Design and Optimization of Global Distribution Supply Chain at McCain Foods

By

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ABSTRACT

Network design has been successfully used by numerous organizations to achieve supply chain excellence through cost effectiveness and superior utilization of resources. This thesis addresses how network optimization methods can be used to provide guidance in the process of creating a company's global supply chain strategy.

In order to demonstrate that this approach can be a source of considerable value for an organization, we collaborated for a period of six and a half months with McCain Foods in the creation of their supply chain strategy plan.

In the past McCain has managed its capacity and distribution from a regional perspective. While this method has historically produced good results, the size of the company and the challenges ahead justify now a more global approach. To fully leverage McCain’s global scale, we conducted a comprehensive study of the supply chain, analyzing possible scenarios and highlights optimal strategies for future growth plans. For this purpose, we created a global supply chain model using LogicNet Plus, representing the movement of finished products from all French fry plants to all markets. From the analysis of the model, recommendations have been produced for McCain’s senior leaders and board, and used in the definition of the 5-year strategic plan.

To comply with the tight deadlines of the high-level decision-making process of the organization, the model uses highly aggregated and easily available data, yet it can represent reality with sufficient accuracy. The results of the study clearly show how this kind of analysis is able to provide significant input for the definition of a supply chain strategy, and to highlight opportunities for substantial cost savings in a global supply chain network.

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Bibliographical note

The author, Andrea Gentiletti, was born in Florence, Italy, where he spent his early years and graduated in Mechanical Engineering. Caught by a particularly bad case of wanderlust, he traveled around the world for the past ten years and worked as a project manager and continuous improvement leader in the automotive and aerospace industries. Apart from his native Italy, he lived in France, England, Germany, Singapore, California and New York, before moving to Massachusetts to join the LGO program at MIT.

In his spare time, Andrea enjoys drawing, traveling and learning foreign languages. He is a keen swimmer and dancer and enjoys being physically active. Overall, he is a pretty decent human being.
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This thesis presents a study on the utilization of network optimization and analysis tools in the creation of a company's supply chain strategy. In particular, the distribution network of McCain Foods was modeled and optimized, and scenarios were analyzed to produce recommendations for their five-year strategic plan.

The thesis is organized into five chapters. Chapter one provides the background on the use of network design tools and their application as a contribution to strategic decision making. The hypothesis and methodology of the work are also detailed here. Chapter two describes the industry and the company in which the tools have been applied and the hypothesis tested. In chapter three, the structure of the model and the data utilized to build it are detailed to provide a comprehensive picture of the tool application. Chapter four outlines the scenarios that have been evaluated and analyzed. In this chapter, the validity of the results and their impact are also illustrated. Finally, chapter five provides some indication about the recommendations and the implementation plan.
Chapter 1: Introduction

This chapter describes the methods used in the design and optimization of complex supply chain networks. Within a literature review, the specific application of the tools in strategic decisions is specifically detailed. The chapter is concluded by a description of the hypothesis at the base of this thesis and of the methods used to demonstrate its validity.

1.1 Supply chain network design and optimization: literature review

The need to design a supply chain network has been important since industrial production and supply chains have existed. However, it is not until recent times that the computational and organizational conditions have made supply chain network design truly comprehensive and value adding for the companies conducting such analyses. Small and large companies alike are now paying close attention at the processes and costs of their supply chains, and are striving to leverage their network as a source of competitive advantage.

Since the beginning of the seventies, using design and optimization tools in supply chain has finally become technically feasible, and rapid developments have occurred in the following decades. The reasons for this trend can be linked to the occurrence of six evolutionary phenomena (Geoffrion, 1995).

Four of these act as core enablers from a technical standpoint:

- Evolution of algorithms: the last thirty years have seen numerous important advances affecting the rapidity in the execution of complex analysis with a large amount of variables. In addition, a number of well-designed heuristic-based methods, sacrificing accuracy to the advantage of a much lower requirement of computer resources, have become increasingly popular.
- Evolution of data development and management tools: the large amounts of data necessary for a comprehensive network analysis can be made more manageable by using an evolving set of data management tools.
- Evolution of model features and software capabilities: a customer driven process has determined an increasingly rapid turnover of updates to the features and capabilities of the supply chain management packages.
- Evolution of how companies actually use software to design distribution systems: often initially purchased to address specific problems, design software is utilized by several companies also for other applications, sometimes extending the indication of the tool beyond the application it was meant for.

The last two phenomena can be defined as environmental:

- Evolution of logistics as a corporate function: logistics and supply chain have progressively acquired higher corporate status, with a drift towards centralization and a gradual increase in formal preparation and hierarchical level for the managers involved.
- Evolution of computer and communications technology: an increment in the price/ performance ratio of hardware and an enhanced “user-friendliness” of the interfaces have made of computer technology a central pillar for most organizations.

The widespread availability of tools and the increased supply chain awareness have led to the application of network design to several domains. In the majority of cases, the objective of the optimization is a cost minimization. To be more specific, this objective is typically expressed as a single objective through the sum of various cost components depending on the set of decisions modeled. Thus, the most typical aim is to determine the network configuration bearing the least total cost (Melo, Nickel, Saldanha-da-Gama, 2008). Specifically, in many multi-stage manufacturing supply chains, transportation related costs are a significant portion of total product cost (Kaminsky, Simchi-Levi, 2003).
The standard problem addressed in this kind of optimizations is to find a network configuration with minimal annual cost, which satisfies the demand for products at specified customer service levels. The input data is generally composed of aggregated product and customer lists, facility data for plants and stocking points (location, cost structure, capacity etc.), transportation options and associated rates per lane, demand forecasts and various constraints and restrictions affecting the network. The desired output focuses to answer questions such as location and product mix of stocking points, active lanes, location of facilities, plant load, suppliers identification etc. (Geoffrion, 1995). The location of the optimal location of distribution facilities between plants and customers in particular, has been treated in numerous instances and is the subject of various publications (Geoffrion, Graves, 1974).

1.1.1 Data Aggregation

A very critical aspect of network design is data collection. Very often, the sheer volume of data required and their variety makes the management of the input to a model a very complex issue. For this reason, it is of the outmost importance to aggregate the data so that it is more manageable and less cumbersome for the optimization engine to process.

Specifically, it is advised to aggregate customers located in close proximity to each other using a clustering technique such as a grid network, in which all customers located in the same cell are collectively replaced by a single customer located at the center of the cell. This process, as it was noted by several researchers, results in no more than 1% error in the estimation of total transportation costs, if the aggregation is performed into 150 to 200 zones. Moreover, because aggregating demand data usually decreases forecasting errors, demand forecast is significantly more accurate when such a customer aggregation is created (Simchi-Levi, Kaminsky, Simchi-Levi, 2008).
Another important source of data management benefit, is the aggregation of products into product groups. Such aggregation can effectively and reasonably be created by distribution pattern (all items shipped from the same source to the same customers can be aggregated) or by product type (all products that are characterized by just small variations of design or packaging can be aggregated). To this purpose, usually 20 to 50 product groups are considered a satisfying aggregation level (Simchi-Levi, Kaminsky, Simchi-Levi, 2008).

With these modifications, data become much more manageable, and model running time and ease of update are positively impacted.

1.1.2 Application to the Global Supply Chain

Due to economic globalization, there has been an insurgence of opportunities for companies to grow their businesses outside of their national boundaries. As a consequence, strategic models addressing the needs of international supply chains have become increasingly popular. In these models, global issues are addressed, for companies whose operations and commercial activities are geographically dispersed throughout multiple countries. In this kind of models, financial factors usually have a predominant impact on network configuration. These are usually basic features of international trading (duties, tariffs, exchange rates etc.), but comprise also incentives and financing offered by governments to attract investments. Of great importance are also budget considerations, which act as constraints that influence important supply chain decisions (Melo, Nickel, Saldanha-da-Gama, 2008).

The taxation aspects in particular, can be so pervasive in some business environments that they justify network design efforts specifically tailored for this scope. The emerging phenomenon of global manufacturing networks requires specific criteria for nodal location in different tax areas and international logistics zones, which can have a significant impact on the total supply chain cost (Feng, Wu, 2009).
1.1.3 Network design as a strategic planning tool

Supply Chain Management (SCM) through network design tools, can be divided into two types, based on the purpose: strategic and operational. Both types, or levels, have been the objects of model development efforts. The main objective of strategic optimization models is to determine the most cost-effective location of facilities, flow of goods throughout the supply chain and assignment of customers to distribution centers. Differently, operational level models aim to determine factors such as the safety stocks for each product at any given location, the size and frequency of production batches, transport and production lead times and customer service levels (Sabri, Beamon, 2000). To this difference of intent, is also associated a difference of priorities in the construction of the model and a difference in the type of details that are most critical to obtain a significant solution.

Of note, we can find a recent growing stream of research aiming at the integration of strategic and tactical/operational decisions in supply chain planning. This is motivated by the fact that items such as location decisions (see paragraph 1.1.4), while not typically made at the operational level, are influencing a number of issues such as inventory control or vehicle routing (among others). The increasing computational power and software capability available to today’s companies is certainly providing help in such direction.

By nature, strategic decisions are typically associated to large investments, therefore stability with respect to the configuration of the supply chain network is a highly desirable feature. “The strategic level deals with decisions that have a long-lasting effect on the firm. These include decisions regarding the number, location and capacities of warehouses and manufacturing plants, or the flow of material through the logistics network” (Simchi-Levi, Kaminsky, Simchi-Levi, 2004). However, in some cases it may be important to consider the possibility of making adjustments to allow gradual changes in the supply chain structure or in the capacity of the manufacturing facilities. In these instances, a planning horizon divided into several time-periods is typically used, and
strategic decisions are taken for each individual period (Melo, Nickel, Saldanha-da-Gama, 2008).

