

The Efficiency of the Container Shipping Industry and the Development of a Performance Measurement System

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Declaration

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Executive Summary

An efficient container shipping industry is something every country strives toward. Continuous improvement in this industry is of utmost importance in order to grow a country's economy. One of the objectives of this research study is to determine the inefficiencies that exist within the South African container shipping industry. A lot of these inefficiencies cannot be eliminated by a single organisation, but require the cooperation of all the parties in a supply chain.

Currently there is not enough interaction between the organisations in the supply chain apart from limited contact with direct customers and suppliers. The aim of the performance measurement system is to drive organisations throughout the supply chain to focus on the areas that require the most improvement. If inefficiencies are identified, the parties concerned should jointly come up with action plans to address these inefficiencies. This research study will focus mostly on the Cape Town region.

The performance measurement system (PMS) developed in this study can be used to improve supply chain efficiency. Existing PMSs were researched in order to develop a system that is applicable to the container industry. Research of the industry was done with the aid of questionnaires, interviews, surveys and a focus group.

The benefits of such a system should be carefully explained to representatives of the organisations in the industry to attract their participation. The success of the system is highly dependent on how well the parties in the supply chain participate, as it is only then that the efficiency of a supply chain can be measured. Management representatives were asked to indicate which key performance indicators they are measuring. This information was used as a basis for the study. There are various parties that are currently busy with similar studies, which emphasises the increased need for a supply chain PMS in the container shipping industry.

Two case studies were identified that will benefit from a PMS. BMW's manufacturing plant in Rosslyn and the fruit export industry in the Cape Town region were used as examples of integrated supply chains. The PMS can be easily adapted in order to apply it to other corridors or commodities.

Opsomming

'n Doeltreffende houer verskepingindustrie is iets waarna elke land streef. Konstante verbeterings in die industrie is baie belangrik vir 'n land se ekonomie. Een van die doelwitte van hierdie navorsingsprojek is om te bepaal wat die ondoeltreffendhede in die houer verskepingindustrie is. Baie van hierdie ondoeltreffendhede kan nie deur een organisasie opgelos of geïlimineer word nie. Dit moet deur die hele voorsieningsketting gesamentlik gedoen word.

Daar is tans te min samewerking tussen organisasies in die voorsieningsketting. In die meeste gevalle werk organisasies slegs met hulle onmiddellike kliënte en verskaffers. 'n Voorsieningsketting meting-stelsel sal verseker dat daar op die regte aspekte gefokus word. As 'n ondoeltreffendheid geïdentifiseer word, is dit die verantwoordelikheid van die hele voorsieningsketting om te verseker dat die ondoeltreffendheid geïlimineer word. Dit sal beslis samewerking bevorder. Die navorsingsprojek fokus meestal op Kaapstad.

Bestaande meting-stelsels was geondersoek om 'n stelsel te ontwikkel wat van toepassing is op die houer verskepingindustrie. Navorsing was gedoen deur middel van vraelyste, onderhoude, opnames en 'n fokusgroep. Die doel van die meting-stelsel is om organisasies regdeur die voorsieningsketting te dryf om te fokus op die areas wat die meeste verbetering benodig.

Die voordele van die stelsel moet noukeurig aan die bestuursverteenvoordigers van die organisasies in die voorsieningsketting verduidelik word sodat hulle sal deelneem aan die inisiatief. Die sukses van die meting-stelsel hang af van hoeveel organisasies sal deelneem. Die doeltreffendheid van 'n voorsieningsketting sal eers werklik gemeet kan word as daar 'n redelike groot belangstelling vanaf die industrie is. Bestuursverteenvoordigers was gevra om aan te dui watter prestasie-aanwysers hulle tans meet. Hierdie inligting was gebruik as 'n basis vir die studie. Daar is tans verskeie partye wat besig is met soortgelyke navorsing. Dit beklemtoon die feit dat 'n voorsieningsketting meting-stelsel werklik nodig is vir die houer verskepingindustrie.

Twee gevalle studies was geïdentifiseer dat hulle sal voordeel trek uit die implementering van 'n voorsieningsketting meting-stelsel. BMW se Rosslyn voorsieningsketting en die vrugte uitvoer industrie in Kaapstad was gebruik as voorbeelde van geïntegreerde voorsieningskettings. Die meting-stelsels kan maklik aangepas word vir ander kommoditeite.

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GLOSSARY

3PL	Third Party Logistics Company
ASN	Advanced Shipping Notification
AHP	Analytical Hierarchy Process
BSC	Balanced Scorecard
CI	Consistency Index
CLOF	Container Liners Operating Forum
CSCM	Centre for Supply Chain Management
CSI	Customer Service Index
CTCT	Cape Town Container Terminal
CTQI	Container Terminal Quality Indicator
CR	Consistency Ratio
DCT	Durban Container Terminal
DEDAT	Department of Economic Development and Tourism
DPE	Department of Public Enterprises
DTI	Department of Trade and Industry
DTS	Department of Technology and Science
EDI	Electronic Data Interchange
EU	European Union
EVA	Economic Value Added
Exco	Executive Committee
FEU	Forty Foot Equivalent Unit
FFA	Freight Forwarders Association
FPEF	Fresh Produce Exporters Forum
GCH	Gross Crane Hour
GDP	Gross Domestic Product
GIL	Global Institute of Logistics
HCA	Harbour Carriers Association
ICT	Information and Communications Technology
JIS	Just In Sequence
JIT	Just In Time
KPA	Key Performance Areas
KPI	Key Performance Indicators

MECE	Mutually Exclusive, Collective Exhaustive
MSC	Mediterranean Shipping Company
Navis SPARCS	Container Terminal Operating System
NCT	Ngqura Container Terminal
Opco	Operations Committee
PECT	Port Elizabeth Container Terminal
PMS	Performance Measurement System
PPECB	Perishable Produce Export Control Board
Reefer	Refrigerated Container
RI	Random Index
ROCE	Return on Capital Employed
SACD	South African Container Depot
SAP	Business Management Software Solutions, Applications and Services
SCC	Supply Chain Council
SCOR	Supply Chain Operating Reference Model
Short shipment	A unit that was not shipped on the intended vessel, left behind in the origin port
SOE	State Owned Enterprise
SPARCS	Synchronous Planning and Real-time Control System
SWH	Ship Working Hour
TEU	Twenty Foot Equivalent Unit
TFR	Transnet Freight Rail
TNPA	Transnet National Ports Authority
TPT	Transnet Port Terminals
US	University of Stellenbosch
ZAR	South African Rand

1. Introduction

1.1 Problem statement

The efficiency of the container shipping industry is of great importance to the economy of South Africa, however, there are a number of inefficiencies that exist within container shipping that a single organisation is unable to eliminate. Currently there is not enough interaction between organisations in the South African container industry apart. A need for a supply chain performance measurement system was thus identified to ensure that focus is directed towards elements in the supply chain that require the most improvement. If such a performance measurement system can be developed, the role players should jointly come up with action plans to meet and improve the standards set by the measurement system. This research study will focus mostly on the Cape Town region and the inefficiencies that exist in this area, but can easily be expanded into other areas and commodities.

1.2 Objectives of the study

The objective of this study is to research and evaluate the inefficiencies that exist within the container industry to determine which areas need to be improved. A performance measurement system will be developed as an outcome to this study. The aim of the performance measurement system will be to drive organisations throughout the chain to focus on the areas that require the most improvement.

1.3 Methodology of the study

The literature study was divided into three phases. The first phase entailed studying the container shipping industry and the planned developments in South Africa. Forecasts of the global container throughput growth and planned developments in the industry were researched. The second phase entailed studying the shipping supply chain framework. Processes as well as supplier and customer relationships between organisations were investigated. The third phase included studying existing performance measurement systems that are used within different industries. This was done to determine whether performance management would contribute effectively to the success of the shipping industry.

