light of the analysis in part 1 and mark for each dimension what the job/role will be like as you look ahead. Do this without looking at your previous ratings so that you can compare with minimum bias how you look at the job now and how you perceive it in the future. Rate each dimension on the 5 point scale next to each item (1 is low, 5 is high).

	Rate
1. Degree to which I work in and with groups of various sorts (committees, task forces, meetings, etc.).	
2. Degree to which I operate as a consultant/catalyst in my day to day role.	
3. Degree to which I integrate the efforts of others who are technically more competent in their specialities than I am.	
4. Degree to which I have to rely on second hand information that is gathered by others.	
5. Degree to which I have to monitor the thinking and decision making of others rather than doing the thinking and decision making myself.	
6. Degree to which I facilitate the processes of management and decision making rather than making the decisions myself.	
7. Degree to which I identify the relevant problems and make sure that the right problems are worked on.	
8. Degree to which I am dependent on others (i.e. subordinates, peers, etc.) for total performance (rather than it being within my own control).	
9. Degree to which my level of responsibility (accountability) is greater than my direct degree of control.	
10. Degree to which I spend time considering the long range health of the organization rather than its day to day performance	

3. My job/role as I now see it

Redo on this page your description of your job in the light of the open systems planning you have done

1) List your basic responsibilities as you now see them:

2) List your main resources for getting the job done as you now see them:

3) Before assessing what skills, talents, attitudes, etc. you will need to get the job done, complete the next section to stimulate your thinking.

Step 5. Redefining the requirement for doing the job and fulfilling the role

For each of the below items, select the number that represents your perception of yourself in the present, and select the number that represents what you think you ought to be in the future in the light of your job/role planning analysis.

1. Motives, attitudes, abilities, and skills relevant to effective organizational performance.

a) Motives and Values

		Present	Future
1	My desire to get a job done, my need for accomplishment		
2	My commitment to my organization and its mission		
3	My career aspirations and ambitions		
4	My degree of involvement with my career		
5	My desire for high levels of responsibility		
6	My desire to take risks		
7	My desire to make tough decisions		
8	My desire to work with and through people		
9	My desire to exercise power and authority		
10	My desire to monitor and supervise the activities of others		
11	My desire to delegate and help others to succeed		
12	My desire to function as a general manager free of functional and technical constraints		
13	My desire to work collaboratively rather than competitively with others		
14	My desire to learn		
15	My desire to take risks even if that lead to errors		

b) Analytical Abilities and Skills

		Present	Future
16	My ability to identify problems in complex, ambiguous situations		
17	My ability to sense quickly what information is needed in relation to a complex problem		
18	My ability to obtain needed information from others		
19	My ability to assess the validity of information that I have not gathered myself		
20	My ability to learn quickly from experience		
21	My ability to detect errors in my own actions		
22	My flexibility, my ability to think of and implement different solutions for different kinds of problems		
23	My creativity, ingenuity		
24	My breadth of perspective--insight into a wide variety of situations		
25	My degree of insight into myself (strengths and weaknesses)		

c) Interpersonal and Group Skills

		Present	Future
26	My ability to develop open and trusting relationships with peers		
27	My ability to develop open and trusting relationships with superiors		
28	My ability to develop open and trusting relationships with subordinates		
29	My ability to listen to others in an understanding way		
30	My ability to communicate my own thoughts and ideas clearly and persuasively		
31	My ability to communicate my feelings clearly		
32	My ability to influence people over whom I have no direct control		
33	My ability to influence my peers		
34	My ability to influence my superiors		
35	My ability to influence my subordinates		
36	My ability to diagnose complex interpersonal and group situations		
37	My ability to develop processes that ensure high quality decisions without having to make the decision myself		
38	My ability to develop a climate of collaboration and teamwork		
39	My ability to design processes to facilitate intergroup and interfunctional coordination		
40	My ability to create a climate of growth and development for my subordinates		

d) Emotional Abilities and Skills

		Present	Future
41	The degree to which I am able to make up my own mind without relying on the opinions of others		
42	The degree to which I am able to share power with others		
43	The degree to which I am able to tolerate and acknowledge errors		
44	My degree of tolerance for ambiguity and uncertainty		