Moreover, as changes in supply chain design usually carry substantial economic risks, a critical component of strategic planning is to incorporate several future scenarios to evaluate risks and identify better solutions. Therefore, the input data for this kind of modeling is not only based on current knowledge, but typically it also encompasses certain additional possible scenarios (alternative demand patterns or cost structures, for instance) (Shu, Ma, Li, 2010).

1.1.4 Facility location

Facility location decisions play a critical role in the strategic design of supply chain networks. A well established research area in Operations Research, facility location aims to answer two specific questions: Which facilities should be used? Which customers should be serviced from which of these facilities, in order to minimize total costs? (Melo, Nickel, Saldanha-da-Gama, 2008).

For instance, in the uncapacitated, or simple, facility location problem, new facilities of unrestricted size are selected between a finite number of available candidate locations with the objective of minimizing total cost for satisfying fixed demand specified in a defined number of locations (Erlenkotter, 1978).

Among the most significant and complex strategic issues, locating a facility is the beginning of a long-term process, with long-lasting ramifications and impacting numerous operational and logistical decisions, not to mention the investment of large amounts of capital. Thus, facilities that are located today are expected to remain in operation for an extended time, but their appeal can be drastically altered by environmental changes during their lifetime, thus turning today's optimal location into tomorrow's investment blunder. Determining the best location for a new facility is therefore a delicate and complex strategic challenge (Owen, Daskin, 1998).
For a critical item such as facility location, computer models can definitely help in making the decision, but they cannot make the final decision, because they operate with a complex yet limited set of data, without considering other important, and possibly unquantifiable, sources of decisional input. Such sources can be as basic as considerations on the classic economic factors of land, labor and capital, or even pertain broad categories such as sources, production, markets and logistics (Mentzer, 2008).

For instance, sources of supply can be modeled in terms of cost-related and volume-related quantities, but there are socio-political aspects that are likely better discussed separately from quantitative analysis. As noted by the Analytic Strategy Team working at P&G on a supply chain initiative including a significant plant consolidation effort in 1993: “The major insight we gained from this effort is that a hybrid approach is needed to solve difficult problems of this type, an approach that closely links expert human judgment and mathematical optimization” (Camm, Chorman, Dill, Evans, Sweeney, Wegryn, 1997).

1.2 Hypothesis

This thesis explores the possibility of utilizing network design tools to produce valuable input for the definition of a high-level strategic supply chain plan. Through the creation of a model of the supply chain network, it should be possible to evaluate different scenarios and select an appropriate set of recommendations that can be trusted to produce sizeable financial impact once implemented.

In particular, any model created with this purpose in mind will need to be quick to build, update and modify, to enable for a large number of scenario analyses in short period of time. Therefore, the real challenge becomes being able to define a model that is highly aggregated, yet very representative of the actual network and able to produce meaningful results.
1.3 Research methodology

To prove that it is actually possible to successfully utilize network design for high-level strategic purposes, we collaborated with the McCain Foods company in planning their 5-year distribution strategy. A model of McCain’s distribution network was created, verified against historical data and then optimized in different scenario configurations. The goal was to create executable change proposals, to be assessed and approved by the company’s top leadership. The assumption was that if the model is proven to represent the network with a sufficient degree of accuracy, and if the recommendations are viable and generally accepted as coherent with the company’s past experience and vision for the future, then network design tools can be considered to be significantly valuable in a strategic planning setting.

In order to provide quantifiable evidence, we also aimed at measuring the projected impact of the changes. If such impact proved to be sizeable, we could consider network design tools to be also able to create a clear advantage for the company, thus justifying the investment of time and capital required to employ them.

1.4 IBM ILOG LogicNet Plus

LogicNet Plus is a packaged network design and planning solution, combining the optimization software package CPLEX with a graphical user interface to manage complex supply chains. The interface allows users to enter data about products, plants, customers and warehouses in an intuitive yet detailed way, as well as to specify constraints. The user can then optimize the network and analyze the output through a variety of reports (IBM LogicNet website).

While the graphic format doesn’t allow for as much freedom as it would be possible by developing an ad-hoc optimization program, it can model enough complexity to encompass most of the main issues and questions arising in a complex supply chain network. Moreover, the organization of data in clearly defined buckets (products,
demand, capacity etc.) and the possibility to export data tables to MS Excel and to modify them directly as a normal spreadsheet, enable for quick updates and for an increased flexibility in the analysis of different scenarios.

As it will be detailed in the following chapter, rapidity of input and updates were definitely priorities in the strategic application of network design and optimization at McCain Foods. Thus, the specific characteristics of LogicNet Plus proved to be particularly appropriate to this case.

1.5 Chapter summary

Supply Chain design and optimization is commonly used in the operations world to drive important decisions significantly impacting a company’s business from both the strategic and the tactical level. The purpose of this thesis is to demonstrate that network optimization methods can be successfully be utilized in the creation of a high-level strategic plan. For this purpose, we created a LogicNet Plus model representing McCain Foods distribution network, to provide recommendations contributing to such plan.
Chapter 2: Global Supply Chain at McCain Foods

This chapter describes the environment in which we applied the tools and techniques for network optimization and analysis. After a description of McCain Foods and the frozen potato products industry in general, we provide some insight on the transition of the company towards a more centralized supply chain model and on the role that network design plays within this transition. The chapter closes with a description of the team involved in the supply chain study and the support received by the project.

2.1 Background and industry

Before even beginning to describe the McCain Foods Company, we find that it is worthwhile to define the business of frozen potato products in general. Relied upon by a multitude of global customers, yet virtually unknown to the majority of them, this industry processes and ships millions of tons of products every year, creating and promoting a vast agricultural and industrial ecosystem that employs thousands of people. Each portion of French fries or hash browns, enjoyed in one of many different settings and geographical locations, is just the final step of a commercial and distribution network characterized by great complexity.

2.1.1 The diffusion of frozen potato products

Frozen potato products begun to be produced and to circulate shortly after World War II, due to the simultaneous presence of two important enabling factors.

The first was the development of the technology that made the industry possible. Towards the end of the War, Ray L. Dunlap, a scientist working for Simplot, one of the biggest shippers of potatoes in the western United States, found that precooking the potato stabilized it so it could be frozen and thawed later without breaking down the cellular structure. After several years, it was possible to produce a frozen fry bearing the same quality of a fresh one. In 1953, Simplot started selling the new product.
The second important factor was the important social change happening in North America in the same years. After the war, the population of the US and Canada started to grow very rapidly, thanks to the baby boom and to a high rate of immigration. More people meant more mouths to feed and more business for food processors. More important still, a momentous social change was getting underway, one that would fuel the growth of the industry through the 1960s and beyond: the entry of ever-increasing numbers of women into the labor force. With both partners working, families had less time and energy to prepare meals. Anything that made the task easier, frozen French fries, for example, was welcome.

The proliferation of fast food restaurants was also in part the result of the entry of married women into the labor force. Families with two wage earners had less time to cook at home and more disposable income to spend in restaurants. Eating out, once reserved for special occasions, became routine. Adding to that was the post-war increase of automobile ownership. To cater to hungry drivers, the restaurant industry started to build drive-in and other quick-service restaurants. French fries, which can be eaten without utensils, were the perfect food for the automobile era. Several of the known brands of fast food restaurant chains, such as McDonald’s and Kentucky Fried Chicken came into existence in the early fifties, and frozen French fries companies grew along with them as their most important suppliers.

With the right technology and an increasing market need for the product, frozen French fries begun to be widely diffused in restaurant and home kitchens alike. The progressive increment of international commerce in the following decades and the diffusion of cross-national food culture further developed the market making of its products and its players a global reality and a multi-billion dollar business.
2.1.2 Main players in the industry

Other than McCain Foods, which will be described in detail in the next few paragraphs, there are other two major players in the frozen French fries industry: Lamb Weston (a subsidiary of ConAgra Foods) and Simplot.

Lamb Weston is a supplier of frozen potato, appetizer and vegetable products to restaurants and consumers throughout the world, employing close to 6,000 people and producing around USD$2 billion in annual sales. The company has a history of rapid growth, beginning from 1950, when it was incorporated in Weston, Oregon. In 1960, founder F. Gilbert Lamb, an established vegetable producer, invented the Lamb Water Gun Knife, the first device to slice French fries in a high-velocity water flow, an idea that is now the industry standard worldwide. Shortly after, Lamb Weston begun to process potatoes and entered the domestic potato processing market after building a new frozen potato processing plant in Idaho, followed by several other facilities around the US.

In 1988, when Lamb Weston was acquired by ConAgra Foods and Golden Valley Microwave Foods, a rapid rate of expansion started which continued in the 1990s through a series of acquisitions, including the purchase of Universal Frozen Foods in 1994. Today, the company supplies the global frozen French fries market from numerous facilities located in Europe and North America.

The J.R. Simplot Company, commonly referred to as Simplot, was founded in 1923 by 14 years old J.R. Simplot near the small agricultural community of Declo in Idaho. The company grew tremendously and by the early years of World War II, it had become the largest shipper of fresh potatoes in the United States and was selling millions of pounds of dehydrated onions and potatoes to the military. The firm was legally incorporated in 1955. Upon the invention by Ray L. Dunlap of the necessary processes to produce quality frozen French fries, the company developed through the 1960s as the primary supplier of French fires for McDonald’s.
Today, Simplot is one of the largest privately owned companies in the world and has branches in the Americas, Europe and Asia. Other than French fries and other potato products, the company also produces other products such as frozen vegetables, appetizers and agricultural fertilizers. The 10,000-employee company has annual sales of approximately USD$4.5 billion.

2.1.3 Generalities on frozen potato products supply chain

As the potato industry is a processing industry, its supply chain is relatively simple, with a material flow moving from the fields to the factory, then to storage and finally to the customer. However, because of the nature of the raw material and of the product, there are some peculiarities that are worth of note.