From this, a performance measurement system was developed. The information required to develop the performance measurement system was collected in four ways; questionnaires,

interviews, focus groups and research of the available literature. Questionnaires were used to obtain general information on the focus areas and performance measurement techniques of the organisations. Specific data on the performance measurements was also obtained by organising personal interviews with management representatives of some of the organisations. The cost structure of the organisations was also researched to build a model to determine what each organisation adds to the eventual cost of exporting a container. Furthermore, many of the inefficiencies experienced on a daily basis by managers working in the container shipping industry were discussed in a focus group and used as valuable input to the research.

King [24] reported that “for South Africa to become and stay competitive internationally, the logistics and supply chain sector will need to step up and improve its overall performance”. Using the obtained information, a performance measurement system was developed that will stimulate improvements within the industry.

The following chapter will give an insight into trade as a broad topic as well as containerised trade. The role players in the industry will be identified and the recent developments and trends in the industry will be discussed.

2. Background to containerised trade

This chapter will discuss the origins of international trade and how it has developed until now. The South African shipping industry is discussed. The role players in the industry are identified and the recent developments in the industry are deliberated on.

2.1 International trade

International trade started when products produced or services produced in one country were required in another. The international economy has changed dramatically since international trade started developing and has caused countries to grow more and more interdependent. Former US President Bill Clinton said in a speech at the World Economic Forum in 2000 that Japan and the nations of South-eastern Europe were “poor, largely rural societies 50 years ago. Today, they are prosperous global leaders, in no small measure because of trade. South Korea, Mexico or Thailand, who built their growth on openness even after the recent traumas of financial crises; their national incomes are still more than double the 1970 levels. Their gains in literacy, education and life expectancy are truly extraordinary, far outpacing countries that chose not to open to the world.” [40].

Trade seemed to expand even more after the new millennium as different economies started to integrate more. This phenomenon in the global economy is called globalisation and will be elaborated on more. There is a positive and a negative viewpoint of globalisation. The positive viewpoint is that with the opening of new markets, knowledge is shared, the efficiency of resources is increased, more opportunities exist for the people and poverty is alleviated [7]. International export volumes increased at a constant rate between 1950 and 1955 due to international trade. After 1955 the growth rate increased rapidly so that by the mid 1970's exports was five times what it was in 1950. According to Mohr *et al.* [7], world export volumes were more than 1000% of the 1950 level at the beginning of 1990. The negative viewpoint is that there are many risks. The market vulnerability to international or foreign trends increases and increased competition makes it challenging for small companies to rise up and compete against global players. The type of trade that takes place today has changed a lot since the 1950's. Trade has changed from agricultural products, raw materials and a few simple manufactured goods to more complex and advanced manufactured products and services [7].

Former US President Bill Clinton also said in 2000 that “those who wish to roll back the forces of globalisation because they fear its disruptive consequences I believe are plainly wrong. Fifty years of experience shows that greater economic integration and political cooperation are positive forces. Those who believe globalisation is only about market economics, however, are wrong, too. All these new networks must lead to new arrangements that work for all; that work to spur growth, lift lives, raise standards, both around the world and within a nation” [40].

2.2 Globalisation

A definition of globalisation is a closer contact between societies, a compression of time and space, dissolution of boundaries, integration of markets, and the displacement of local and national factors in people’s lives by trans-national ones [4].

Buckman [1] states that globalisation did not happen intentionally. It started because one country needed the products produced in another or because another country could produce it at a cheaper price. One reason why globalisation has evolved is because multi-national corporations and businesses span over multiple countries [1]. Companies are no longer limited to the countries in which they were established. The various parts of one product can be sourced from a number of countries and can be assembled in a different country. Companies are able to look at the global market to find the producer that can supply them with the best product/service based on cost, quality or lead time.

China is one of the leading countries when it comes to exporting products produced at a low cost. This creates a problem for the rest of the world as other countries cannot compete with the low prices of Chinese products. Cote [76] and Wadhwa [91] states that the reasons for the low prices are a growing technological expertise and low wages for both skilled and unskilled labour. Chinese wages have been increasing due to workers demanding an increase in wages, but wages still remain relatively low when compared to other countries [83]. China experiences an industry growth rate of more than 10% per year [76, 83]. China has become a key player in the export market and is playing a vital role in globalisation. The challenge for the rest of the world is competing with “low labour costs, a seemingly unlimited supply of labour, a highly educated workforce, rapidly increasing costs of commodities and resources as well as a competitor poised to become the economic power worldwide” [76].

The fight between globalisation and localisation is an on-going one. The British Prime Minister, Tony Blair said in 1998 that “globalisation is irresistible and irreversible” [1]. This statement is believed to be false by those that fight for anti-globalisation, which is also referred to as localisation. They believe that there are alternatives to globalisation and that the advantages of localisation far outweigh that of globalisation. Buckman [1] states that the anti-globalisation movement consist of a number of individuals and organisations that strive pro-actively towards empowering the local economy. Former US President Bill Clinton also mentioned some of the advantages of globalisation. He stated that “open markets and rules-based trade is the best engine we know of to lift living standards, reduce environmental destruction and build shared prosperity” [40]. Globalisation and free trade create jobs, spark innovation and spread technology which would otherwise have stayed in the country that developed it [40].

2.3 The current state of international trade

Goods were mainly traded on a bulk and break-bulk basis before containers were used [19]. It was a slow process to load and off-load vessels and frequent damages occurred. Herod [20] stated in a study done in 1998 that handling containers is nearly 20 times faster than handling break-bulk and that it uses almost a third of the amount of labour required for a break-bulk operation.

The first container vessel was loaded in 1956. This was the idea of a trucking company owner, Malcolm McLean. He had the idea that transporting goods via the ocean would be much more efficient if one unit or box could be transported to a vessel and loaded directly without having to unload the contents. The very first container vessel was loaded with only 58 containers and set off from Port Newark, New Jersey to Houston, Texas [75].

The world container trade has been growing at a substantial pace. According to Heymann [21], the international container shipping industry grew at just under 10% p.a. on average between 1990 and 2005. The main reason why this sector showed such immense growth is due to a substantial increase in demand. The production of goods that are high in value and suitable for transportation in a container has increased. The fact that vessels have increased in size and that the total time to load and off-load vessels has decreased dramatically since containers were first introduced, also played a role in the growth of this sector.

According to Heymann [22], global container throughput has recovered from the recession the world experienced in 2009 as shown in Figure 1. Container throughput decreased by nine percent in 2009 and increased by 11% in 2010. Heymann [22] forecasted that the global container throughput will grow between seven and eight percent from 2011 until 2015 (see Figure 2).

