

**PROCUREMENT SUPPORT TOOL FOR A
BAR SOAP MANUFACTURING FACILITY IN
VENEZUELA**

by

MIGUEL ANGEL MARCANO DIAZ

B.S. Universidad Metropolitana (Caracas, Venezuela) 1994

M.B.A. Universidad Metropolitana (Caracas, Venezuela) 2000

A THESIS

Submitted in partial fulfillment of the requirements

for the degree

MASTER OF AGRIBUSINESS

Department of Agricultural Economics

College of Agriculture

KANSAS STATE UNIVERSITY

Manhattan, Kansas

2008

Approved by:
Major Professor
Arlo Biere

ABSTRACT

Laundry bar soap has been produced commercially in Venezuela for over a century and is one of the most important products for beauty and personal care throughout the Venezuela. More than 10 Venezuelan companies produce and sell it, but two companies hold almost 85 percent of the market share, with the Las Llaves brand, alone, holding nearly 70 percent. Management for Las Llaves is concerned about how to remain competitive not only with quality and acceptance of its product (effectiveness) but also with how to produce the soap efficiently (at the lowest possible cost) to remain competitive in today's global economic environment.

The objective of this thesis is to identify and analyze the sourcing costs of three raw ingredients used to produce laundry bar soap in the Las Llaves facility and to provide a model scenario to support the decision making analysis within the purchasing department.

TABLE OF CONTENTS

List of Figures.....	iv
List of Tables	v
Acknowledgments	vi
Chapter I: Introduction	1
1.1 Empresas Polar	1
1.2 History of Empresas Polar’s Laundry Bar Soap Production.....	1
1.3 Problem Statement	3
Chapter II: Venezuela Situation	7
2.1 Venezuela’s Political and Economic Environment	7
2.2 Exchange Rate Control.....	8
2.3 Fixed Retail Prices.....	12
2.4 International Competition (Mercosur)	14
Chapter III: Literature Review	18
Chapter IV: Problem Definition and Data Used	22
4.1 Technical Considerations	23
4.2 Freight Cost	24
4.3 Raw Materials.....	26
4.4 Storage Costs	28
4.5 Exogenous	29
Chapter V: Procurement Support Tool.....	30
5.1 Price Projections and Scenarios	30
5.2 Sales Estimates, Manufacturing Formulas and Sea Freight.....	38
5.3 Comparing Results	45
Chapter VI: Conclusions and Recommendations	51
References.....	54
Apendix – Historical Data	56

LIST OF FIGURES

Figure 1.1 Factory Aerial View..... 2

Figure 2.1 Commodity Prices – FOB US\$/MT 13

Figure 3.1 Crude Oil - June 08 Contract (US\$/MT) 20

Figure 4.1 System Overview 23

Figure 4.2 Baltic Exchange Dry Index vs Crude Oil in US\$/MT (Jan 04 – Jan 08)..... 25

Figure 5.1 Palm Fruit 31

Figure 5.2 Palm Oil Originated Products 32

Figure 5.3 Crude Palm Oil Index vs. Palm Oil Nearby Futures Index (Jan 2004 – Feb 2008) 33

Figure 5.4 Palm Kernel Oil Index vs. Palm Kernel Oil Nearby Futures Index (Jan 04 – Feb 08)..... 34

Figure 5.5 Palm Stearin Index vs. Tallow Index (Jan 2004 = 100)..... 35

Figure 5.6 Case No. 1..... 46

Figure 5.7 Case No. 2..... 47

LIST OF TABLES

Table 2.1 Argentina, Brazil and Venezuela Data Profile.....	16
Table 4.1 Sea Freight Cost Variation – Years 2000 to 2008.....	24
Table 4.2 Prices of Raw Materials	27
Table 4.3 Quantities Restriction Per Origin (Annual Supply in MT).....	27
Table 5.1 Palm Oil Products Prices Correlation	32
Table 5.2 Correlation of Palm Oil Prices & Palm Kernel Prices vs. Futures Market.	34
Table 5.3 Premiums / Discounts – June 2008	36
Table 5.4 Scenarios Detail – Change in Price over Next 12 Months	37
Table 5.5 Notations: Denomination of Prices.....	38
Table 5.6 Detail of Sales and Manufacturing Formulas	39
Table 5.7 Contract Freight Rates to Venezuela	40
Table 5.8 Detail of Tallow Procurement Strategy	48
Table 5.9 Detail of Stearin Procurement Strategy.....	49
Table 5.10 Detail of Kernel Procurement Strategy	50

ACKNOWLEDGMENTS

The author would like to thank all the members serving on my committee as well for Dr. Biere for providing the support when required. I also would like to thank Lynnette and Mary, for always helping when required and especially from the distance while I was living in Venezuela.

Also thanks to all my classmates and the members of MAB 2008, for providing a unique experience in this program. Lastly to my wife, Andreina, and my family for their support.

CHAPTER I: INTRODUCTION

1.1 Empresas Polar

Las Llaves laundry bar soap has been commercially produced in Venezuela for more than 100 years. The company started in the late 19th century with a candle and laundry bar soap factory that later led its founder to foresee other important business growth opportunities that also improved community welfare.

Today, Empresas Polar, with such well-known brands as Mavesa, Las Llaves, Pan, Pepsi and Gatorade, is the biggest privately owned food and beverage manufacturer in Venezuela. It has a direct workforce of 21,000 persons working in Venezuela and Colombia and an indirect workforce of 15,000. With annual sales of about \$2.5 billion, Empresas Polar accounts for 1.5 % of Venezuela's GDP and is second in size only to PDVSA, the state-owned petroleum company.

The future of the company is very good considering the opportunities for new markets in the region and also for new products the company will launch for Venezuelan consumers, but Venezuela's macroeconomic environment is challenging for it and other Venezuelan companies.

1.2 History of Empresas Polar's Laundry Bar Soap Production

Soap manufacturing in Venezuela was started in the late 1800 by a company called "Las Llaves." Although other brands were introduced, later, and have become well know, the best known is still Las Llaves, a blue bar soap¹. In Late 2001, Empresas Polar acquired the facility where Las Llaves soap had been manufactured for over 100 years. The Las Llaves

factory was built at the Port of Puerto Cabello in the central state of Carabobo. Las Llaves offered an excellent product for the Venezuelan market, and the factory was located ideally because the economy of the central region was booming. In addition, being located near the port, its location also provided easy access to international markets.

Although continuously making major technical and manufacturing improvements, Polar continued to operate at that original location until 1998. In 1998, the plant was moved to Valencia where it produces bar soap and powder detergents, and through a joint venture with another company, is commercializing liquid detergents. Figure 1.1 shows an aerial view of the factory.

Figure 1.1 Factory Aerial View



¹ Bar soap is used in Venezuela for both laundry and personal hygiene

This plant has capacity to produce 60,000 metric tons of soap and 45,000 metric tons of powdered detergent per year, employs 450 and has warehouse space to store 12,000 metric tons (MT) of raw materials and 4,000 MT of finished product. Even though this factory employs only 2.5 % of Polar's labor force, its production accounts for more than 8% of Polar's total annual sales. Because of the contribution of soap sales to the company's revenues and because the company's soap products have more than a 70% market share in Venezuela, it is important for Polar to seek to maintain and enhance its competitive advantage in the production, handling and marketing of soap.

1.3 Problem Statement

While Polar is aware of its leadership position in the soap market, increasing competition and government-fixed retail prices, including for bar soap, are pushing it to reduce costs wherever possible. The cost of raw materials and related, such as sea freight, formulation, import duties, packaging and holding inventory account for over 65 % of the total cost. This project will focus on providing a procurement-support tool to provide management better information to support its raw material procurement decisions such as where to originate raw materials, the choice of formulation to obtain the least cost, and to control the cost of holding inventory outside the factory, especially at companies that offer warehousing services.

The analysis of supply chain replenishment begins with the use of distribution resource planning (DRP) to forecast retail sales, retailer's orders by product, inventory levels and production schedules. This project will develop a tool to help in the sourcing of three primary raw materials that must be imported: beef tallow, palm stearin and palm kernel.

The model is supported in the analysis of inventory management with forecasts of projected prices, company desired product availability and safety inventory levels, and data on shipment quantities, storage capacity and other constraints to obtain a suggested procurement strategy based on the available information. A brief overview of the components of the procurement support tool is as follow:

- Estimate variations of prices of the three main raw materials as a function of the futures market, and provide a forecast of prices in a monthly basis.
- Provide an estimate of prices for those raw materials base on three different scenarios labeled: Optimistic Scenario, Pessimistic Scenario and Status Quo Scenario. These scenarios differ only in the forecasted purchase prices of the three primary raw materials where the future purchase price for each scenario is a different function of the current futures market price for the month of the anticipated purchase.
- Obtain the total requirement of raw materials based on the annual sales estimates and then, allocate the requirements over the next twelve months.
- Determine the metric tons of raw material required under each of three different manufacturing formulas. The amounts of the three major raw materials required — palm stearin, tallow and palm kernel—differ among the three manufacturing formulas.
- Create an inventory analysis of each raw material by considering the following:

- Initial and ending inventory
- Safety inventory level
- Storage capacity
- Procurement, where the tool will provide the amount in metric tons to originate from each possible origin for each month of the year according to the quantity restrictions in the model.
- Availability per year and month of raw material per country of origin.
- Maximum quantity allowed on a vessel per shipment.

The final and most important step is to obtain a month-by-month detail of cost for the laundry bar soap that will allow the user to make or change other decisions related to the manufacturing and procurement including sourcing location.

The procurement support tool will be interactive; the user will have access to different solutions that will be related to the different possible scenarios and manufacturing formulas. The user of the procurement support tool will be able to mix scenarios for the different variables according to one's opinion of the likely scenarios of prices. The procurement support tool will provide a least cost procurement strategy given the user's criteria and projected conditions and given the forecasting equations.

The intention is to provide an interactive learning tool, not a black box that will only generate a number. That will provide a learning tool for those engaged in the procurement process.

CHAPTER II: VENEZUELA SITUATION

2.1 Venezuela's Political and Economic Environment

With a campaign centered on promises of aiding the poor majority, Hugo Chávez was elected president of Venezuela in December 1998 and reelected two times since. His election has had a major impact on the business, economic and social environment of Venezuela. Never associated with the political parties that exchanged the presidency for the previous five decades, Chávez' economic changes have critically impacted the private sector, especially manufacturing. Two major economic changes affecting domestic manufacturing have been the institution of exchange rate and currency control and the institution of fixed prices for many consumer staples.

The unexpected growth in commodity prices, especially for energy, is a major concern around the world, but is most serious in Venezuela where over 60% of all the products and raw materials consumed by Venezuelans are imported. Companies are seeing the cost of raw materials, freight, energy and other manufacturing inputs increasing dramatically, with little prospect for a cost retrenchment.

This general inflation in international commodity prices has also influenced the macro-economy of Venezuela, but booming petroleum prices and increasing oil exports by state-owned PDVSA provides the government with revenues and which gives the government more options as to address inflation in the short run, especially for consumer staples. To address the inflationary pressures the government in 2003 imposed retail-sale price control for many consumer staples such as for food and household items including laundry soap. The ceiling price on no retail product was increased from 2003 until early 2007. The

government increased the ceiling (maximum) prices in 2007, but not enough to compensate for the increase in cost of the raw materials to produce those products. With those price controls, Venezuelan producers are experiencing tight or negative profit margins. Some have gone bankrupt because the higher costs for raw materials and freight could not be passed on to buyers (the consumers) in the form of higher product prices. Some say, “prices of raw material are taking the elevator while product prices (controlled by the government) are taking the stairs.” That situation cannot continue much longer, but in the meantime the only route to survival is to reduce cost where possible. One way to reduce cost might be to improve procurement efficiency.