		Present	Future
45	My ability to take risks, to pursue a course of action even if it may produce negative consequences		
46	My ability to pursue a course of action even if it makes me anxious and uncomfortable		
47	My ability to confront and work through conflict situations (versus suppressing or avoiding them)		
48	My ability to keep going after an experience of failure		
49	My ability to confront my stakeholders if there is role ambiguity, overload, or conflict		
50	My ability to continue to function in the face of continued environmental turbulence		

2. Developmental implications for you

Look at those items above where there is the greatest discrepancy between your present rating and where you feel you should be. For each area where you feel there is a significant discrepancy figure out a development plan for yourself, or figure out how to restructure the job so that your present capacity will be sufficient to do the job.

Item #	Item	Present	Future	Developmental Plan

3. Developmental Plan Timeline

Given all of the above plans, what are the next steps that you will take. Try to be specific and give a time table for each step.

#	Step	Beginning	End

Step 6. Extending the planning activity

What other jobs are also changing?

#	Person	Job Position	Email	Why he/she could benefit from this activity?

Career Anchors Analysis

This form is taken from Schein (1980)

In this interview guide you are asked to inquire about information in the left hand column and reasons for choices, decisions, etc., in the right hand column.

External Factors and Events	Internal Reasons and Feelings
1. What was your major area of concentration in college?	Why did you choose that area? How did you feel about it?
2. Did you go to graduate school? If yes, what was your area of concentration; what degree did you get?	Why did you go or not go?
3. What was your first job after school? (Include military if relevant)	What were you looking for in your first job?
4. What were your ambitions or long-range goals when you started you career? Have they changed? When? Why?	
5. What was your first major change of job or company?	Did you or the company initiative it? Why did you initiate it, or accept it? What were you looking for in your next job?

Continue to list what you consider to be the major job, company, career changes you see in your career. List each step and answer the questions for each step.

6. Change	Why did you initiate or accept it? What were you looking for?
7. Change	Why did you initiate or accept it? What were you looking for?

8. Change	Why did you initiate or accept it? What were you looking for?
9. Change	Why did you initiate or accept it? What were you looking for?
10. As you look back over your career, identify some times you have especially enjoyed it.	What about those times did you enjoy?
11. A you look back, identify some times you have not especially enjoyed it.	What about those times did you not enjoy?
12. Have you ever refused a job move or promotion?	Why?
13. How would you describe you occupation to others?	What do you see yourself to be?
14. Do you see any major transition points in your career? Describe the transition objectively.	How did you feel about it? Why did you initiate or accept it?
Review all or your answers in this colurmn and look for the pattern in the answvers. Do you see any anchor in the answers?	
Rate each of the anchors below based on your answers above, from 1 - 5, 1-low importance, 5-high importance Managerial competence ____ Technical/functional competence ____ Security ____ Creativity ____ Autonomy ____	
15. If you could have only one of the anchors satisfied, which one would you hold on to?	