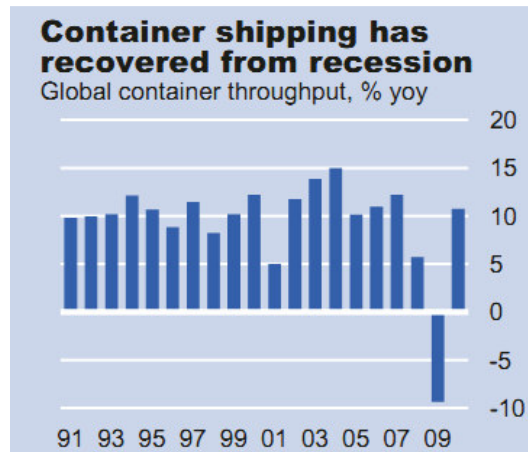


Figure 1 - Year on year % change on global container throughput

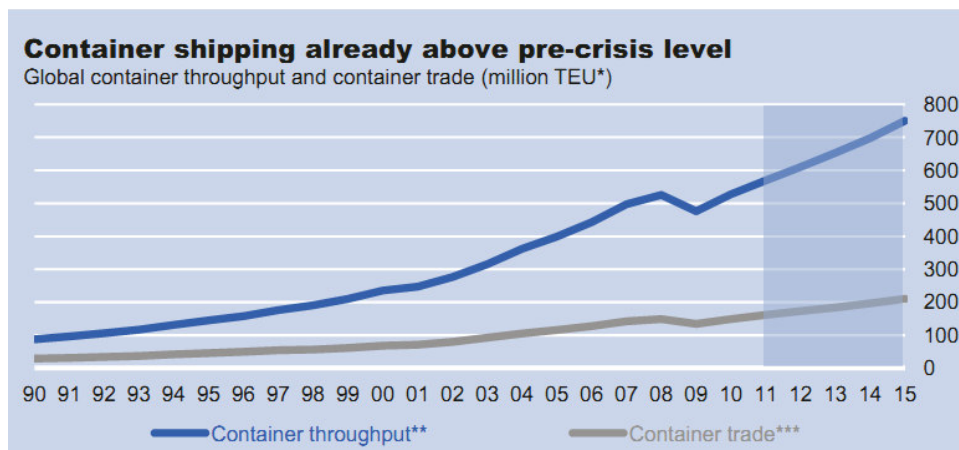


Figure 2 - Annual container throughput growth from 1990 – 2010

2.4 The shipping industry in South Africa

As previously discussed in section 2.2, a major effect of globalisation is that markets and countries are brought closer together. South African companies have been expanding gradually, first into the rest of Africa, and then into the global market. According to the

and Industrial Research (CSIR), the main reasons for manufacturing companies to expand into Africa and international markets are access to new markets, expanding businesses, diversification and improving competitiveness. Companies refining natural resources and agricultural products may expand in order to:

- Access more natural resources.
- Have increased control over value chains.
- Increase privatisation opportunities.
- Decrease the cost of production.

The expansion of South-African companies into Africa is referred to as the “South-Africanisation” of Africa [11].

Risks are taken when changes are made to any business. The risks, according to the CSIR [11], that are taken when expanding a company into the rest of Africa are:

- The availability and condition of physical infrastructure may not be up to standard.
- The business environment may be different.
- Transportation cost may be high.
- Information and communications technology (ICT) may not be as developed.
- Supply chain and logistical challenges may be very complex.
- The quality of the labour force may be different.

Managing these risks is complex in most cases and the failure to manage these risks can lead to an unsuccessful venture.

Smaller companies are forced to enter the global market to keep up with the competition of the larger companies, but often do not have the necessary resources and knowledge of dealing with the international market. It is often not cost effective to invest in the resources that will be required to manage these logistical functions. Many companies therefore make use of external parties who specialises in providing cost-effective logistical functions. These external parties are referred to as third party logistics companies.

The World Bank released the results from the second survey that was used to determine the Logistics Performance Index (LPI) of the participating countries in 2010 [35]. The survey focused on six performance areas in the logistics industry, which were:

- The efficiency of the customs clearance processes.

- The quality of trade and transport-related infrastructure.
- The ease of arranging competitively priced shipments.
- The competence and quality of logistics services.
- The ability to track and trace consignments.
- The frequency with which shipments reach the consignee within the scheduled or expected time.

The LPI survey shows that South Africa was ranked 28th in terms of international logistical competitiveness, narrowly missing the 27th place to China. If the results from the previous survey performed in 2007 is compared to the latest survey results which was released in 2010, it shows that South Africa's LPI rating increased from 3.46 to 3.53 and the ranking from 24th to 28th (see Figure 3). S South Africa was ranked as the top logistics performer if the high income countries are excluded, thereby outperforming all African nations, but if compared to high-income competitors, there is still a lot of room for improvement [35].

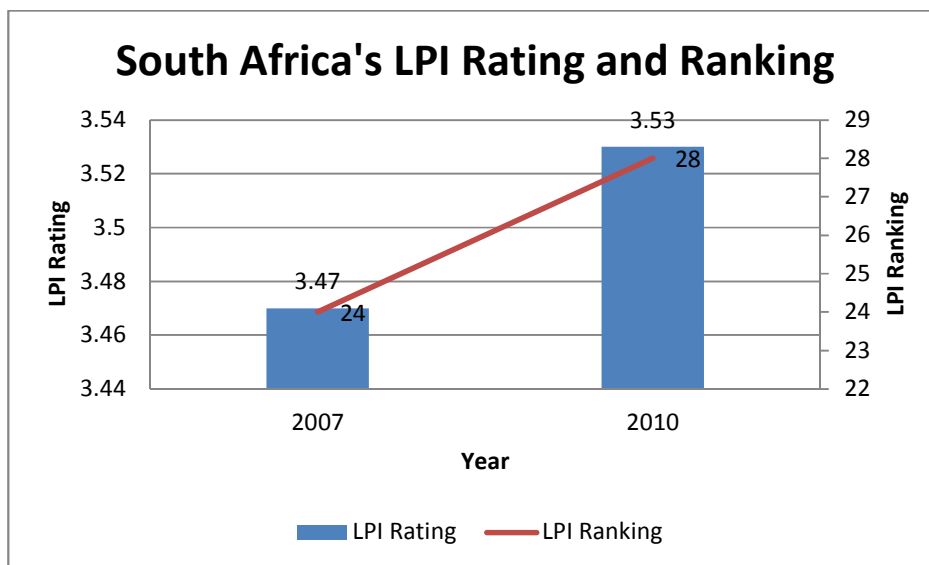


Figure 3 - South Africa's LPI Rating and Ranking

Globalisation has forced countries to progress on the logistical front and to make “uninterruptible supply chains” possible. According to the World Bank, the logistics industry is dominated by 25 large corporations in the maritime, port and air freight segments. The World Bank stated that a trade supply chain is only as strong as its weakest link and in order

to improve the entire supply chain, the focus should be on identifying the weak links and on the improvement thereof [35].

The CSIR reported that logistics costs in South Africa decreased as a percentage of the country's GDP from 2007 to 2009, as seen in Figure 4 [19]. The CSIR researchers believe that the downward trend was not due to improvements made on the logistical front, but mainly due to logistics operators utilising spare capacity that existed within the organisations more efficiently. The combined effect of the decrease in the fuel price and interest rate in 2009 also positively influenced logistics costs. There is still significant room for improvement within this industry. South Africa's logistics cost at a percentage of GDP was at 13.5% in 2009, while the United States of America's was at 7.7% [19].

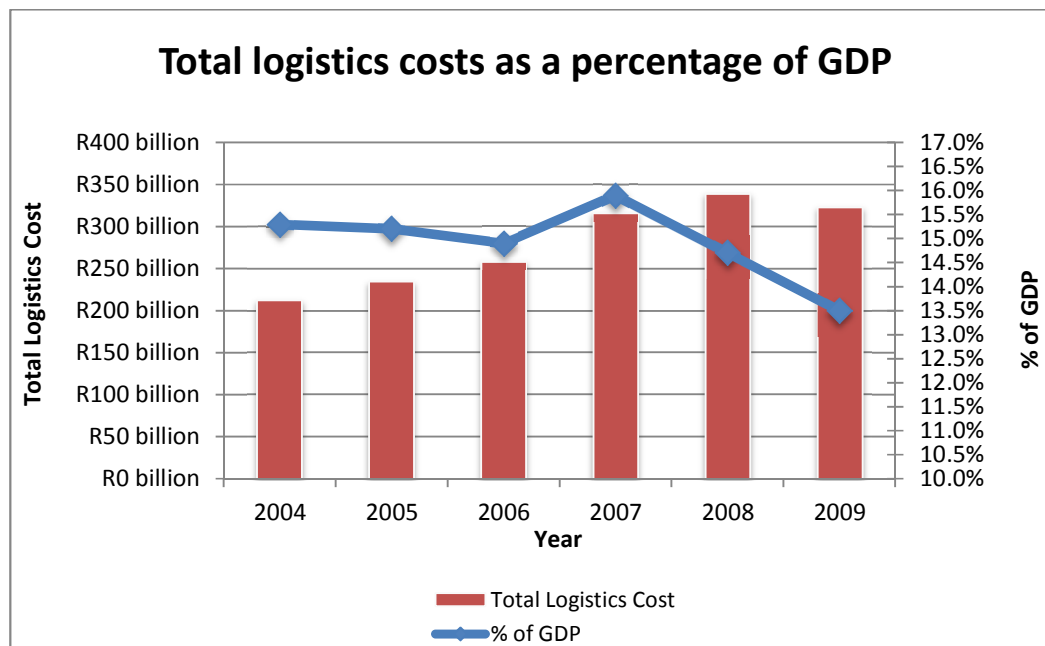


Figure 4 - Total logistics costs as a percentage of GDP

Logistics cost is split up in four main elements, as seen in Figure 5 [19], which are:

- Inventory carrying cost.
- Storage and ports.
- Management, administration and profit.
- Transportation cost.