One important constraint in the flow is due to the fact that raw potatoes are very prone to damage and deterioration. For this reason, long-haul transportation can produce unwanted phenomena such as sun burning, collision marks or rotting. All these contribute to a decrease in the utilization rate of the raw, thus making the product more expensive. In practice, the cost of the percentage of fresh potatoes that cannot be utilized because rotten or sunburnt, will increase the total cost of the product without creating additional value. For this reason, differently from assembly-intensive industries such as automotive, where the facilities are located in proximity to the customer, potato-processing plants are located directly in the potato-growing regions, minimizing transportation needs.

A second interesting aspect is a consequence of the quality requirements for different potato products. French fries are ideally produced with a certain degree of geometrical homogeneity, making some products of the cutting process unsuitable in shape although chemically compliant. Thin cuts (called slivers) for instance, or the short cuts produced by the elimination of defects, are prone to burning during the cooking and also non-compatible with the quality requirements of most quick service customers who require the length of the fries to be within a tolerance range. The same cuts, however, are perfect for the ricing process that creates the texture of hash browns or for dehydrated
products, like potato flakes, as shown in Figure 1. Thus, while 50 to 60% of the weight of raw becomes French fries, a percentage of the byproducts of a French fry line can become the raw material for another line, limiting the amount of scrap. For this reason, specialty product lines, such as the ones producing harsh browns are often combined with high volume French fries lines. This increases the rate of utilization, but also creates ambiguity in the definition of the cost structure of a specific product. In Chapter 3 we will see how this fortunately doesn’t have a significant impact in the modeling of the product cost.

Another aspect is represented by the perishability of the product, which is largely mitigated by the freezing process. The final frozen product constrains all distribution to the need for cold chain, reducing the transportation and storage options available. However, the average shelf life for most product extends to approximately one and a half year, which makes perishability much less of a limiting factor, as long as the frozen conditions are maintained.

2.2 McCain Foods

McCain Foods is an international leader in the frozen food industry. Founded in 1957 in Florenceville, New Brunswick, Canada by brothers Wallace and Harrison
McCain, the company couldn’t have started at a better time. The McCain brothers were entering a new industry just when the technology that made the industry possible was being developed, and the 1950s saw a surge of growth in processed and more convenient food options.

The potatoes grown in New Brunswick, while perfect table and seed potatoes, were not suitable for processing French fries. This meant that an extended agronomy effort was required to manage to meet the growing demand. Despite the initial difficulties, since its modest beginnings with just 30 employees, McCain has grown through acquisitions and with daring entrepreneurial spirit to be a multi-billion dollar, multinational company employing 19,000 people and generating annual sales in excess of CN$6 billion. Still a private company despite its size, McCain is a global organization with strong brand and a prominent public position in Canada (Stoffman, 2007).

2.2.1 Products

McCain identifies itself as a potato company, coherently to its historical development as a supplier for the growing frozen French fry market. Still the highest volume product, French fries are produced by McCain in different shapes and forms, from the classic longitudinal cuts served in quick service restaurants, to lattice and spiral cuts, and more that 20 different varieties of potatoes are used. The company has also followed and actively contributed to the evolution of the product: oven fries, introduced for the first time in the mid-eighties, are an example of this.

Apart from French fries, McCain is also producing a wide variety of specialty potato products, such as hash browns, tater tots and mashed potatoes. These are most often manufactured in the same locations as French fries, because of the need to localize potato-processing facilities in close proximity to the fields.
While potatoes are at the heart of the offering, the company also produces numerous other food products, including pizza, appetizers, oven meals, juice and desserts, which in many cases meet the demand of a local market (Stoffman, 2007).

2.2.2 Processing plant locations and Markets

Starting from the 1960s, McCain started offering their products to consumers outside of Canada, first in the United Kingdom then in Australia and in the United States. In the following years, the strategy for expanding the business into a new country was to initially ship from Canada until the demand in that market became large enough to justify the construction or the acquisition of a local facility. Thus, to McCain’s entrance in the British market followed the start of production in Scarborough, Great Britain, for instance (Stoffman, 2007). Today, McCain foods ships its products from 50 facilities located in 6 continents, to more than 160 countries around the world. Figure 2a and Figure 2b represent the global production network, and specify which facilities are producing French fries.

Figure 2a – McCain’s global production network
2.3 Supply Chain at McCain foods: from regional to global

The way the company has grown, expanding the business region by region, is reflected in the organizational structure of McCain Foods. There are 8 main regions in which McCain has facilities and sells products: Canada, U.S.A., South America, Continental Europe, United Kingdom, South Africa, India/China and Australia/New Zealand. To each region corresponds an organization, operating with a significant degree of independence. A ninth organization, McCain International, covers the areas in which the company does not have a plant: the markets that are supplied exclusively by imported products.

The entrepreneurial spirit of the founders is still very much present in the regional organizations, making them operate almost like separate entities, each one with their agendas and standards. Coordination has traditionally happened largely by agreements linked to a contingency, which has enabled great flexibility but has sacrificed an optimal organization of resources. Even McCain International, which addresses more global
needs (i.e. satisfying demand in countries where there is no production) operates like a region procuring from the others more than as a centralized function.

By enabling a customized approach and making it possible to quickly seize opportunities, this organizational structure and general business attitude has proven very effective during the period of transition from a small entrepreneurial business to a leading global company. However, the mature organization that McCain now is, with its size and reach, is increasingly facing global supply chain challenges, which require and justify a more globalized strategy.

The Global Supply Chain group, a function recently created and located in the US Headquarters of Lisle, IL, is progressively introducing a more global approach to strategic decision-making. The group is charged with the creation and the coordination of supply chain plans that, once implemented, leverage McCain's global scale to create sizeable competitive advantage. This centralized approach embodied by the group represents a revolution in the way the company thinks about supply chain, and will require time to become fully understood and embraced.

2.4 The project

It is undeniable that the company is benefiting from a more global outlook, from effective volume allocation in moments of raw material scarcity, to long term capacity planning, to rationalization of product mix. But to better understand the complexity of such a large supply chain, it is quickly becoming more necessary to introduce tools able to process the multitude of data and variables that define it. It is here that network design and optimization, as described in chapter 1, becomes very relevant.

The frozen potato products market, which is the main source of revenue for the company, is configured as a predominantly commodity-oriented business environment. In order to produce competitive advantage, McCain has begun to create a supply chain strategy that is resilient to changes and utilizes capacity effectively. To define this
strategy, which will support the company’s growth plans for the next five years, the Global Supply Chain group is beginning to analyze the network from a global perspective, through the use of modeling tools. The goal of this effort is to identify opportunities and produce recommendations to guide and support the decisions made by McCain’s steering team, which will be presented to the board for approval.

Employing modeling tools and evaluating scenarios, it is possible to gain a comprehensive idea of what kind of interventions will positively affect the supply chain network, and to set priorities for the changes to be implemented. The model needs to be highly aggregated and easy to modify, so that it can be quickly updated and that a high number of scenarios can be tested in a short time. The model also needs to be based on reasonable assumptions and to represent reality with a certain degree of accuracy, to offer relevant insight. Although antagonistic, both aspects are equally fundamental in order to provide a valuable contribution to the formulation of the strategy. In the following chapters, we will describe how this was achieved.

2.5 Project team and support

A project that aims to initiate durable change cannot be effective unless it involves the active participation of decision makers and has full support from leadership. The supply chain improvements of which the modeling effort is part is blessed with both.

To ensure that the model adequately represents reality and to validate the results to transform them into viable recommendations, a team was created, which is mainly composed by people from the Global Supply Chain group, residing in either the US or Canada HQ. Most people in the team have senior positions (VP or Director) and are entitled to make important decisions affecting the global supply chain strategy of the company. All the main functions involved are represented: Finance, Engineering, Agriculture, Planning and Procurement, Manufacturing and Business Development. In addition, the team includes a Trade Networks Manager from Day&Ross, a logistics and transportation company also part of the McCain group, providing the freight perspective.
All team members are very much in line with the scope of the project, which originated from the vision of the Chief Supply Chain Officer and head of the group.

Led by the Global VP of Planning and Procurement, the team meets once a week to follow the progress in the creation of the model and later to discuss the findings and coordinate aspects of the implementation. Closer to the times in which the recommendations needed to be proposed to the steering team, the meetings become two per week compatibly with the availability of the members.

The main customer for the project is the steering team, composed of members of the top leadership of the company: chief officers at global and regional levels. The recommendations coming from the model’s results are proposed to them by the project team and discussed to define the 5-year strategy. When the strategy is created, its most critical aspects are then proposed to Management.

The steering team fully supports the network analysis and provides guidance to the project team on the scenarios that need to be evaluated. This enables the team to have a very clear purpose and to focus on the project by creating a non-conflicting team dynamic.

In addition, regional VPs of operations and regional supply chain directors also collaborate to the data collection and to the shaping of the model, providing insights that help in understanding the data from the various regions.

2.6 Chapter summary

Rapidly grown from a small entrepreneurial business into a large international company, McCain is striving towards becoming a more global organization with centralized processes to manage their supply chain. To produce competitive advantage in the commodity market of frozen French fries, a clear distribution strategy is required, based on the analysis of the supply chain network from a global perspective. To achieve
this, with the support of the senior leaders within the organization, a model was created to analyze scenarios and produce a supply chain configuration that is resilient to changes and utilizes capacity effectively.
Chapter 3: Model development

This chapter describes the model and how it was built. After an overview of the key cost drivers considered for the study, we will explain the model’s general structure and boundaries. We will then detail the assumptions made, as well as the process of data collection and aggregation. An illustration of the measurement and validation of the model output concludes the chapter.

3.1 Key cost drivers

As the purpose of this modeling effort is to produce recommendations that positively impact the distribution cost, particular attention was given to the determination of the main cost drivers of the supply chain. In order to do that, we started by selecting the cost drivers to include in the model between the ones that contribute the most to the product cost structure.