Cultural Web

1. Paradigm

1.1. Write in this section the assumptions and core beliefs that are mentioned the most throughout the research

1.2. Which factors of the paradigm identified need to be changed to achieve a successful transformation?

2. Control System

2.1. What are the main KPIs in the company?

2.2. Which processes are most controlled and monitored in the organization?

2.3. Could you give me examples of rewards made to employees?

2.4. Could you mention me examples of punishments to employees?

2.5. What reports do you issue? How often and to whom do you deliver them?

2.6. How do your controls contribute to company's strategy?

2.7. More questions about the control system of the company.

3. Organizational Structure

3.1. How would you describe the structure of the company (flat or hierarchical, formal or informal, etc.)?

3.2. Could you draw for me the formal lines of authority?

3.3. Are there informal lines of authority?

3.4. How much do company departments and country offices collaborate?

3.5. How much do company departments and country offices compete?

3.6. How do you see yourself and your department contributing to company's strategy (local, regional and global)?

3.7. Additional questions regarding the organizational structure of the company.

4. Symbols

4.1. What language and jargon are used in the company? How well used are these by all employees?

4.2. Could you give me examples of status symbols used in the company?

4.3. What do you think is the image that customers have about the company?

4.4. What do you think is the image that the community has about the company?

4.5. How do you interact with people from different departments and country offices?

4.6. Other questions to identify the symbols of the company.

5. Rituals

5.1. Could you describe a week in your job?

5.2. Which duties are repetitive? Why are they repetitive?

5.3. What would be immediately obvious if change? Which would be consequences of this change?

5.4. Which rituals and routines are transmitted to employees on training programs? Why?

5.5. What are the rules people follow to solve an unusual situation?

5.6. More questions to recognize rituals of company's employees.

6. Power Structures

6.1. Who are the most influential people in your department? In company's office? In the region? Globally?

6.2. What are the core beliefs of the most influential people?

6.3. Could you mention me some leaders you identify in the organization? Why do you think they are leaders?

6.4. What are the core beliefs of the leaders you mentioned?

6.5. To whom do employees look to for defense against management decisions?

6.6. Could you describe me all the interactions, internal and external, you have for company purposes?

6.7. Do you participate in extracurricular activities offered by the company? Who organize them? Could you describe me the team members you have had on those activities?

6.8. Could you talk to me about recent major changes that were successful? Who participated in these successful transformations? And failures? Who participated on these failures?

6.9. Other questions to understand power in the company.

7. Stories and Myths

7.1. What are the most common stories you hear in the company? What do these stories intent to communicate?

7.2. Where did you hear the most common stories?

7.3. How pervasive are stories across all levels of the company?

7.4. Is it common to transmit important company messages throughout stories?

7.5. How often do you see changes on which is the most popular story?

7.6. When you talk to people from different offices (locally, regionally, and globally), do you hear similar stories? What is similar? What is different?

7.7. Additional questions about stories and myths in the organization.

Appendix D. Setting Process Improvement Dynamics Model in Equilibrium

Fourteen conditions have to be met for the system to be in steady-state equilibrium.

1. **Position1 Stock** – Inflow New Hires must equal the sum of Position1 Leaving outflow and Adv P1 to P1toP2 outflow.

2. **Position1 to be Position2 Stock** – Inflow Adv P1 to P1toP2 must equal the sum of P1toP2 Leaving outflow and P1toP2 Promotion Rate outflow.

3. **Position2 Stock** – Inflow P1toP2 Promotion Rate must equal the sum of Position2 Leaving outflow and Adv P2 to P2toP3 outflow.

4. **Position2 to be Position3 Stock** – Inflow Adv P2 to P2toP3 must equal the sum of P2toP3 Leaving outflow and P2toP3 Promotion Rate outflow.

5. **Position3 Stock** – Inflow P2toP3 Promotion Rate must equal the sum of Position3 Leaving outflow and Adv P3 to P3toP4 outflow.

6. **Position3 to be Position4 Stock** – Inflow Adv P3 to P3toP4 must equal the sum of P3toP4 Leaving outflow and P3toP4 Promotion Rate outflow.

7. **Position4 Stock** – Inflow P3toP4 Promotion Rate must equal the Exists outflow

8. **Total Position1 PI Skills Stock** – Sum of inflows Change in Initial PI Skills, Monthly Position1 PI Skills Training, and Skill Increase by experience Position1 must equal sum of outflows Monthly PI Skills Position1 Lost and PI Skills raise to P1toP2.

9. **Total P1toP2 PI Skills Stock** – Sum of inflows PI Skills raise to P1toP2, Monthly P1toP2 PI Skills Training, and Skill Increase by experience P1toP2 must equal sum of outflows Monthly PI Skills P1toP2 Lost and PI Skills raise to Position2.

10. **Total Position2 PI Skills Stock** – Sum of inflows PI Skills raise to Position2, Monthly Position2 PI Skills Training, and Skill Increase by experience Position2 must equal sum of outflows Monthly PI Skills Position2 Lost and PI Skills raise to P2toP3.

11. **Total P2toP3 PI Skills Stock** – Sum of inflows PI Skills raise to P2toP3, Monthly P2toP3 PI Skills Training, and Skill Increase by experience P2toP3 must equal sum of outflows Monthly PI Skills P2toP3 Lost and PI Skills raise to Position3.