Transport is still the main contributor to logistics costs and contributed 50% of the logistics costs in 2008.

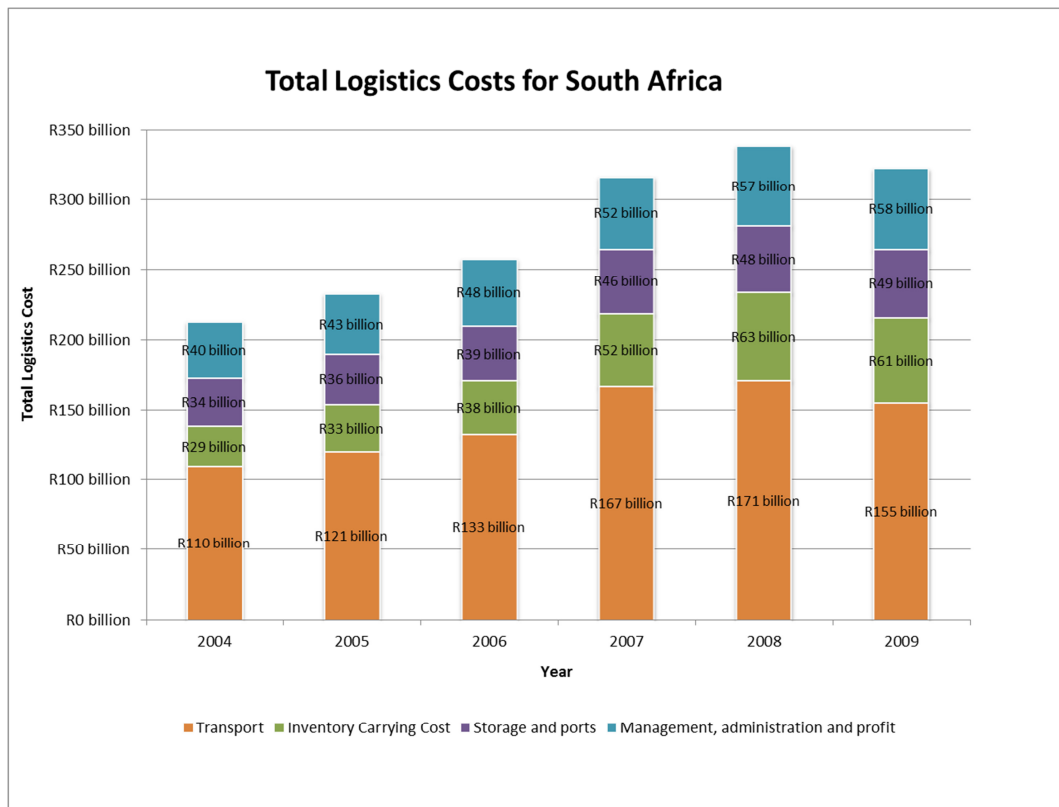


Figure 5 - Stack elements of South Africa's logistical costs

2.5 Role players

The role players in the South African container shipping industry are:

- Importers/exporters
- Clearing and forwarding companies
- Logistics companies
- Shipping lines and vessel agents
- Trucking companies
- Storage depots
- Customs
- Packing facilities
- Cold stores
- Port authorities
- Container terminals
- Rail transporter

The previous paragraph lists the main role players that should cooperate to make this industry efficient in order for the country to compete internationally.

A big portion of the industry is controlled by state-owned, Transnet. Transnet consists of five divisions, namely:

- Transnet Port Terminals
- Transnet Freight Rail
- Transnet National Ports Authority
- Transnet Rail Engineering
- Transnet Pipelines

The organisational structure of Transnet can be seen in Figure 6 [71]. The five divisions operate the country's freight railway system, ports and pipelines.

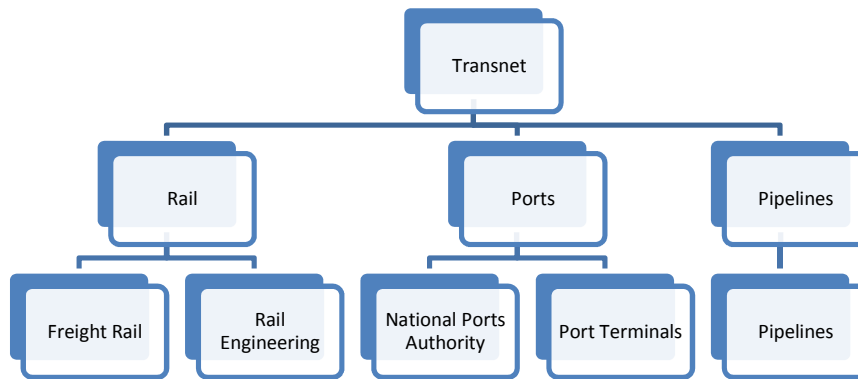


Figure 6 - The five core operating divisions of Transnet

2.6 Recent developments in the industry

Containerised trade has changed significantly since the 60's. At the 5th Asean Ports and Shipping Conference in June 2007 Johari [42] presented that 60% of the world trade is containerised. Currently it is estimated that approximately 90% of non-bulk cargo is transported in containers [81]. This increase in containerised cargo will result in an increase in the level of traffic at the world's ports. Therefore container handling terminals need to be prepared for this increase.

The focus of the industry has shifted to cost minimisation. Shipping lines aim to ship a container at the lowest cost by using larger vessels and thus making use of economies of scale. Container terminal operators are under great pressure to operate at high productivity levels and to turn vessels around in the shortest possible time.

Some of the trends in the industry will be discussed in the next sections. These trends are:

- Shipping lines ordering larger vessels.
- Mergers between shipping lines.
- Shipping lines operating as container operators.

2.6.1 Size of vessels

The trend shows that container vessels are increasing in size. The six generations of vessels are presented in Figure 7 [49]. Currently the largest vessel generation in existence is the super post panama plus class (sixth generation vessels), which can transport more than 8,000 TEU's. The larger the vessel, the more the shipping lines will benefit from

economies of scale and a reduced cost per TEU slot. The vessel draft¹ also increases as the vessel size increases, and therefore the draft of the ports where the vessels are docking need to increase. Vessels larger than 10,000 TEUs accounted for 48 percent of the vessels on order in October 2011 and vessels between 7,500 and 9,999 TEUs accounted for 21 percent of the vessels on order [70]. The average size of new container vessels in the year 2000 was only 2,900 TEUs compared to 6,100 TEUs in 2011 [70].