Of these, the raw potato cost is clearly the major contributor, at about half of the total product cost. Raw cost aside, we decided to aggregate the rest in two broad categories: indirect costs and direct costs. The former, including mainly overhead and depreciation of assets, vary on a plant-by-plant basis, based on age of equipment and leanness of management. For instance, a newly renovated plant led by a multi-layered organization will tend to have comparatively higher indirect costs. The latter, including items such as direct labor, shortening (frying oil), packaging and energy, generally highlight differences between the regions in which the plants are located. For instance, all plants located in the same country will tend to have similar labor and energy costs.

McCain Foods is a global company operating in a large number of markets; therefore we could clearly see that freight and import duties can correspond to a significant amount of the supply chain cost for exported products. Moreover, as the model would determine the optimal total supply chain cost by generating the optimal configuration of distribution lanes, we thought that such delivery costs could be
particularly impacted by our analysis. All these costs are a function of both the plant of origin and the market in which the product is sold.

### 3.2 Overall structure of the model

As previously mentioned, the model is intended as a strategic analysis tool to run multiple scenarios on. As such, its structure should enable quick optimization runs and modifications, and its results should be easy to understand and interpret. With this in mind, we decided to structure the model as simply as possible, to avoid clutter and unnecessary complications.

The model depicts a simplified network, where production plants directly deliver to the customers. No warehouses are modeled and there is only one possible lane connecting each plant to each market, as illustrated in Figure 3. The choice of not including warehouses was mainly required because of the lack of readily available information regarding the warehouses' data details. This simplification was legitimized by the relative small impact of holding costs in the total cost structure. Moreover, not only this makes for a rapid input update and very fast scenario runs (most typically under 30 seconds), but it allows to identify major features of the solutions just by looking at a small number of key output data.
The recommendations that the model is expected to create are going to provide a strategic outlook on the distribution supply chain for the next 5 years. Therefore, the model is set to perform a multi-year analysis from 2012 until 2016, where each year corresponds to the fiscal year. This allows for a higher freedom in the scenarios that can be modeled (i.e. cost cycles or gradual increases), thus providing not only a strategic direction but also a timeline for when the proposed changes will be required. In addition, a multi-year model allows for transfer of inventory from one year to another, allowing the network to sustain slight demand variation through pre-processing of products.

Finally, since both production planning and network design are strategic considerations of interest for the company, the model has been set to run as a "combination model", allowing open/close decisions as well as pre-building of production.
3.3 Boundaries of the model

Upon consideration of McCain’s product portfolio, we chose to concentrate exclusively on French fries, defined as any cut potato product produced on a French fry processing line. The choice is due to the fact that frozen potato products in general, and French fries in particular, are by far the highest volume products for the company. Moreover, the SKU’s that can be described as French fries are considerably similar in terms of processing, and they are generally products that are relatively standardized across the globe (in the case of quick service restaurant (QSR) customers with big accounts and global presence, for instance). This means that the distribution of French fries has numerous possible network configurations, and the network is large enough to produce significant impact if optimized.

As opposed to other industries such as automotive where assembly plants are located close to the customer, the potato industry locates processing facilities in proximity of the potato fields, thus operating in reverse. This is due to the high perishability and sensitivity of raw potatoes to transportation. Thus, the supply chain matter for a potato company is in fact overwhelmingly a distribution issue. Following these considerations and accordingly to our decision of considering cost of raw in finished product as one of the key cost drivers (see paragraph 3.4), we implemented the model starting the supply chain from the plant instead of from the field. In addition to that, as the location of most plants is a given, modeling the inbound portion of the supply chain would be unlikely to affect the network.

In order to leverage the global scale of the company as much as possible, the model has been set to satisfy demand in all markets currently served, from all plants that have at least one French fry line. This creates a comprehensive outlook over the network, allowing taking into account many different interrelations between the network elements.

To represent the perishability of the products, a shelf life of 1 year was imposed, which for a model whose smallest time unit is 1 year, corresponds to a “next year”
delivery. McCain’s frozen products are generally assumed valid for distribution and consumption for about 1.5 years. Assuming that any product shipped in the year after its production is generally being processed towards year-end and delivered at the start of the following year, the 1-year shelf life assumption appears to be appropriate.

3.4 Data collection and aggregation

To create a model that can effectively support strategic decision-making, we took particular care of selecting and aggregating data so that it is easy to procure and makes the model fast to update. For this reason, we chose to use financial data to define the three values that compose the cost of product (raw, indirect and direct) for each plant. This data is periodically reviewed and presented in a unified report, which makes it particularly convenient to use and to compare.

Concerning the cost of raw in particular, we decided to consider the cost of raw in the finished product instead of the cost of raw delivered from the fields. While this is the cost recorded in the commonly used financial reports, making it readily available, its choice also entailed that each product/plant combination would have a different raw cost, because the changes in weight that occur during the processing can vary depending on the product. However, upon evaluation, we determined that such variations between products were only significant for small volume products. We selected then the most popular cut (3/8”) as proxy and used the associated raw in finished product cost as the input data. With this approximation, the values are aggregated so that there is no raw cost variation between the products of a given plant, which greatly simplified the model (only 1 cost of raw per plant, just like in the case of indirect and direct costs).

For the very few plants that do not produce the 3/8” cut, we estimated the cost of raw in finished product from the cost of raw off the field, appropriately converted. The conversion was made using a utilization rate calculated from the historical volumes of raw potatoes bought by the plant in the last five years and the historical volumes of product net of oil, batter and byproducts. The resulting utilization rate was found to
represent an acceptable approximation of the change of weight that these plants would see, were they to produce 3/8” cut. The cost of raw in the finished product for those plants was then calculated as follows:

\[
\frac{\text{cost/unit of raw off the field}}{\text{utilization rate}} = \text{cost/unit of raw in finished product}
\]

Both rates, the ones from the financial reports and the ones we calculated ad hoc, are net of byproducts, and do not consider the fact that the scrap of the French fries production can still be utilized for specialty products (see paragraph 2.1.3). However, upon evaluation, the amounts of “scrap” recovered this way, although relevant in the cost structure of the specialty products, is revealed to be dimensionally negligible vis-à-vis the cost structure of French fries. Therefore, it is legitimate to assume this raw material as scrap when developing a model for French fries only.

The demand data was provided by the sales organizations of the different regions, and reflected the expected sales of French fries and QSR French fries for the next 5 years, in Metric Tons. As the demand data is highly aggregated, it was necessary to make approximations on the products, forcing all SKUs to be defined in the model as either French fry or QSR French fry. Due to the decision of expressing the cost of raw on a per-plant basis, as previously detailed, this high degree of demand aggregation did not further limit the cost aspects of the model. The data was presented per region or country, depending on the size and importance of the market, and included in most cases a low, high and likely demand projection profile.

As in all cases in which data needs to be provided by various regions, the demand data came in different formats and differently aggregated. In some cases, for example, the data for a region was presented aggregated by the countries in the region, while in other cases it was aggregated by customer type. In those cases, we had to communicate with the regions and go through several iterations and communication exchanges before getting to a homogenous format. The depth of aggregation was also an issue; with some
regions presenting data so much grouped that it would not provide any useful insight when analyzed. In several instances, we requested a lower level aggregation, with data points for each country in the region instead of just one data point for the whole region, for instance.

The Day&Ross Freight Services organization provided the freight rates, as a zone to zone price per container from each plant to each of the markets for which demand was provided. The delivery points were selected as the closest entry port or the city of highest demand within each market. When a market was defined by the sales organization as a set of countries, the entry port in the country demanding the highest volumes was found to be the best approximation in most cases. Also from Day&Ross, came the up-to-date import duties for each plant/market pair.

The rate of production lines was extracted directly from a database that monitors the output of all plants. This part of the data was already recorded in close-to-real-time and very accurate, and it did not require any further analysis.

Complementary data such as costs of plant closure and expansion or quantitative constraints (availability of raw in region, need to dedicate part of the lines to a specialty product etc.) were evaluated and provided on an ad-hoc basis by the members of the team.

3.5 Detailed structure of the model

The data, selected, collected and aggregated as described, creates suitable basis for the network analysis. In the following paragraphs, we will relate in detail the specific characteristics of the various inputs of the model. Figure 4a and 4b provide an outlook over the main dimensions of the model and the main input, respectively.
Figure 4a – Main dimensions of the model

Figure 4b – Main input of the model
3.5.1 Products

As previously stated, the available demand detail forces the model to only distinguish between 2 products: French fries and QSR French fries. Fortunately, this rudimentary division turns out to be acceptable. The straight cut French fries product family makes up for a large percentage of production, and all other cuts are in volumes low enough to justify annexing to the main family. However, QSR requires specific standards and restrictions that justify dedicating a second product category to them. For instance, only a subset of plants is QSR certified, and markets generally have preferences regarding the source of QSR products, as it is detailed in paragraph 3.6.2. Figure 5 exemplifies the aggregation of products within the 2 product denominations in the model.

![Figure 5 - Aggregation of products from families](image-url)
3.5.2 Markets and demand

Demand is aggregated in 40 customers or markets and expressed in metric tons. Each market represents either a single entire country (ex: Italy, Malaysia), a region when demand is relatively low or overwhelmingly associated with one of the region’s countries (ex: Balkans, Caribbean) or a subset of a country for geographically extended developing markets (ex: China, Brazil). With few exceptions, all markets have demand for both products in the model.

The reference demand levels (i.e. the demand levels in the first optimized run) are defined as flat over the 5 periods of the model for mature markets and as moderately growing for developing markets. This is consistent with the relatively static nature of mature markets that has been witnessed in the last few years.

3.5.3 Plants

The model defines 34 plants, with 1 or 2 lines each. The total network of McCain Foods plants currently producing French Fries is composed of 28 plants, with presence in all continents. The additional 6 plants are potential, to be added as either an acquisition or a green field site. About 1/3 of the current 28 plants are assumed as pre-existing. This means that they can be closed incurring a cost, expensed in the year of closure and estimated to include Net Book Value, severance cost and legal cost. The remaining plants are defined as open. Each of the 34 plants incurs the indirect cost described in paragraph 3.1 on a yearly basis.