2.2 Exchange Rate Control

The phrase “exchange rate control” is not part of most people’s vocabulary, except Latin America. Most Latin American countries have a history of imposing exchange rate controls from time to time, and dealing with exchange rate controls has been part of everyday life. The development of a global market economy over the past two decades has changed that. Only Venezuela has reverted to exchange rate control in this new global environment.

In the past 60 years, Venezuelan governments have put in place more than four different exchange rate regimes, counting the current regime. On January 23, 2003 the Ministry of Finance suspended foreign exchange trading, and on February 6, CADIVI was charged with handling foreign currency exchange with the rate pegged at 1,596 Bolivar to the US dollar. The rate was raised to 2,150 Bolivars to the US dollar in 2005. Along with exchange rate control, the Chavez government imposed currency controls to try to reduce

the outflow of Bolivars. (Venezuelans desiring to protect their savings against inflation and devaluation and from the economic impacts of the political instability would like to exchange their Bolivars for another more stable currency, thus the need for currency controls.)

In today's global economy such controls on exchange rates and currency conversions are uncommon because of the negative impact those controls have on the local economy; they restrict market behavior that keeps companies competitive in both domestic and foreign markets. Reed wrote that a fixed exchange-rate could lead to several problems. First, a fixed exchange rate usually leads to an overvalued local currency, which affects the competitiveness of domestic manufacturers, whether they sell locally or export. The theory of purchasing-power parity argues that the market-based exchange-rate between two countries should move to that which equalizes the cost of an identical basket of goods and services in the two countries. If one uses a simple index called the Big Mac Index, the exchange rate would need to be 3,950 Bolivars per US dollar for the cost of a Big Mac to be the same in both countries. But, the official exchange rate is 2,150 Bolivars per US dollar and the recent black market rate had been as high at 4,850 Bolivars per dollar. An over-valued Bolivar benefits Venezuelan importer and harms domestic producers and exporters.

In order to control the flight of currency out of the country, Venezuela has resorted to currency controls. Consider a firm needing to purchase and import goods and services or raw materials from a foreign seller. That buyer must obtain foreign currency in order to make the purchase. Because only CADIVI, a government agency, is allowed to change

bolivars into another currency the importer must go to CADIVI to get the foreign currency to pay for the imports. Now, one of the reasons for CADIVI to exist is to slow the outflow of funds from the country. One way to slow the outflow of funds, CADIVI can take a long time to make the conversion. Furthermore, all foreign currencies obtained from exporting from Venezuela must be reimbursed to CADIVI for exchange at the official (fixed) rate.

Second problem according to Reed, is the cost of using international reserves to keep the rate fixed. If the currency is overvalued for a long period of time, there is excess demand for foreign currency. However, Venezuela is a special case, which will allow it to continue to overvalue the Bolivar longer than in most instances. The Venezuelan government is the owner of one of the biggest state-owned petroleum companies in the world. As that company exports oil overseas, the company earns for the government foreign currency that allows the government to keep the exchange rate overvalued, especially with today's high petroleum prices. However, this ability to keep the rate fixed is at the expense of the lost competitiveness for private Venezuelan companies who employ residents of Venezuela.

The third problem according to Reed is the necessity of devaluation after a long period of exchange rate control could lead to hyper-inflation or at the minimum intense pressure on the price of goods highly correlated to the value of the foreign currency. The longer the exchange rate is fixed the more it grows out of line with the market determined rate. When the controls are removed, the rate will go to the market rate, which means an immediate devaluing of the currency. That creates huge inflationary pressures in the local economy.

This situation also creates substantial risk for local manufacturers. A local manufacturer may have used imported materials to make the goods that it sold on the Venezuelan market or exported. With the slow process of obtaining foreign currency from CADIVI, it is likely that the bill for the imported materials has not been paid at the time the manufacturer sold its goods. Now, should the currency be devalued, the local cost to the manufacturer for the unpaid invoice has just gone up to reflect the decline in the value of the currency after deregulation. When the government devalues the Bolivar, the difference in the local value of the invoice before and after devaluation will be an immediate loss to the domestic companies with outstanding invoices. There is no local instrument to hedge against such a possible devaluation. In addition, the government prohibits the use of alternative routes to access foreign currency; domestic companies and individuals are permitted to use only the local currency or government issued foreign currency.

Having no other source of currency other than from CADVI creates problems beyond that of the inflated Bolivar. To reduce the outflow of Bolivars, the government has reduced the number of currency exchange applications approved and delaying the exchange process. Even when company applications are accepted, the lag between the application and receiving the foreign currency has increased from an average of 30 days when the exchange rate control was started to a range of 210 to 370 days, now. While an importer may be required to pay the invoice within 30 days after the shipment, the seller may have no choice but to wait up to 370 days to receive payment because of the delay of CADIVI in getting the foreign currency to the manufacturer who purchased the materials. That situation is increasing the financial cost for importers and reducing importer's credit lines

with foreign suppliers as few such suppliers are willing to wait that long for payment. Furthermore, foreign suppliers have less and less confidence that they will even receive payment because of Venezuela's unstable financial and political situation.

While Venezuelan companies have difficulty keeping raw material inventories at the level needed for efficient operation, more and more companies have concluded that the cost of stopping production may be less than the cost of holding such inventories, given the high interest rates banks and suppliers charge to finance their raw material purchases.

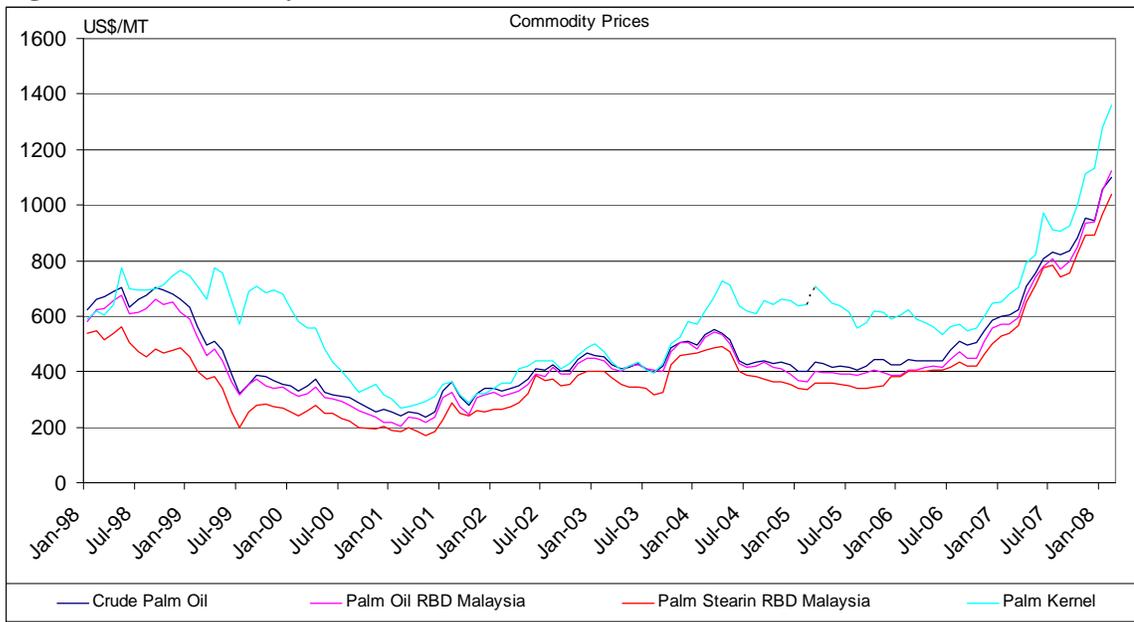
Finally, domestic manufacturers are finding it harder every day to compete with imports. For example, today's bar soap manufacturers must compete against Colombian and Ecuadorian imports. Those soap producers who can export duty-free to Venezuela under the terms of the Andean Pact Trade Agreement, and they are more efficient because they operate in freer, more market-based economies and can more readily adjust to changing conditions.

2.3 Fixed Retail Prices

In 2003, the Venezuelan Food Ministry published the "Maximum Retail Prices List," designed to stop the inflation in the price of consumer staples. When published, some of the maximum retail prices were set below 2003 prices. An example is corn meal, a dietary staple in Venezuela. The maximum retail price for corn meal was set at 1,850 Bolivars per kilo, while the market price (in stores) was already 2,450 Bolivars per kilo. That was an immediate net loss to manufacturers and retailers of 600 Bolivars per kilo.

Figure 2.1 shows, graphically, the history of prices of five major fats and oil products, three of which are key raw materials in the manufacture of bar soap. Prices of the three main raw materials used in the manufacture of bar soap have increased over 80 % in the last ten years. Yet, because of price controls the companies have not been able to increase their retail price. This is a major problem not only for Polar, but also for any other bar-soap company in Venezuela.

Figure 2.1 Commodity Prices – FOB US\$/MT



The private sector has tried to educate government officials of the importance of having retail prices that not only cushion consumers against inflation and lower wages in the country, but also allows the producers to make a profit or at least not incur a loss, but those attempts have failed change government policy. Because companies have no incentive to produce at a loss, consumer staples, nationwide, are becoming scarce.

Polar, the client for the product of this project, has not considered closing its operations, rather its intent is to continue to grow and expand. For the project here, the intent is to provide management with a procurement support tool that will enable the company to evaluate procurement alternatives in order to reduce the cost-price pressure of fixed retail prices and the exchange rate control difficulties.

2.4 International Competition (Mercosur)

The Andean Pact is a free trade zone agreement among Venezuela, Ecuador, Colombia and Bolivia. It is second only to Mercosur in size in South America. Because of the economic situation in Venezuela, more is imported to Venezuela than is exported from Venezuela. Thirty-five percent of all Colombians exports, 26% of Ecuadorian exports and about 30% of Bolivian exports go into the Venezuelan market. On the other hand, Venezuela's export business with Ecuador, Colombia and Bolivia accounts for only 2% to 5% of total Venezuelan exports, including petroleum.²

In addition, each member of the Andean Pact has its own trade and duty agreements with other countries around the world that provide reduce trade barriers that make it easier and cheaper to import raw materials from those countries. This is especially true for Colombia and Ecuador, whose governments have signed trade agreements and are in the process of reaching bilateral agreements with other trading zones such as NAFTA, the European Union and certain countries in the Asia-Pacific region.

Bar soap producers in Colombia and Ecuador have two sources of competitive advantage over the producers in Venezuela. In the first place, they buy all their raw materials within

their countries at competitive cost and payments terms. When necessary, they import from other markets at better prices and terms of payments than Venezuelan producers can obtain because they do not face the Venezuelan problems of exchange rate, currency and political control. Second, by taking advantage of the free-trade zone of the Andean Pact, they can export their soap products at very competitive prices Venezuelan retailers using distribution agreements. That enables these foreign producers to compete favorably with Polar on price and quality at the wholesale and retail level.

