Supply Chain Analysis at Hall Longmore

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Submitted in partial fulfillment of the requirements for the degree of

BACHELORS OF INDUSTRIAL ENGINEERING

in the

FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
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23 October 2008

Executive Summary

Hall Longmore is the largest manufacturer of large bore welded steel pipes south of the Sahara and their success is based on their proud history of delivering the highest quality products and service excellence. They are however coming under pressure from increased competition and more recently, the current economical crisis. They must reduce costs and attempt to increase customer service if they are to keep their market share. This project looked at the supply chain to accomplish this and aimed to give Hall Longmore a better picture of its supply chain and its performance and to suggest some improvements.

The Supply Chain Operations Reference (SCOR) model is a cross industry standardized model for supply chain management endorsed by the Supply Chain Council (SCC). It was used to determine the performance of the supply chain and benchmark data supplied by SCORmark was used to compare it with its industry.

In conjunction with SCOR, financial ratio analysis, lean and six sigma were used to analyze and improve the company's supply chain. It was found that on almost all metrics, financial and supply chain related, Hall Longmore's performance was poor and significant room for improvement exists.

Material and information flow analysis revealed inefficiencies in the processes and gaps in information flow, that when addressed could result in large inventory reductions and process improvements. Currently, inventory costs are estimated at R66 million per year. A 40% reduction in inventory is possible, which would result in a 47% increase in profits due to lower inventory costs. Other improvement suggestions were to record data on perfect order fulfillment, use control charts for perfect order fulfillment and to use a Monte Carlo simulation to aid procurement decision making.

By implementing these suggestions they should see rapid and significant results. Costs can be reduced by reducing waste and these savings can be translated to more competitive prices to increase their competitiveness amidst increasing competition and economic uncertainty. Additionally, reduced costs can help improve the company's poor liquidity.

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1 Introduction and Background

1.1 Company background

When Hall Longmore, a wholly owned Murray & Roberts company, began manufacturing welded steel pipes in 1924, it paved the way for the largest operation of its kind in Africa south of the Sahara, exporting its products world wide. Hall Longmore's success is based on its proud history of delivering highest quality product and service excellence.

Today the company owns manufacturing facilities in Wadeville and Duncanville offering modern industry leading equipment and process control for the production of large-bore welded steel pipes. Applications range from the transportation of water, gas, petrochemical products, slurries to piling and structural steel fabrication.

Electric resistance welding (ERW) and submerged arc welding (SAW) technologies are used to produce pipes from different grades of carbon or special alloy steels and can be supplied square ended, beveled, belled or with specialized jointing methods depending on customer requirements. Their mills are equipped with state-of-the-art non-destructive testing and edge milling equipment to meet the stringent requirements of international oil and gas customers.

The Hall Longmore team is committed to applying its vast wealth of industry knowledge and experience to ensure delivery of world-class products and service excellence to its customers.

1.2 Problem Description

Hall Longmore has always had the vast majority of the market share in its industry. Recently a number of Chinese owned companies, among others, have entered the market and are promising to deliver the same quality products to the market at a fraction of the price of current companies.

For Hall Longmore to retain its market share it is important for them to increase their competitiveness. Hall Longmore's supply chain is one area in which an opportunity for improvement exists.

1.3 Project Aim

The aim of this project is to give Hall Longmore a better picture of its supply chain performance and the operation in order for them to direct there efforts more effectively in increasing their competitive advantage and the project will also aim to generate some high level improvement suggestions. This will be achieved by analyzing the AS-IS situation of Hall Longmore's supply chain and compare its performance with that of industry leading benchmarks.

1.4 Project Scope

In the analysis phase, this project will attempt to investigate all aspects of Hall Longmore's supply chain at a configuration level (SCOR level 2). This includes customer interactions, product transactions from their supplier to their customer's customer and market interactions.

The investigation will include performance measurement and benchmarking up to level two of the Supply Chain Operations Reference (SCOR) model. Based on these measurements, some key areas will be chosen within Hall Longmore's defined supply chain for further investigation. Some high level improvement suggestions will also be made.

2 Literature Review

"If you can define your supply chain—which isn't hard to do—then you can measure it. Once you've measured it, you'll find the opportunities are so big that you won't need any more motivation. You'll want to drive continuous improvement in your supply chain." (Bolstroff et al, 2003).

2.1 Supply Chain Management

A definition for “supply chain” is given by Stevens (1989): “A system whose constituent parts include material suppliers, production facilities, distribution services and customers linked together via the feed forward flow of materials and the feedback flow of information.”

Tan et al. (1998) gives the following definitions for supply chain management: “Supply chain management encompasses materials/supply management from the supply of basic raw materials to final product (and possible recycling and re-use). Supply chain management focuses on how firms utilize their suppliers' processes, technology and capability to enhance competitive advantage. It is a management philosophy that extends traditional intra-enterprise activities by bringing trading partners together with the common goal of optimization and efficiency.”

In today's world, supply chain management (SCM) is a key strategic factor for increasing organizational effectiveness and for better realization of organizational goals such as enhanced competitiveness, better customer care and increased profitability (Gunasekaran et al, 2001).

According to Macbeth and Ferguson (1994) and Cox (1997), supply chain should be seen as the central unit of competitive analysis. Companies should not seek to achieve improvement at the expense of their supply chain partners, but rather seek to make the supply chain as a whole more competitive. The fact that supply chains, and not single firms, compete is a central principle in the field of supply chain management (Christopher, 1992; Macbeth and Ferguson, 1994).

Gunasegaram et al (2001) states: "… it is clear that for effective management in a supply chain, measurement goals must consider the overall supply chain goals and the metrics to be used. These should represent a balanced approach and should be classified at strategic, tactical and operational levels, and be financial and nonfinancial measures, as well.

Supply chain management has been studied since the early 1980s, however the management of supply chains is not particularly well-understood, and many authors have highlighted the necessity of clear definitional constructs and conceptual frameworks on supply chain management (Saunders, 1995, 1998; New, 1995; Cooper et al., 1997; Babbar and Prasad, 1998).

2.2 A Framework for Defining the Supply Chain

Bolstorff et al. (2003) give a few examples of how various companies could define their supply chain: "A technology provider trying to sell software might align SCM with using advanced planning functionality; a third-party logistics provider (3PL) trying to sell its outsourcing capabilities will align SCM with distribution practices; and a consulting firm selling services will align SCM with its intellectual property." But is there an objective, unbiased way to define supply chain management? The answer, according to Bolstorff et al. (2003), is a cross industry standardized model called the Supply Chain Operations Reference (SCOR) Model, a product of the Supply Chain Council (SCC). Their book, which is endorsed by the SCC, describes the SCOR model and its implementation.

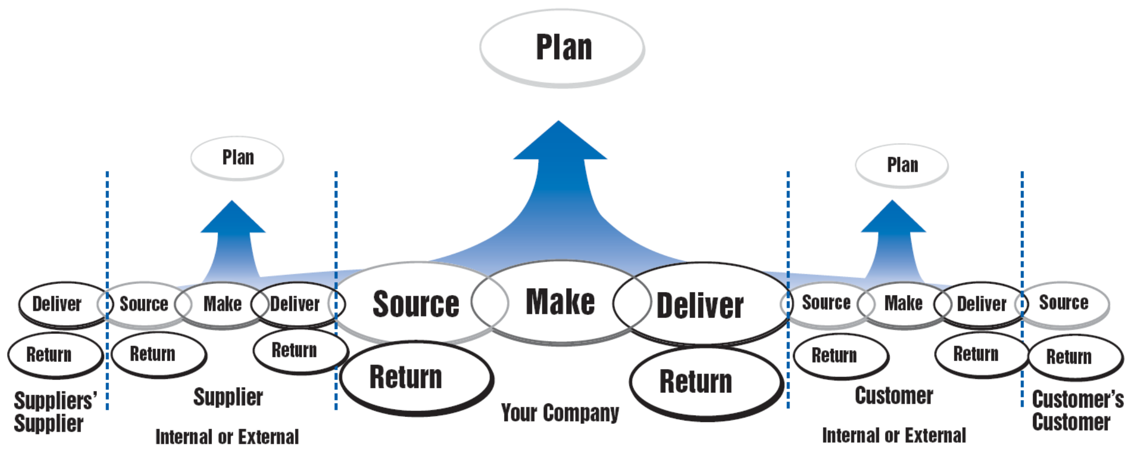
The SCC is an independent not-for-profit corporation formed in 1996 as a grassroots initiative to develop a supply chain implementation model. Their methodology, diagnostic and benchmarking tools help organizations make dramatic and rapid improvements in supply-chain processes. Sixty-nine of the world's leading companies participated in the council's founding. The Supply-Chain Council now has closer to 1,000 corporate members world-wide and has established international chapters in North America, Europe, Greater China, Japan, Australia/New Zealand, South East Asia, Brazil and Southern Africa. By mid

2008 the SCC has released nine subsequent versions of the SCOR model, providing updates to process elements, metrics, practices, and technology.

The SCOR-model captures the SCC's consensus view of supply chain management. While much of the underlying content of the Model has been used by practitioners for many years, the SCOR-model provides a unique framework that links business process, metrics, best practices and technology features into a unified structure to support communication among supply chain partners and to improve the effectiveness of supply chain management and related supply chain improvement activities.

The SCOR-model has been developed to describe the business activities associated with all phases of satisfying a customer's demand. The model itself contains several sections and is organized around the five primary management processes of Plan, Source, Make, Deliver, and Return. Figure 1 shows a visual representation of the SCOR model with these five processes.

Figure 1: Five Management Processes (SCC, 2008)



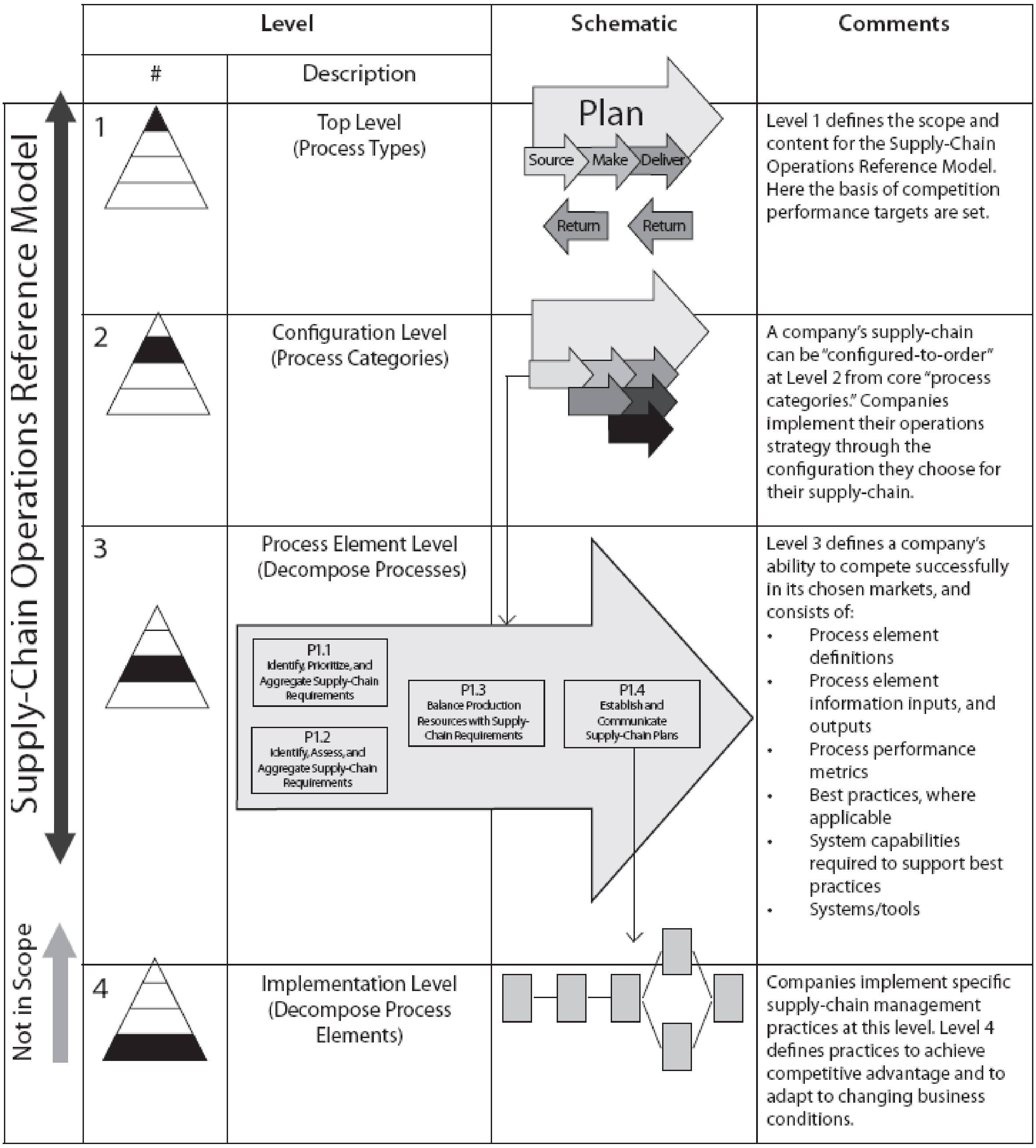
The SCOR Overview Booklet (2008) gives the following definitions for each Level 1 process. "Plan" is those processes that balance aggregate demand and supply to develop a course of action which best meets sourcing, production and delivery requirements. "Source" describes the processes that procure goods and services to meet planned or actual demand. "Make" is defined as the Processes that transform product to a finished state to meet planned or actual demand. “Deliver” is the processes that provide finished goods and services to meet planned or actual demand, typically including order management, transportation management, and distribution management. “Return” describes the processes associated with returning or receiving returned products for any reason. These processes extend into post-delivery customer support

By describing supply chains using these process building blocks, the model can be used to describe supply chains that are very simple or very complex using a common set of definitions. As a result, disparate industries can be linked to describe the depth and breadth of virtually any supply chain. The model has been able to successfully describe and provide a basis for supply chain improvement for global projects as well as site-specific projects.