Generation (Year Range)	Vessel Type	Length	Draft	TEU
First Generation (1956-1970)	Converted Cargo Vessel	135 m	< 9 m	500
	Converted Tanker	200 m		800
Second Generation (1970-1980)	Cellular Containership	215 m	10 m	1,000 – 2,500
Third Generation (1980-1988)	Panamax Class	250 m	11-12 m	3,000
		290 m		4,000
Fourth Generation (1988-2000)	Post Panamax	275 – 305 m	11-13 m	4,000 – 5,000
Fifth Generation (2000-2006)	Post Panamax Plus	335 m	13-14 m	5,000 – 8,000
Sixth Generation (2006-2012)	Super Post Panamax Plus	360 m	14-16 m	>8,000

Figure 7 - The six generations of vessels

The largest container vessels that are currently used to move cargo have a capacity of between 12,000 and 14,000 TEUs. It is estimated that by the end of 2012, the largest container vessel will have a capacity of 16,000 TEUs and by the end of 2013 this will increase to 18,000 TEUs [70]. The smaller vessels (less than 4,000 TEU's) are mostly used to provide a feeder service to the smaller ports and to move transshipment cargo [70]. The deployment of the different size vessels from 2007 to 2010 can be seen in Figure 8 [42]. The amount of vessels and the capacity of these vessels have increased significantly

¹ The draft of a vessel refers to the distance between the vessel's waterline and the lowest point of the vessel. The draft will change if the vessel becomes heavier or lighter.

since 1980. More fully cellular vessels² are in operations. These vessels have a competitive advantage above the multi-purpose vessels being that they have cell-guides³ which allow for faster loading and off-loading.

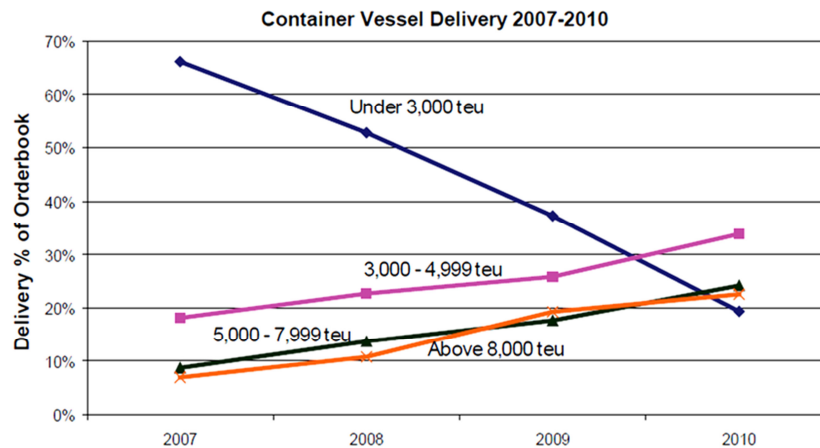


Figure 8 - Deployment of larger vessels

2.6.2 Shipping lines

A few new trends are also evident in shipping lines. Smaller shipping lines are amalgamating to form large alliances that can better compete in the market. Shipping lines are also finding that if they control the container terminals they can better manage delays and keep cost as low as possible. These two trends will be discussed in the following paragraphs.

2.6.2.1 Mergers between shipping lines

The current trend in the shipping industry is to merge dominant role players in the shipping industry to form a combined company with an even larger competitive advantage and a larger market share. This started with Dutch transportation company, Nedlloyd Line and British shipping line P&O Containers in 1997 [82]. These two companies merged to form P&O Nedlloyd Ltd. This was not the end of the restructuring of this company as another big merger occurred between P&O Nedlloyd Ltd and AP

² A fully cellular vessel is specially designed for the efficient storage of containers on top of each other with cell guides throughout all the bays on the vessel.

³ Cell guides are vertical bracings on a vessel that assists the crane operator by guiding the container between the bracings into a specific slot.

Moller Maersk [79]. This merger occurred due to the fact that the merged company would be the largest shipping company in the world with a combined world market share of approximately 18%. As per Figure 9, AP Moller Maersk (APM-Maersk) owned 15.4% of the global container TEU capacity in July 2011 [90].

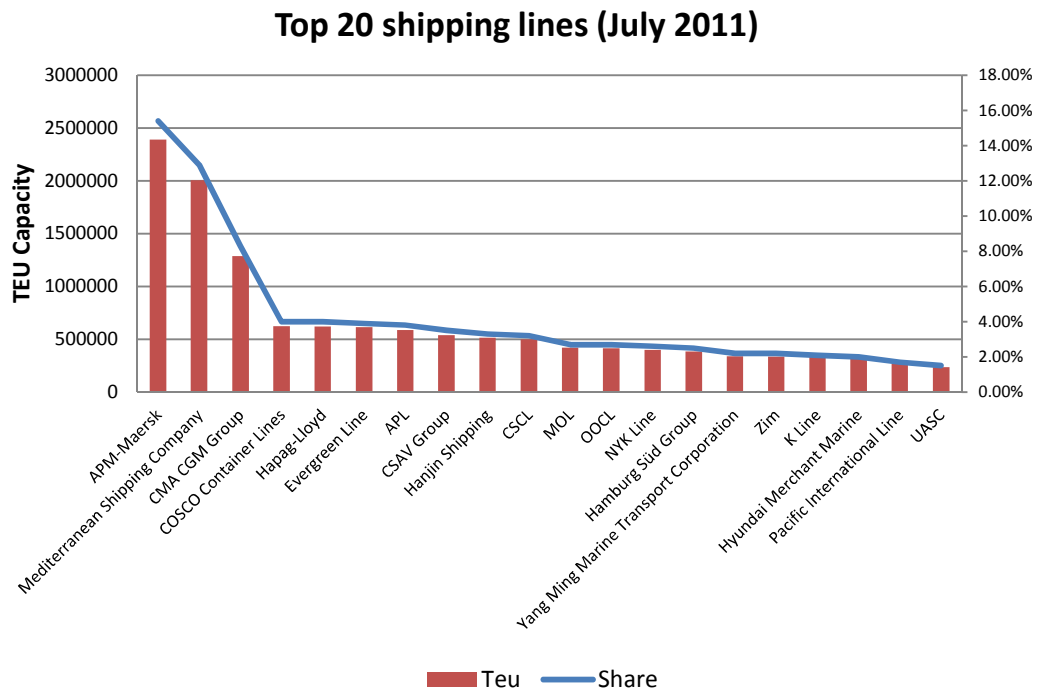


Figure 9 - Top 20 shipping lines

The reasons for the merger as reported to the Competition Tribunal of the Republic of South Africa were [79]:

- To consolidate the shipping industry that mostly works in silos.
- To make full use of economies of scale.
- To improve service delivery.
- To generate returns to attract continued investments.

Large company mergers which have taken place can be seen in Figure 10 [42]. Johari [42] states that “there is a continuous trend for consolidation since the last decade. Today the top 10 liners handle approximately 55% of global container trade. Industry projected continued consolidation through mergers and acquisitions.”

Year	Acquirer	Target
1996	CMA	CGM
1997	Hanjin	DSR-Senator
1998	Evergreen	Lyod Triestino
1998	Hamburg Sud	Allianca
1999	A.P. Moller	Safmarine
1999	Hamburg Sud	Transroll Nav S.A
1999	A.P. Moller	Sea-Land
2000	CSAV	Norasia
2002	Hamburg Sud	Ellerman Services to Med/India
2003	Hamburg Sud	Kien Hung Shipping Co.
2005	A.P. Moller	Royal PONL
2005	CMA-CGM	Bollere (Delmas)
2005	TUI/Hapag Lyod	CP Ships

Figure 10 - Mergers in the shipping industry

2.6.2.2 Shipping lines diversifying their service offerings

Shipping lines are investing in ports and more specifically, container terminals. Shipping lines find it best if they have control over the scheduling of vessels and the management of port delays. According to Johari [42] the benefits of carrier-owned port operators lie in:

- Ensuring sufficient port capacity.
- Enhancing their port call efficiencies.
- Optimising their value chain cost.
- Diversifying their income stream.