12. **Total Position3 PI Skills Stock** – Sum of inflows PI Skills raise to Position3, Monthly Position3 PI Skills Training, and Skill Increase by experience Position3 must equal sum of outflows Monthly PI Skills Position3 Lost and PI Skills raise to P3toP4.

13. **Total P3toP4 PI Skills Stock** – Sum of inflows PI Skills raise to P3toP4, Monthly P3toP4 PI Skills Training, and Skill Increase by experience P3toP4 must equal sum of outflows Monthly PI Skills P3toP4 Lost and PI Skills raise to Position4.

14. **Total Position4 PI Skills Stock** – Sum of inflows PI Skills raise to Position4, Monthly Position4 PI Skills Training, and Skill Increase by experience Position4 must equal sum the Decrease in total PI Skills.

Position1 Stock

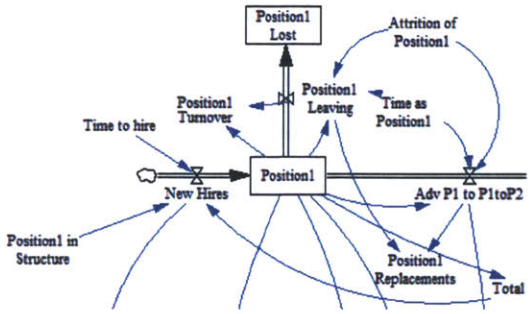


Figure D.1 – Position1 Stock

The equilibrium formula for the Position1 stock is the following equation:

$$Position1\ in\ Equilibrium = \frac{((Time\ as\ Position1) * (Position1\ in\ Structure\ -\ Position1\ to\ be\ Position2))}{(Time\ to\ hire\ +\ Time\ as\ Position1)}$$

Equation D.1 – Position1 Stock Equilibrium Formula

Position1 to be Position2 Stock

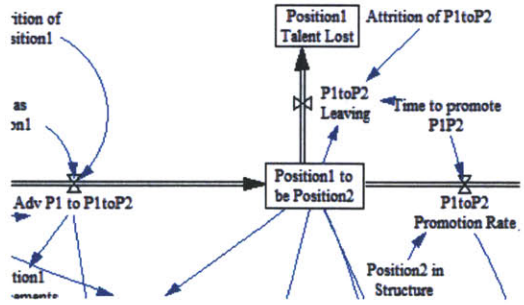


Figure D.2 – Position1 to be Position2 Stock

The equilibrium formula for the Position1 to be Position2 stock is the following equation:

$$Position1\ to\ be\ Position2\ \ in\ Equilibrium = ((((1 - Attrition\ of\ Position1)/(Time\ to\ hire + Time\ as\ Position1)) * Position1\ in\ Structure) - ((Position2\ in\ Structure - ((Position2) + (Position2\ to\ be\ Position3)))/Time\ to\ promote\ P1P2))/((Attrition\ of\ P1toP2 /Time\ to\ promote\ P1P2) + ((1 - Attrition\ of\ Position1)/(Time\ to\ hire + Time\ as\ Position1)))$$

Equation D.2 – Position1 to be Position2 Equilibrium Formula

Position2 Stock

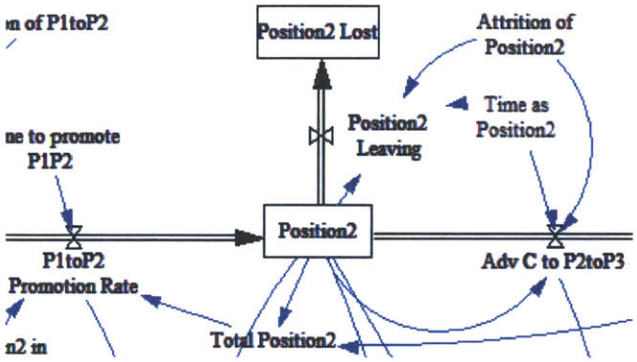


Figure D.3 – Position2 Stock

The equilibrium formula for the Position2 stock is the following equation:

$$Position2\ in\ Equilibrium = \frac{((Time\ as\ Position2) * (Position2\ in\ Structure\ -\ Position2\ to\ be\ Position3))}{(Time\ to\ promote\ P1P2\ +\ Time\ as\ Position2)}$$