The lines under each plant operate at a capacity calculated as actual instantaneous metric tons per hour produced multiplied by the days of operation. For the purpose of this model, days of operation for most plants are assumed as 340 (maximum achievable, considering periodic cleaning and maintenance cycles). There are however 3 exceptions: the lines of two plants, located in regions characterized by agriculture and storage limitations, operate at 255 days (9 months) and at 283 (10 months). The lines of a third
plant, which operates somewhat independently from the others producing privately labeled products that have virtually constant demand, has total capacity fixed at the demand level for year 2011.

For two of the plants, capacity decreases through the years modeled. In both cases, this is due to the fact that these French fry lines can also be used to produce specialty products that do not fall into our definition of French fry, and that satisfy a demand that has been predicted to increase. The capacity of such lines is therefore decreased each year by an amount equivalent to the projected specialty demand for that plant.

Direct costs are associated to the lines and are assumed as constant through the 5 periods, while raw cost in finished product, also per line, is subject to a 5% yearly increase.

3.5.4 Distribution lanes

The lanes are directed from most plants to all 40 markets, with the exception of 4 of the potential plants that are meant to satisfy exclusively the demand of the region in which they are located. Therefore, there are 1204 (30X40+4) viable lanes in the model.

The freight costs associated to each of the lanes are incremented yearly from 2012 following an approximate estimation of the oil price increases: +1% in 2013 and +3% in each following year.

Additionally, the freight rates from certain plants to certain markets are incremented to include an overprice. This overprice represents an increase in the cost of raw potato and it is applied when the agricultural area associated with the plant produces a variety of potato that is not the one requested by one of the markets. As there are only a few of these cases, we associated the extra cost to the lane connecting these plants to these markets via an inflated freight cost. We found this to be preferable to introducing an additional product, which would add more complexity due to some markets accepting
more than one potato variety, and due to the structure of LogicNet which requires demand to be associated with a specific product.

3.5.5 Duties

Duties have been calculated as current and are assumed not changing during the 5 modeled years. As duty variations are issued through typically lengthy trade agreements or governmental policies, it is fair to assume them to be relatively static over our timeframe. LogicNet limits the application of duties to a pre-specified product cost that remains constant through the model’s periods. We assumed this cost to be the sum of the three product costs (raw+direct+indirect), with the cost of raw in finished product assumed at 2012 level. Given the small increment in cost of raw most commonly used and the mitigating effect of the multiplication by the duty percentage, we estimated the error due to this approximation to be minimal.

3.5.6 Currency

While all freight rates are provided in USD, the product costs associated with each plant are generally expressed in local currency (USD, CAD, INR, CNY, AUD, EUR, NZD, GBP, ZAR). We chose to input the exchange rates as a separate dataset instead of converting all costs; in other words, leaving it to the model to do the conversions. While this, because of LogicNet’s restrictions, forced us to input only 1 exchange rate per currency, therefore linking the model to an unlikely set of perfectly stable conversion rates across 5 years, we established that the high uncertainty in forecasting currency exchanges likely nullified the effort of converting all cost data instead. Moreover, separating the exchange rates from the costs allows expressing the results of the optimization runs in any of the different currencies, if so wished. For the duration of our study, the model output is set to CAD, in accordance to the global financial reporting, and all exchange rates are set at their values in June 2011. As detailed in paragraph 4.3.1, we looked at currency variations as part of the sensitivity analysis.

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3.6 Constraints

As we specifically designed the model to have a simple structure and a high level of aggregation of data, it has a very high degree of freedom, which can generate solutions that are incompatible with the reality of the company’s supply chain and do not make sense from a real business perspective. To prevent inconsistency, we introduced several constraints that limited the model more similarly to what really happens in the business.

3.6.1 Limits to product exportability

Unconstrained, the model allows to ship each of the two products to any market that has a demand for either or both. However, there are some restrictions to exports that need to be taken into account. These are mainly non-GMO regulations and market demand for product made from a specific potato variety.

Concerning the first restriction, the issue comes from a difference in the definition of the use of GMO (Genetically Modified Organism). While some countries define as GMO-free any product that doesn’t present traces of GMOs, some others employ a more restrictive definition stating that if GMOs were used in making the product, then it cannot be said to be GMO-free, even if it presents no traces of GMOs. Some growing regions make such pervasive use of GMOs during processing that it is virtually impossible to track GMO presence. Therefore, the model restricts the plants in these regions from shipping products to the markets that use the more restrictive definition.

As far as potato varieties are concerned, some growing regions mainly grow white varieties, while some others mainly grow yellow varieties. Similarly, there are markets that demand yellow, white or both varieties. Due to the structure of LogicNet, it is not possible to introduce products (i.e. define Yellow and White French Fries) unless demand is similarly split within these products. Consequently, we determined which markets are absolutely impervious to yellow fries and imposed a constraint to export from yellow potato growing regions to those markets. While this is a simplifying assumption (many
markets will accept both but in specific percentage ranges) it represents reality sufficiently well for our intents.

Of particular interest is the case of a growing region and market that mainly imports white flesh and mainly grows yellow flesh potatoes. An ad-hoc set of constraints limits imports from yellow flesh regions while allowing that region to sell their own product on the internal market.

One additional constraint on exportability comes from a slightly different issue. The demand of one specific market cannot be satisfied by a particular group of plants because the port that would be used by that lane is not available for most of the year due to challenging weather conditions. These lanes are therefore blocked.

3.6.2 Limits to QSR sourcing

QSR markets have well defined preferences concerning the sourcing of their products. Through a series of constraints, the model links each market to their regions or plants of preference. Globally, the constraints limit QSR French fries shipments towards each market to the plants that shipped QSR French fries to them in previous years. This historical data reflects preferences ratified in delivery contracts.

For a few markets, the situation is even more complex, because such contracts also specify well-defined percentages to be sourced from each approved plant. For this reason, these markets are constrained to be satisfied from the same sources and in the same split proportions recorded in previous years.

In a few cases, the same logic applies to all products delivered to a market. In some countries, customers are partial to a specific growing region and are not flexible with respect to alternative sources. In these cases, a similar set of constraints is used also for French fries.
3.6.3 Deviations from product aggregation

With the high aggregation of products comes the risk of having optimized configurations that do not satisfy demand. This is the case for French fries made with complex mechanical cuts, such as lattice or spiral cuts. These cuts are only produced in a couple of plants and are mainly consumed in few markets, but the optimization may direct the undifferentiated products of these plants to other markets, de facto not satisfying the demand. To avoid the introduction of additional products that would unnecessarily complicate the model, we forced the lanes from these plants to these markets to send volumes of product equivalent to the ones shipped in previous years. As demand for waffle and curly fries is significantly stable, this simplification is justified and sufficiently representative of reality.

The private label plant we referred to in paragraph 3.5.3, is also the object of a similar constraint. Not only its production is limited, but it is also forced towards the specific markets where the totality of its demand is originated.

3.6.4 Interim constraints for strategic reasoning

Finally, there are some considerations that limit the strategic decision-making and that rely on factors other than cost aspects. While most of these considerations have not been included in the model to preserve the ability of analytics to challenge beliefs and preconceptions, some of them were relevant enough to deserve a temporary spot into the study.

Some plants for instance, were at moments constrained to ship predetermined quantities to specific markets. This highlighted the differences between the unconstrained and the constrained solutions, thus assigning a monetary value to a specific strategic concept or paradigm. While this was not aimed at completely replacing business sense with analytics in decision-making, it created awareness and introduced several interesting opportunities for discussion.
3.7 Base case assessment

If the structure we gave to the model enables for a very practical and intuitive approach, its simplicity also has the side effect of making the model less likely to provide a correct representation of reality. To make sure that the highly aggregated data and simple structure are not detrimental to the accuracy of the output, we ran a base case scenario meant to test to what degree the model is different from reality.

The base case scenario has a similar structure to the model, but differs from it in several important ways:
- The scenario is limited to a single period: 2011.
- There are no constraints.
- The capacity of lines is unlimited.
- Only the 28 currently existing plants are active and they are all defined as open.
- The actual lanes used and the actual volumes shipped through them in 2011 are predefined as the only connections between the plants and the markets.
- The demand is the historical demand from 2011.
- All costs are from 2011 financial reports.

Due to the predefined nature of the lanes, the model cannot be optimized and is limited to calculating the total cost of the imposed network configuration. These results represent the total cost of the distribution supply chain computed according to the model structure when the model reproduces what actually happened in 2011. Therefore, the delta between these results and the historical cost of supply chain recorded in 2011 provide an indication of the model’s ability to represent reality. This, in turn, gives an idea of how much the cost of a supply chain network optimized by the model may be a reliable estimate of the actual cost of that configuration implemented in the real world. Clearly, the smaller the delta, the more reliable the model.
Upon comparison with the actual financial data recorded for year 2011, our model executes calculations with a delta lower than 2% from actual supply chain costs. These results are definitely positive, and testify that the model satisfactorily represents reality.

3.8 Chapter summary

In the effort to easily define strategies to decrease distribution cost, the model optimizes the supply chain network for French fries over the duration of 5 years. Financial data for indirect, direct and potato cost, as well as actual freight rates and duties are used as inputs because they are readily available and presented in a standardized format. All data is aggregated in a way that simplifies the model’s structure without compromising accuracy, leading to results that can be trusted to provide reliable guidance in developing a sound supply chain strategy.
Chapter 4: Scenario modeling

This chapter details the scenarios that we analyzed using the model as well as the sensitivity analysis we performed to verify the resilience of the results. Some reference to the type of results obtained, undetailed in the interest of confidentiality, is also included. A description of the technique employed to estimate the impact of the optimized solutions on the supply chain concludes the chapter.