As shown in Figure 2, the model is designed and maintained to support supply chains of various complexities and across multiple industries. The SCC has focused on three process levels and does not attempt to prescribe how a particular organization should conduct its business or tailor its systems or information flow. Every organization that implements supply chain improvements using the SCOR-model will need to extend the model, at least to Level 4, using organization-specific processes, systems, and practice.

The SCOR-model is a business process reference model as illustrated in Figure 3. That is, it is a model that links process elements, metrics, best practice and the features associated with the execution of a supply chain in a unique format. The uniqueness and power of the model and its successful implementation is chiefly derived from using these four elements together.

Figure 2: SCOR Scope (SCC, 2008)



It is important to note that this model describes processes not functions. In other words, the model focuses on the activity involved not the person or organizational element that performs the activity.

Figure 3: SCOR is a business process reference model (SCC, 2008)

Business Process Reengineering	Benchmarking	Best Practices Analysis	Process Reference Model
Capture the "as-is" state of a process and derive the desired "to-be" future state			Capture the "as-is" state of a process and derive the desired "to-be" future state
	Quantify the operational performance of similar companies and establish internal targets based on "best-in-class" results		Quantify the operational performance of similar companies and establish internal targets based on "best-in-class" results
		Characterize the management practices and software solutions that result in "best-in-class" performance	Characterize the management practices and software solutions that result in "best-in-class" performance

2.3 Measuring Your Supply Chain

"The era of both globalization of markets and outsourcing has begun, and many companies select supply chain and logistics to manage their operations. Most of these companies realize that, in order to evolve an efficient and effective supply chain, SCM needs to be assessed for its performance." (Gunasekaran Et al, 2001)

According to Gunasekaran (2001), metrics that are used in performance measurement influence decisions to be made at a strategic, tactical and operational level. Using a classification based on these three levels, each metric can be assigned to a level where it would be most appropriate. This makes the SCOR model metrics very useful, because it has multiple levels of measurement.

The SCOR model has several metrics at the strategic level 1. Each of these relates to certain performance attributes. Table 1 gives the definitions of the Performance attributes and associates them with the applicable level 1 metrics.

The Performance Attributes are characteristics of the supply chain that permit it to be analyzed and evaluated against other supply chains with competing strategies. Without these characteristics it is extremely difficult to compare an organization that chooses for example to be the low-cost provider against an organization that chooses to compete on reliability and performance.

The strategic level 1 metrics that are associated with the performance attributes are calculations by which an organization can measure how successful it is in achieving its desired positioning within the competitive market space. Many of these level 1 metrics are hierarchical, just like the processes. They are created from lower level calculations.

2.4 Addressing the Shortcomings of SCOR

So your supply chain can now be defined and measured but what about improvement? The SCOR model framework contains so called “best practices” for each process. When implemented these best practices should dramatically improve your supply chain performance.

But when things don’t go as planned how will you analyze problems and solve them? The SCOR framework does not include the required methods and/or techniques. The SCOR model scope also does not include detailed processes (level 4) which makes analysis using just the SCOR model very difficult. Therefore for the purpose of problem analysis and solution development some additional tools and techniques will be needed.

Table 1: Definitions of SCOR Performance Attributes and Listing of associated Level 1 Metrics (SCC, 2008)

Performance Attribute	Performance Attribute Definition	Level 1 Strategic Metric
Supply Chain Reliability	The performance of the supply chain in delivering: the correct product, to the correct place, at the correct time, in the correct condition and packaging, in the correct quantity, with the correct documentation, to the correct customer.	Perfect Order Fulfillment (RL.1.1)
Supply Chain Responsiveness	The speed at which a supply chain provides products to the customer.	Order Fulfillment Cycle Time (RS.1.1)
Supply Chain Agility	The agility of a supply chain in responding to marketplace changes to gain or maintain competitive advantage.	Upside Supply Chain Flexibility (AG.1.1)
		Upside Supply Chain Adaptability (AG.1.2)
		Downside Supply Chain Adaptability (AG.1.3)
Supply Chain Costs	The costs associated with operating the supply chain.	Supply Chain Management Cost (CO.1.1)
		Cost of Goods Sold (CO.1.2)
Supply Chain Asset Management	The effectiveness of an organization in managing assets to support demand satisfaction. This includes the management of all assets: fixed and working capital.	Cash-to-Cash Cycle Time (AM.1.1)
		Return on Supply Chain Fixed Assets (AM.1.2)
		Return on Working Capital (AM.1.3)

One way in which the shortcomings of SCOR are being addressed is by developing a concept known as Convergence. The Convergence concept began development in 2002 with the formation of the Supply Chain Council's Convergence Special Interest Group (SIG). Their purpose is to bring together professionals across multiple industries and disciplines to leverage the methodologies of SCOR, Six Sigma and Lean and promote their convergence.

2.4.1 Lean

Lean aims to increase value while eliminating waste. Lean manufacturing is a philosophy that emphasizes minimizing the amount of resources used in the various activities of an enterprise. It involves identifying and eliminating non-value-adding activities in design, production, supply chain and customer service. The goal is to maximize process flow and flexibility. Lean has evolved over the last couple of decades into a highly capable well defined multi-step approach.

Womack and Jones (1996) defined a set of five basic principles that characterize a lean enterprise. The first principle is to specify value from the standpoint of the end customer by product family. The second principle is identifying all the steps in the value stream for each product family, eliminating every action and every practice that does not create value. Thirdly, the remaining value-adding steps should be arranged in a tightly integrated sequence so that the product will flow smoothly toward the customer. The fourth principle states that as flow is introduced, customers must pull value from the next upstream activity. The last principle is to pursue perfection through continuous improvement.

Kent and Attri (2008) states that as with any methodology, Lean also has its advantages and disadvantages. The advantages are: It is a structured methodology for waste identification and elimination in any process. Organization wide training involves employees at all levels. It gives focused and rapid process improvement and cost reduction. Strong analytical tools exist to map the process and identify root causes.

Some of the disadvantages include (Kent and Attri, 2008): Few tools exist that focuses Lean efforts on strategic and operational process priorities. There is inadequate analysis of financial expectations and accountability and lacks an overall supply chain discipline. The main drawback of using Lean alone as a process improvement methodology is lack of strategic supply chain direction. Lean efforts will certainly yield results, but can lead to islands of excellence within an organization if used alone and the time from effort to any significant results can be long.

2.4.2 Six Sigma

Six Sigma is a statistical quality goal that equals no more than 3.4 defects per million opportunities. Six Sigma is also a business improvement program that targets process variation. It has a very structured and disciplined methodology designed to translate strategic and\operational opportunities into resourced, well-scoped executable projects. The Six Sigma "tool set" focuses on reducing defects and variability with a formalized project management structure. Six Sigma is not only for manufacturing, but any process where an opportunity exists for error. Six Sigma projects are based on a problem solving methodology called DMAIC.

The five letters of DMAIC each correspond to a step in the process. The first step is to define the project goals and customer, internal and external, deliverables. Step two is to measure the process to determine current performance and quantify the problem. The fourth step is analyzing and determining the root cause(s) of the defects. Next you improve the process by eliminating defects and finally you control future process performance.

Some of the advantages include the following (Kent and Attri, 2008): It is a structured methodology approach for defect and variance reduction in any process. With Six Sigma you have dedicated roles, responsibilities and program infrastructure and organization wide training and development. It is customer and data driven problem solving. There is rigid tracking and financial accountability for results.

Kent and Attri (2008) states the critique of Six Sigma include that it lacks alignment of project execution with strategic and operational priorities. There is no methodology to develop understanding of relationships between projects. Data dependent tools and techniques are difficult to use in situations where data is not available or readily collected.

Compared to Lean, Six Sigma has a narrow focus. It is highly dependant on the availability of valid data for analysis and improvement.

2.4.3 SCOR, Lean and Six Sigma Convergence

If you consider the strengths and weaknesses of these three methodologies, it is evident that that can benefit from each other. The strong fact based, data-driven problem solving approaches of Lean and Six Sigma can help to discover root causes. Lean also brings focus to customer value.

SCOR assists companies to make major decision that will affect their supply chain and dramatically impact on its performance and offers a quick return on investment (ROI). Lean and Six Sigma compliment and strengthen the SCOR-based strategic decisions by providing a continuous improvement philosophy. Value Stream Mapping (VSM), part of the Lean methodology, can be effectively used to map the workflow and transactions which are specific to each company, adding considerable detail to support a deeper understanding of current and future state processes. Using all three these methodologies will lead to a holistic process improvement methodology.

The preferred implementation strategy for SCOR, Supply Chain Excellence (SCE) also maps well with the DMAIC approach of Six Sigma. Table 2 shows the relationships.

Table 2: DMAIC (Kent and Attri, 2008)

DMAIC	SCE
Define	Supply chain definition and priorities
Measure	Analyze basis of competition (SCORcard)
Analyze	Work and Information Flows
Improve	Project definitions and implementation plan
Control	Deployment organization

SCOR’s level 1 metrics are used to understand supply chain performance and also to benchmark against competitors. When a company defines its supply chain strategy, it provides an indication of what its supply chain’s performance should be. This drives the targets that a supply chain aspires to achieve for the different metrics. Table 3 outlines how Lean and Six Sigma can play a role during project execution to realize improvements in the specific metrics.

Perfect Order Fulfillment is defined to be the percentage of orders that are delivered on time in full and damage free. Six Sigma can be used to understand variation, identify out of control situations and determine the root causes of the defects that lead to imperfect order fulfillment. The causes can then be addressed and rectified.

Table 3: Metrics and Approach (Kent and Attri, 2008)

	Attribute	SCOR Metric	Approach
Customer	Reliability	Perfect Order Fulfillment	Six Sigma
	Responsiveness	Order Fulfillment Cycle Time	Lean
	Flexibility	Supply Chain Flexibility	Lean
Internal	Cost	Supply Chain Management Cost	Lean
		Cost of Goods Sold	Lean & Six Sigma
	Assets	Cash-to-Cash Cycle Time	Lean & Six Sigma
		Return on Supply Chain Fixed Assets	Lean & Six Sigma
		Return on Working Capital	Lean & Six Sigma

Order Fulfillment Cycle Time is defined as the average actual cycle time consistently achieved to fulfill customer orders from initial demand to delivery and installation (where applicable). Value stream mapping can be used to model level 4 order fulfillment processes which aren't included in SCOR. These end-to-end processes can be analyzed to identify problems that cause delays. If there is large variation, Six Sigma can be used to identify the causes.

Supply Chain Flexibility measures the number of days required to achieve an unplanned sustainable 20% increase in production. The value stream map can be used to identify key processes that that could constrain the supply chain's flexibility.

Supply Chain Management Cost is the sum of costs associated with processes used for managing and executing a supply chain. Lean could be used to minimize the use of resources and time and cost centers can be targeted to be more efficient with less number of resources to bring down supply chain cost.

Cost of Goods Sold (COGS) includes direct and indirect costs. Lean and Six Sigma were originally used to reduce production costs, which make them ideal to improve COGS.

Return on Supply Chain Fixed Assets and Return on Working Capital both rate of return on investments. Investments span a wide variety supply chain areas and therefore the use of both Lean and Six Sigma is advised although in some cases one might be more appropriate.

Figure 4 (adapted from the SCC Model) provides the unique and common strengths of the three methodologies discussed. It is evident that these methodologies are complimentary and their individual weaknesses are resolved by their convergent strengths.

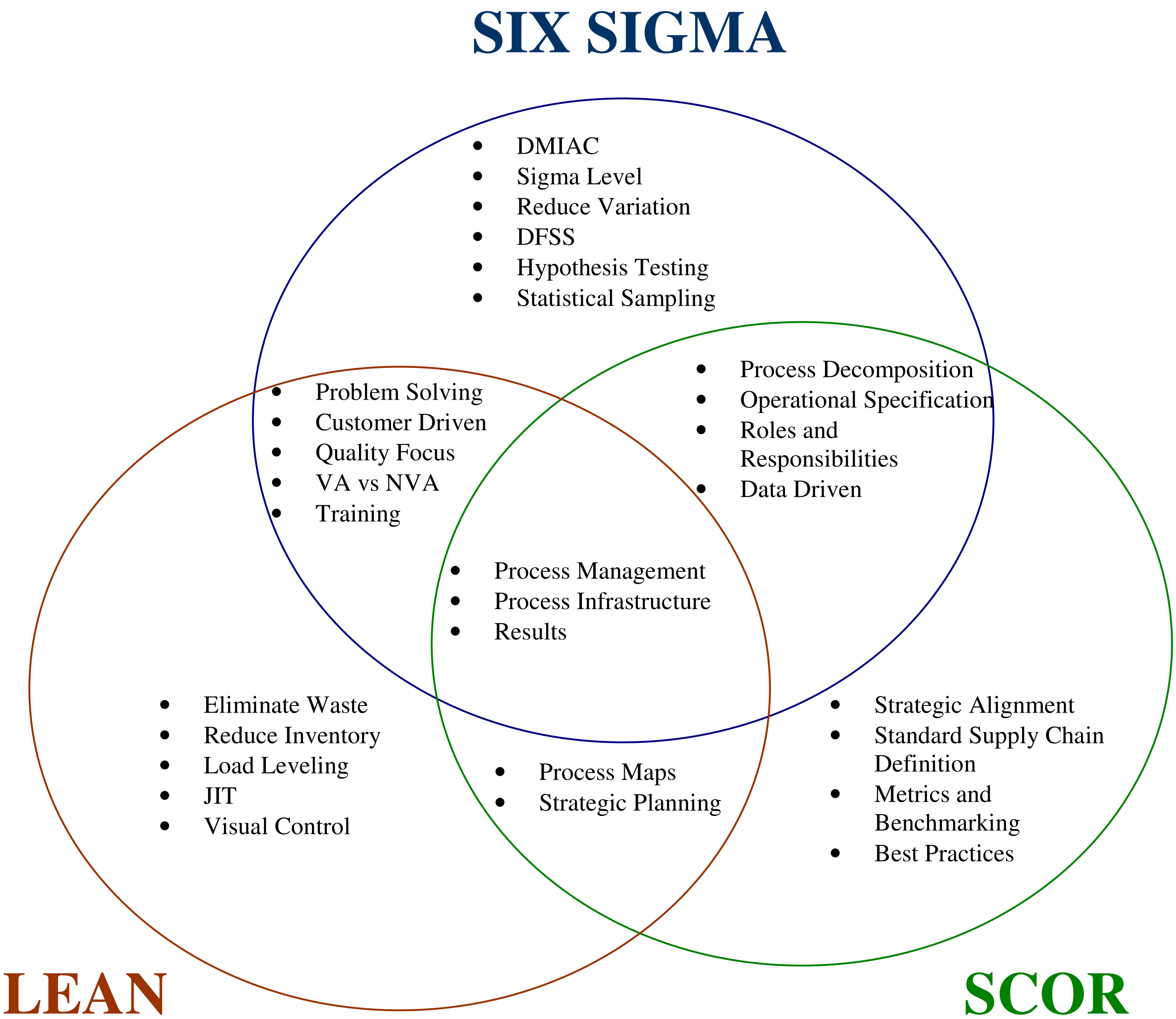
2.5 Additional Tools and Techniques

A few additional tools and techniques that could be useful during this project will now be discussed.