Equation D.3 – Position2 Stock Equilibrium Formula

Position2 to be Position3 Stock

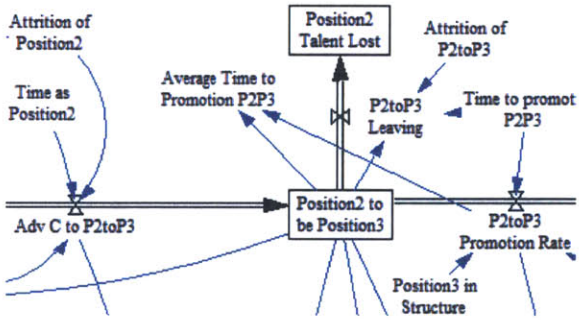


Figure D.4 – Position2 to be Position3 Stock

The equilibrium formula for the Position2 to be Position3 stock is the following equation:

$$\begin{aligned} Position2\ to\ be\ Position3\ in\ Equilibrium \\ = ((((1 - Attrition\ of\ Position2)/(Time\ to\ promote\ P1P2 + Time\ as\ Position2)) \\ * Position2\ in\ Structure) - ((Position3\ in\ Structure - ((Position3) \\ + (Position3\ to\ be\ Position4)))/Time\ to\ promote\ P2P3))/((Attrition\ of\ P2toP3 \\ /Time\ to\ promote\ P2P3) + ((1 - Attrition\ of\ Position2)/(Time\ to\ promote\ P1P2 \\ + Time\ as\ Position2))) \end{aligned}$$

Equation D.4 – Position2 to be Position3 Stock Equilibrium Formula

Position3 Stock

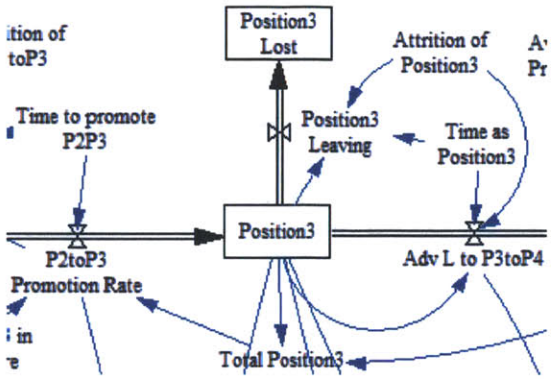


Figure D.5 – Position3 Stock

The equilibrium formula for the Position3 stock is the following equation:

$$Position3\ in\ Equilibrium = \frac{((Time\ as\ Position3) * (Position3\ in\ Structure - Position3\ to\ be\ Position4))}{(Time\ to\ promote\ P2P3\ +\ Time\ as\ Position3)}$$

Equation D.5 – Position3 Stock Equilibrium Formula

Position3 to be Position4 Stock

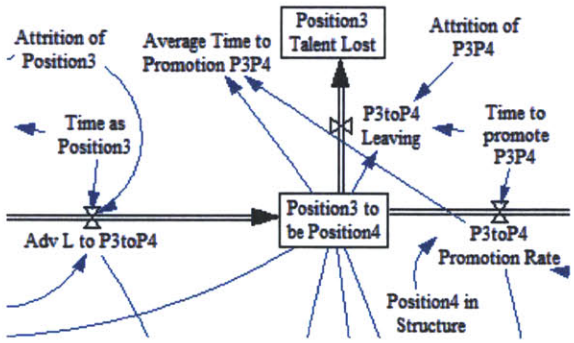


Figure D.6 – Position3 to be Position4 Stock

The equilibrium formula for the Position3 to be Position4 stock is the following equation:

$$\begin{aligned} Position3\ to\ be\ Position4\ \ in\ Equilibrium \\ = ((((1 - Attrition\ of\ Position3)/(Time\ to\ promote\ P2P3 + Time\ as\ Position3)) \\ * Position3\ in\ Structure) - ((Position4\ in\ Structure \\ - (Position4))/Time\ to\ promote\ P3P4))/((Attrition\ of\ P3P4/Time\ to\ promote\ P3P4) + ((1 \\ - Attrition\ of\ Position3)/(Time\ to\ promote\ P2P3 + Time\ as\ Position3))) \end{aligned}$$