Container shipping lines are not the only entity in the supply chain that is diversifying their service offerings to the importer or exporter. Many of the role players in the industry are realising that control of more than one aspect of the supply chain can be what puts them ahead of their rivals. Integration between the various organisations is much better when there are fewer links in the chain. Communication is more established and processes flow more fluently. Cost is also positively impacted because fewer transfers of responsibility from one organisation to another leads to a decrease in cost throughout the chain [46]. The illustration in Figure 11 shows how the container trade supply chain is slowly moving from a chain with multiple role players, each with their own specific function, to a chain where the larger role players start to control more than one function and eventually the entire supply chain [46].

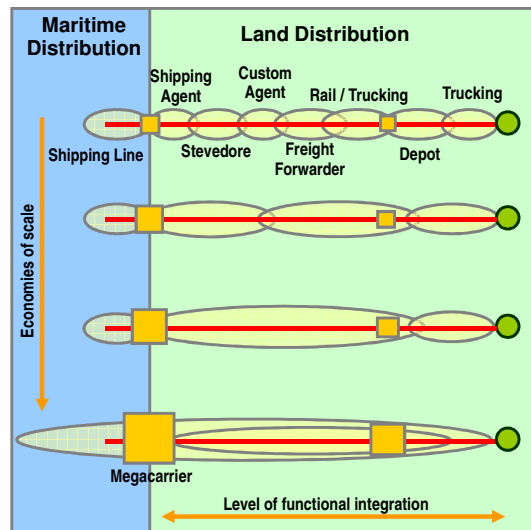


Figure 11 - Functional integration of the shipping supply chain

In South Africa, we are currently at a stage where the larger shipping lines are involved not only in the shipping aspect of the chain, but also in the road haulage, storage (depots) and logistical/freight forwarding activities. The Mediterranean Shipping Company (MSC) is an example of a company that currently offers additional services under the subsidiary company of MSC Logistics. These services are [80]:

- Full third party logistics management (including raw materials).
- Cross-docking operations.
- Container de-stuffing.
- Freight management (including import/export).
- Bar-coding and radio-frequency (RF) solutions.
- Provision of full range of applications software.
- Inventory management system.
- Freight and distribution management system.
- Dangerous goods/food grade to AIB standards.

Multiple functions being performed by one entity can mean a decrease in cost to the importer/exporter and they only have to deal with one party.

2.6.3 Third party logistics companies

Recently customers prefer multimodal solutions for their global shipments. They require an integrated approach to the entire process and they need someone to manage their shipments on their behalf. Therefore companies make use of the services of third party logistics (3PL) companies to perform their logistical activities. The 3PL industry has grown at a rapid pace worldwide as more companies have opened their doors to foreign markets. By outsourcing these administrative and often very complex tasks, companies can focus on their core competencies and meet the demands of the markets in which they find themselves.

By making use of a 3PL, companies can benefit from economies of scale. 3PLs manage the logistical activities of multiple companies and do not have separate resources dedicated to each one. This lowers the logistical costs. The cost of distributing goods also decreases considerably. The fifteenth Annual Third Party Logistics Study showed that outsourcing these logistical activities to 3PLs reduced a firm's logistics cost on average by 15% [27]. 68% of the shippers partaking in this survey also indicated that 3PLs provide them with new and innovative ways to improve their logistics effectiveness [27].

3PL companies are often responsible for arranging the transportation, packing, storage and shipment of products. By outsourcing these logistical activities to a 3PL, companies can focus on keeping "their supply chains current, flexible, and adaptable" [27]. Outsourcing these activities will suit companies that experience a seasonal demand, for example companies that are in the fruit exporting business. In these instances the logistical activities can be outsourced as and when required. The exporting company therefore focuses on the core function of its business and on identifying new business opportunities.

3PL companies can make use of freight forwarding companies for the transportation leg of the supply chain. Freight forwarding companies are specialists in transporting goods via road, rail, air and ocean and control approximately 75% of all less than container load⁴ shipments via sea [74].

⁴ A 'less than container load' is consolidated in a container with other shipper's cargo. It is cost effective if the shipper does not have enough cargo to fill a container.

2.7 Infrastructure development in the South African shipping industry

Transnet is currently implementing a five year R80.5 billion capital investment plan for the South African transportation sector for the period 2010 to 2014 as stated in the Transnet Capital Investment Report [71]. The capital investment plan includes the investment in infrastructure and human resources. Transnet's investment started before the worldwide economic recession began. Investment plans were reviewed when volumes started to plummet, but Transnet decided to continue with its plans to create capacity ahead of demand. The amount spent per Transnet division for the year 2009 as well as forecasts for spending until 2014 can be found in Figure 12 [71].

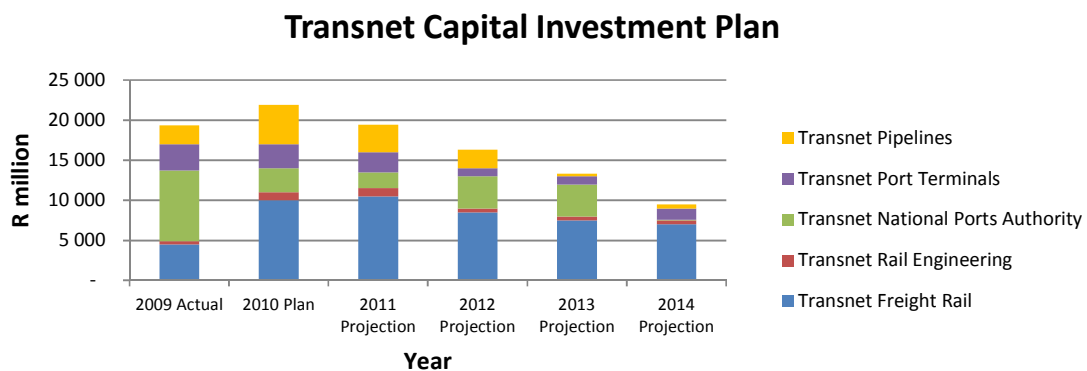


Figure 12 - Capital investment figures per Transnet division from 2009 to 2014

2.7.1 Transnet Port Terminals

Transnet Port Terminals is currently in the process of investing in its ports and container terminals. Some of the projects include:

- The reengineering of Durban Container Terminal.
- The expansion of Cape Town Container Terminal.
- A new container terminal in Durban (Pier 1 container terminal).
- Building a new container terminal in Port Elizabeth called the Ngqura Container Terminal.

The newly constructed container terminal, Pier 1 Container Terminal, which is located next to Durban Container Terminal (DCT), started operating in August 2007 whilst partially still under construction. The terminal's construction was completed in September 2009. It was built for the purpose of increasing Durban's container throughput capacity by an additional 720 000 TEU's per annum [52]. DCT was upgraded by purchasing new equipment,

resurfacing the stacking areas and adding an additional capacity of 200,000 TEU's. The port entrance channel was widened to improve the ability of vessels to navigate in and out of the port and to allow larger vessel to enter the port. This project was completed in September 2009. The entrance channel is currently 225m wide and ranges between 16m and 19m deep [52].

The expansion of Cape Town Container Terminal (CTCT) commenced in January 2007 and includes purchasing eight new quayside cranes and 32 new Rubber Tired Gantries (RTGs). It also includes extending the quay wall and resurfacing the entire stacking area. The project is in progress way with a completion date of 2013 [52].

A new container terminal in Port Elizabeth, the Ngqura Container Terminal (NCT), was constructed in order to service the newer generation of vessels. The construction included all port infrastructures such as the quay wall, concrete surfacing of stacking areas, roadways, administration facilities and rail infrastructure, as well as all operating equipment. The construction of this terminal was completed in October 2009 [52].

2.7.2 Transnet Freight Rail

Transnet Freight Rail (TFR) is investing in upgrading its rail infrastructure. Projects that started in 2009 include the expansion of the iron ore and coal export lines and the acquisition of 204 locomotives for deployment on the coal, iron ore and general freight lines. TFR is also upgrading the existing rolling stock as well as the infrastructure for the general freight business [71].