2.5.1 SCORcards

Bolstorff et al. (2003) advises the use of SCORcards. The SCORcard is a collection of metrics divided into the different performance attributes and also three categories namely internal, external and shareholder. It must be decided which metrics will be relevant to company's supply chain performance and then each metric is compared to industry benchmarks. From this the company can determine targets and identify areas that need attention.

Figure 4: SCOR, Lean and Six Sigma Convergence



3 Design and Problem Solving

3.1 Strategic Risk Assessment

A Strategic Risk Assessment was supplied by Hall Longmore. This detail various identified risks to the company and the current controls that are in place including the perceived effectiveness of the controls. All of the controls are perceived to be effective, according to the assessment. Many of these risks relate to the supply chain.

The first risk is the entrance of a new competitor which is controlled by improving customer relations, giving discounts and rationalization of stock holding. Another risk is the availability and quality of steel supply. This is evident from the data that shows that the average lead time for steel supply is 104 days with a standard deviation of 54 days. The current control for this risk is to import steel and to maintain stock. The steel price is also a risk and this is controlled by importing steel. It should be noted that according to supplier statistics that will be given later, very little, if any, steel is imported.

Inbound and outbound logistics is also seen as a risk and is controlled by spending capital and appointing specialized personnel. Long order fulfillment periods are another identified risk and the plan is to hold stock and rationalize their products. The fact that Hall Longmore only has a single source for key critical raw materials, that is steel coils, is also a risk and developing multisourcing is its control.

It is important to note that Hall Longmore operates as a make-to-order business. An advantage of operating at that specific capability is that a product is only manufactured if an order is received. The holding of stock that is not on order therefore diminishes some of the advantages of a make-to-order model, but reduces average order fulfillment times.

3.2 Financial Performance

The financial statements of a company are the most basic indicator its performance and this is inherently influenced by its supply chain strategy, tactics and operations. It is therefore prudent to have a look at Hall Longmore's financial statements and its performance from a financial perspective over the last couple of years.

3.2.1 Balance Sheet

The balance sheet data for the last 3 financial years is given in Appendix A. It can be seen that a large portion of the total assets of the company is tied up in inventory (38% for 2008). It is notable that there was a very large increase in payables outstanding in 2008. The reason for this is still unclear, but it is suspected that at least some of it is due to an upgrade of the plant. The impact of this will be made clearer when die financial ratios are discussed.

3.2.2 Income Statement

The income statement for the past three years is given in Appendix B. It shows an increase in sales over the last 2 years with a steadily increasing net profit over the last 3 years.

3.2.3 Financial Ratio Analysis

To give better insight into the meaning of values on the financial statements, financial ratios are calculated. By analyzing these ratios, the performance of the company can be analyzed and monitored, mostly from a financial perspective. Two types of ratio analysis are typically done. The first is a so called "Cross sectional analysis" where the company's performance is compared to its industry. All industry data was supplied by Fintel. The second is a time series analysis where the company's performance is tracked over time. Both have been done for at least some of the ratios. A detailed list of the calculated ratios for the past three years is given in Appendix C together with the industry data for the last financial year. The ratios indicating the liquidity of the company will be discussed first.

3.2.3.1 Liquidity

Liquidity measures a company's ability to satisfy its short-term obligations as they come due. It refers to the solvency of the firms overall financial position, or, the ease with which it can pay its bills. A common precursor to financial distress and bankruptcy is low or declining liquidity and these ratios are viewed as good leading indicators of cash flow problems. The current ratio is one of the most commonly cited financial ratios and measures the company's ability to meet its short-term obligations. It is calculated by dividing the current assets by the current liabilities. The Quick (Acid Test) ratio is similar, but excludes inventory from the current assets.

Figure 4 shows the time series analysis for the liquidity of Hall Longmore, while Figure 5 shows the comparison to the industry. The industry was selected according to the North American Industry Classification System (NAICS). Hall Longmore has been defined as "Iron and Steel Pipe and Tube Manufacturing from Purchased Steel". There has been a significant decline in both ratios in 2008 and the value of the current ratio also falls below the 10^{th} percentile in the industry. This shows very poor liquidity and some further investigation into the reasons behind this may be necessary.

Figure 4: Liquidity Time Series Analysis

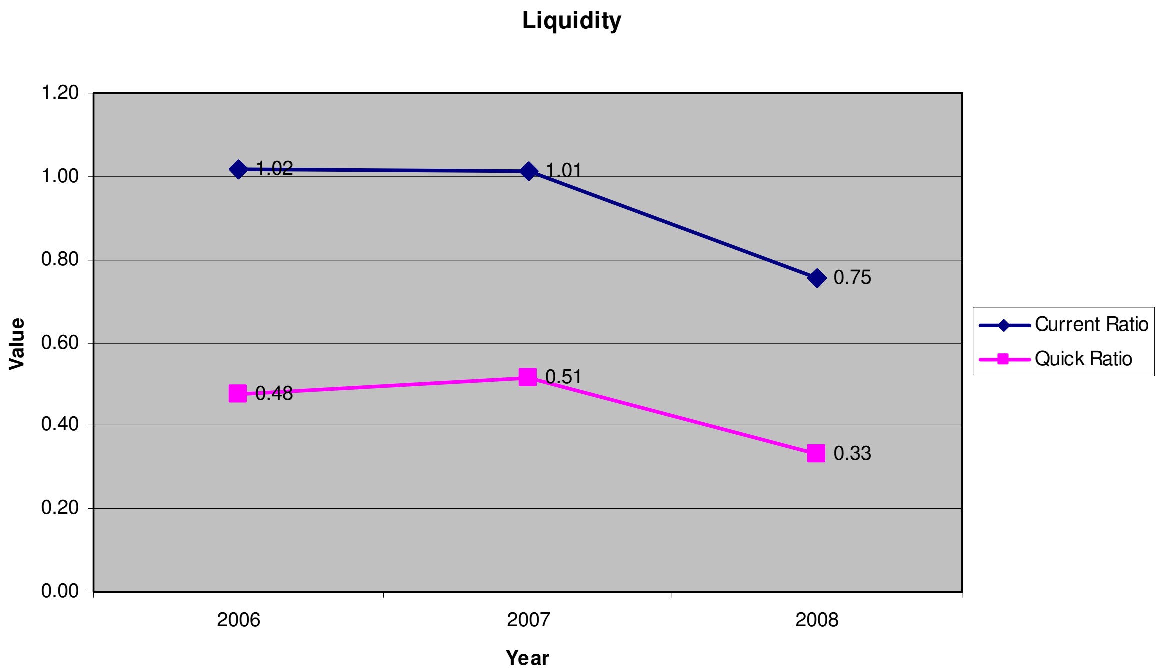


Figure 5: Current Ratio Cross-Sectional Analysis

Percentile	10^{th}	25^{th}	50^{th}	75^{th}	90th
Value	1.33	1.33	2.27	3.78	5.3

3.2.3.2 Activity

Activity Ratios measure the speed with which various accounts are converted into sales or cash – inflows or outflows. It is used in conjunction with liquidity to assess the "true liquidity", as liquidity ratios can be easily affected by the composition of a company's assets.

Inventory turnover measures the activity, or liquidity, of a company's inventory. The value of Hall Longmore's inventory turnover shows no real trend over the last three years, but the value of 2.36 for 2008 is again poor when compared to the industry average of 7.24. Hall Longmore's inventory turnover falls below the 25^{th} percentile as shown in Figure 6.

Figure 6: Inventory Turnover Cross-Sectional Analysis

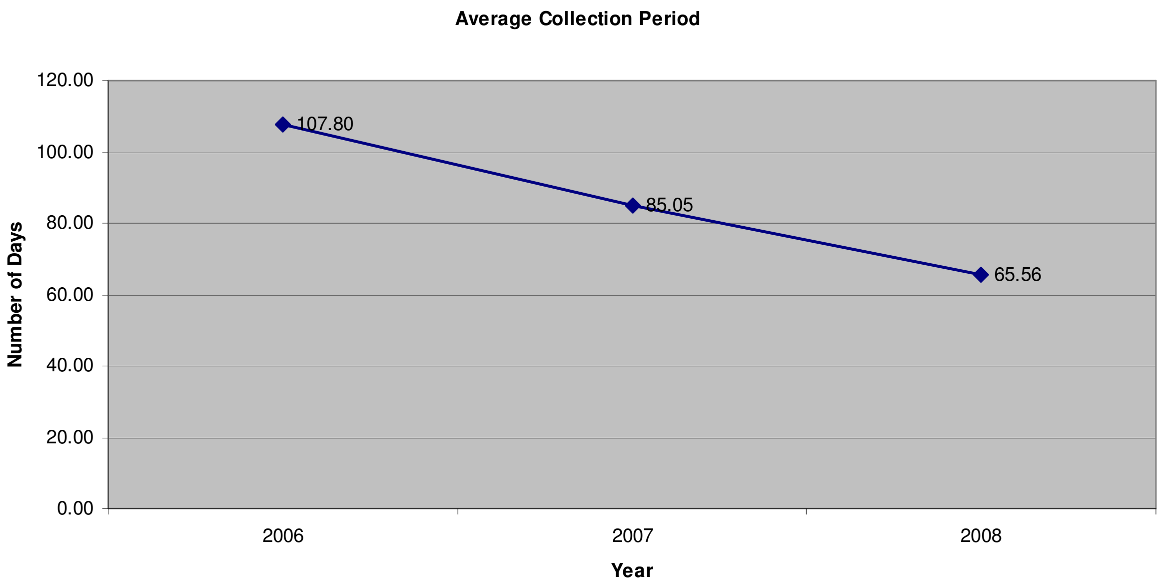
Percentile	10^{th}	25^{th}	50^{th}	75^{th}	90th
Value	0.3	4.13	7.24	9.15	16.4

The average collection period evaluates the company's credit and collection policies. Although Hall Longmore's average collection is still considerably below par according to the cross-sectional analysis shown in Figure 7, it has shown a constant decline over the last 3 years (Figure 8). This indicates that credit and collection policies and activities are being improved.

Figure 7: Cross Sectional Analysis of Average Collection Period

Percentile	10th	25th	50th	75th	90th
Value	68.4	68.4	46.54	35.24	11.8

Figure 8: Time Series Analysis of Average Collection Period



The average payment period has seen a sharp increase during 2008 to reach 340 days from a value of 114 days in 2007. This is largely due to a large increase in accounts payable in 2008. The reason for this increase is not known. Total Asset Turnover has remained relatively stable and is now at 1.15. The total asset turnover indicates the efficiency with witch the company uses its assets to generate sales. No benchmark data was available, but 1.15 is not seen as a bad asset turnover.

3.2.3.3 Debt

The debt position of a company indicates the amount of other people's money being used to generate profits. With a higher the debt ratio comes higher potential return but also higher risk. The debt ratio has been stable over the last three years and is now at 87%, which means 87% of the company's assets are financed by debt.

3.2.3.4 Profitability

Profitability is arguably the most important measure of a company's success, as the goal of any business is to make money and as much of it as possible. The higher your profit margins are, the higher your profits will be. The Gross Profit Margin is the percentage of sales left over after the company has paid for their goods sold. Operating profit margin is the percentage of sales left over after expenses have been deducted and the net profit margin is the so-called bottom line – the profits that remain after interest and taxes have also been deducted.

The profit margins have been up and down over the last 3 years, but they are now at their highest level as shown in Figure 9. This goes hand-in-hand with an increase in profits over the last three years. The net profit margin also compares well with that of the industry as it is very close to the 75th percentile as shown in Figure 10.

Return on assets and return on equity has also seen a rise in 2008. This means that the effectiveness of management in generating profits with the available assets has improved and the return on investments in the firm is also much stronger.

The external profile will now be considered, that is, looking at Hall Longmore's suppliers and customers.