Equation D.6 – Position3 to be Position4 Stock Equilibrium Formula

Position4 Stock

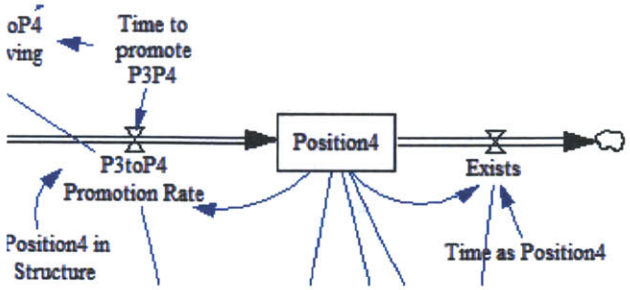


Figure D.7 – Position4 Stock

The equilibrium formula for the Position4 stock is the following equation:

$$Position4\ in\ Equilibrium = \frac{(Time\ as\ Position4 * Position4\ in\ Structure)}{(Time\ to\ promote\ P3P4\ +\ Time\ as\ Position4)}$$

Equation D.7 – Position4 Stock Equilibrium Formula

Total Position1 PI Skills Stock

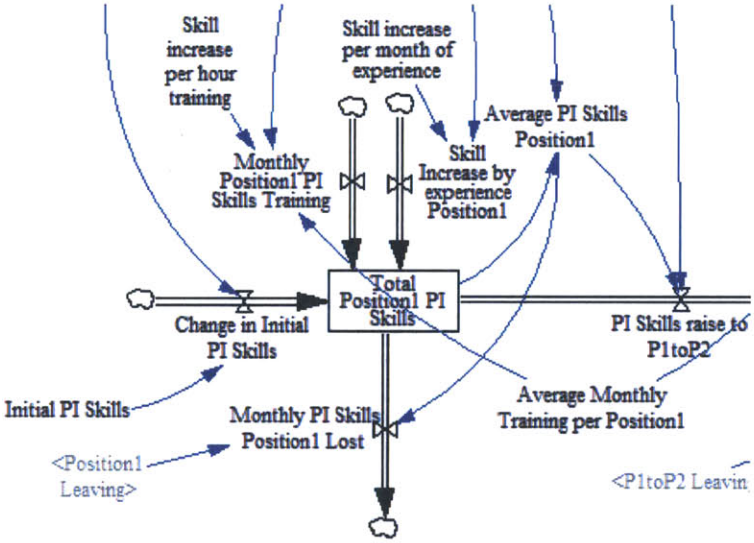


Figure D.8 – Total Position1 PI Skills Stock

The equilibrium formula for the Total Position1 PI Skills stock is the following equation:

$$Total\ Position1\ PI\ Skills\ in\ Equilibrium = ((Skill\ Increase\ by\ experience\ Position1 + Monthly\ Position1\ PI\ Skills\ Training + Change\ in\ Initial\ PI\ Skills) * (Position1))/(Adv\ P1\ to\ P1toP2 + Position1\ Leaving)$$

Equation D.8 – Total Position1 PI Skills Stock Equilibrium Formula

Total P1toP2 PI Skills Stock

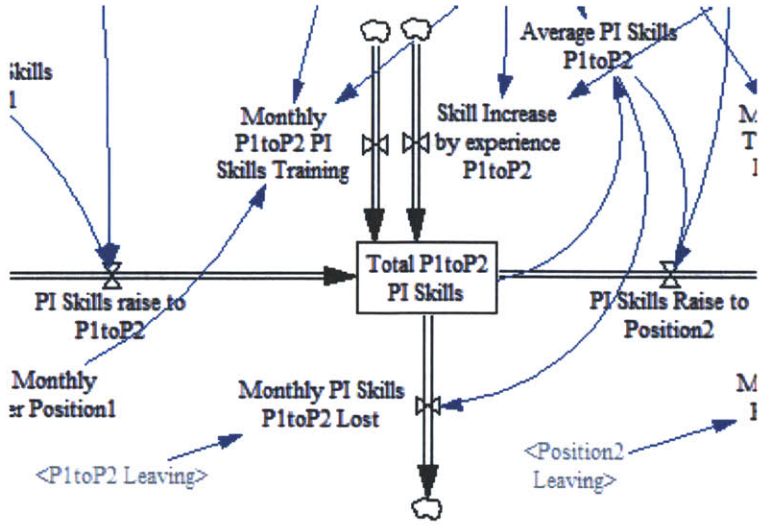


Figure D.9 – Total P1toP2 PI Skills Stock

The equilibrium formula for the Total P1toP2 PI Skills stock is the following equation:

$$Total\ P1toP2\ PI\ Skills\ in\ Equilibrium = ((Monthly\ P1toP2\ PI\ Skills\ Training + PI\ Skills\ raise\ to\ P1toP2 + Skill\ Increase\ by\ experience\ P1toP2) * Position1\ to\ be\ Position2)/(P1toP2\ Promotion\ Rate + P1toP2\ Leaving)$$

Equation D.9 – Total P1toP2 PI Skills Stock Equilibrium Formula

Total Position2 PI Skills Stock

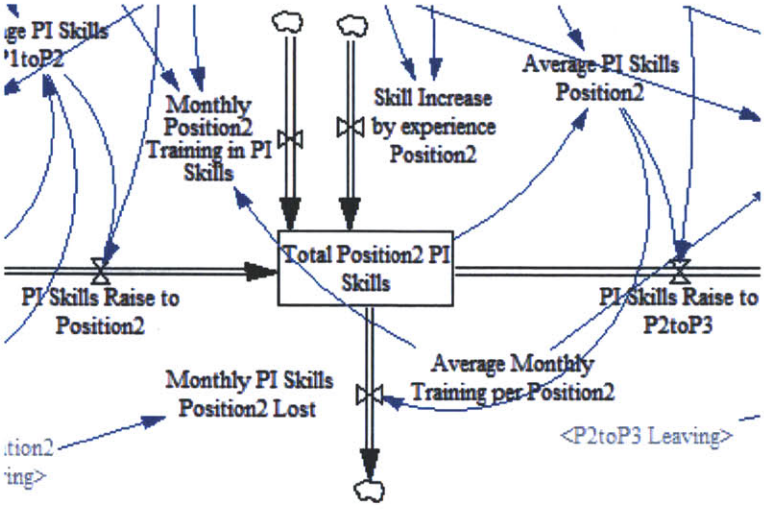


Figure D.10 – Total Position2 PI Skills Stock

The equilibrium formula for the Total Position2 PI Skills stock is the following equation:

$$Total\ Position2\ PI\ Skills\ in\ Equilibrium = ((Monthly\ Position2\ Training\ in\ PI\ Skills + PI\ Skills\ Raise\ to\ Position2 + Skill\ Increase\ by\ experience\ Position2) * Position2)/(Adv\ C\ to\ P2toP3 + Position2\ Leaving)$$

Equation D.10 – Total Position2 PI Skills Stock Equilibrium Formula

Total P2toP3 PI Skills Stock

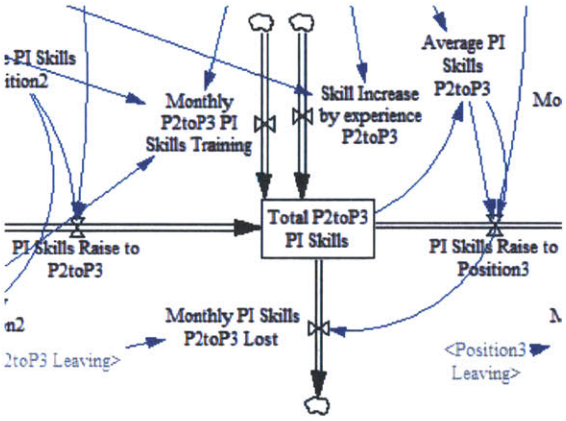


Figure D.11 – Total P2toP3 PI Skills Stock

The equilibrium formula for the Total P2toP3 PI Skills stock is the following equation:

$$Total\ P2toP3\ PI\ Skills\ in\ Equilibrium = ((Monthly\ P2toP3\ PI\ Skills\ Training + PI\ Skills\ Raise\ to\ P2toP3 + Skill\ Increase\ by\ experience\ P2toP3) * Position2\ to\ be\ Position3)/(P2toP3\ Promotion\ Rate + P2toP3\ Leaving)$$