Additionally, Venezuela is in the process of becoming a member of the Mercosur. As a member of Mercosur, Venezuela would have better terms to export products, especially petroleum and natural gas to the other Mercosur countries, and the Mercosur partners would have better terms to import into Venezuela. That increase local competition for Venezuelan firms in agriculture and manufacturing. The greatest competition will come from the two largest Mercosur economies: Argentina and Brazil. Both Brazil and Argentina have strong agricultural businesses, and their manufacturers have the competitive advantage of operating in more open economies where they face true market forces and are freer to adjust to changing economic conditions. That makes those companies strong competitors to Venezuelan manufacturers. The next table provides data that illustrates the challenge for Venezuela and its private companies when it joins Mercosur.

² Data provided by <http://www.comunidadandina.org>

Table 2.1 Argentina, Brazil and Venezuela Data Profile

Year 2006	Argentina	Brazil	Venezuela
GNI, Atlas Method (Current US\$ - billion)	201.4	892.8	164
GNI/person	5,168	4,780	6,067
GDP (Current US\$ - billion)	214.1	1,100	144.8
GDP/person	5,494	5,890	5,357
Population	38,970,611	186,770,562	27,030,656
Agriculture Value Added (% GDP)	9%	5%	3%

Source: World Bank

Per capita GDP is similar across the three countries, but both Brazil and Argentina have much larger economies, which creates economies of scale. Furthermore, both have stronger agricultural sectors, agriculture accounts for 9 percent of the total GDP in Brazil and 5 percent in Argentina compared to only 3 percent in Venezuela.

The Venezuelan government is seeking admission to Mercosur because it would open new markets for Venezuela's oil exports. By joining Mercosur it expects to increase its petroleum exports to Brazil and Argentina as its exports would no longer be subject to the tariff and import barriers in Brazil and Argentina. On the other hand, joining Mercosur will increase competitive pressures for Venezuela's private sector, including for bar soap manufacturers. Considering that Argentina and Brazil have access to local raw materials that can provide them with lower costs of production than Venezuela's manufacturers, the agreement can be expected to increase local competitive pressures. The future for the local

manufacturers like Polar is unknown, but the company must anticipate the changing situation.

CHAPTER III: LITERATURE REVIEW

The future structure of supply chains is uncertain in many countries around the world. Falling trade barriers and lower cost transportation alternatives have reduced distribution costs and increased the geographic size of trade areas, and further application of the Internet and technology are pushing companies to become more global³.

Companies continually redesign manufacturing processes and distribution to improve competitiveness. The relocation of manufacturing facilities around the world by companies such as Procter & Gamble, Unilever and Cargill is an example of how important it is to succeed first in the supply chain operations in order to succeed in the business world. Competition from China is just one example of the increasing necessity to reduce the cost of manufacturing to increase profitability.

Another important revolution is taking place is in procurement. More and more companies realize that the purchasing function must be viewed not as a mechanical function, but must be performed at a strategic level considering the impact it has on corporate profitability (Raper / Jones / Whipple – 2004). Companies in the agricultural sector such as Bunge, Cargill and ADM understand how important purchasing is for their operations and for continuity of their business, especially where margins are thin. Any inappropriate procurement decision can destroy a major advantage in another area of the supply chain. Companies that are highly dependent on agricultural commodities also understand the importance of a proper procurement strategy considering the variability of prices, especially in those products traded at different commodity exchanges around the world.

³ David L. Levy , International Sourcing and Supply Chain Stability

The increasing use of risk management tools to protect cost competitiveness is another aspect of changing procurement process.

The work reported here provides a support tool for use within the purchasing department. Because of Polar's emphasis on efficient procurement, the company is open to new procurement tools tailored to its needs.

The development of new technological alternatives using the Internet and other customized corporate tools helps business managers understand the scenarios facing them when making decisions. In procurement, such tools can help management to make better purchasing decisions. Online reverse auctions, internet catalogs, interconnected suppliers and consumers are examples of how more and better information can improve procurement.

Another important dimension of the supply chain is transportation. Physical distance between countries remains unchanged, but increasingly companies are finding ways to reduce those apparent distances with more efficient and reliable transportation systems that reduce cost and travel time. The recent surge in petroleum and other energy prices, which has increased transportation costs, has increased the importance of reconsidering transportation decisions within the procurement process. (Figure 3.1)

Figure 3.1 Crude Oil - June 08 Contract (US\$/MT)



Source: NYMEX

The increasing demand for fuel efficient transportation is another important development. Companies focus not only on electric or wind supported transportation systems, but also developing vegetable oil sources to increase mileage per gallon, while at the same time systems friendlier to the environment. In a very real way, transport services hold global production networks together⁴. In this sense, the support tool must consider two alternatives for ocean freight transportation of raw materials: freight contracts and the spot freight market

Distribution resource planning (DRP)—a valuable tool for tracking sales, inventories and replenishment throughout the supply chain—is the foundation today for effective and efficient procurement. The key variables in a DRP model are as follows:

- On-hand inventory at the end of a period

⁴ Capineri, Cristina & Leinbach, Thomas, Freight Transport, Seamlessness and Competitive Advantage in the Global Economy

- Backordered demand at the end of a period
- Required quantity of product at the beginning of a period
- Constrained product availability at the beginning of a period
- Recommended order quantity at the beginning of a period

At the same time DRP requires information such as:

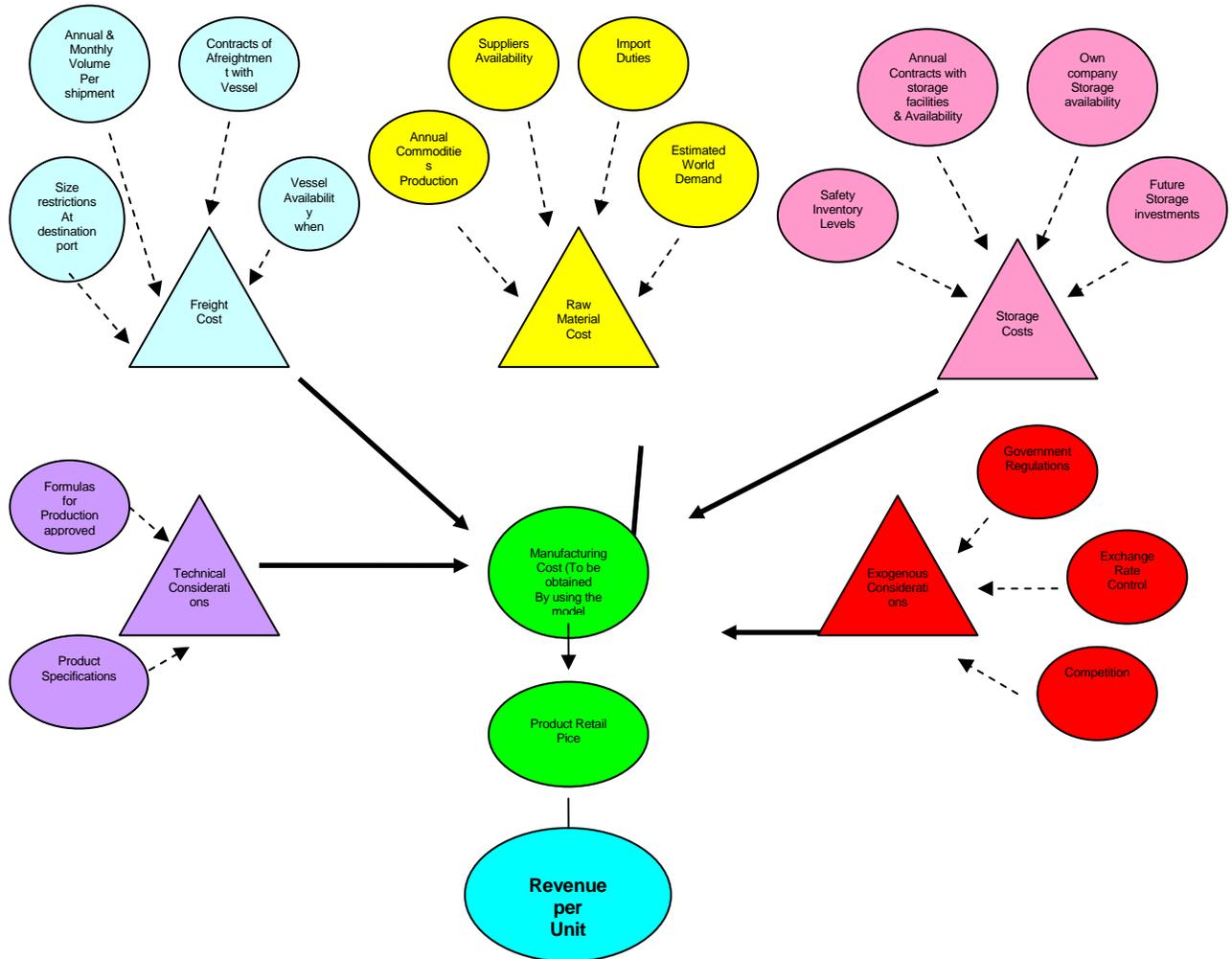
- Safety stock requirements
- Demand in future periods
- On-hand inventory at the beginning of a period
- Schedule receipts at the beginning of a period

SAP (System Applications and Products), Oracle and others understand the importance of DRP and offer software to implement DRP. Such companies have different options available that can be customized to any customer according to the type of activity a company handles, but mainly they focus on matching manufacturing requirements to customer demands. The procurement support tool developed here will expand DRP to include sourcing of raw materials. The person in charge of procuring the raw materials will be able to support his/her decisions considering production, quality, freight cost, inventory levels and other variables necessary to make the right decision.

CHAPTER IV: PROBLEM DEFINITION AND DATA USED

The objective of this project is to build a procurement support tool for sourcing raw materials to manufacture bar soap. The decision period is for 12 months into the future. Many steps are involved in procurement, but the project here will focus only on the strategic of raw material prices and availability, ocean freight rates, technical considerations and storage cost. The diagram in figure 4.1 provides an overview of the variables involved in the manufacture of bar soap:

Figure 4.1 System Overview



The diagram illustrates the five main aspects of manufacturing and marketing soap. Those aspects impact the cost and revenue of manufacturing and marketing bar soap. The variables with each aspect are explained below.

4.1 Technical Considerations

The objective is to originate at least total cost the raw materials that comply with the quality standards required for quality bar soap that satisfies one of the formulas that

conforms to the quality required by the consumer⁵. In this project, the procurement support tool will consider only suppliers certified by the company. That is to reduce the risk of procuring defective, damaged or late delivery of product.

4.2 Freight Cost

Because the cost of freight to transport supplies is part of total procurement cost and the raw materials imported will arrive by ocean freight, the impact of the ocean freight cost on procurement cost is an important consideration. In the last eight years, the cost of ocean freight has increased dramatically as can be seen in Table 4.1.