Figure 9: Time Series Analysis of Profit Margins

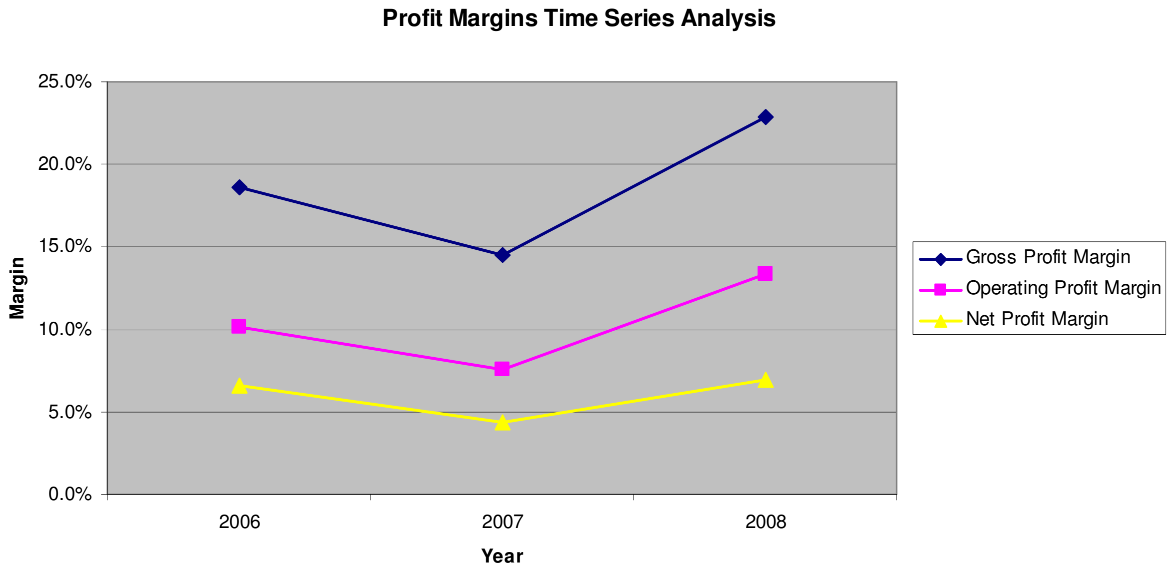
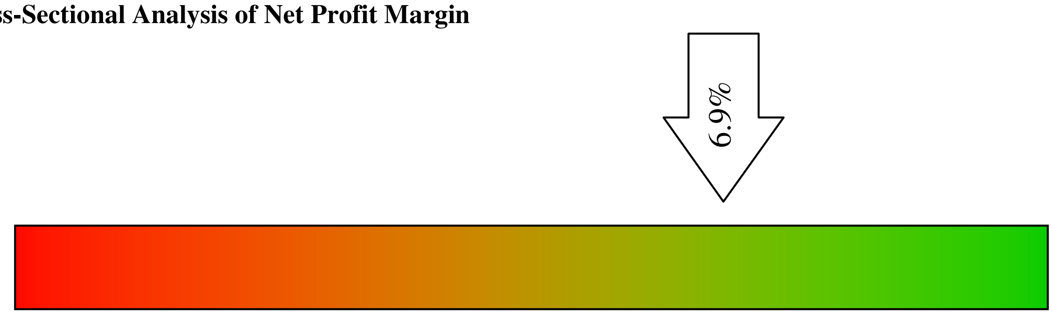


Figure 10: Cross-Sectional Analysis of Net Profit Margin



Percentile	10th	25th	50th	75th	90th
Value	-16.1%	0%	2%	7%	26.6%

3.3 External Profile

The process of manufacturing pipes has very few different material inputs. Table 4 shows the suppliers that make up 82% of material spend. The main raw material used in pipe manufacturing is of course steel. The steel sheets used for pipes come in coils, which are mostly supplied by Arcelormittal (76.8%). Some alternative suppliers of steel have been used for steel, but not enough to make a significant impact. Therefore multisourcing still needs to be developed further.

Table 4: Shortened List of Suppliers

Supplier Name	Supplies	Supplier Location	Material Spend	Percentage of Total Spend
ARCELORMITTAL	Steel Coils	VANDERBIJLPARK	R 388,203,111.49	76.8%
STEMCOR	Steel Coils	CRAMERVIEW	R 12,116,909.09	2.4%
SIGMA COATINGS	Coating	ALRODE	R 8,567,978.09	1.7%
SASOL GAS LIMITED	Gas	RANDBURG	R 4,601,655.06	0.9%
TRIDENT STEEL	Steel Coils	ALRODE	R 2,856,474.45	0.6%

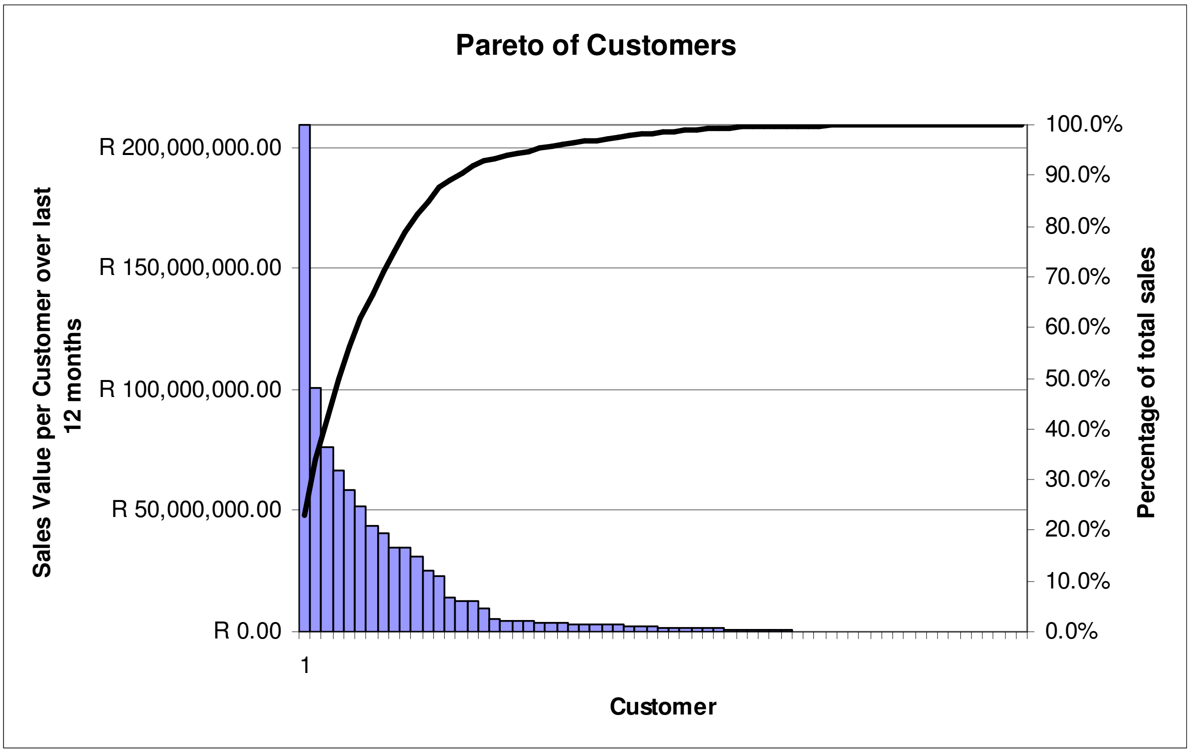
Two other major inputs are coating material and gas. The coating material is used to coat some pipes, according to a customer order, and is supplied by Sigma Coatings. Gas is used in the production process and is supplied by Sasol Gas.

The customers of Hall Longmore include stockists, and projects. Projects could be local or export. Except for stockists, the customers of the company are not constant and neither are the locations of delivery, even for a single customer. Figure 11 shows a pareto chart of the sales per customer. From this you can see that 80% of sales came from about 11 customers (16% of customers). The next step in the process is to choose the relevant supply chain metrics, compile the necessary data and then place them on a SCORcard.

3.4 SCOR Metrics

The selected metrics have been compiled into a SCORcard, given in Table 5. The SCORcard metrics are grouped according to the five supply chain performance attributes. The actual values for every metric have been given and next to that are the benchmark results obtained from SCORmark and the parity gap calculations. The benchmark data given by SCORmark includes the 25th, 50th and 75th percentile in the industry. The industry was defined by SCORmark as industrial products. For each of the metrics, if the value is worse than the median in the industry, the parity gap is coloured red, otherwise it is green.

Figure 11: Pareto Chart of Sales per Customer



3.4.1 Supply Chain Reliability

Supply chain reliability is an indicator for the ability to deliver on-time, in-full, in the right condition, right packaging, with the right documentation to the right customer. Reliability is an indicator that describes the predictability of a supply-chain.

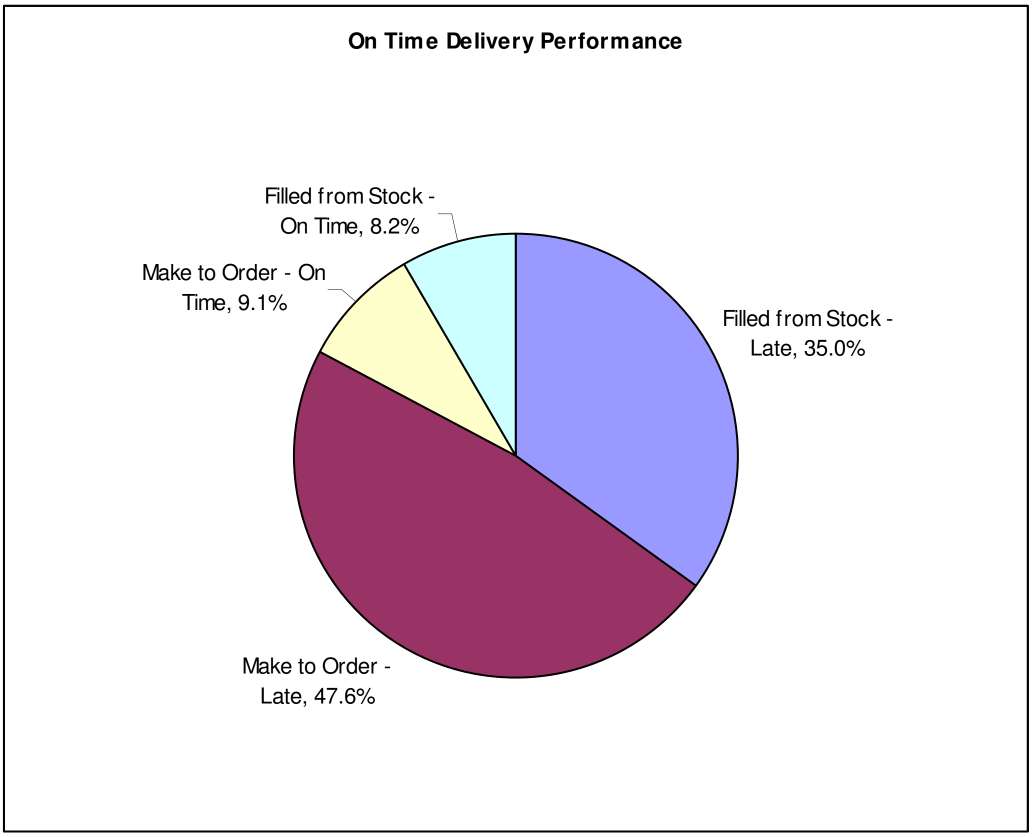
Unfortunately, the only data being captured at Hall Longmore is on time delivery in the form of a promised delivery date and an actual invoice date for the last shipment on an order. After extracting the data it was determined that 17% of orders are delivered on time and this is lower than parity by 63.6% and even much lower that the bottom performer which delivers 57% of orders on time.

After some further analysis it has been determined that order can be classified in two groups, namely orders that are make to order, and others that are filled from stock. When the indicated required ship date is equal to the order date, it is assumed that the order is filled from stock. Figure 12 is a pie chart showing the on time delivery performance for both of these groups.

Table 5: Hall Longmore's SCORcard

Performance Attribute or Category	Performance Metric	Actual Value	Industrial Products Peers: Sample Size	Bottom Performer (25th Percentile)	Parity (50th Percentile)	Top Performer (75th Percentile)	Parity Gap
Supply Chain Reliaility	External Perfect Order Performance	-					
	Delivery Performance to Customer Commit Date	17%	31	57.00%	81.00%	94.20%	-63.60%
Supply Chain Responsiveness	Order Fulfillment Cycle Time (days)	126.3	34	44.25	19.00	7.00	-107.30
	Source Cycle Time (days)	103.76	N/A	N/A	N/A	N/A	N/A
Supply Chain Flexibility	Upside Supply Chain Flexibility (days)	30	N/A	N/A	N/A	N/A	N/A
	Upside Supply Chain Adaptability	30%	N/A	N/A	N/A	N/A	N/A
	Downside Supply Adaptability	100%	N/A	N/A	N/A	N/A	N/A
	Upside Source Flexibility (days)	56	N/A	N/A	N/A	N/A	N/A
	Upside Make Flexibility (days)	30	N/A	N/A	N/A	N/A	N/A
	Upside Deliver Flexibility (days)	4	N/A	N/A	N/A	N/A	N/A
	Upside Make Adaptability	30%	N/A	N/A	N/A	N/A	N/A
	Upside Deliver Adaptability	70%	N/A	N/A	N/A	N/A	N/A
	Downside Make Adaptability	100%	N/A	N/A	N/A	N/A	N/A
Supply Chain Costs	Total Supply Chain Management Cost (per R1000 Revenue)	R 148	16	R317.90	R67.24	R41.44	-80.7597
	Cost of Goods Sold (Cost to Make) (per R1000 Revenue)	R 772	9	R686.13	R540.75	R437.50	-230.9759
Supply Chain Asset Management	Cash to Cash Cycle Time (Days)	-92	30	98.25	71.95	38.25	163.9500
	Return on Supply Chain Fixed Assets	73.87%	9	125.00%	242.42%	302.61%	-168.55%
	Return on Working Capital	-121.02%	11	30.23%	43.64%	229.32%	-164.6609%
	Days Sales Outstanding (Days)	66	15	66.00	42.00	32.00	-24.0000
	Inventory Days of Supply (Days)	155	17	120.00	56.00	49.50	-99.0000
	Days Payable Outstanding (Days)	313	19	43.50	35.00	29.03	-278.0000
	Supply Chain Revenue (per R1000 Revenue)	R 213	13	R391.46	R162.09	R50.00	-50.4052
	Cost of Goods Sold (per R1000 Revenue)	R 772	9	R686.13	R540.75	R437.50	-230.9759
	Total Supply Chain Management Cost (per R1000 Revenue)	R 148	16	R317.90	R67.24	R41.44	-80.7597
	Supply Chain Fixed Asset Value (per R1000 Revenue)	R 288	13	R78.33	R126.48	R183.33	161.1887
	Sales Outstanding (per R1000 Revenue)	R 180	17	R247.50	R133.91	R87.67	-45.7155
	Payables Outstanding (per R1000 Revenue)	R 683	16	R90.85	R69.84	R58.10	-612.6740
	Inventory Value (per R1000 Revenue)	R 327	17	R208.38	R116.90	R75.00	-210.4000

Figure 12: On Time Delivery Performance Breakdown



Hall Longmore defines itself to be operating as make to order, however 43.2% of orders (not in terms of sales value) are filled from stock. The question needs to be asked why such a large percentage of order can be filled from stock if it is a make to order business. This may need some further investigation. Some employees even commented that as far as they are concerned, Hall Longmore actually makes to stock, referring to the amount of inventory being kept.