4.1 Scenarios analysis

Upon completion of the model’s structure, we proceeded to model a number of scenarios to target specific strategic issues and to provide guidance with respect to various subjects of discussion. In the vast majority of cases, these scenarios are meant to tackle two main kinds of themes:
- Establishing which growing region/s should satisfy the demand of a given market.
- Assessing and modifying the processing capacity of a growing region.

In addition, we looked at macro-trends affecting the global network in order to identify opportunities for the creation of competitive advantage.

The scenarios were introduced into the model in three successive rounds, each one building on the previous ones. The results of each round of scenarios were analyzed and discussed, and recommendations were produced. Because the division in rounds was only due to the need to report specific recommendations to the board at specific times, the following paragraphs detail the scenarios with no reference to the order of incorporation into the model, but grouping them by type of analysis.
4.1.1 Aging plants

Two 2-line plants, located in different regions, have older processing lines, which are both important for the network. We allowed the model to choose between different options and combine them to produce the best impact.

For the first plant, the scenario looks into the following option for Line 2: either close it or invest capital to keep it running. Of course, reducing/increasing capacity would have an impact on indirect cost, as it would entail a reduction/increase of salaried workforce and other resources. Therefore for this plant the model distinguishes between fixed indirect cost, assigned to the plant, and variable indirect cost, assigned to Line 2. Specifically, 76% of the total indirect cost is assumed as fixed (based on financial data) and the remaining is assumed as proportional to total plant capacity. In the second year, the model can decide whether to shut down Line 2 for a closing cost, thus saving the part of variable indirect cost corresponding to Line 2 capacity, or keep on paying the whole indirect cost by investing capital to keep Line 2 running. The investment has been modeled as a yearly charge corresponding to the total investment cost expensed over 20 years following linear depreciation to 0 salvage value. This is compatible with the company’s standard for the expenditure of invested capital.

The model also considers, independently from the Line 2 decision, the addition of a third line of either 15 or 25 MT of hourly output. A constraint forces the model to choose to open either one of the 2 potential lines or none. This choice can be made starting in the third year of modeling, to give time for the lines to be built. The cost of either option is a yearly charge including the yearly depreciation at 20 years of the total capital invested plus the added variable indirect cost associated with the additional capacity.

For the second plant, both Line 1 and Line 2 can be either renovated with an investment expensed in 20 years or closed. The two lines are constrained to be both closed or both saved. Similarly to the previous plant, another option for this plant is to
open a Line 3 starting in the third year of modeling, at the cost of the usual 20-year depreciation plus the additional variable indirect cost.

In addition, the model can decide to close the existing plant and transfer it to a location in the same area. A constraint imposes there to be at least one plant in the area, thus practically transforming a closure into a move. As we are talking about a move, the closure of the plant does not incur any cost: there are no severance costs or legal costs because all employees would be transferred nearby, and book value is null because most of the old equipment in the lines has been fully depreciated. The building being in a premium area, the cost of demolition could be easily covered with the sale of the land it is built on. The new plant in the new location is modeled with the same cost structure as the previous, but also considers the capital investment (expensed in 20 years).

4.1.2 Existing plants in developing regions

Two 1-line plants, located in two different regions in which demand is rapidly growing, have been evaluated with scenarios targeting expansion. Both scenarios combine a component of agricultural and storage increase (reflected in an increase in the availability of capacity) with a component of capacity increase for the existing lines.

For the first plant, starting from year two, the model can expand the number of days in which current capacity will be available from 283 up to 340, at no additional cost other than the increase of indirect cost proportional to the added yearly capacity. In this case, indirect cost is assumed as 100% variable because of low overhead cost in the region. Also, there is no capital investment necessary, as the increase, modeled as an additional line, is obtained with an agriculture optimization effort and storage is farm-owned. Also starting from year two, the model can add 2.5 MT/hour capacity to the existing line, adding a yearly cost composed of the total investment depreciation over 20 years and the additional indirect cost corresponding to the additional capacity. The model is constrained to expand agriculture before considering expanding capacity.

In the scenario for the second plant, starting from year two, the model can expand the number of days in which current capacity will be available from 255 up to 320, for an
additional cost. This cost includes an increase of indirect cost proportional to the added yearly capacity and an investment for the storage (company owned in this region) necessary to hold the increased crops. As in the previous case, indirect cost is assumed as 100% variable because of low overhead cost in the region. The increase, modeled as an additional line, is obtained mainly with an agriculture optimization effort and doesn’t have any cost other than the ones specified above. Also starting from year two, the model can add 2.5 MT/hour capacity to the existing line, adding a yearly cost composed of the total investment depreciation over 20 years and the additional indirect cost corresponding to the additional capacity. The model can also add another 3 MT/hour, with the same cost structure used for the 2.5 MT increase. A constraint forces the three expansions to follow the following order of implementation: agriculture/storage before 2.5 MT/hour expansion before 3 MT/hour expansion.

4.1.3 Potential plants

Other than the one modeled as the reincarnation of one of the aging plant, as seen in paragraph 4.1.1, there are other 5 plants that can be opened in the model. These are distributed between three different regions. Of the five, four can only be opened with a single line, while the fifth can have either 15 or 25 MT of hourly output. In this case, the model is constrained to pick either one option or none. The plants can be opened in various years of modeling, starting from the third, to give time for the facility to be built or converted and brought up to speed. The cost structures are obtained as inferences from the ones of pre-existing plants adjusted as needed, adding the usual capital investment depreciated over 20 years to the indirect portion.

4.1.4 Target growth demand

Probably the most involved of all scenarios has been developed to take into account a very challenging situation in which demand is growing with a different growth pattern than initially proposed and to very high total volumes at the end of the fifth period. Not to be confused with the sensitivity analysis described in paragraph 4.3, this scenario has been challenged with volumes that cannot be met with the regular model
capacity and under the current constraints. Therefore, in order to make the model solvable, all QSR constraints have been removed (See paragraph 3.6.2).

Moreover, one of the goals of this scenario is to obtain a high-level picture of the global capacity distribution and to evaluate what regions are most fit to produce important savings across the network. For this reason, the 10 most cost effective plants have been allowed to add either one or two extra 15 MT/hour lines, at the price of an investment depreciated over 20 years and a proportional increase in variable indirect cost associated with the additional capacity.

This scenario and the associated version of the model, is significantly less constrained than the previous, and the changes made impact the outcome of the optimization, generally exacerbating any unbalance between the utilizations of capacity in the different regions across the globe. For these reasons, it has been developed and studied as a separate case from the others.

4.2 Results

After the optimization runs, we started to analyze the results to identify the key changes from the current network. First of all, the optimized network concentrates the distribution flows in fewer active lanes. This is due to the fact that the model analyzes the network organically, selecting the most cost effective sources between all the ones available, while a non-optimized network is the result of choices based on local strategies and pre-existing agreements. As a consequence, the resulting network is significantly less complex and presents a higher degree of site dedication, with fewer different plants satisfying the demand of any given market.

Figure 6a and 6b use randomized data to provide a realistic representation of the current and of the optimized network respectively, with arrows corresponding to each and every active shipment lane, regardless of the volumes shipped. Because the current state also includes a sizeable amount of ad-hoc, low-volume shipments, which the optimized solution by definition doesn't include, the network in figure 6a appears even more
intricate when compared to 6b. However, the visual difference still is representative of the impact that network optimization can have on McCain's distribution.

Figure 6a – Example of current network (random data)

Figure 6b – Example of optimized network (random data)
Apart from this very visible difference, there are other important points that emerge from the model. We relate here only the most general ones, in the interest of confidentiality.

- Some of the growing regions currently utilized as heavy exporters have changed, creating a change in the strategic importance of some plants. The optimization engine strives to select the most cost effective sources for each market. Following this logic some plants previously used prevalently for internal distribution are now used for export and vice-versa. This modifies well established network structures that find their reason for being in the way the company has grown and have not always been challenged in the past.

- The optimized network tends to concentrate production volumes in a few specific growing regions and plants instead of distributing them more uniformly as it currently is. As a consequence, the utilization of some plants is greatly reduced compared to current practice. In the effort to find the lowest total cost, the engine tends to particularly utilize the sites with the most favorable cost structures. These sites are likely to be the most cost effective to deliver to several markets, and for this reason are loaded with higher volumes. This logic is also applied to freight cost, which leads to a preference for sites that have a favorable geographical location. This produces a shift in what regions are more suitable to export from compared to what is currently assumed, which suggests changes in how some of the markets should be sourced.

A side effect of this consolidation is also an increase in the volumes exported from a region to another. While apparently counterintuitive, such increase is due to the fact that in some instances it might be worth to incur an increased cost of freight than producing locally at a higher production cost. In addition, the optimization considers shipping lanes that are not currently pursued due to the regional nature of the organization. Consequently, in some of the model iterations,
we found an overall increase in export volumes but at the same time a decrease in total shipping cost.

- The model seems to be partial to cut cost by closing less loaded facilities and consolidating regional capacity while only occasionally opening new capacity. Despite the high cost incurred in a closure, the indirect cost savings across 5 years can be very high and often offset the expenses. On the other hand, even if the marginal cost of opening a new facility or line is relatively low (expended each year), there are often numerous viable alternative sources of capacity that make this investment less likely to be chosen. This is in part due to the higher volumes of total processing capacity vis-à-vis the total demand. The notable exception would be the scenario in paragraph 4.1.4 in which demand is much higher and increasing capacity becomes a very impactful strategy.