Table 4.1 Sea Freight Cost Variation – Years 2000 to 2008

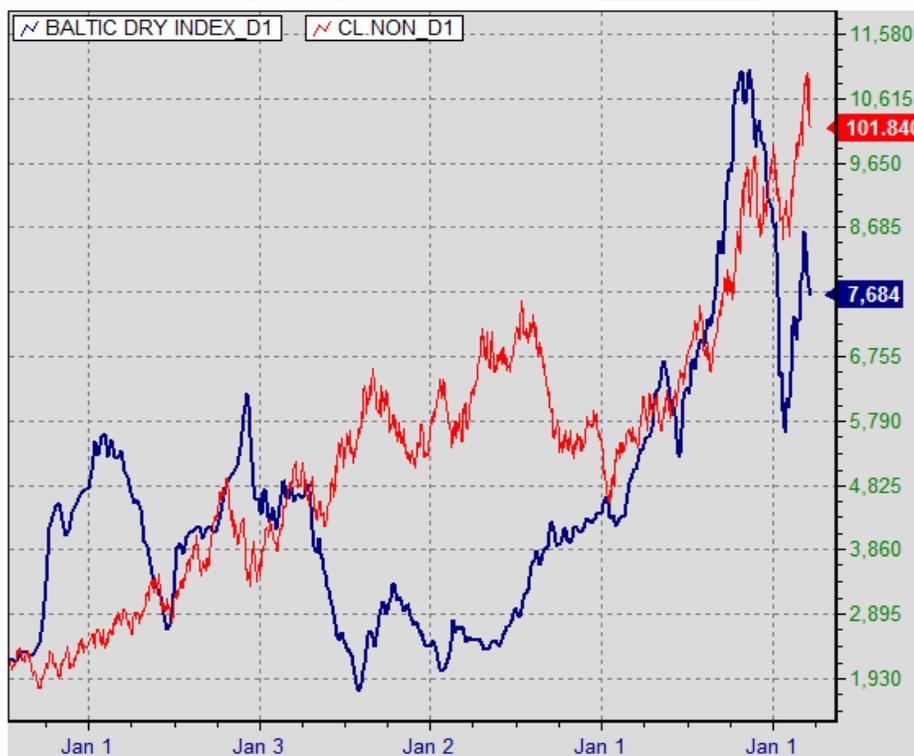
US\$/MT	Origin	Average Year 2000	Quotes for January 2008	Variation
Tallow	East Coast	33	65	+ 96.9 %
Tallow	US Gulf	30	50	+ 66.6 %
Palm Stearine	Malaysia	75	150	+ 200 %
Palm Stearine	Ecuador	40	75	+ 87.5 %
Palm Kernel	Malaysia	75	150	+ 200 %
Palm Kernel	Ecuador	45	75	+ 66.6 %

The rise in ocean freight rates can be attributed to two major factors: the rapid rise in the cost of energy to fuel the cargo ships (primarily diesel) and the rapid increase in the demand for transportation service from countries in Asia, especially China. China's exports have skyrocketed over the past decade or so. The Baltic Dry Index, Baltic

⁵ The factory can manufacture the soap bar with over 35 different approved formulas.

Exchange in London, is the key index for determining freight rates. It reports dry rates for various vessel sizes: Supramax⁶, Panamax⁷ and Capesize⁸ dry bulk carriers. These cargo ships carry a range of commodities, such as coal, iron and grain. The graph in Figure 4.2 traces the Baltic Exchange Dry Index and Crude Oil price for the past five years. One can see that the Baltic Dry Index increased 268 % from early 2004 to 2008.

Figure 4.2 Baltic Exchange Dry Index vs Crude Oil in US\$/MT (Jan 04 – Jan 08)
Baltic Exchange Dry Index (BDI) & Crude Oil (red)



Source: Investment Tools.com

⁶ Also known as Handymax, is a term for a bulk carrier for vessels between 35,000 and 60,000 metric tons of deadweight.

⁷ A category of vessel that is considered maximum to fit through the Panama Canal (110 feet Wide/1,050 feet Long and 85 feet deep)

⁸ Vessels bigger than Panamax with an average 150,000 long tons of deadweight.

A freight contract provides a shipper with a settled price or rate for a period of time (in this case for one full year). At the same time, the contract provides more certainty of having a vessel when required for any shipment of raw material. Another important variable in the ocean freight market is the availability of space through the entire year. Vessels in the world are not like taxis on Fifth Avenue in New York; they are scattered across the oceans and in different regions during different times of the year, and especially throughout different crop seasons. In the case of bulk cargo, it is important to have the space always available when needed. Many service providers are not willing to offer a contract rate for shipment to Venezuela because of the delay of getting paid due to the delay at the CADIVI office. The other option for ocean freight is the use of the spot market. Here a shipper may be able to catch a possible decrease in market freight rates. On the other hand, it is just as likely that the rates might increase. The other important consideration is that if no vessel is available when needed, the procuring company may face shutting down manufacturing because a shortage of an input. Some companies in Venezuela prefer to work with the ocean freight spot market because their small annual volumes do not allow them to negotiate better rates with long-term contracts. This is not true for Polar. Considering the annual sales volume of bar soap, the total amount of raw material required would be of interest to most major vessel owners. Polar's expectation for the coming years is to increase its market share in the bar soap Venezuelan bar soap industry, and that will increase its raw material requirements.

4.3 Raw Materials

The three main raw materials are palm stearin, beef tallow and palm kernel. The inventory of each is monitored, monthly. The cost of those three items constitute up to 80% of the

total cost of raw materials used to make bar soap. In the last eight years, prices of these commodities have increased considerably (Table 4.2):

Table 4.2 Prices of Raw Materials

US\$/MT	Origin	January 1999	January 2008	Variation
Palm Stearine	Malaysia	451	988	+ 119 %
Tallow	USA	421	852	+ 102 %
Palm Kernel	Malaysia	744	1,277	+ 71.6 %

Source: Oil World Annual 2007

The monitoring of the raw material will also include observing the restrictions of quantity availability from the different possible origins. Many suppliers have limitations on the amount they can supply due to their own raw material suppliers, processing capabilities or simply because of commitments to other customers. Those restrictions for this project are shown in Table 4.3.

Table 4.3 Quantities Restriction Per Origin (Annual Supply in MT)

	US Gulf	US East Coast	Malaysia	Colombia	Ecuador
Palm Stearin	N/A	N/A	50,000	N/A	9,000
Palm Kernel	N/A	N/A	25,000	6,000	6,000
Beef Tallow	25,000	15,000	N/A	N/A	N/A

The company is able to originate its requirements by sourcing from the different locations while staying within the above quantity restrictions. How the company decides from where to buy and how many metric tons to buy is part of the output of the procurement support tool.

It is important to mention that palm stearin importation from Colombia is limited by the Venezuelan government. The government of Venezuela requires licenses to import palm stearin from Colombia, and the government has issued no such licenses for the past two years. Another important consideration is the influence of the tariff duty on the final cost of the raw materials as the tariff rate is not the same for all origins. As a member of the Andean Pact, Venezuela has no duty on palm stearin from Columbia or Ecuador. Because Venezuela will not issue licenses to import from Columbia, only Ecuadorian palm stearin enters duty free. While Malaysia is the largest stearin producer, Ecuadorian stearin has two advantages over Malaysian stearin: a closer proximity and no tariff when entering Venezuela.

4.4 Storage Costs

Polar has a limited storage capacity at the factory. The average quantity of raw material demanded per year is above the storage capacity available at the plant. The main concern is to reduce annual expenditures for offsite storage cost. The company decided not to invest in additional storage capacity due to the risk of the government expropriating storage facilities throughout the entire country, not just bulk storage but also container storage. The storage availability must also comply with safety inventory levels needed to continue

Polar's operation. Finally, it is important to recognize the impact on storage costs on restrictions of minimum or maximum shipments.

4.5 Exogenous

Other variables also influence business decisions. Even though it is not the objective of this project to analyze the impact of such variables, issues such as government actions and regulations, economic competition and exchange rate controls affect the procurement strategy, too.

Venezuela is a special case in government regulation. The government exerts heavy economic control that can be expected to continue so long as the current president is in power. For Polar and its soap business to survive Polar must pay close attention to the political climate and the regulations governing procurement. Whether explicit in the procurement tool or not, decision makers need to be aware of all five categories of considerations.

CHAPTER V: PROCUREMENT SUPPORT TOOL

The development of the procurement support decision tool consists of five steps as follows:

- 1) Determining projected prices and alternative scenarios to put in the model for raw material procurement
- 2) Obtaining sales estimates for the next 12 months, obtaining sea freight rates and selecting manufacturing formulas.
- 3) Model specification: objective function and restrictions in the model to be run using solver
- 4) Obtain model results
- 5) Perform sensitivity analysis

5.1 Price Projections and Scenarios

This initial step is to project the future prices for the three main raw materials: tallow, palm stearin and palm kernel. The data used for the support tool, are monthly data from January 2004 to February 2008⁹ for crude palm oil, refined bleached deodorized palm oil, refined bleached deodorized palm stearin, tallow, palm kernel oil and also the future price for the nearby contract for palm oil and palm kernel oil traded at the Kuala Lumpur commodity exchange. The raw material prices were obtained from the “Annual World” publication as well for data obtained from the Malaysian palm oil board.

⁹ The support tool considers only 2004 to 2008 due to restriction for futures contracts at the Kuala Lumpur Commodity Exchange historical data.

Figure 5.1 shows two pictures. The one to the right shows a fresh palm fruit bunch, and the one to the left shows a palm fruit kernel (the white circle). Crude palm oil is obtained from processing the palm fruit. The crude palm oil can be fractionated into palm olein (the liquid fraction) and palm stearin (the solid fraction). Palm kernel oil is obtained from the outside of the kernel. Likewise, palm kernel oil can be fractionated into Palm kernel olein and palm kernel stearin.

Figure 5.1 Palm Fruit

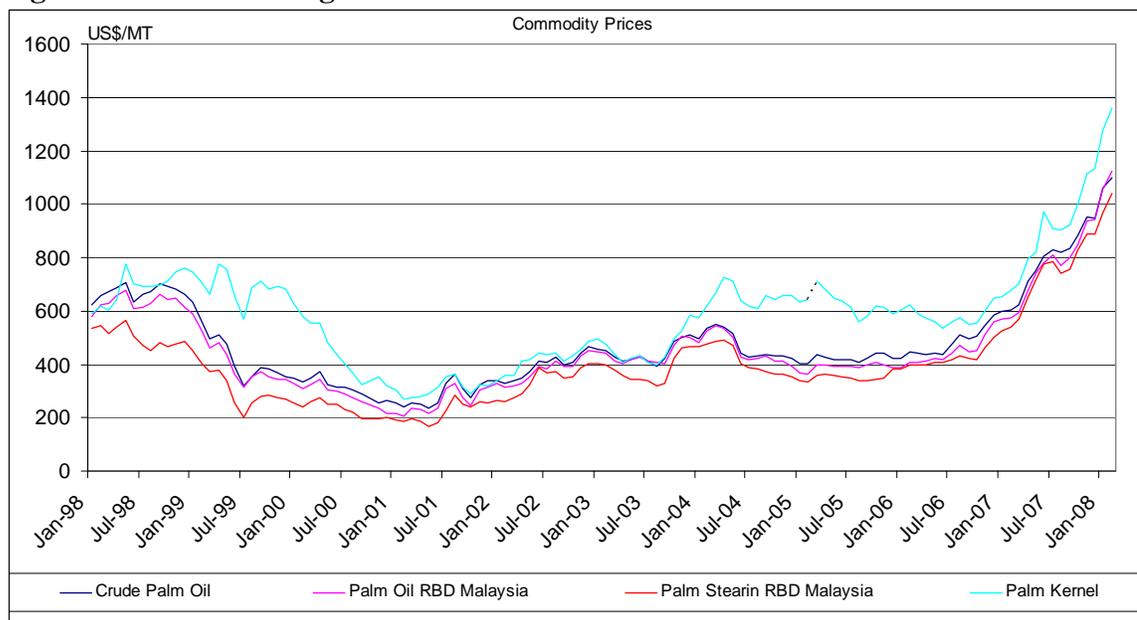


The graphs of the prices for palm stearin, crude palm oil, rbd¹⁰ palm oil and other palm oil originated products like palm olein and pure palm fatty acid are shown in figure 5.2.