3.4.2 Supply Chain Responsiveness

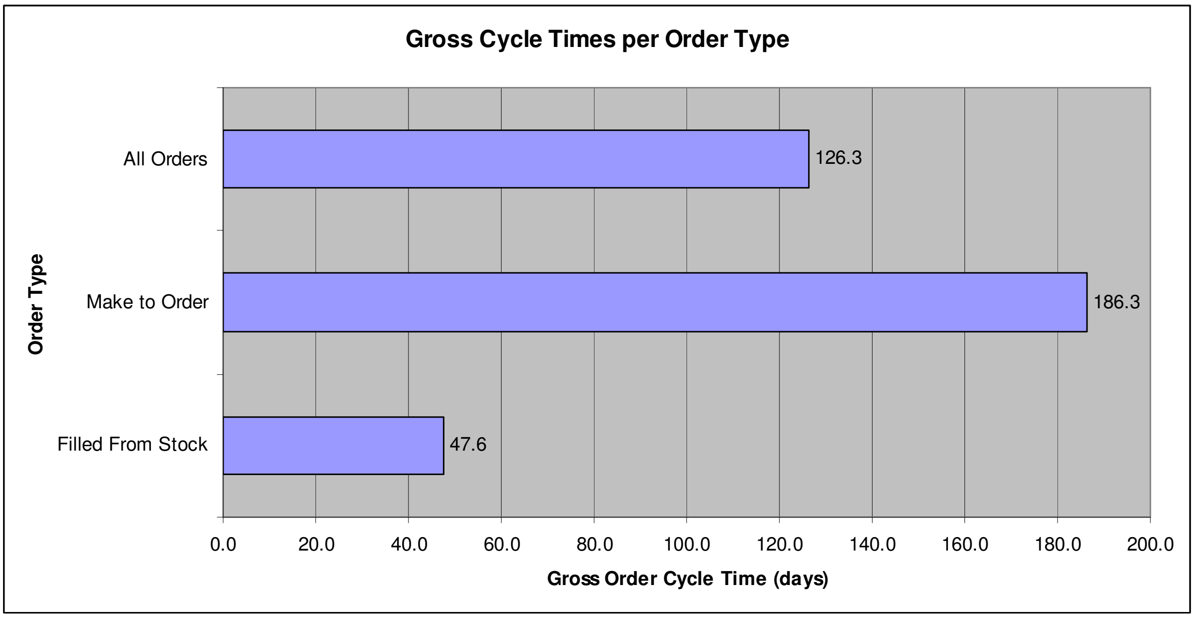
Supply chain responsiveness is an indicator of a supply chain's ability to respond to customer requests. It indicates the continuous average response time to events.

The level one metric in this category is order fulfillment cycle time. This metric is made up of 3 components that are added together. These components are the source, make and deliver. The elapsed time from when an order is placed to when it is delivered is considered to be the gross cycle time. This gross cycle time can be different than the order fulfillment cycle time as defined by SCOR. The average gross order fulfillment cycle time of Hall Longmore is 126.3 days. It should however also be noted that the median gross order fulfillment cycle time is only 58 days.

This gross cycle time includes orders filled from stock. This is different from what the order fulfillment cycle time would be as defined by SCOR which will include the source cycle time of steel which is an average of 103.76 days. Figure 13 illustrates breakdown of gross cycle time. For the 43.2% of orders filled from stock, the gross cycle time is 47.6 days and for orders that are made to order the gross cycle time is 186.3 days. Steel is only supposed to be ordered once an order has been placed and the effect of this can be seen in the 186.3 day order fulfillment cycle time for orders that are actually made to order. The parity in the industry for order fulfillment cycle time is 19 days which is much lower than that of Hall Longmore.

It should also be mentioned at this point that steel supply is the biggest driver for the order fulfillment cycle time and that the reliability and performance of this supply is very poor. Besides the average lead time for steel supply of 103.76 days there is also a standard deviation of 54.6 days, which means that planning is very hard to do and delivery promises are very hard to keep.

Figure 13: Gross Order Fulfillment Cycle Time



3.4.3 Supply Chain Flexibility

Supply chain flexibility indicates a supply chain's ability to respond to changing (market) conditions.

All of the values for these metrics were estimated by Hall Longmore’s Logistics Manager, taking into account idle capacity, time to acquire additional transport and labour etc. Determining actual values for these metrics is almost impossible as they mostly do not use historical data as input. Therefore the simplest, fastest and in my opinion, the best means for determining these values is for the people who know the company well and deal with issues on a regular basis to estimate them to the best of there ability. Sometimes the best guess is a much more efficient and cost effective method than determining the right answer.

Upside supply chain flexibility is a level 1 metric and is defined as the number of days required to achieve an unplanned sustainable 20 percent increase in quantities delivered. The estimated value for this metric is 30 days.

Upside supply chain adaptability is also a level 1 metric and is defined as the maximum sustainable percentage increase in quantity delivered that your business entity can achieve in 30 days. This is estimated to be 30% for Hall Longmore’s supply chain.

Downside supply adaptability is the last level 1 metric for this attribute and is defined as the maximum percentage reduction in quantities ordered that your business entity can sustain at 30 days prior to deliver with no inventory or cost penalties. Hall Longmore has orders for the next 3 months, therefore downside supply chain adaptability was estimated at 100%.

The rest of the metrics on the SCORcard for this attribute are level 2 metrics and the values can be found in Table 5. No benchmark data is included, because of insufficient sample sizes.

3.4.4 Supply Chain Costs

Supply Chain costs indicate an organization's ability to manage the costs associated with operating the supply chain. To make comparisons with industry benchamrks meaningful, monetary metrics are given in Rands per R1000 revenue.

Total supply chain management cost is the first level 1 metrics for this performance attriburte and is defined as the sum of the costs associated with the processes to Plan, Source, Deliver, and Return and is calculated as: sales - profits - cost to serve (e.g., marketing, selling, administrative). The total supply chain management costs for Hall Longmore is R148 per R1000 revenue., which is between the 25th and 50th percentile but still not in line with Hall Longmore's competitive requirements.

The second and last level 1 metric for supply chain costs is the cost of good sold. The cost of goods sold for Hall Longmore for 2008 was R772 per R1000 revenue which is well below the 25th percentile performer. This indicates that Hall Longmore has a high cost of goods sold, which reduces its profitability and competitiveness in the market.

The level 2 metrics that are of use to Hall Longmore are cost to plan, source, make and deliver. Besides the cost to make, which is the cost of goods sold, these are also hard to determine. Collecting transactional information, primarily resource expenses and operational "drivers" is necessary. If this information is available, the challenging task will be to logically transform these expenses into calculated costs of the "horizontal" processes based on cause-and-effect relationships without the temptation of using broad averages or arbitrary factors. The values of these level 2 metrics have not been determined as they are not deemed to be a priority when considering the competitive requirements that will be discussed later.

3.4.5 Supply Chain Asset Management

Supply chain asset management indicates the effectiveness of an organization in managing assets to support demand satisfaction. This includes the management of all assets: fixed and working capital.

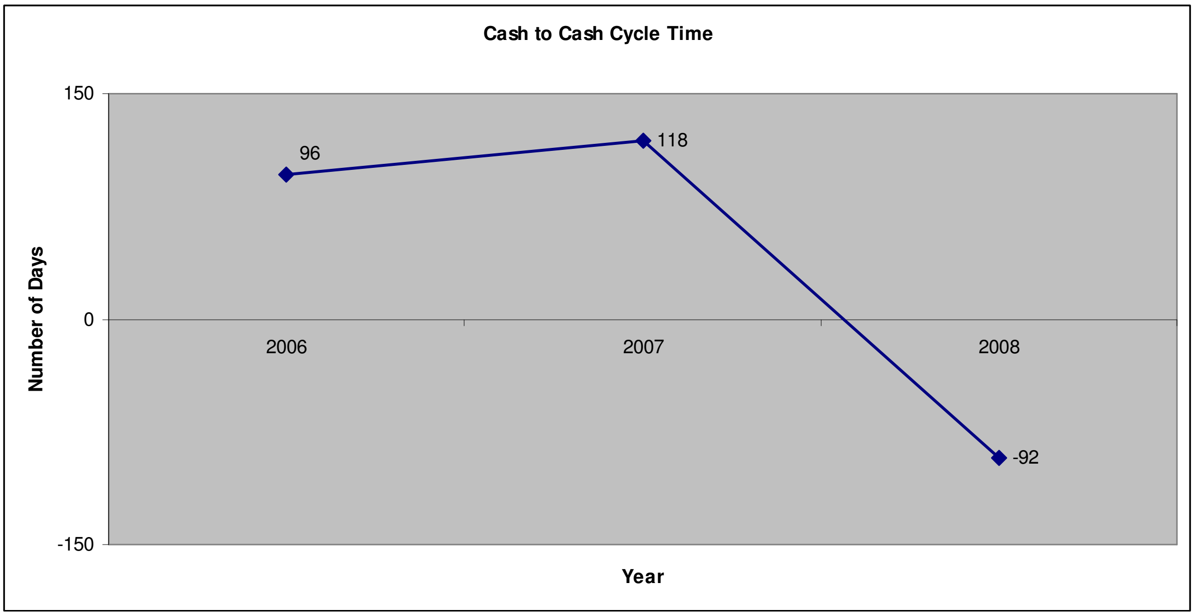
The first level 1 metric is cash-to-cash cycle time which is the time it takes for an investment made to flow back into a company after it has been spent for raw materials. A cash-to-cash cycle is the number of inventory days of supply plus days of sales outstanding minus the average payment period for materials. The value for Hall Longmore’s cash-to-cash cycle time is -92 days which is much better that its peers which seems to be out of place with the rest of the benchmarks.

Bierley (2008) states that: “While a shorter cash-to-cash cycle is generally considered a positive indicator of operating leaner, you need to look deeper to be sure. You can achieve shorter or even negative cycle times by means that are inconsistent with lean.”

Bierley (2008) goes on: “To properly evaluate your cash-to-cash cycle performance, you need to analyze your cycle time in conjunction with other information. First, always assess it over time. The trend of your cycle time is more critical than its value at a single point. Second, if you want to understand a point-in-time value, look to the typical cash-to-cash cycle for other businesses in your industry. You always want to have faster conversion cycles than your competitors.” Figure 14 shows the cash-to-cash cycle time over the last three years. It seems to have been stable and then drop dramatically during 2008. The large increase in payables for 2008 is a large factor for this seemingly very good cash-to-cash cycle time. The constantly decreasing “days sales outstanding” as seen in Figure 8 is also a factor albeit mush smaller.

Bierley (2008) goes on describing two cautions. Each explains a way you can achieve fast cash turnaround that would not be perceived as worthy or smart from a lean perspective. The first caution is the squeezing of suppliers. “Some companies shorten their cash-to-cash cycle and can achieve negative cycle times by squeezing their suppliers to accept long payment periods. From a lean perspective, such control strategies corrupt the extended value stream by pitting components against each other. On a purely pragmatic level, such squeezing can undermine the viability of your suppliers and do undermine your supply relationships.

Figure 14: Cash to Cash Cycle Time Over Time



Bierley (2008) states further: "Threatened and exploited suppliers are provoked to develop a counterbalancing force to offset your buying power. They will seek to dilute that power through commercial or political action that progressively erupts into full blown adversarial relationships" The large increase in payables for 2008 could very well be an indicator of this but further investigation is necessary. A failsafe check is to check the days payable outstanding. The ideal value from a lean perspective is actually zero days and Hall Longmore's days payable outstanding is actually 313 days.

The second caution is to make sure that increased performance in inventory turnover is also in line with lean thinking. As preciously determined Hall Longmore's inventory turnover performance is poor, thus this is not a misleading factor in the positive performance of cash-to-cash cycle time.

Return on supply chain fixed assets is the next level 1 metric and measures the return an organization receives on its invested capital in supply chain fixed assets. This includes the fixed assets used in Plan, Source, Make, Deliver, and Return. Hall Longmore's return on supply chain fixed assets is 73.9% which again is lower than that of the bottom performers in the industry.

The last level 1 metric is return on working capital and it is a measurement which assesses the magnitude of investment relative to a company's working capital position verses the revenue generated from a supply chain. For Hall Longmore this is -121.02% and is well below the 25th percentile in the industry. The negative value is again a result of the large increase in payables.

To evaluate the actual performance of all these metrics you need to know how you choose to compete in the market, which brings us to the competitive requirements.