Equation D.11 – Total P2toP3 PI Skills Stock Equilibrium Formula

Total Position3 PI Skills Stock

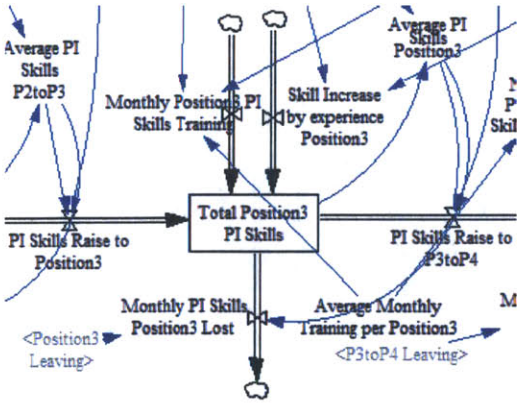


Figure D.12 – Total Position3 PI Skills Stock

The equilibrium formula for the Total Position3 PI Skills stock is the following equation:

$$Total\ Position3\ PI\ Skills\ in\ Equilibrium = ((Monthly\ Position3\ PI\ Skills\ Training + PI\ Skills\ Raise\ to\ Position3 + Skill\ Increase\ by\ experience\ Position3) * Position3)/(Adv\ L\ to\ P3toP4 + Position3\ Leaving)$$

Equation D.12 – Total Position3 PI Skills Stock Equilibrium Formula

Total P3toP4 PI Skills Stock

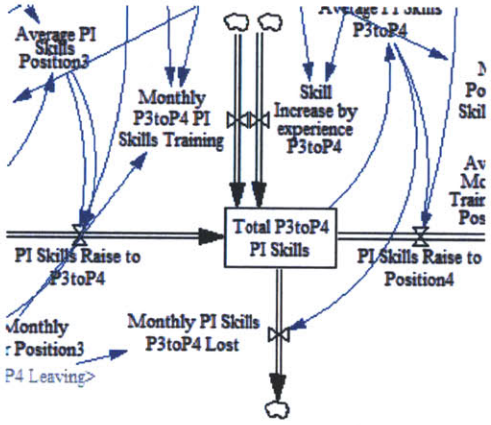


Figure D.13 – Total P3toP4 PI Skills Stock

The equilibrium formula for the Total P3toP4 PI Skills stock is the following equation:

$$Total\ P3toP4\ PI\ Skills\ in\ Equilibrium = ((Monthly\ P3toP4\ PI\ Skills\ Training + PI\ Skills\ Raise\ to\ P3toP4 + Skill\ Increase\ by\ experience\ P3toP4) * Position3\ to\ be\ Position4)/(P3toP4\ Promotion\ Rate + P3toP4\ Leaving)$$

Equation D.13 – Total P3toP4 PI Skills Equilibrium Formula

Total Position4 PI Skills Stock

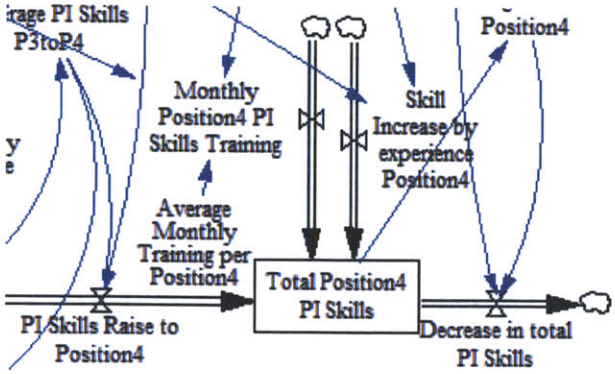


Figure D.14 – Total Position4 PI Skills Stock

The equilibrium formula for the Total Position4 PI Skills stock is the following equation:

$$Total\ Position4\ PI\ Skills\ in\ Equilibrium = ((Monthly\ Position4\ PI\ Skills\ Training + PI\ Skills\ Raise\ to\ Position4 + Skill\ Increase\ by\ experience\ Position4) * Position4)/(Exists)$$

Equation D.14 – Total Position4 PI Skills Stock Equilibrium Formula