Observe that the prices of products obtained from fractionating crude palm oil, such as palm stearin and rbd palm oil, move with the price of crude palm oil. Palm kernel prices do not move as closely with those other price series. Table 5.1 is the correlation matrix for those same price series over the same ten-year period.

¹⁰ RBD – Refined Bleached and Deodorized

Figure 5.2 Palm Oil Originated Products



The price of both rbd palm oil and rbd palm stearin are highly correlated with the price of crude palm. So is price of palm kernel, but not as strongly. Malaysian prices—at Kuala Lumpur Commodity Exchange (Bursa Malaysia) — established the world price for crude palm oil and crude palm kernel. Because the futures market price for a given delivery month, is as good as any price forecast for the cash price for the same in that same month,

Table 5.1 Palm Oil Products Prices Correlation

	Crude Palm Oil	RBD Palm Oil	RBD Palm Stearin	Palm Kernel
Crude Palm Oil	1			
RBD Palm Oil	0.997	1		
RBD Palm Stearin	0.971	0.977	1	
Palm Kernel	0.873	0.873	0.852	1

the Malaysian futures market prices will be used as the best estimates of the prices of the raw products to be procured over the next 12 months. The graph shown in Figure 5.3

provides a history from January 2004 to February 2008 of the prices, FOB Malaysia, for crude palm oil the nearby contract price, considering January 2004 as the base month (Jan 2004 = 100). Figure 5.4 shows the same for palm kernel prices.

Figure 5.3 Crude Palm Oil Index vs. Palm Oil Nearby Futures Index (Jan 2004 – Feb 2008)

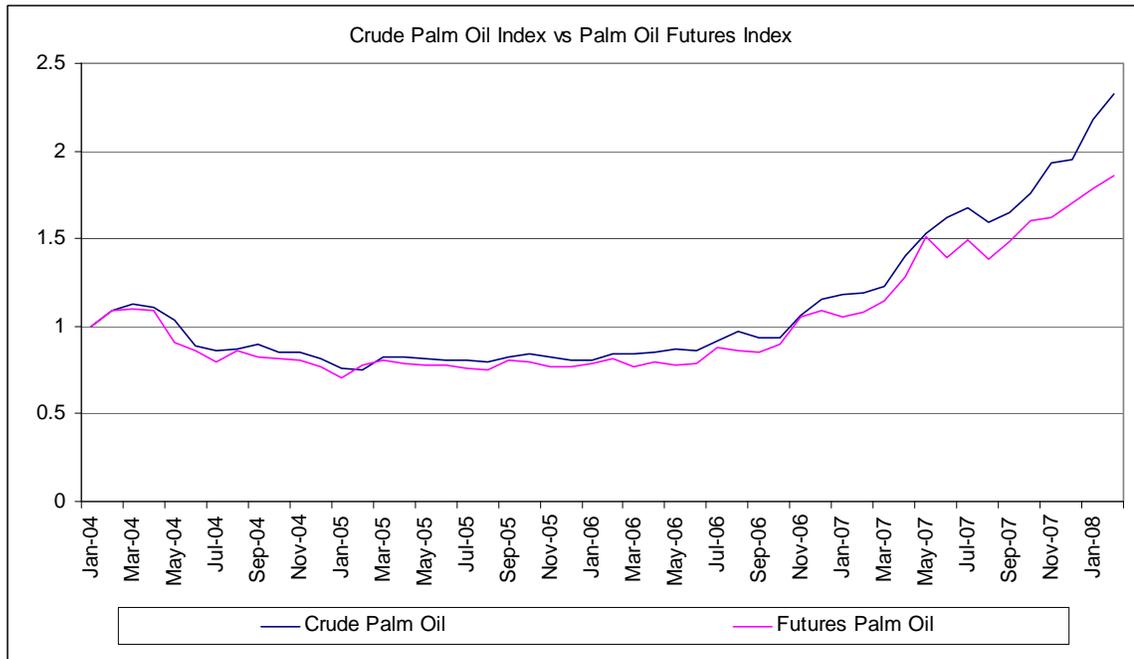


Figure 5.4 Palm Kernel Oil Index vs. Palm Kernel Oil Nearby Futures Index (Jan 04 – Feb 08)

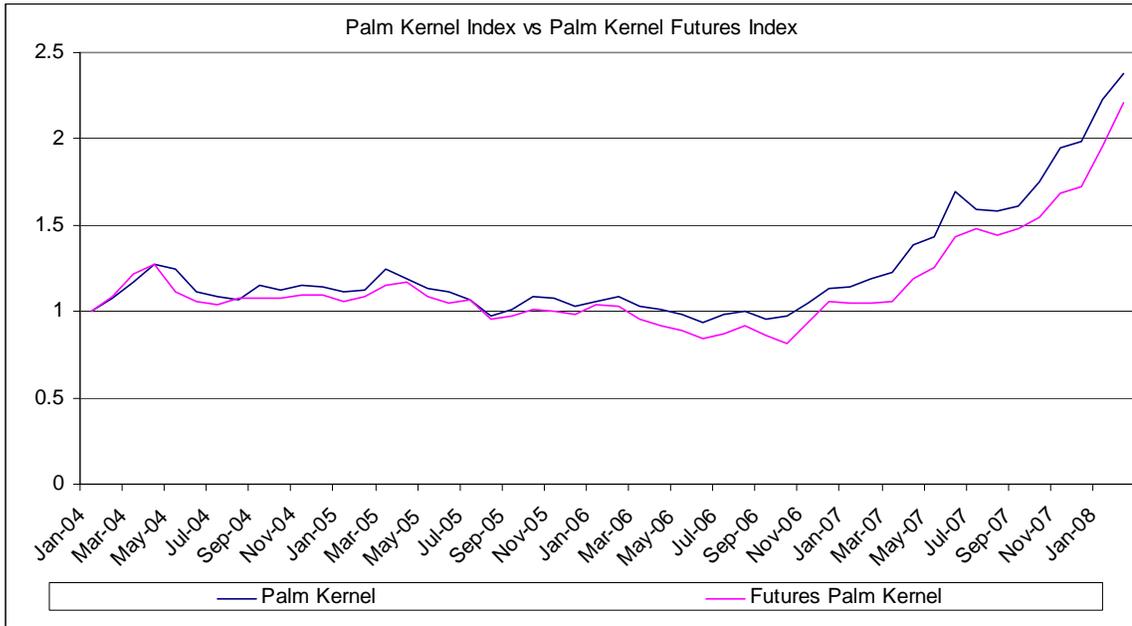


Table 5.2 Correlation of Palm Oil Prices & Palm Kernel Prices vs. Futures Market

	Crude Palm Oil	Futures Palm Oil	Crude Palm Kernel	Futures Palm Kernel
Crude Palm Oil	1			
Futures Palm Oil	0.987	1		
Crude Palm Kernel	0.939	0.916	1	
Futures Palm Kernel	0.895	0.880	0.983	1

Considering the previous graphs and correlation Table 5.2, monthly crude palm oil nearby futures prices tracked the monthly price of crude palm oil well over the last four years, ($r = .987$). Likewise, nearby palm kernel futures prices were highly correlated with crude palm kernel prices ($r = .983$). The futures price of palm kernel will also be used to forecast the price of palm stearin and palm kernel. Palm stearin trades on the cash market at a

discount compared to the palm oil futures price, while palm kernel trades at a premium.

Palm stearin and tallow are considered close, but not perfect, substitutes. Even though the two products originate from different sources, their prices are highly correlated ($r = .971$) as can be seen in Figure 5.5.

The price of tallow and palm stearin moved together fairly closely from January 2004 through January 2008. Tallow traded at a premium to palm stearin from late 2004 to early 2006. That is considered to be the result of worldwide issues with mad cow disease at that time. Considering the previous graphs and correlations among all raw materials, table 5.4 shows the premiums and discounts used to construct the prices of the main raw materials in the support tool for the month of June. The same approach of discount and premiums was used for the other delivery months.

Figure 5.5 Palm Stearin Index vs. Tallow Index (Jan 2004 = 100)

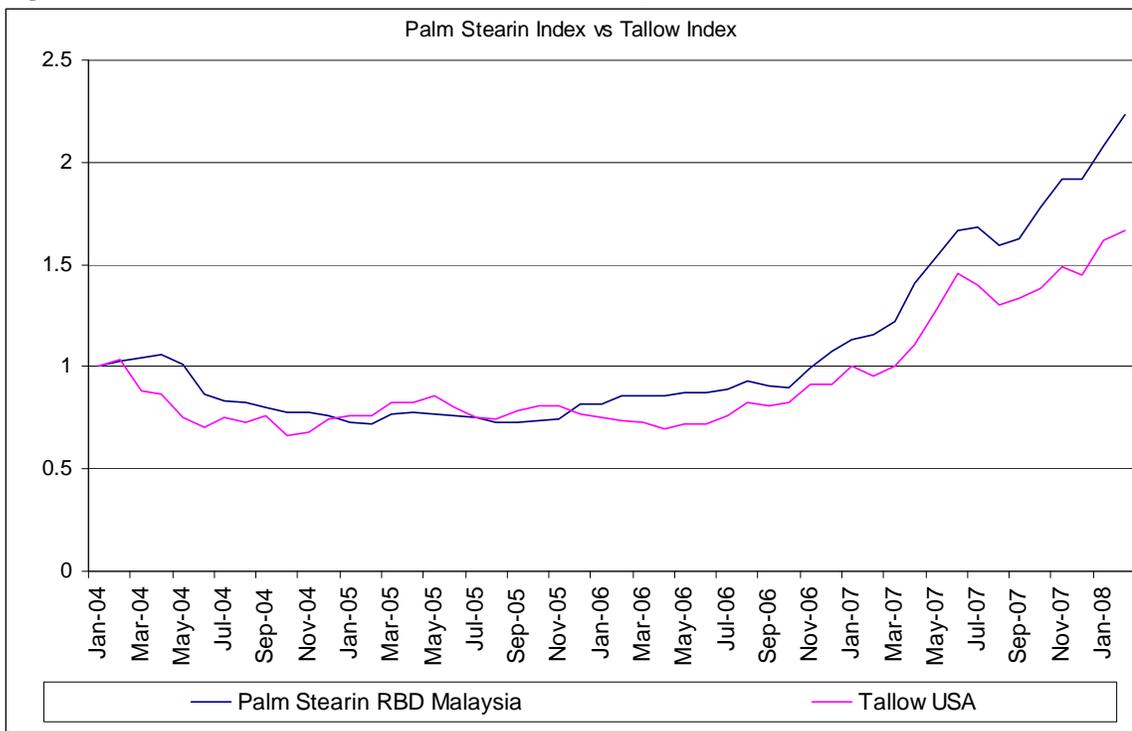


Table 5.3 Premiums / Discounts – June 2008

Product	Premium (+) / Discount (-)	Reference Market
Crude Palm Oil (MYR/MT)	+ 165	Palm Oil Futures
Palm Stearin (MYR/MT)	- 192	Palm Oil Futures
Palm Kernel (MYR/MT)	+720	Palm Kernel Futures
Tallow (US\$/MT)	- 70	Palm Stearin

The price forecast for palm kernel oil was obtained by adding 720 Malaysian Ringgits to the palm kernel futures contract price for the month of shipment. In the case of tallow, the FOB price would be US\$ 70 under the price of palm stearin. Even though the prices above are for Malaysian palm oil and US tallow, the procurement support tool will also consider sourcing from Ecuador and Colombia. It is important to mention that for each month the exchange rate on that month was used to find the value in US\$ from the Malaysian Ringgits quote. That exchange rate was obtained from Reuters. Different suppliers around the world use different market indicator prices to define their own export prices. In those cases, the price is settled by adding a premium or a discount (basis) against the market indicator to set their FOB prices. The premium or discounts for all the raw materials considered in this model vary on a daily basis, and this situation affects considerably the outcome of were to buy each of the raw materials. Ecuador and Colombian producers of palm stearin and palm kernel add a premium to the Malaysian price to set their FOB price. The actual market premium in Ecuador is US\$ 50 above the FOB Malaysian and it is evenly used for palm

kernel and palm stearin. Colombia uses a premium of US\$ 60 against the Malaysian indicator for both products.