3.4.6 Competitive Requirements

The competitive requirements assign targets to your supply chain performance attributes and the associated metrics. There are 3 possible targets. Firstly you can choose to perform at parity, which means your performance needs to be close to that of the median in your industry. Secondly you can choose to perform at an advantage level which will set your target at the 75th percentile in the industry. Lastly you can choose to perform at a superior level in which case you need to perform at the 90th percentile. The benchmark data for the 90th percentile is at this time not available, but is not crucial as achieving a superior level of competitiveness will only come some time after a company has reached parity and that would be the immediate goal of Hall Longmore at this stage. A company should choose to compete with one attribute at superior, 2 attributes at advantage and 2 attributes at parity.

Hall Longmore decided to compete at a superior level in terms of supply chain responsiveness. They will aim to achieve an advantage in supply chain reliability and flexibility and target parity for supply chain costs and asset management. It is ironic that for the performance attributes that are deemed as a priority, information is regarding actual performance is either hard to come by or non-existing. Furthermore it will be very hard to meet competitive requirements if parity is not even met on almost all metrics. But this SCORcard now gives Hall Longmore the information they need to place themselves in the competitive market and will help them to focus their attention where it is most needed to accomplish a competitive advantage.

3.5 AS-IS Material and Information Flow Analysis

This section will examine some details of material and information flow in the supply chain. It starts by examining the material flow from a logical and simplified point of view, moves on to the planning processes that exist and then brings these two together in the thread diagram.

3.5.1 Logical Map of Material Flow

The purpose of the logical map is to give a logical view of the supply chain in terms of material flow.

Figure 15 shows Hall Longmore's logical material flow map. It is interesting to note that stockists are part of the supply chain. There place in the market would be to stock certain pipes and therefore reduce the order fulfillment time of their customers, compared to when those customers would order from Hall Longmore. They are therefore stocking pipes at a premium so that customers can get their pipes faster. If 52.5% of orders at Hall Longmore are filled from stock, then they are actually fulfilling that same role as the stockists. It might be beneficial for all to look into the possibility of returning Hall Longmore to a purely make-to-order model and then collaborating with stockists and let them keep all the stock that isn't on order.

3.5.2 Planning Processes

Table 6 shows the planning processes that are done at Hall Longmore, including which SCOR process it relates to, the horizon of the planning and also the update interval. Sales and operations planning happens on a strategic level and is planned for 12 months in advance and is updated semi-annually. It relates to the SCOR process P1 which includes 4 sub-processes. The first is to identify, prioritize and aggregate supply chain requirements, then identify, asses and aggregate supply chain resources. Then you need to balance supply chain resources with supply chain requirements and lastly establish and communicate the supply chain plans.

Tactical planning is done in the form of quarterly forecasts and scheduling is done for 2 to 3 weeks updated every week.

Figure 15: Logical Map of Material Flow

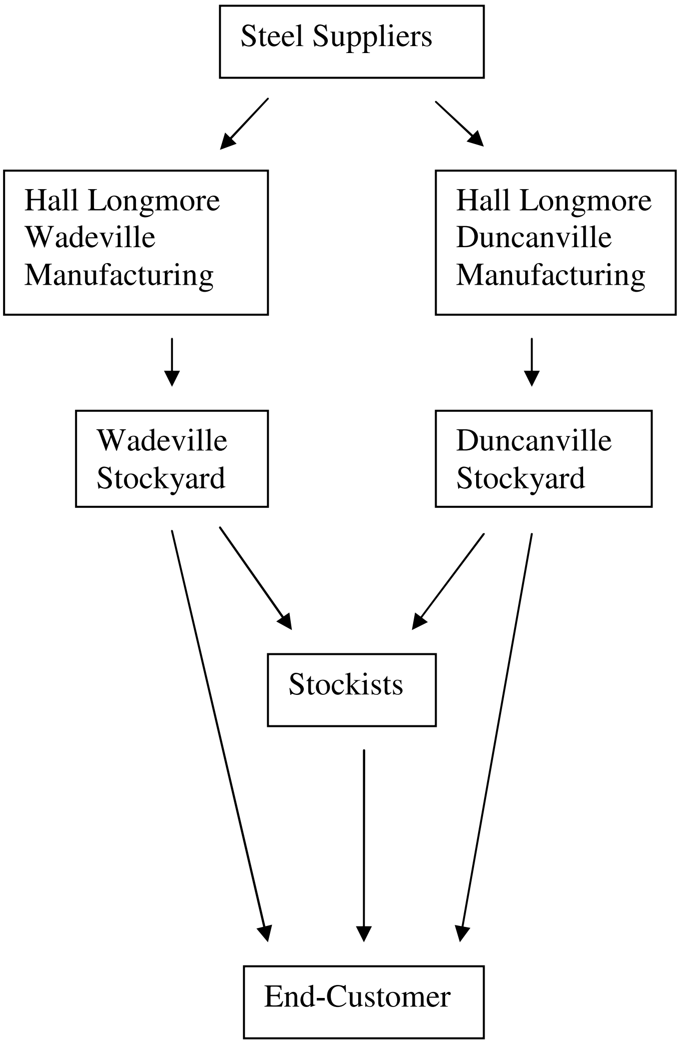


Table 6: Planning processes

	SCOR Processes	Horizon	Update Interval
Sales and Operations Planning	P1	12 months	6 months
Tactical Planning (Forecast)	P2,P3	1 quarter	1 quarter
Scheduling		2-3 weeks	1 week

3.5.3 Thread Diagram

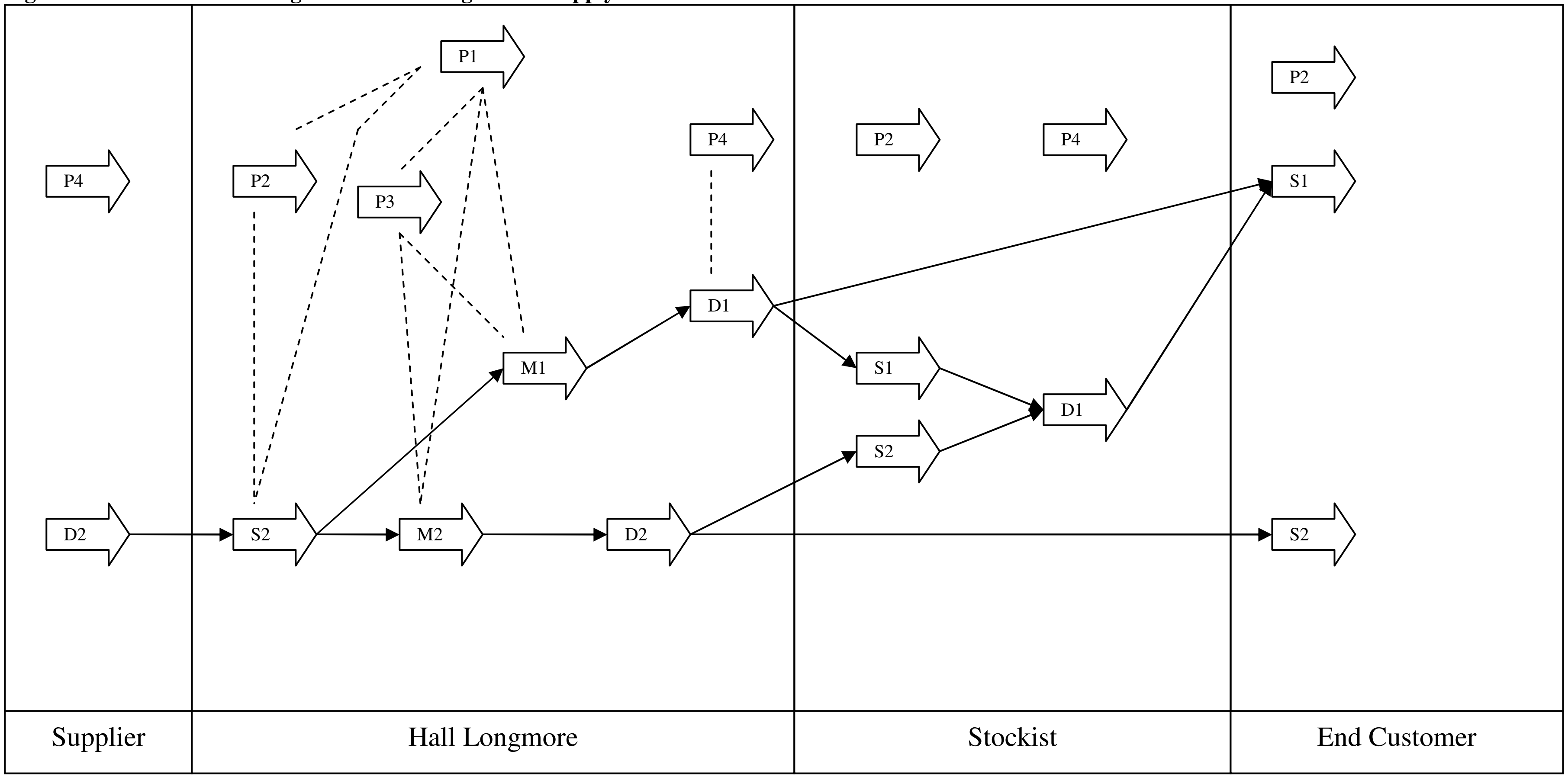
The thread diagram is a process view of the supply chain developed for SCOR that illustrates the material flow, material strategy and planning process relationships. Figure 16 shows Hall Longmore's thread diagram. Table 7 shows the SCOR level 2 processes. The relevant processes are shown in the thread diagram and solid arrows are used to illustrate material flow whereas dotted lines indicate information flow.

Table 7: SCOR level 2 processes

Plan		**Source**	
Process	*Description*	*Process*	*Description*
P1	Plan Supply Chain	S1	Source Stocked Product
P2	Plan Source	S2	Source Make to Order Product
P3	Plan Make	S3	Source Engineer to Order Product
P4	Plan Deliver		
Make		**Deliver**	
Process	*Description*	*Process*	*Description*
M1	Make to Stock	D1	Deliver Stocked Product
M2	Make to Order	D2	Deliver Make to Order Product
M3	Engineer to Order	D3	Deliver Engineer to Order Product

A couple of things can now be noted by looking at the thread diagram. The existence if the Make to order process at Hall Longmore is contradictory to their operating model. But the existence of this process is largely due to Hall Longmore attempting to improve customer service by reducing order cycle time. However this relates to inefficiencies in the supply chain and increased inventories, which from a lean perspective is seen as waste.

Figure 16: AS-IS Thread Diagram of Hall Longmore's Supply Chain



From this diagram one can also see that there is no real communication through the supply chain in terms of planning and this also contributes to the inefficiencies experienced. This results in pipes being manufactured for an order and then the stock sometimes stands for months on end before being shipped to the customer, because of poor communication and planning between customer and manufacturer. In addition, there is no information sharing between Hall Longmore and its suppliers in terms of planning which is detrimental to supplier lead times.

3.5.4 Coil Activity

Coil activity data was obtained from production reports for Hall Longmore's ERW plant in Wadeville which accounts for most of the manufacturing activities at Wadeville of the past year. Figure 17 shows the weekly closing stock, usage and received amount of coils in tons and Table 8 shows the average and standard deviation of these activities.

The graph shows a steady decline in coil stock for the first 30 weeks after which it goes into the negative for a couple of weeks. This is possible due the fact that coils can be exchanged between the facilities in Wadeville and Duncanville if necessary. After this period there was a large inflow of stock that could be either an overreaction due to the shortage of stock experienced or this could be due to simultaneous arrival of a number of purchase orders that were delayed. The latter would also explain the slump in stock around weeks 18 to 20.

It is however evident from the data that coil stock arrives on a regular basis, which is preferable over large quantities arriving at large intervals, because it leads to less inventory and thus less waste and reduced costs if managed properly. From the table it can be seen that the average weekly stock received was less than the actual usage of stock, which led to the steady decline in stock. This could indicate a planning error or again could be a result of poor supplier performance or even poor communication with the supplier. In the next section, some improvement suggestions will be put forward to help address the performance and efficiency problems that have been raised.