It is also interesting to note that in some scenarios, the choices made only marginally improve the solution and the investment involved does not correspond to significant cost savings. This aspect, easily verifiable by simply blocking the corresponding scenario option and comparing the two optimized results, is linked to the solutions space considered by the optimization engine. The optimum solution can often be just the solution of minimum cost within a significantly large neighborhood of solutions all with similar total cost. Figure 7, in which the solutions space is represented by a curve, illustrates this point. This means that the choices made by the optimization can in some cases be preferable by negligible differences in cost savings and further analysis is necessary to determine how convenient it really is to pursue such changes in the real world. The next paragraph details the work we performed to identify and validate the most significant solutions.
4.3 Sensitivity analysis

The results of the optimization runs with the modeled scenarios show a network configuration that entails some important changes in the distribution strategy. To justify these changes and the effort needed to implement them, we performed sensitivity analysis by stretching some key parameters of the model and verifying the resilience of the solution to such changes.

The parameters to change were selected between the most likely to present real variation in the next few years and affect the results: exchange rates, demand volumes and cost of raw potato. In addition, we conducted tipping-point studies of the changes in the equilibrium between highly exporting regions. The model responds sufficiently well
to the changes, producing in general only slight variations in the solution. For instance, the investment to extend capacity in some plants may be delayed or accelerated, or the utilization of the plants can be slightly altered. Of course, the majority of those investments mentioned in the previous chapter that do not seem to produce significant savings, did not survive when subject to model changes. In conclusion, most responses to the questions asked in the scenarios and most interventions suggested by the solution are resilient and can be relied on to produce significant cost savings within reasonable parameter variations.

4.3.1 Exchange rates

In this analysis, we modified the exchange rates between USD and CAD within a -10% to +10% interval. Also, we tested the solution with a -40% points variation in the exchange rate between CNY and CAD. This was meant to verify if the proposed network configuration could be trusted to be relevant despite different positions of the currencies in comparison to the Canadian Dollar. The modified rates between USD and CAD come from an assumption compatible with the variation historically recorded, while the CNY variation is based on a scenario of sudden change in the value of the Chinese currency. The main difference between the two tests was that while the USD/CAD exchange rates affect most aspects of the model (USD is the currency of 6 plants and of all freight rates), the CNY/CAD rate has an effect on China specifically. For this reason, in the USD case we evaluated several rates in both directions and verified the resilience of several findings, while in the CNY case, just one variation allowed us to simply check the effects on local scenarios.

4.3.2 Demand

The purpose of this analysis was to verify if the network could be used to satisfy a higher or a lower market growth than it had been predicted. The base demand (flat in mature markets and slightly increasing in developing markets) was replaced by several other configurations. The first case was the one in which developing markets were growing more than expected, leading to a steep increase of demand volumes. In another
run, we combined this steep increase with a slight demand increase in the mature markets. Then we checked what could happen if all markets were to grow very steeply, maybe due to new global scale contracts. Finally, we tested a pessimist scenario, in which no growth in developing markets was combined with a slight decrease in mature markets. This scenario could materialize in the case of a generalized aversion of the public versus French fries.

All those demand configurations were particularly useful in the determination of when it would become critical to increase capacity or if the introduction of such additional capacity could be postponed to when the situation would become more clear. In none of these cases was the capacity currently available theoretically insufficient to meet demand, with the exception of the target growth demand scenario, as previously stated.

4.3.3 Cost of raw potatoes

With this analysis, we tested the solutions for resilience to significant variations to the cost of raw in specific regions. First, we changed the global raw cost growth, modifying the 5% yearly increase to 0% and 8%.

While this provided an idea of what a change in the relevance of raw cost in the cost structure might entail, it did not test the model for changes in the equilibriums between regions. For this reason, we modeled two additional cases, reproducing trends that can actually happen in the next few years. The first tone is a steep decrease in the cost of raw in North America in one of the next years, followed by a slow increase, which could make this region a critical capacity base for exports. The second one reproduces a cyclical steep increase of the cost of raw in Europe, which happens every 5 to 6 years. To the increase, generally follows a season of extremely low prices, due to a strong increment in the raw supplies generated as a reaction to the elevated market prices of the previous year. As one such instance has recently occurred, we modeled the increase to happen in 2015, and the price drops for 2016. In this case, we tested the ability of the
network to withstand a sudden and brief change without resorting significant modifications.

4.3.4 Tipping points

In this last analysis, we tried to identify the specific amount of parameter variation (tipping point) that would produce a radical change in the network balances. We performed two distinct studies, in both cases modifying the chosen parameter by consecutive intervals and measuring a specific variable at each step, until a certain state of said variable was reached.

In the first study we gradually modified the exchange rate between one of the currencies and CAD, until the demand of a given region was not satisfied anymore by the plant located in that region. The results obtained allowed to determine what monetary conditions would make the existence of that plant unnecessary.

The second study was performed uniquely in the target growth demand scenario. Here, we gradually increased the cost of raw potato for a series of plants, until the model stopped adding capacity to the region. Because in this scenario the model tends to add capacity to the most cost competitive facilities, we were able to verify what kind of cost disadvantage would make the region uncompetitive, diverting the sourcing of products to other plants.

4.4 Estimation of impact

After having identified a network configuration and verified that it can withstand significant variations in the conditions that we assumed for the model, we proceeded to measure the impact that such changes could produce in the distribution supply chain. The model presents a report including the total cost of the supply chain, but the difficulty is to determine what to compare these results with. We could be tempted to compare the cost, normalized per metric ton, from the base case (which represents historical data) with the
one from the optimized model, but since our model spans 5 years, with associated increments in freight, raw cost and demand, not to mention some capital investments, the two measures would not compare fairly.

To overcome this issue, we designed and created an "as is" model, which projects the historical network configuration (meaning constraining all lanes and volumes shipped through them) from the base case through five 1-year periods, with the associated cost and demand increments mentioned above. The 2011 network is adapted to each year with as little variations as possible, but some slight modifications, including the addition of some minor extra capacity, are necessary to make the model solve. The results can be said to provide a reasonable representation of what the next 5 years would look like if the network was kept in almost exactly the present conditions.

Using the results of this "as is" model, we can compare any network configuration coming from the model with a base line, thus determining the net impact from the implementation of the changes. The optimized network we obtained incorporating all scenarios, produces considerable yearly savings (2% to 6% per year), which are compatible with the targets pursued for the team's activity. Figure 8 summarizes some of the aspects of the model's projected impact, providing approximate percentage ranges.

<table>
<thead>
<tr>
<th>Notable results (and their meaning)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total network cost deviation from base case (significance of results): 2%</td>
</tr>
<tr>
<td>Projected data from the optimized model compared to current state:</td>
</tr>
<tr>
<td>- Total yearly network cost (decreased cost): -2% to -6%</td>
</tr>
<tr>
<td>- Number of active lanes (reduced network complexity) -60% to -70%</td>
</tr>
<tr>
<td>- Volumes exported outside producing region (consolidation of sources): +30% to +40%</td>
</tr>
<tr>
<td>- Portion of export volumes that changed region of origin* (shift of sources): 50% to 60%</td>
</tr>
</tbody>
</table>

* Calculated as volumes exported outside each region in the optimized model, net of the volumes in the same lanes in the current state

Figure 8 – Summary of results
4.5 Chapter summary

To generate a resilient optimized supply chain configuration that clarifies topics currently discussed and provides guidance for strategic planning, we evaluated several scenarios. The resulting network greatly rationalizes the distribution supply chain, and allows the identification of ways to positively impact the total cost. Through a sensitivity analysis and an estimation of savings, we confirmed that the proposed network is not only stable to variations in exchange rates, cost of raw and demand, but is also able to produce significant cost advantage on a global scale for the next 5 years.
Chapter 5: Follow up

This chapter relates the use of the results of the analysis for the creation and the implementation of the strategy. To preserve confidentiality, no details are provided as to the content of neither the recommendations nor the decisions, but some specific features of the decision making process are described. The chapter closes with some considerations about the future utilization of the model and the integration of analytical methods in the strategic supply chain planning of the company.

5.1 Recommendations

With the optimization, not only did the model answer the specific questions linked to each scenario (whether to expand capacity, open a new facility and so on), but also it computed the interrelations between all available choices, to produce the most cost effective network from a global perspective. Thus, some of the results of the analysis came as surprising to the team, and they were perceived as somewhat counterintuitive.

Clearly, the reason for some of these apparently odd results are due to the high aggregation of data and to the lean nature of the model’s structure. By design, some important business considerations that contribute to the creation of the strategic plan, could not find a place in the model. As a result, some of the choices presented in the solution have in reality some hidden costs, difficulties of implementation or they are even in contrast with the objectives of the organization. An example of this is the saturation of capacity in some growing regions, which would make the network very sensitive to the effect of cyclical crop failures.

But some other results, while apparently unorthodox, come from the fact that the optimization engine creates global optimums, and global optimums may require regional or local sub-optimization to capture opportunities in other geographical areas. For instance, if the model suggests satisfying demand in market A by importing from abroad instead of using local capacity, this would cause a performance decrease for the local
plant due to the increased cost of sourcing from another region (due to import duties and freight). However, from a global perspective, that local plant may represent the best option to supply market B, and using its capacity for that market would produce savings higher than the additional cost of importing to market A instead of sourcing locally.

To interpret the impact of both the limited nature of the model and the local-VS-global dichotomy, the team conducted a thorough evaluation of each recommendation and of the ancillary effects that they could have. Thus, each suggested point was assessed for consistency with other business and strategic logics, to make sure that there was no constraint to the feasibility during the implementation phase. Aspects such as the strategic need to be present in a given region, the presence in a given plant of additional lines producing other products than French fries, or the social responsibility towards the agricultural ecosystems connected to parts of the business were taken into consideration when analyzing the recommendations.

As far as understanding the reason that made the chosen solution more cost efficient than others, the team evaluated the active lanes in the network comparing them to the lanes that were not selected by the optimization, to identify the logic behind the choices. In addition to defining a robust rationale to corroborate the recommendations with, when proposing them to the steering team and the board, this discussion highlighted some important characteristics of the regions that had not been previously considered. For instance it was possible to identify the specific factors leading to the competitive advantage of a plant over others, in relation to a given market.