A report compiled by the Department of Transport (DoT), *Moving South Africa*, reported that freight customers rate the reliability of freight services as the factor with the highest impact on the industry and high tariffs as the factor with the second highest impact [13]. According to this report, "freight customers revealed a significant level of dissatisfaction with key aspects of the freight system. While customers expressed satisfaction in general with road freight prices and levels of service, they were significantly less satisfied with rail general freight prices and service, and were highly dissatisfied with current levels of service, especially delays, at the ports" [13].

Transnet is in the process of dealing with the unreliability of the freight system by implementing a corridor strategy. The strategy entails a defined focus that will be placed on certain routes and specific commodities. TFR needs to prove to customers that the rail service delivery has improved in order to increase the volumes that are being transported by rail and to re-build the division's reputation by providing a more efficient service to their customers [70].

The next chapter will discuss the cost structure of the container shipping industry. The tariffs structures of the main role players in the industry will be investigated in order to determine what each role player add to the final cost of shipping a container.

3. The cost structure of container shipping

This chapter deals with the tariff structure of the container industry. The available literature on tariffs structures was researched in order to build a model to determine what each link in the supply chain adds to the total cost of shipping a container.

3.1 The tariff structure of container shipping

Mergeglobal Value Creation Initiative completed a study in 2008 where they analysed the revenue earned and the return on capital employed for different organisations in the container industry. These organisations were grouped into five categories [39]. The five categories are as follows:

- Administration, routing and procurement of services.
- Providing containers.
- Inland transportation.
- Providing and operating vessels.
- Port management, load and off-load shipments.

The tariff structure of the container shipping industry will be discussed using the five categories of container shipping (see Figure 13).

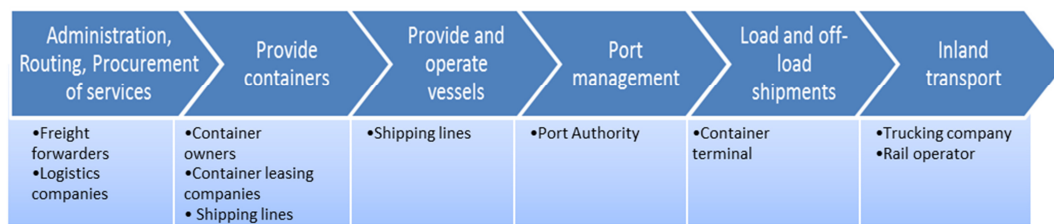


Figure 13 - Summarised process flow of the shipping supply chain

All the role players in the container shipping industry have their own pricing structure, each adding to the handling and shipping cost of the cargo. In the end the consumer has to pay for all the delays and inefficiencies in the supply chain. The percentage of the cost that each of the supply chain role players add to the final cost of exporting/importing a product is determined later in this chapter. This information was collected by having interviews with representatives from all the links in the supply chain and by researching their tariffs online

where it was available. In instances where the tariff information could not be obtained, global averages obtained from previous studies were used.

The cost structure for the container shipping industry is displayed in Figure 14. In most cases the importer/exporter utilises a logistics or freight forwarding company to handle all aspects of the shipping chain. The logistics or freight forwarding company makes a booking with the shipping line, arranges the clearance with customs, organises the inland transport and manages all the other administrative functions on behalf of the shipper⁵.

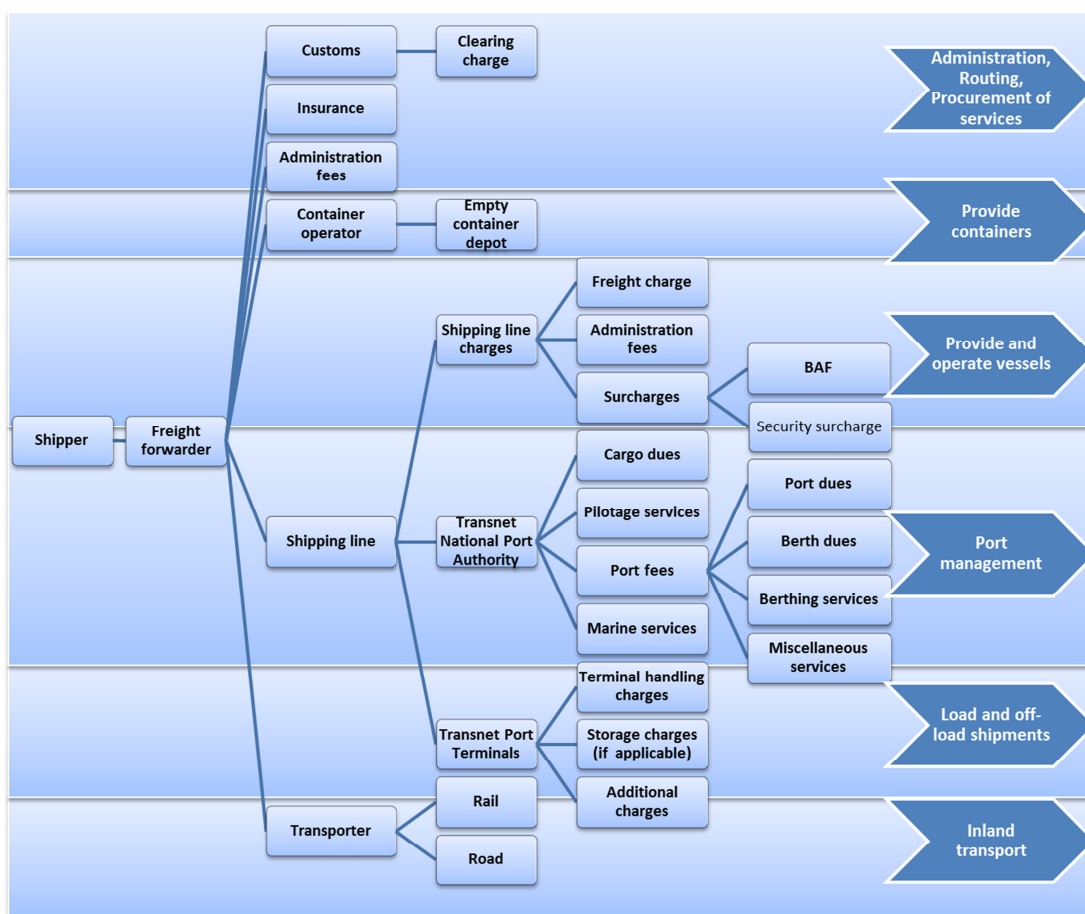


Figure 14 - Cost structure of the container shipping industry

The administration, routing and procurement of services are mostly done by third party logistics (3PL) companies or freight forwarding companies. This includes booking a

⁵ The term shipper refers to the importer or exporter.

container slot on a vessel with the shipping lines, arranging with the trucking companies to transport a container, arranging for the container to be cleared by Customs and any other service that the shipper (importer/exporter) would require. The containers are usually provided by the shipping lines or container depots. The pick-up or delivery time for a container needs to be specified. The inland transportation leg of the supply chain can be done via road or rail. The shipping lines are responsible for providing and operating the vessels. Transnet National Ports Authority manages and controls the port as a landlord and Transnet Port Terminals performs the loading and off-loading of vessels.

Figure 15 shows the breakdown of the revenue earned per industry segment in container shipping [39]. It can be concluded from this pie chart that 50% of the total cost that the shipper pays is for providing and operating the vessel. 17% of the total cost is paid to the container terminal operator, 15% of the total cost is paid to the logistics company, 14% contributes towards the inland transportation leg and 4% is paid to the container owner.