Figure 17: Steel coil activities for the last 12 months

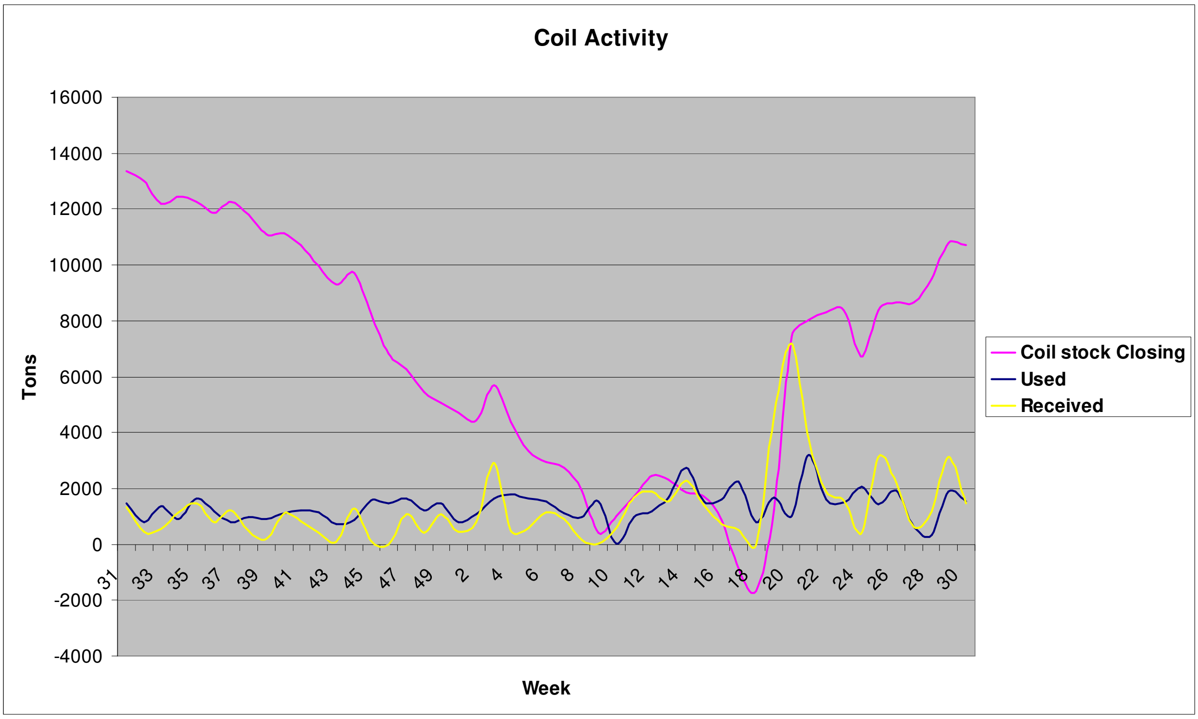


Table 8: Summary Statistics of Coil Data from Production Reports

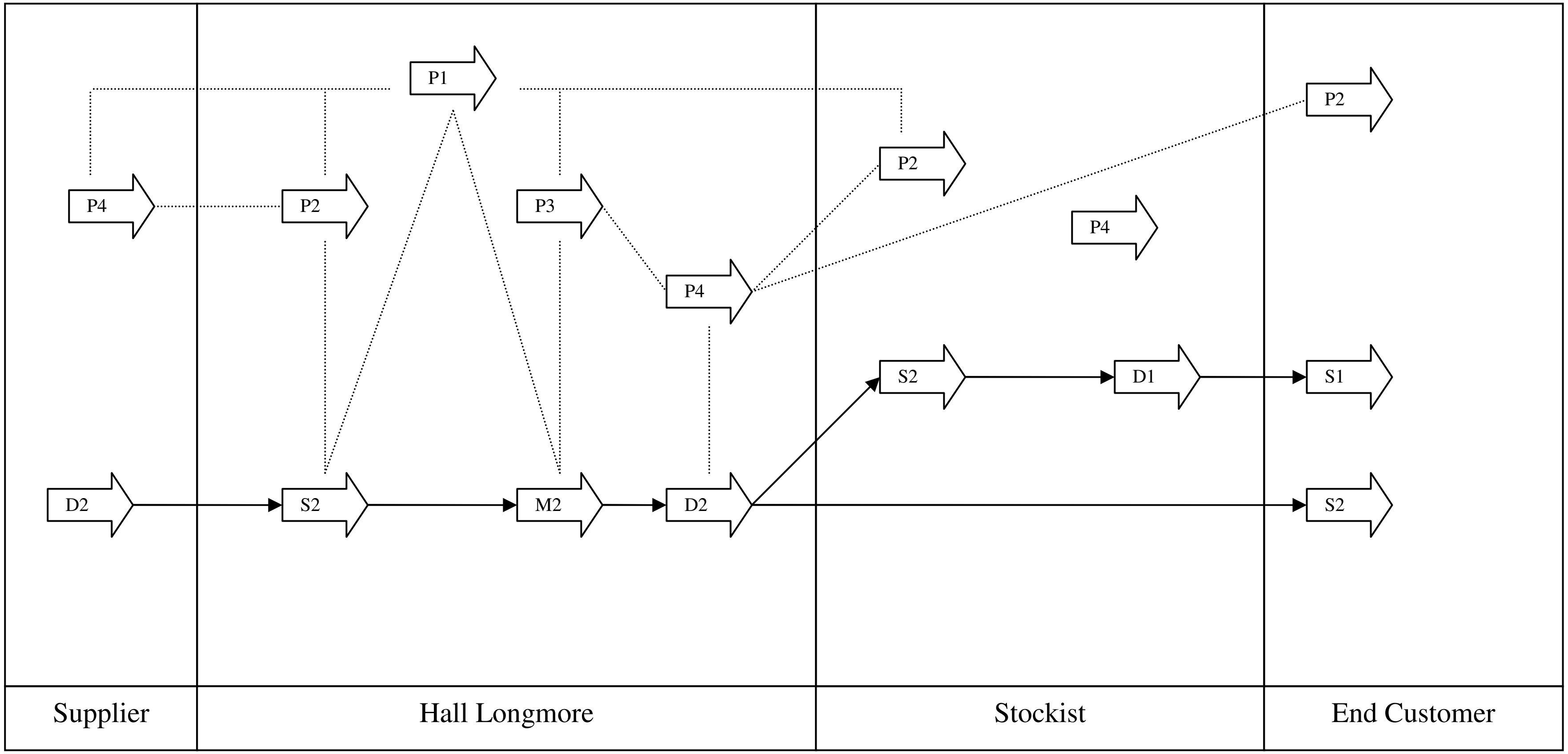
	Weekly Closing Stock	Weekly Usage	Weekly Stock Received
Average (tons)	6731.174245	1350.701	1293.238
Standard Deviation (tons)	4234.218334	554.4848	1319.262

3.6 Improvement Suggestions

3.6.1 Process Improvement

The first improvement that needs to be made is the restructuring of the supply chain processes and information flows. Figure 18 shows the suggested TO-BE thread diagram for Hall Longmore's supply chain.

Figure 18: TO-BE Thread diagram of Hall Longmore's Supply Chain



The first major process change is the removal of the make-to-stock process leg at Hall Longmore. The function of this process is to improve general customer satisfaction, by stocking pipes and reducing average lead times. The variability in supply and the inherent cost of keeping stock because of the high value of goods makes this a very costly and difficult exercise that generates waste not only in the form of inventory, but also in the form of process functions being duplicated in the supply chain. A general rule of thumb for inventory cost is to take 25% of its value and applying this rule means that Hall Longmore loses R66 million for inventory costs every year.

The thread diagram also shows that the removal of the make-to-order process need not decrease customer service, as customers will still be able to obtain stocked pipes from stockists. The crucial part of this is that Hall Longmore must collaborate with stockists, rather than viewing them as customers. This will allow them to take full control of a function in the supply chain in which they have more experience, knowledge and skills.

A number of effects can be expected. This strategy will not decrease sales, because pipes that would have been sold directly to customers from stock will now just first be sold to stockists on a make-to-order basis. The stockists however will see greatly increased sales due to taking over so many of direct-to-customer sales of Hall Longmore. Inventory at Hall Longmore will therefore be greatly reduced thus reducing waste and not sacrificing customer service which is crucial. A 40% reduction in inventory should be achievable and this would relate to a 47% increase in net profit, assuming 25% inventory costs.

Also illustrated in the TO-BE thread diagram is the increased information sharing between all stakeholders. Currently pipes tend to manufactured without the customer actually being ready to receive them. This leads to finished goods being kept at Hall Longmore for much longer than should be necessary. It is suggested that the manufacturing scheduling be planned in conjunction with the customers regarding when they are ready for delivery. This will also reduce inventory of finished goods.

Improved information sharing with suppliers, regarding planning, can also aid in the reduction of both lead times and variability. But in order for Hall Longmore to have a better view of order delivery performance and to plan better, some changes should be made to the information system.

3.6.2 Information Improvement

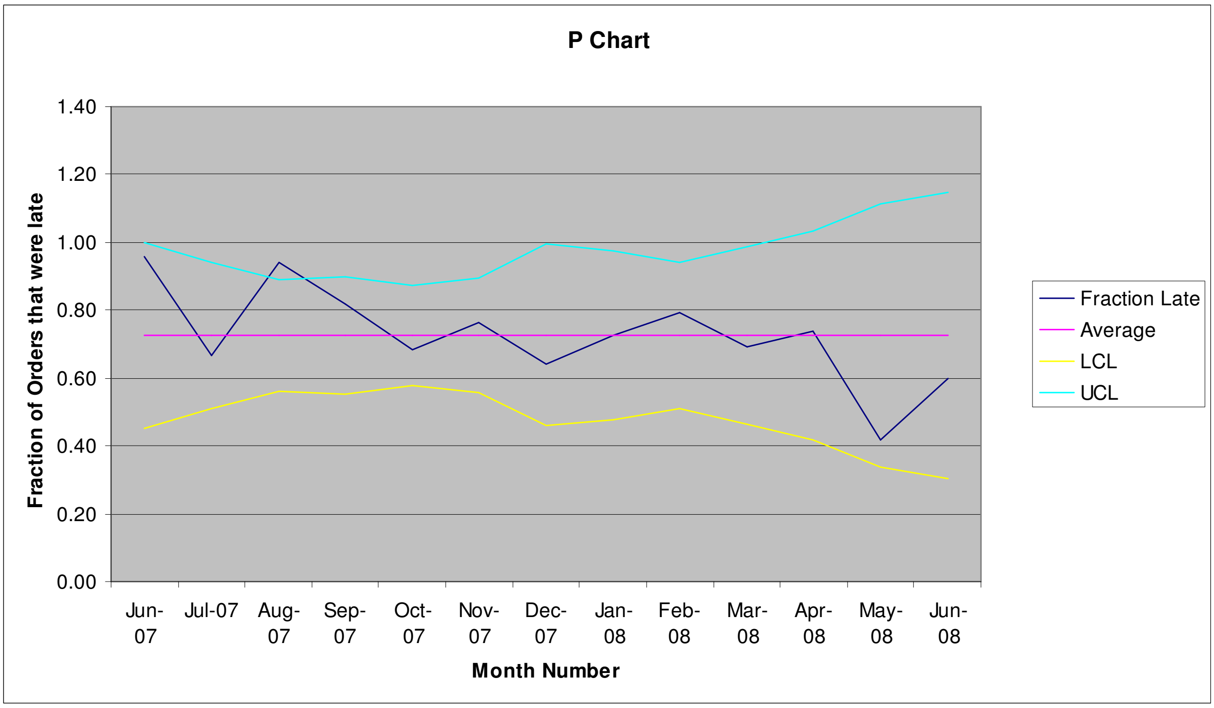
Currently, there is lack of good information regarding order performance. Some additional information should be recorded on sales orders. Firstly it should be stated for each order whether it was filled from stock or not. Secondly for each order, perfect order performance fields should be added which include whether delivery was on time, in full and in perfect condition. Control charts for all of these metrics can then be used to measure and control the process.

3.6.3 Delivery Performance Quality Control

A p-chart for variable subgroup sizes has been designed to control the fraction of deliveries that are late and this illustrates how six sigma can be used in supply chain management. Similar charts can be used for other metrics regarding perfect order performance once the necessary data is recorded.

The p-chart for the fraction of orders that are late for a certain month is given in Figure 19. It includes the fractions of orders that were late, average fraction late, upper control limit and lower control limit. From this chart it seems that although the fraction of orders that are late is very high, the process seems under control as all but one month's data fall within control limits. This means that promise dates for sales orders are too early, but seems to be consistently so. After having a look at the sales order statistics, the promise dates should be adjusted to more realistic values that are possible to keep and the process should be consistently monitored through the use of control charts.

Figure 19: P Chart for fraction of orders late per month



3.6.4 Monte Carlo Analysis for Procurement Strategy

A simple Monte Carlo simulation was designed to aid Hall Longmore in developing procurement plans for coils. The simulation views coils as a universal resource in terms of tons, as also currently used in production reports. Because of the fact that orders seem to arrive on a weekly basis, as seen from production reports, it is assumed for this simulation that there is a constant weekly order for coils and this can be given as input together with the current inventory at the start of the simulation. The simulation also accepts as input the purchase order lead time average and standard deviation and the average weekly usage of coils in tons together with its standard deviation. The input box is shown in Figure 20. The simulation then runs by generating random numbers from the normal distribution for the activities of usage and receiving of stock. A warm-up period of 50 weeks is included to allow for normalization of the purchase orders and the simulation then runs for 100 weeks and is repeated 500 times. When there is a stock out, the scheduled usage for that week runs over to the next week.

Figure 20: Inputs used for the Monte Carlo analysis

INPUTS

				Average	STDEV
Weekly order (tons)	1350.7		**Order Lead Time (days)**	103.76	54.65
Starting Inv (tons)	4050		**Usage (tons)**	1350.7	554.5

Figure 24 in appendix D shows an example of the output generated by the simulation. The simulation gives three graphs as output. The first graph gives the cumulative probability that there will be stock-outs for a certain percentage of weeks. The second graph gives the cumulative probability for average stock and the last graph plots the average inventory that corresponding stock-out percentage for the repetitions.

To illustrate how different inputs affect the output, three trial runs were done and their outputs summarized onto the same graphs. Table 9 shows the inputs used. Weekly orders were set to equal the weekly usage of 1350.7 tons. For the first run starting inventory was set to 4050 tons and order lead time and average set to what is currently experienced by Hall Longmore. For the second run the starting inventory was reduced to 1350.7 tons and for the third run the standard deviation of the order lead time was reduced to 14 to illustrate the benefit of reducing process variability.

Table 9: Input data for trial runs

		Run 1	Run 2	Run3
Starting Inventory		4050	1350.7	1350.7
Weekly Orders		1350.7	1350.7	1350.7
Order Lead Time	Average	103.76	103.76	103.76
	Standard Deviation	54.65	54.65	14
Weekly Usage	Average	1350.7	1350.7	1350.7
	Standard Deviation	554.5	554.5	554.5

Figure 21 shows the cumulative probability for average stock for the three runs. It shows that reducing the starting inventory reduced the average inventory and when lead time variation was reduced then average inventory was reduced even further by a considerable margin.