Market scenarios are another consideration in the procurement support tool. Those scenarios refer to three possible directions in the movement of prices over the one-year procurement period considered in the model. The scenarios are labeled Optimistic, Pessimistic and Status Quo. The values of those scenarios are the result of conversations and investigation with various sources of information at the company. Even though each run of the model is for the next twelve month period, the intent of the procurement support tool is that those scenarios are updated every month and run for the subsequent twelve-month period. That allows the procurement team to update the projections and evaluate their plan given changes that may have occurred in prices of inputs. The scenarios are specified in Table 5.4.

Table 5.4 Scenarios Detail – Change in Price over Next 12 Months

Variable	Optimistic	Pessimistic	Status Quo
Palm Oil Futures Contract	- 30 %	+ 30 %	0%
Palm Kernel Oil Futures Contract	- 30 %	+ 30 %	0%

Table 5.5 Notations: Denomination of Prices

Product and Origin	Short Version	Time Period
Tallow East Coast	PTEC(t)	$t = 1, \dots, 12$
Tallow US Gulf	PTG(t)	$t = 1, \dots, 12$
Palm Stearin Malaysia	PPEMY(t)	$t = 1, \dots, 12$
Palm Stearin Ecuador	PPEECU(t)	$t = 1, \dots, 12$
Palm Kernel Malaysia	PPKMY(t)	$t = 1, \dots, 12$
Palm Kernel Colombia	PPKCOL(t)	$t = 1, \dots, 12$
Palm Kernel Ecuador	PPKECU(t)	$t = 1, \dots, 12$

5.2 Sales Estimates, Manufacturing Formulas and Sea Freight

Estimates of soap sales for the twelve months ahead are used to calculate the metric tons of raw materials required for the next twelve months. The sales estimation would be provided by the sales department considering a forecast of the total bar soap sales in Venezuela for the last twelve months and the expected, and maybe desired, market share for Las Llaves brand. The sales estimates are provided on a monthly basis to continue with the next steps.

The manufacturing formula is another important consideration of the procurement support tool. For this project, only three formulas are considered, and are labeled as formula A,

formula B and formula C (the differences among the three are in the percentages of tallow and palm stearin used). The formula used will also be selected by the tool, as it chooses the formula that gives the lowest cost for the three raw materials to manufacture the soap (see Table 5.5).

Table 5.6 Detail of Sales and Manufacturing Formulas

	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09
Total Laundry Soap Market Sales Estimates (MT)	5,882	5,882	5,882	5,882	5,882	5,882	5,882	5,882	5,882	5,882	5,882	5,882
Las Llavas Market Share	85%	85%	85%	85%	85%	85%	87%	87%	87%	87%	87%	87%
Candado Mar	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Other Brands	7%	7%	7%	7%	7%	7%	5%	5%	5%	5%	5%	5%
Las Llavas - Sales in MT	5,000	5,000	5,000	5,000	5,000	5,000	5,117	5,117	5,117	5,117	5,117	5,117
Total Raw Material Requirement (MT)	3,750	3,750	3,750	3,750	3,750	3,750	3,838	3,838	3,838	3,838	3,838	3,838
Raw Materials Requirement per Formula (In MT):												
Formula A												
Fancy Tallow	70%	2,625	2,625	2,625	2,625	2,625	2,687	2,687	2,687	2,687	2,687	2,687
Palm Stearine	25%	937	937	937	937	937	960	960	960	960	960	960
Palm Kernel	5%	187	187	187	187	187	192	192	192	192	192	192
Formula B												
Fancy Tallow	65%	2,437	2,437	2,437	2,437	2,437	2,495	2,495	2,495	2,495	2,495	2,495
Palm Stearine	30%	1,125	1,125	1,125	1,125	1,125	1,151	1,151	1,151	1,151	1,151	1,151
Palm Kernel	5%	187	187	187	187	187	192	192	192	192	192	192
Formula C												
Fancy Tallow	67%	2,512	2,512	2,512	2,512	2,512	2,571	2,571	2,571	2,571	2,571	2,571
Palm Stearine	28%	1,050	1,050	1,050	1,050	1,050	1,075	1,075	1,075	1,075	1,075	1,075
Palm Kernel	5%	187	187	187	187	187	192	192	192	192	192	192

The other important input for the procurement support tool is the ocean freight cost. The company has two ocean freight options and prices. The first option is a twelve-month contract that fixes freight rate and volume for the twelve-month period. The second option is to purchase freight on the spot market as needed. With the second option the company would experience with uncertainty about future spot rates and vessel availability. Even though the second option could be considered as a risky possibility because of possible increases in ocean freight cost and uncertainty as to vessel availability, this is an option that some companies in Venezuela use to avoid binding contracts with service providers. However, the spot market is not an option for Polar because of the volumes used. Contract

rates are given in table 5.6 and are based on current market rates for contracts for shipment to Venezuela from various origins.

Table 5.7 Contract Freight Rates to Venezuela

East Coast	US\$/MT 55
Gulf	US\$/MT 50
Malaysia	US\$/MT 110
Colombia	US\$/MT 40
Ecuador	US\$/MT 50

Considering the previous information, the next step provides a general overview of how the Procurement Support Decision Tools is applied:

1) **Obtain the estimated sales of bar soap for the company for the coming months.**

This initial information will support the system by later translating the total sales into total of metric tons of raw material required for the manufacturing of the soap according to the scenarios defined.

2) **Define scenarios for raw materials.** The user defines the criteria for each raw material considering the information available at the moment from meetings with commodity brokers, fundamental information from other sources, subscription magazines, etc. This definition will consider any of the three possible scenarios—optimistic, pessimistic or status quo—for each of the three raw materials..

3) **Confirm solver for each of the three raw materials and get results.** This process will assure that the scenarios defined by the user are properly used in the spreadsheets. The first step is defining decision variables accordingly. Decision variables are the amount in metric tons suggested by the model to buy for each of the three raw materials from the origins available according to:

TEC (t) = Tallow purchased from the east coast for month t, t = 1,...,12

TG (t) = Tallow purchased from the US gulf for month t, t = 1,...,12

EMY (t) = Palm stearin purchased from Malaysia for month t, t = 1,...,12

EECU (t) = Palm stearin purchased from Ecuador for month t, t = 1,...,12

PKMY (t) = Palm kernel purchased from Malaysia for month t, t = 1,...,12

PKCOL (t) = Palm kernel purchased from Colombia for month t, t = 1,...,12

PKECU(t) = Palm kernel purchased from Ecuador for month t, t = 1,...,12

The second step refers to denote the objective function. Considering three raw materials, the objective function for each of those raw materials will focus in minimizing the total cost of procurement for a twelve month period. The total cost of procurement for each raw material is the sum of the cost of procurement plus the cost of holding inventory according to:

a) Cost of procurement (CP): is the sum of the multiplying the metric tons to buy per month against prices of such raw materials for each month. The next detail provides cost of procurement for each raw material:

$$CPTallow = \sum_{t=1}^{12} TEC(t) \times PTEC(t) + \sum_{t=1}^{12} TG(t) \times PTG(t)$$

$$CP Stearin = \sum_{t=1}^{12} EMY(t) \times PEMY(t) + \sum_{t=1}^{12} EECU(t) \times PEECU(t)$$

$$CP Palm Kernel = \sum_{t=1}^{12} PKMY(t) \times PPKMY(t) + \sum_{t=1}^{12} PKCOL(t) \times PPKCOL(t) + \sum_{t=1}^{12} PKECU(t) \times PPKECU(t)$$

b) Cost of holding inventory (CHI): any quantity of raw material above plant storage capacity at the end of the month will be considered as the amount to store in another warehouse (W). In this case the cost considered in the model is equal to US\$ 5 per metric ton per month. The next detail provides the cost of holding inventory for each raw material:

$$Tallow Cost of Holding Inventory = TCHI = \sum_{t=1}^{12} 5WT(t)$$

$$Stearin Cost of Holding Inventory = SCHI = \sum_{t=1}^{12} 5WS(t)$$

$$Kernel Cost of Holding Inventory = KCHI = \sum_{t=1}^{12} 5WK(t)$$

Considering the previous detail for cost of procurement and cost of holding inventory, the next detail provides the objective function for each of the raw materials for total procurement cost:

$$\begin{aligned} \text{Total Procurement Cost} &= \\ \text{Cost of Procurement} + \text{Cost of Holding Inventory} &= \\ \text{TCP} &= \text{CP} + \text{CHI} \end{aligned}$$

$$\begin{aligned} \text{TCP Tallow} &= \text{CP Tallow} + \text{Tallow CHI} = \\ \text{TCP Tallow} &= \sum_{t=1}^{12} \text{TEC}(t) \times \text{PTEC}(t) + \sum_{t=1}^{12} \text{TG}(t) \times \text{PTG}(t) + \sum_{t=1}^{12} \text{5WT}(t) \end{aligned}$$

$$\text{TCP Stearin} = \sum_{t=1}^{12} \text{EMY}(t) \times \text{PEMY}(t) + \sum_{t=1}^{12} \text{EECU}(t) \times \text{PEECU}(t) + \sum_{t=1}^{12} \text{5WS}(t)$$

$$\begin{aligned} \text{TCP Kernel} &= \sum_{t=1}^{12} \text{PKMY}(t) \times \text{PPKMY}(t) + \sum_{t=1}^{12} \text{PKCOL}(t) \times \text{PPKCOL}(t) + \\ &\sum_{t=1}^{12} \text{PKECU}(t) \times \text{PPKECU}(t) + \sum_{t=1}^{12} \text{5WK}(t) \end{aligned}$$

The third step is specification of model constraints. Those constraints will refer to different aspects such as safety inventory, quantity availability per origin, storage capacity, total quantity available at the beginning of each month and maximum quantity allowed per vessel shipment. The following equations specify the constraints used for one input (tallow for example).

$$\text{Total Available per month} \geq \text{Plant consumption per month}$$

$$\text{TAva}(t) \geq \text{Pcons}(t) \quad (t = 1, \dots, 12)$$

Define that the total quantity available before the factory starts producing each month must be equal or greater than the total metric tons require by the plant each month.