Upon several discussions and reviews, the team selected a set of recommendations that can be implemented and whose significance is well understood and justifiable. These recommendations allow to produce savings comparable to the ones coming from the optimized network initially proposed, which contained a few more interventions to the supply chain. This was proven by constraining the model to only consider the viable changes, and comparing the solution to the one previously found.
5.2 Strategic planning

The recommendations proposed represent the outcome of an analysis, which is mainly cost-based, although validated by the filter of complementary business considerations. But, even having solutions that are viable and can be reasonably expected to produce significant cost advantages, does not guarantee that they can immediately be implemented. Given the sizeable capital investments and the considerable changes entailed, it is necessary to prioritize the execution and to determine how supply chain improvements can be performed as part of the numerous initiatives that the company is planning for growth. Fortunately, the solution to the model provides clear indications as to when to implement each recommendation, which are invaluable guidelines in creating the plan.

Clearly, the modeling effort is one that will need to be repeated periodically and re-assessed against the evolution of the measured variables with respect to the predicted ones. As a consequence, some of the changes that the model suggests to perform in the later years can be reviewed in the future and re-evaluated. However, some interventions require considerable time before being approved and executed, which means that the work needs to start much earlier. It is here that having performed a sensitivity analysis becomes important, because it hedges the recommendations against some degree of change in the underlying conditions, making it safer to begin longer-term projects.

Finally, some other initiatives can be leveraged to facilitate the changes proposed by the model. For instance, a planned renovation investment can be the occasion for a capacity increase. While the creation of synergies between different plans can alter the timing of the recommended interventions, some cost advantages can generally be achieved by aggregating the resources with positive impact on the capital investment.

These discussions, happening within the project team but also with the steering team, lead to an implementation plan for each recommendation, to which resources are allocated for the execution.
5.3 Implementation

Because the model covers five years starting from the current fiscal year, and given the physiological planning and approval cycles delaying any project, the implementation for some of the recommendations needs to start very rapidly. Among these, the interventions requiring a change in the processes, such as the creation of a new distribution lane or a modification of the production planning for a plant, are relatively painless changes. Scheduling or attribution of customers is a continuous process, subject to changes by nature, and the recommended variations can be inserted in the existing update routines.

Quite different is the case of radical changes, especially when capital investment is involved, which require approval and discussion. In these cases, additional studies covering the financial and technological implications of the change need to be conducted, and several iterations in the decision-making process can delay the implementation. In this case, having very high-level decision makers in the team really proves to be critical, as they can access information much more rapidly and pre-approval becomes a significantly leaner process.

Another noteworthy characteristic of this kind of top-down, centralized decision making, is the importance of getting the local operations affected by the changes to buy in. The global optimum logic we mentioned in paragraph 5.1 is even more foreign to the regional parts of the organization, which are used to think exclusively in local terms. Many of the recommendations risk to be discordant from the strategic plans of the single plants, and even to represent a negative impact when measured against local incentives. As a consequence, there is an important aspect of marketing of the implementation, and together with the strategic changes has to come a paradigm shift, a realignment of incentives and an adaptation to a more centralized model of strategic planning.

Even after the end of the collaboration with MIT, the team continues to meet and to follow the execution of the plan, making of this global optimization approach to
distribution strategy an integrated part of the modus operandi of the supply chain function.

5.4 Future use of the model

The model has proven its ability to provide valuable insight into the company’s supply chain, and has allowed to highlight some important aspects of the operations that will be taken into account for future strategic planning. As these kind of analytical methods become more and more employed however, some thought has to be given to making the process of updating the model and running the analysis more efficient. Defining clear processes and appropriately coordinating resources around the different aspects of the analysis will undoubtedly lean-out the future modeling efforts and create the prerequisite for a sound, repeatable and fast response to the company’s strategic needs.

We propose here three opportunities to favor the integration of the model into the decision-making process. In particular, the first two can be used as a theme for future LGO projects.

5.4.1 Integration with ERP

As noted in paragraph 3.4, collecting demand data from the different regions required a time-consuming work of homogenization of the formats. Similarly, the cost data is aggregated and reported in the financial documents on a yearly basis, so potentially, also this important set of data may not be available in its latest version when needed.

McCain is currently going through the process of introducing a global ERP system throughout the organization. This means that information will be readily available through the software and will be updated regularly, thus eliminating the issues with the different formats and reducing the obsolescence of data.
Once the implementation is completed it will be possible to create connections between LogicNet Plus and the ERP, so that the model’s tables are populated via an automatic update from the system. The main advantage will be the possibility of running scenarios immediately when needed, without the lag due to the need of procuring differently presented information from various regions. In addition, an automatized system will reduce the risk of human error due to modification and transcription of the data into the model. As a result of the connection with the ERP, the model will be more readily available and more reliable.

5.4.2 Integration with regional models

This global supply chain optimization project does not represent for McCain the first encounter with network design and LogicNet Plus. The company has been conducting detailed studies on specific regions for the last couple of years. These models are much more complex, with a lower level of data aggregation (demand by final freight destination, products defined by SKUs etc.) and modeled warehouses. However, these models are only executing calculations over the period of a single year and employ actual historically recorded data instead of projections. Differently from the global model, aimed at defining a large-scale strategy, the regional models evaluate scenarios going into the details of the product mix and quantities being shipped by the specific lanes, focusing more on details of distribution and production planning than on capacity management.

While providing a more detailed view, the regional models are limited by their restricted scope: exports outside the region are assumed as constant and the impact of the changes only results in a local optimization. Also, the high number of data required makes these models difficult and lengthy to update. On the other hand, the global model lacks the level of detail that determines the choices on a tactical level.

A good way forward is to structure the evolution of the two approaches so that they can progressively converge to an integrated analytical solution. Initially, the output
of the global model can be used as an input for the regional ones. For instance, in a first moment, the exports determined by the strategic model can become demand points for the plants in the regional ones. Then, once the ERP integration will be made possible for the global model, as described in the previous paragraph, a transition of the regional models towards the same method of update can be gradually pursued. Once the update will be fast and manageable enough, the regional models can be combined using the structure of the global model, thus creating a comprehensive tool that can produce recommendations that are detailed, yet reflect a global perspective.

5.4.3 Creation of a supply chain analytics function

To the increase in model usage corresponds an increasing need for resources to conduct the scenario analysis, the updates and the integration with the ERP and with the other models. Presently, the available resources are represented by regional staff working mainly to the regional models. However, with the introduction of a global model, the application of analytics to the supply chain strategy is being configured more and more as a global topic. It is essential then to coordinate the modeling activity in a centralized manner, to avoid loosing the global perspective and to avoid generating a collection of disconnected local optimums.

To achieve this centralization, a supply chain analytics function can be created, charged with the modeling efforts and staffed with resources belonging to the Global Supply Chain function. This central location and reporting structure would enable direct participation to the strategic discussions with a role of technical expertise and advisory. The presence of a clearly defined function would prevent duplication of effort and would guarantee that the approach is impartial, comprehensive and not dictated by local incentives.

In conclusion, objectivity, visibility, global outlook and clarity of purpose are the main qualities that an analytical approach to supply chain strategy should demonstrate in
order to be effective. A centralized dedicated function would enable all these, making of network optimization an invaluable contribution to the creation of the company strategy.

5.5 Chapter summary

The results of the analysis, stemming from the optimization, have been assessed for feasibility and their implications have been examined and evaluated. After various discussions and considerations, a subset of results was taken as the recommendations from the analysis and a strategic plan was created for their implementation. As the recommendations are beginning to be put into practice, modeling is gaining more and more importance within the company’s approach to supply chain strategy. This adoption of analytical methods can be made even more valuable by leveraging systems that are being developed in parallel and by dedicating a global function specifically to them.
Conclusion

Based on the success in representing McCain’s actual distribution network with a good degree of accuracy, and based on the fast turnover time in defining and analyzing different scenarios, we can safely say that the model we created has been proven to produce relevant input for the definition of a strategic plan. Although in this thesis we do not provide details about the specific solution proposed to preserve confidentiality, the overall results and network structure that we described in the previous chapters are definitely obtainable in reality, upon execution of an appropriate plan.

In particular, the proposed recommendations are actively being discussed by McCain’s leadership, and implementation of some of them has already begun. This was made possible by the high degree of data aggregation and by the appropriate definition of a highly simplified modeled network structure. Moreover, the measured significant financial impact potentially obtainable by executing said plan, is indicative of the potential of using network design as a focal tool in high-level strategic decision-making.

Clearly, network design of this highly aggregated type needs to be integrated in the context of a broader strategic discussion at the leadership level of an organization, and combined with a deep understanding of the business and sound expert human knowledge of all the influencing factors. To enable this, it is therefore required for the study to be performed with the support and the active contribution of the levels of the organization at which important strategic decisions are taken.

It is also important to state that while this application to McCain Foods’ distribution network was successful, exporting the same methodology to another industry or business context requires the presence of specific pre-requirements. As previously stated, the cardinal point to the positive outcome in the use of network optimization in strategy is the ability to create a model that is simply structured and highly aggregated, yet representative of reality. This is clearly a delicate equilibrium, and it cannot be always easily obtained.
In the case of McCain, a similar cost structure and a comparable total cost of the products, has allowed for the aggregation of all SKUs into just two items. Moreover, the location of the whole processing value stream within a same plant, the negligibility of inbound logistics due to the location of plants in agricultural areas and the presence of on-site warehouses, reduce the problem to a pure distribution network that can be relatively harmlessly represented with direct plant-to-market lanes. In other words, the McCain Foods problem is particularly suited for a high degree of simplification.

In an industry characterized by high variation in the cost structure of different products and supported by a complex network of external and internal suppliers, it may not be possible to create a representative model without a degree of complexity which would make the analysis too lengthy to support the tight schedules of strategic decisional processes. In conclusion, the applicability of the results of this study to another context is contingent to the ability of such context to satisfy the requirements that will enable the model to have a simple structure and lean input data sets.
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