Figure 21: Cumulative Probability for average coil stock trial runs

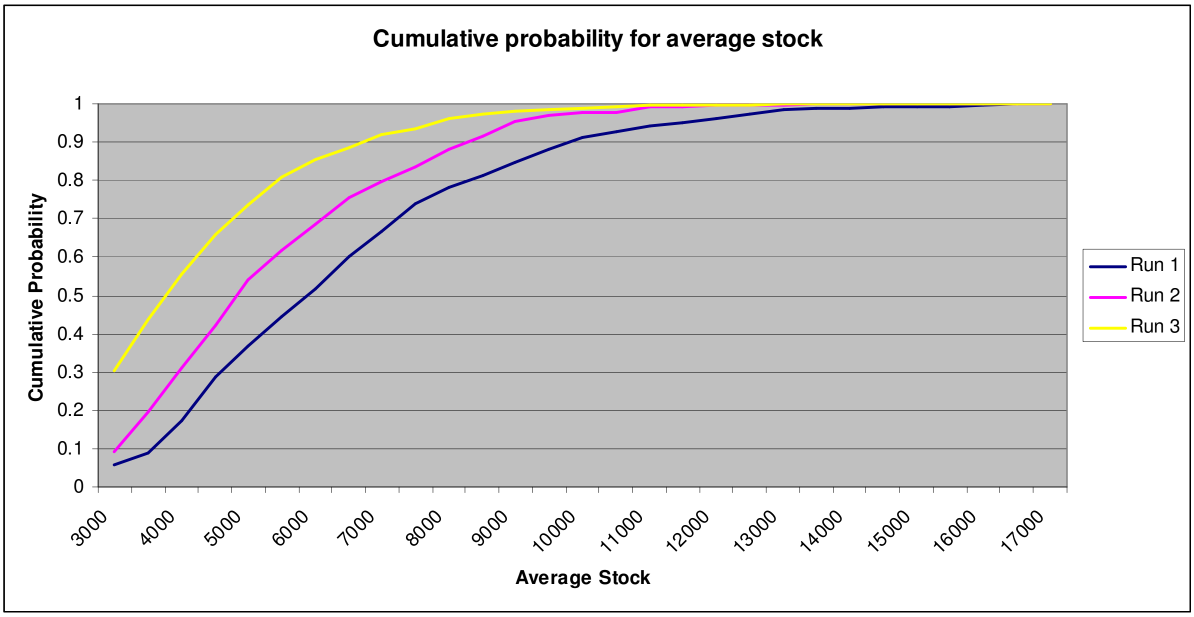


Figure 22 shows the cumulative probability for the percentage of weeks that a stock-out is experienced. Where the starting inventory was 4050 for run 1, the stock-out percentage was much lower that for the other runs, this at a cost of higher average inventories as seen in the previous graph. When the starting inventory was reduced without addressing lead time variability in run 2, the chance for stock-outs increased more than for run 3 where lead time variability was also reduced.

Figure 23 shows the plot of average inventory for the average stock-out percentage. For example for run 3, when the average stock-outs were 10% in the repetitions, the average inventory was 2730 tons. This graph shows that high average inventory goes along with less stock-outs, and that with the current inputs you can expect to get outputs somewhere in the range of the trend line included in the graph. From this graph it is clear that run 3 gave the best results.

This simulation is very simplified and is not intended to provide an optimal solution for procurement of steel coils, but rather to assist with decision making and compare different scenarios. It also demonstrates the principle of and pay-off for reduction in variation visually.

Figure 22: Cumulative Probability for percentage of weeks without stocks trial runs

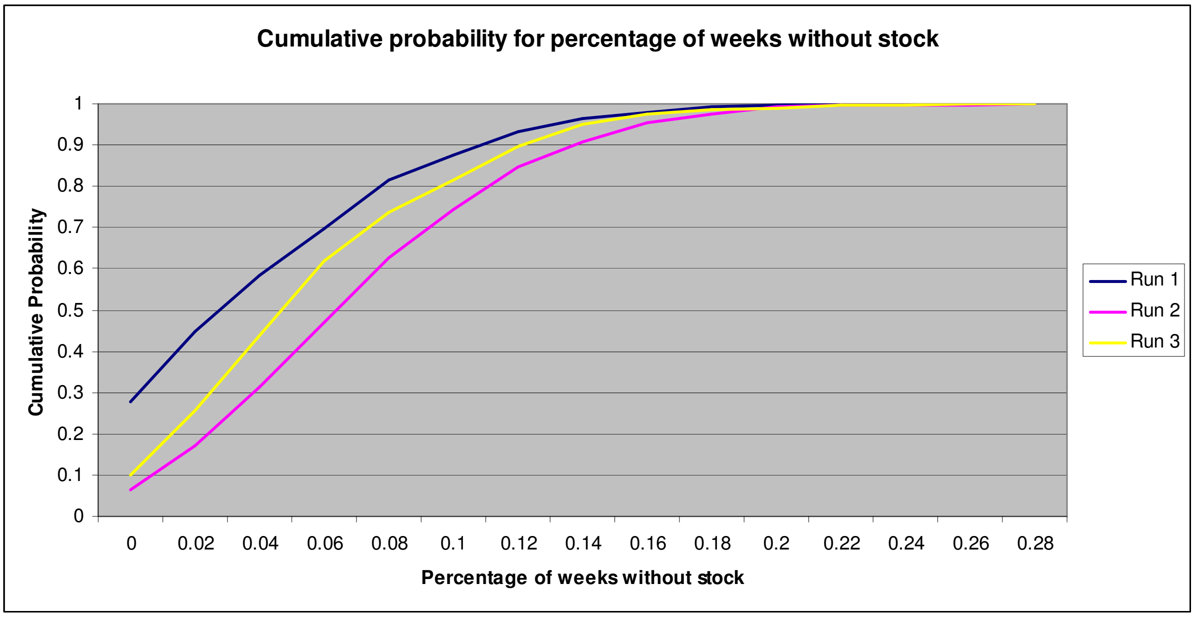
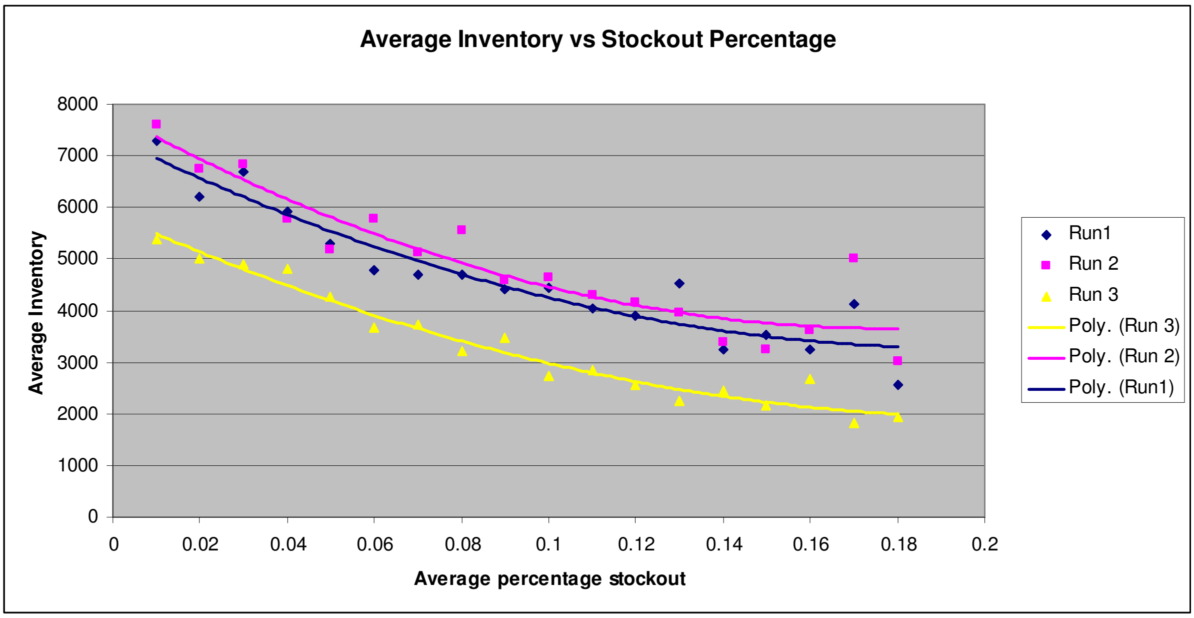


Figure 23: Plotted graph of average inventory versus the average percentage stockout



4 Conclusion

Unfortunately for Hall Longmore, their financial and supply chain performance is not on par with its peers, but the upside of this is that it leaves a lot of room for improvement and large improvements can be made rapidly without large capital expenditures.

Financial ratio analysis and benchmarking helped to get an understanding of the financial status of Hall Longmore and how it compared to its competitors. The SCOR metrics in conjunction with benchmarking data obtained from SCORmark proved very useful in determining and comparing the performance of Hall Longmore's supply chain. It was also demonstrated how lean and six sigma can be used in conjunction with the SCOR framework to analyze and improve a supply chain.

The inefficiencies in the supply chain became very evident when looking at the thread diagram for Hall Longmore and by removing unnecessary processes, improving communication, and collaborating with stockists, waste will be significantly reduced to ensure that Hall Longmore and its entire supply chain becomes leaner.

By capturing all the necessary data regarding perfect order fulfillment and controlling them through the use of six sigma tools such as control charts, Hall Longmore can track its performance and ensure that the process is under control. One can only improve something if you measure it.

And finally it was shown how a simple Monte Carlo simulation can help Hall Longmore plan its procurement and also help to demonstrate how positive an impact a reduction in variation can have on a process.

By using all these tools, Hall Longmore now has a much better picture of how their supply chain looks and its performance compared to its peers and by implementing the few improvement suggestions put forward in this project, they should see rapid and significant results. Costs can be reduced by reducing waste and these savings can be translated to more competitive prices to increase their competitiveness amidst increasing competition and additionally, reduced costs can help improve the company's poor liquidity.

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6 Appendix A – Balance Sheet

	2008	2007	2006
ASSETS			
Non Current Assets			
Property, plant and equipment	229,678,605	79,652,149	88,384,980
Investments	1,598,587	4,212,127	4,470,501
	231,277,192	83,864,276	92,855,481
Current Assets			
Inventories	261,312,790	246,099,440	200,425,246
Trade Receivables	125,530,773	188,572,363	157,326,588
Other Receivables	17,882,178	15,433,529	
Cash and Cash Equivalents	53,961,000	43,412,483	17,975,520
Restricted Cash	5,846,896	6,894,878	227,608
	464,533,637	500,412,693	375,954,962
Total Assets	695,810,829	584,276,969	468,810,443
EQUITY			
Shareholders Equity			
Group Equity Loans in Credit	90,359,655	90,359,655	90,359,655
Total Equity	90,359,655	90,359,655	90,359,655
LIABILITIES			
Non Current Liabilities			
Deferred Taxation Liabilities/(assets)	-10,003,808	-506,377	9,406,819
	-10,003,808	-506,377	9,406,819
Current Liabilities			
Provisions - Current	16,894,617	33,379,837	5,448,443
Trade Payables	25,998,652	17,285,953	1,686,304
Accruals and other Payables	501,872,298	160,329,478	212,857,486
Current Tax Liabilities	17,044,417	11,766,951	32,177,856
Bank Overdraft			15,049,955
Branch/JV distributions payable	18,445,311	1,126,245	32,153,362
Group Call Loans on Credit	35,199,687	270,535,227	69,670,562
	615,454,982	494,423,691	369,043,968
Total Liabilities	605,451,174	493,917,314	378,450,787
Total Equity and Liabilities	695,810,829	584,276,969	468,810,442

7 Appendix B – Income Statement

	2008	2007	2006
Total Net Turnover	798,399,870	875,541,154	532,706,632
Direct Costs/Cost of Sales	-616,148,749	-748,648,298	-433,821,657
Gross Profit	**182,251,121**	**126,892,856**	**98,884,975**
Sundry Revenue	43,427,171	5,809,548	3,192,511
Marketing and Selling Costs	-517,116	-351,525	-387,973
Distribution Costs	-12,586,324	-12,769,163	-14,556,776
Administration Costs/Overheads	-105,921,305	-53,375,576	-32,909,864
EBIT	**106,653,547**	**66,206,140**	**54,222,873**
Exeptional Items			-825,556
Non-Group Interest income/(expense)	482,784	314,937	469,063
Group interest income/(expense)	-29,431,248	-11,207,887	-4,673,593
EBT	**77,705,083**	**55,313,190**	**49,192,787**
Taxation	-22,543,772	-17,029,945	-14,253,402
Profit/(Loss)	**55,161,311**	**38,283,245**	**34,939,385**

8 Appendix C – Financial Ratios and Industry Data

Table 10: Calculated Financial Ratios

Financial Ratio	2006	2007	2008
Current Ratio	1.02	1.01	0.75
Quick Ratio	0.48	0.51	0.33
Inventory Turnover	2.16	3.04	2.36
Average Collection Period (Days)	107.80	85.05	65.56
Average Payment Period (Days)	138.11	114.33	339.80
Total Asset Turnover	1.14	1.50	1.15
Debt Ratio	0.81	0.85	0.87
Gross Profit Margin	18.6%	14.5%	22.8%
Operating Profit Margin	10.2%	7.6%	13.4%
Net Profit Margin	6.6%	4.4%	6.9%
Return on Total Assets	7.5%	6.6%	7.9%
Return on Equity	38.7%	42.4%	61.0%
Assets/Sales	0.88	0.67	0.87

Table 11: Industry Data for Financial Ratios (Fintel, 2008)

	Percentile				
Financial Ratio	10th	25th	50th	75th	90th
Current Ratio	1.33	1.33	2.27	3.78	5.3
Inventory Turnover	0.3	4.13	7.24	9.15	16.4
Average Collection Period (Days)	68.4	68.4	46.54	35.24	11.8
Net Profit Margin	-16.1%	0.0%	2.0%	7.0%	26.6%
Assets/Sales	0.82	0.75	0.59	0.44	0.35

9 Appendix D – Example Output for Monte Carlo Analysis

Figure 24: Example output of Monte Carlo simulation