Ending stocks per month $\geq 4,000$

$$EStock(t) \geq 4,000 \quad (t = 1, \dots, 12)$$

Defines that ending inventory for each month must be equal or greater than the safety inventory defined for tallow.

East coast procurement per month $\leq 2,500$ Metric tons

$$TEC(t) \leq 2,500 \quad (t = 1, \dots, 12)$$

Shipments are not allowed beyond 2,500 metric tons per month

Gulf procurement per month $\leq 2,500$ Metric tons

$$TG(t) \leq 2,500 \quad (t = 1, \dots, 12)$$

Shipments are not allowed beyond 2,500 metric tons per month

Decision Variables ≥ 0 (All purchases and shipments must be numbers greater or equal to zero)

Total East Coast procurement $\leq 15,000$ Metric tons; Total Gulf procurement $\leq 25,000$ metric tons

$$\sum_{t=1}^{12} TEC(t) \leq 15,000 \quad (t = 1, \dots, 12)$$

$$\sum_{t=1}^{12} TG(t) \leq 25,000 \quad (t = 1, \dots, 12)$$

This set that total procurement out of the US Gulf and the East Coast, must not exceed the amount available from all suppliers the company have access to from each origin, which in this case is 25,000 MT out of the Gulf and 15,000 MT out of the East Coast.

The previous detail of solver is also applied for the other two raw materials to also obtain the suggested lowest cost of procurement considering the constraints used and the forecasted prices.

5.3 Comparing Results

Considering the previous information, Figures 5.9 and 5.10 show the results of using the procurement support tool for two different situations. The first one will consider using the optimistic scenario for all three raw materials, while the second example shows a

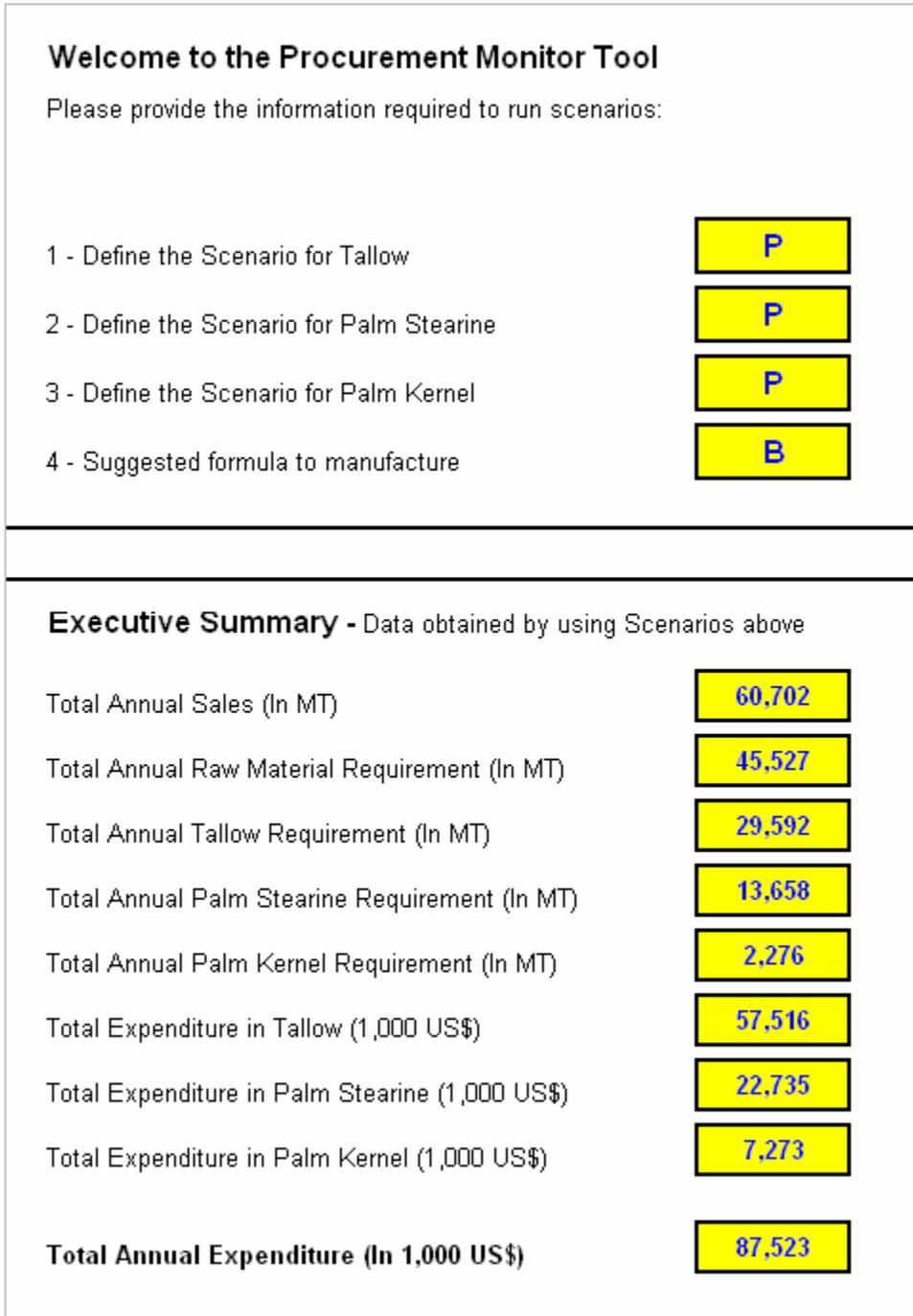
pessimistic scenario for the same raw materials. The results of the executive summary provided by the support tool are as follow:

Figure 5.6 Case No. 1

Welcome to the Procurement Monitor Tool	
Please provide the information required to run scenarios:	
1 - Define the Scenario for Tallow	<input type="radio"/>
2 - Define the Scenario for Palm Stearine	<input type="radio"/>
3 - Define the Scenario for Palm Kernel	<input type="radio"/>
4 - Suggested formula to manufacture	<input checked="" type="radio"/>

Executive Summary - Data obtained by using Scenarios above	
Total Annual Sales (In MT)	60,702
Total Annual Raw Material Requirement (In MT)	45,527
Total Annual Tallow Requirement (In MT)	29,592
Total Annual Palm Stearine Requirement (In MT)	13,658
Total Annual Palm Kernel Requirement (In MT)	2,276
Total Expenditure in Tallow (1,000 US\$)	32,851
Total Expenditure in Palm Stearine (1,000 US\$)	12,679
Total Expenditure in Palm Kernel (1,000 US\$)	4,486
Total Annual Expenditure (In 1,000 US\$)	50,017

Figure 5.7 Case No. 2



From the previous results, is possible to see, that even when the estimated total sales in metric tons for both cases are 60,702 metric tons, total annual expenditure in raw material

differ from \$50,017,000 in the first case to \$ 87,523,000 in the second case. This difference is explained by the use of different scenarios of the raw materials. It is also important to consider that with the price difference in both cases, the support tool suggest to manufacture the soap with formula B, that provides the lowest cost possible in both cases. The previous examples are just two of the different possibilities of the initial page that can be selected by the user and the results given by the PST. In addition to the previous, the user can also see the detail of the suggested procurement strategy by looking at each inventory page. For instance, the very next detail for tallow inventory is shown in Table 5.8:

Table 5.8 Detail of Tallow Procurement Strategy

Manufacturing Formula	B												Total Procurement	
Scenario + Sea Freight Module	O													
Formula A	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09		
Initial Stocks	3,000	4,000	6,437	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	
East Coast Procurement	937	2,389	0	0	0	0	0	0	291	234	923	818	5,592	
Gulf Procurement	2,500	2,466	0	2,437	2,437	2,437	2,495	2,495	2,204	2,260	1,571	1,677	25,000	
Total Procurement	3,437	4,875	0	2,437	2,437	2,437	2,495	2,495	2,495	2,495	2,495	2,495	30,592	
Total Available	6,437	8,875	6,437	6,437	6,437	6,437	6,495	6,495	6,495	6,495	6,495	6,495		
Plant Consumption	2,437	2,437	2,437	2,437	2,437	2,437	2,495	2,495	2,495	2,495	2,495	2,495	29,592	
Ending Stocks	4,000	6,437	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000		
Restrictions														
Safety Inventory	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	
Storage Capacity	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	
Max. Quantity per Shipment	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	
(Prices US\$/TM)														
East Coast - US\$/TM	1,056.80	1,044.85	1,049.63	1,050.16	1,047.51	1,045.91	1,045.12	1,045.12	1,039.81	1,039.81	1,037.15	1,037.15		
Gulf - US\$/TM	1,050.65	1,038.70	1,043.48	1,044.01	1,041.36	1,039.76	1,038.97	1,038.97	1,033.66	1,033.66	1,031.00	1,031.00		
Holding Inventory Cost	0.00	5,100.00	17,530.50	5,100.00	5,100.00	5,100.00	5,100.00	5,100.00	5,100.00	5,100.00	5,100.00	5,100.00		
Total Procurement Cost for Tallow	→ 32,852,094													
Storage space used @ Plant	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	
Storage space used @ Other Location	1,000	3,437	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Cost of Inventory (Other location - US\$/MT/Month)	5													
Quantity Available East Coast (In MT)	15,000													
Quantity Available Gulf (In MT)	25,000													

It shows the suggested procurement strategy for tallow for the next twelve months. The first important information is highlighted in yellow. That refers to the total of metric tons per month and per origin that the tool suggests to buy. In this case the tool suggests buying most of the product from the Gulf (25,000MT). The remainder is obtained from the East Coast (5,592 MT).

Important information from this table is referred to the restrictions of the model. In the table is possible to see that safety inventory, storage capacity and maximum quantity per shipment are displayed. At the same time other restrictions such as the maximum quantity available per origin is also displayed as quantity available at the East Coast and at the Gulf.

Useful information in this table is showed as the Total Procurement cost for Tallow (US\$ 32,852,094). This refers to the total cost of procuring tallow in the next 12 months under the assumption of the scenarios mentioned above and for the procurement strategy selected by the tool

All the previous analysis is also available for Palm Stearin and Palm Kernel as well in the tables that follow:

Table 5.9 Detail of Stearin Procurement Strategy

Manufacturing Formula														
Scenario + Sea Freight Module		B												0
		Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Total Procurement
Initial Stocks		2,000	2,500	3,625	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,600
Malaysia Procurement		625	1,250	0	125	125	125	151	151	151	151	1,151	1,151	5,158
Ecuador Procurement		1,000	1,000	0	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0	0	9,000
Total Procurement		1,625	2,250	0	1,125	1,125	1,125	1,151	1,151	1,151	1,151	1,151	1,151	14,158
Total Available		3,625	4,750	3,625	3,625	3,625	3,625	3,651	3,651	3,651	3,651	3,651	3,651	
Plant Consumption		1,125	1,125	1,125	1,125	1,125	1,125	1,151	1,151	1,151	1,151	1,151	1,151	13,658
Ending Stocks		2,500	3,625	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	
Restrictions														
Safety Inventory		2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	
Storage Capacity		2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	
Max Quantity per Shipment Ecuador		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Max Quantity per Shipment Malaysia		3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	
(Prices US\$/TM)														
Malaysia - US\$/MT		1,013.75	1,001.80	1,006.58	1,007.11	1,004.46	1,002.86	1,002.07	1,002.07	996.76	996.76	994.10	994.10	
Ecuador - US\$/MT		841.05	831.05	835.05	835.49	833.27	831.94	831.27	831.27	826.82	826.82	824.60	824.60	
Holding Inventory Cost		0.00	2,550.00	8,267.16	2,550.00	2,550.00	2,550.00	2,550.00	2,550.00	2,550.00	2,550.00	2,550.00	2,550.00	
Total Procurement Cost for Palm Stearine	→	12,679,484												
Storage space used @ Plant		2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	
Storage space used @ Other Location		500	1,625	500	500	500	500	500	500	500	500	500	500	
Cost of Inventory (Other location - US\$/MT/Month)		5												
Quantity Available Malaysia(In MT)		50,000												
Quantity Available Ecuador (In MT)		9,000												

Table 5.10 Detail of Kernel Procurement Strategy

Manufacturing Formula													B
Scenario + Sea Freight Module													0
	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Total Procurement
Initial Stocks	300	1,500	1,584	1,670	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	387
Malaysia Procurement	387	0	0	0	0	0	0	0	0	0	0	0	500
Colombia Procurement	500	0	0	0	0	0	0	0	0	0	0	0	2,589
Ecuador Procurement	500	271	274	17	187	187	192	192	192	192	192	192	3,476
Total Procurement	1,387	271	274	17	187	187	192	192	192	192	192	192	3,476
Total Available	1,687	1,771	1,858	1,687	1,687	1,687	1,692	1,692	1,692	1,692	1,692	1,692	2,276
Plant Consumption	187	187	187	187	187	187	192	192	192	192	192	192	
Ending Stocks	1,500	1,584	1,670	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	
Restrictions													
Safety Inventory	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	
Storage Capacity	1,500	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	
Max Quantity per Shipment Ecuador	500	500	500	500	500	500	500	500	500	500	500	500	
Max Quantity per Shipment Malaysia	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	
Max Quantity per Shipment Colombia	500	500	500	500	500	500	500	500	500	500	500	500	
(Prices US\$/TM)													
Malaysia - US\$/MT	1,516.57	1,516.57	1,516.57	1,516.57	1,516.57	1,516.57	1,516.57	1,516.57	1,516.57	1,516.57	1,516.57	1,516.57	
Colombia - US\$/MT	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	
Ecuador - US\$/MT	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	1,262.11	
Holding Inventory Cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total Procurement Cost for Palm Kernel	→ 4,486,129												
Storage space used @ Plant	1,500	1,584	1,670	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	
Storage space used @ Other Location	0	0	0	0	0	0	0	0	0	0	0	0	
Cost of Inventory (Other location - US\$/MT/Month)	5												
Quantity Available Malaysia (In MT)	25,000												
Quantity Available Colombia (In MT)	6,000												
Quantity Available Ecuador (In MT)	6,000												

The previous tables provide the details of procuring all three raw materials for the bar soap manufacturing plant as selected by the model, but is the analyst who must choose the procurement strategy. The model run for a range of conditions provides information to help the procurement team choose its strategy. Furthermore, the model helps to structure the problem for the team so the team has a better overall picture of the problem of choosing the right strategy.

CHAPTER VI: CONCLUSIONS AND RECOMMENDATIONS

Considering the analysis done and the construction of the procurement support tool, one can see the following:

- The use of a procurement support tool is an alternative for the purchasing department in creating and defining procurement strategies, but at the same time should not be considered as the only support element for making procurement decisions.
- The time-frame analysis for the procurement support tool is twelve months. This time period could be enhanced or reduced with simple variations to the procurement support tool.
- It is suggested that the definition of the scenarios be reviewed at least once a month, considering the possible variations in the commodity markets and other variables analyzed within this support tool.
- Considering the necessity of an updated scenario each month, it is also recommended to review the premiums or discounts of different raw materials and how they continue to relate to each other.
- It is suggested to include other departments within the company in the analysis of scenarios to have better results by using the best fitted data for the model. Marketing, quality, manufacturing, and finance are just a few of the possible departments that could also benefit from the use of this tool.

- The procurement support tool can be enhanced to include other activities such as the analysis of the income statements for the manufacturing facility by adding other necessary data.
- The procurement support tool can also be shared through the company by using the local intranet platform. Considering the importance of including other departments in the analysis of scenarios, sharing the tool by using intranet could let the results reach all possible users not only related to procurement, but in other areas like accounting and finance.
- Considering the two alternatives for ocean freight transportation, the company might consider negotiating a multi-annual contract to fix the cost of transportation, avoiding further increments.
- The procurement support tool specifies for each of the three raw materials the numbers of metric tons to buy from each origin. If the suggested amounts per origin reach 100 % of the quantity available, the company should also consider developing new suppliers from those origins that could reduce procurement costs.
- This tool can also provide cash flow estimates for purchasing these three inputs. The results found by the PST could be shared with the treasury department for better planning of cash necessities and leverage projections.
- Considering that the price of the three raw materials in the manufacturing facility are highly related to the variations of the futures market, the company should

consider in the future the use of risk management tools to protect against undesired variations of the prices. This could also require the necessity to hedge foreign currencies considering the company buys all its requirements in US dollars.

- Considering restrictions with quantities from suppliers, it is suggested to negotiate long term agreements with lower cost alternatives like Ecuador and Colombia to secure raw material at competitive prices.

REFERENCES

- Bayou, M. "Deviations of Exchange Rates from Purchasing Power Parity: A Story Featuring Two "- I.M.F. Staff Papers, 1999.
- Beamon, B. "Supply chain design and analysis: models and methods". *International Journal of Production Economics*, Vol 55. (1998), pp 281-294.
- Chopra, S. and P. Meindl. "Supply Chain Management – Strategy, Planning and Operations – 2nd". Prentice Hall, 2004.
- Capineri, C. and T. Leinbach. "Freight Transport, Seamlessness and Competitive Advantage in the Global Economy". *European Journal of Transport and Infrastructure Research*, No. 1 (2006), pp. 23-38.
- Ellram, L. and A. Carr. "Strategic Purchasing: A History and Review of the Literature". *International Journal of Purchasing and Materials*, Spring 1994.
- Friedrich, M. and T. Haupt. "Freight Modeling". Paper presented at 10th Annual Travel Research Conference, Lucerne 10-15, August 2003.
- Gebauer, J. and C. Beam. "Impact of the Internet on Procurement". *Acquisition Review Quarterly*, Spring 1998.
- Ghodsypour S. and C. Brien. "The total cost of logistics in supplier selection, under conditions of multiple sourcing, multiple criteria and capacity constraint". *International Journal of Production Economics*, No 73 (2001), pp 15-27.
- Hau L. Lee, V. P and S. Whang. "The Bullwhip Effect in Supply Chains". *MIT Sloan Management Review* (Spring 1997), Vol. 38, No. 3, pp. 93–102.
- Kingman, B. "Purchasing Raw Materials with Uncertain Fluctuating Prices". *European Journal of Operational Research*, Vol. 25, no. 3, pp. 358-372, 1986.
- Kingman, B. "Raw Materials Purchasing: An Operational Research Approach". *International Journal of Production Economics*, Volume 86, Issue 3, 11 December 2003, Pages 183-185.
- Levy, D. "International Sourcing and Supply Chain Stability". *Journal of International Business Studies*, Vol. 26, May 1995.
- Lee H., B. "Managing Supply Chain Inventory: Pitfalls and Opportunities" *MIT Sloan Management Review* (Spring 1992), Vol. 33, No. 3, pp. 65–73.
- Runhaar, Hac, K. "Freight transport in 2010". The Netherlands Trail Research School. Delft/Rotterdam/Groningen, November 2001.

Raper, K. and K. Jones “Food Industry Perspectives on Commodity Procurement Strategy”. Dept of Agr. Econ. Michigan State University, December 2004.

Raper, K. and K. Jones “Evaluating Food Commodity Procurement Strategies”. Dept. of Agr. Econ. Michigan State University, December 2004.

Yano, C. and R. Carlson “Interaction Between Frequency of Rescheduling and the Role of Safety Stock in Material Requirements”. International Journal of Production Research, (1987).

APENDIX – HISTORICAL DATA

	Crude Palm Oil Malaysia	Palm Oil RBD Malaysia	Palm Stearin RBD Malaysia	Palm Kernel Malaysia	Tallow USA	Futures Palm Oil	Futures Palm Kernel
Jan-04	496	483	465	572	565	1806	2069
Feb-04	535	526	477	616	586	1960	2246
Mar-04	550	544	486	669	499	1980	2522
Apr-04	538	533	493	727	488	1974	2630
May-04	513	500	472	711	427	1640	2310
Jun-04	440	429	403	636	397	1560	2180
Jul-04	426	417	386	620	424	1444	2160
Aug-04	432	421	383	610	410	1550	2230
Sep-04	439	434	374	657	428	1491	2230
Oct-04	431	413	362	643	376	1465	2230
Nov-04	433	411	363	660	384	1452	2262
Dec-04	423	394	355	656	419	1384	2262
Jan-05	402	367	340	635	430	1275	2185
Feb-05	403	362	333	641	429	1403	2249
Mar-05	435	400	359	710	464	1455	2382
Apr-05	429	397	361	681	464	1427	2414
May-05	417	395	358	647	486	1411	2252
Jun-05	419	391	353	639	452	1410	2179
Jul-05	417	391	350	612	423	1365	2204
Aug-05	407	386	339	558	420	1358	1971
Sep-05	421	396	338	577	444	1449	2021
Oct-05	442	407	344	619	455	1445	2092
Nov-05	444	396	347	614	459	1389	2065
Dec-05	424	388	381	590	435	1397	2039
Jan-06	424	388	381	606	424	1428	2155
Feb-06	445	407	399	623	414	1470	2140
Mar-06	440	408	399	591	410	1390	1984
Apr-06	439	413	399	576	394	1441	1901
May-06	440	420	408	560	408	1411	1848
Jun-06	437	415	408	535	407	1429	1741
Jul-06	478	443	415	560	431	1590	1802
Aug-06	510	470	432	572	465	1557	1899
Sep-06	497	449	422	548	459	1542	1779
Oct-06	507	450	418	557	468	1622	1693
Nov-06	547	511	461	601	516	1901	1928
Dec-06	583	559	499	647	516	1976	2193
Jan-07	599	569	527	653	565	1902	2162
Feb-07	605	573	538	678	541	1952	2164
Mar-07	622	593	567	702	566	2064	2195
Apr-07	710	675	653	795	625	2320	2460
May-07	753	740	715	820	724	2725	2598
Jun-07	807	781	775	971	821	2513	2965
Jul-07	830	808	783	910	790	2691	3061
Aug-07	820	770	740	905	735	2490	2986
Sep-07	835	798	755	923	754	2687	3065
Oct-07	881	848	827	1001	781	2890	3206
Nov-07	952	935	890	1116	840	2925	3496
Dec-07	945	940	890	1135	820	3070	3555
Jan-08	1059	1053	968	1277	914	3230	4052
Feb-08	1100	1125	1040	1360	940	3350	4565