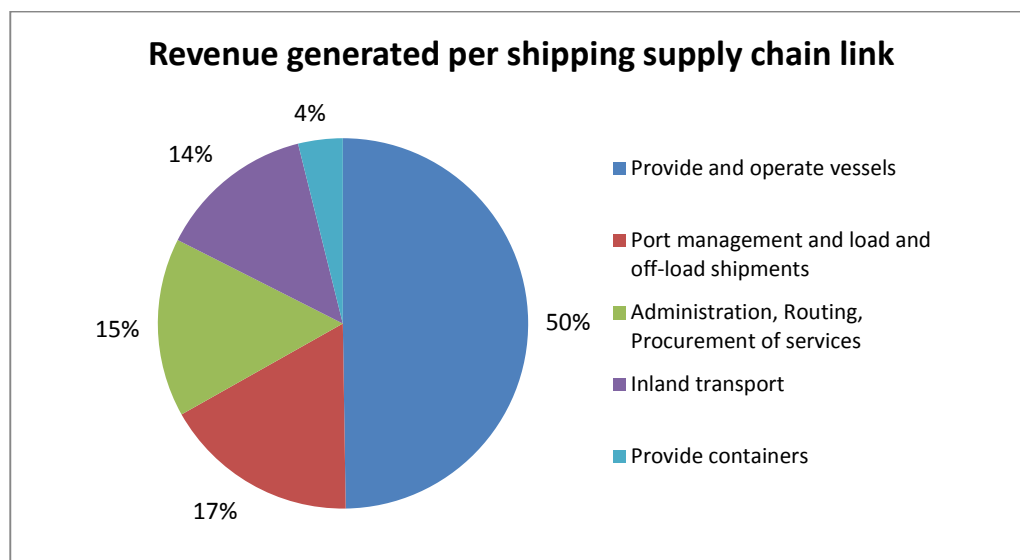


Figure 15 - Percentage of revenue earned by each link of the container export supply chain

Figure 16 displays the total revenue generated and the Return On Capital Employed (ROCE) for each of the five categories of the freight transport industry [39]. ROCE is a financial indication of how profitable a business is. It is a ratio of the revenue generated against the capital invested in a company.

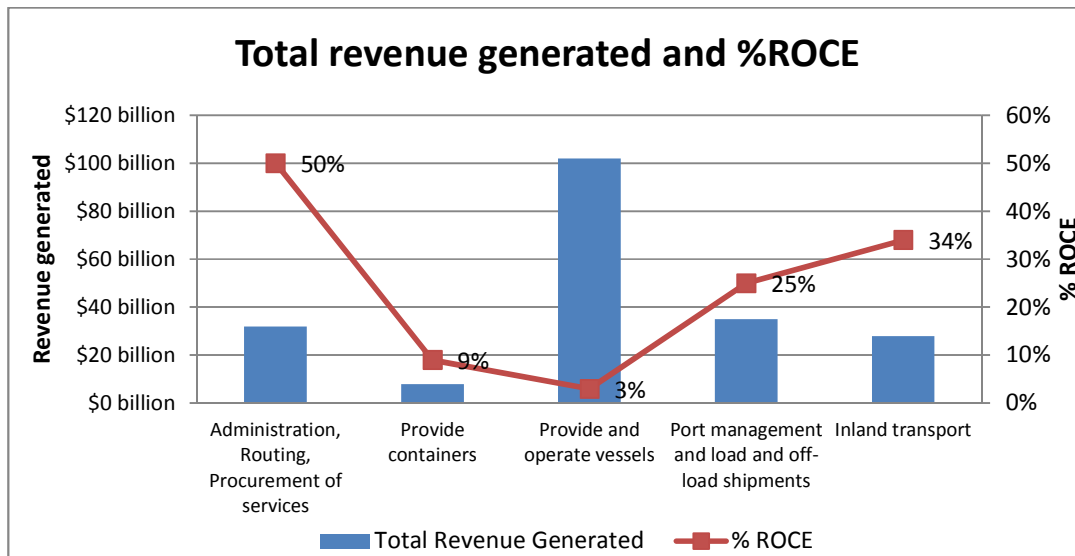


Figure 16 - Total revenue earned and % ROCE per supply chain link

If Figure 15 is considered in conjunction with Figure 16, the conclusion can be made that most of the total revenue generated by shipping lines is absorbed by the vessel operating cost due to the fact that shipping lines only achieve a three percent ROCE. Shipping lines therefore have limited flexibility when it comes to adjusting their freight rates and they are very dependent on container volumes. As soon as the demand for capacity decreases, prices have to decrease in order to attract more cargo. Bunker and vessel operating costs however remain, decreasing the profitability of shipping lines. When the container shipping demand increases again, prices can be increased to increase the profit margin of shipping lines.

3PLs and freight forwarding companies on the other hand have an administrative function and do not have a large asset base. Freight forwarders achieve a 50% ROCE on average [39]. Logistics companies have the benefit of being much more flexible when quoting their tariffs and they have the ability to adapt quicker to changes in the market.

Port authorities and terminal operators achieve a 25% ROCE according to Figure 16, due to the fact that they require a larger asset base such as operational equipment (lifting equipment, terminal trucks, tug boats, etc.) and human resources to operate the equipment in order to perform their respective functions. In South Africa, with both the port authority and the terminal operator divisions of a State-owned Enterprise (SOE), flexibility is very limited.

Decisions to respond to changes in the market are only done at management levels high in the organisational structure and usually filter through to the lower levels too late.

All trucking companies in South Africa form part of the private sector. Trucking companies are responsible for the inland transport leg of the supply chain. 88.7% of the total tons of cargo transported in 2009 in South Africa were via road [19]. Trucking companies are, similar to the shipping lines, very volume dependant. They have the option of decreasing their prices to attract more cargo, which in turn decreases their profit margins. The rail operator, Transnet Freight Rail (TFR), a division of the SOE Transnet, was responsible for moving 11.3% of the total tons of cargo in 2009 [19]. Transnet and TFR have numerous plans to address inefficiencies and to subsequently increase this percentage by transporting more cargo by rail.

3.1.1 Logistics companies

Most logistics companies cover the following functions:

- Customs clearance.
- Sea, air or road freight solutions.
- Booking capacity on a transport mode.
- Container packing.
- Warehousing.
- Tariff consultation and quotations.
- Advising on containerised or break-bulk solutions.
- Logistical consultation.

A logistics company is the one entity that the importer or exporter deals with. The customer only has the one bill at the end of the day that he/she has to settle. The logistics company/freight forwarder is responsible for arrangements with customs, the shipping line and the trucking company or the rail transporter. The shipping line on the other hand pays the port authority and the container terminal.

3.1.2 Shipping lines tariff structure

The shipping line tariffs consist of a freight fee, a service fee, a security fee, administration fees and various other surcharges. Some of the surcharges that may be added to the tariff fee in certain instances by the shipping line are:

- Bunker adjustment charges that are based on the price of oil.
- Currency adjustment charges that are based on currency fluctuations.
- Port congestion surcharges to cover the cost of having a vessel waiting outside a congested port for service.
- Terminal congestion surcharge to cover the cost of delaying a vessel due to a congested container terminal.
- Weight limitation surcharges on containers that are under declared.

Maersk's ocean freight rates for 2002 for shipping a full unit from Cape Town can be found in Annexure A. In December 2010 the global average for Maersk's ocean freight rate was USD 3,064 per FEU [67], an increase of 29% from 2009 after the worldwide recession.

3.1.3 Container terminal operator tariff structure

The container operator in South Africa, Transnet Port Terminals, charges a terminal handling charge (THC) per container.

The THC includes:

- The loading/discharging of the container to/from the vessel.
- The storage of container before the vessel arrives in the case of an export cycle or after the vessel departs in an import cycle.
- The loading/discharging of the container to/from a truck or train.

An extra fee is charged for reefer containers, called a reefer surcharge. This fee is for the electricity usage of the reefer container whilst it is stored in the container terminal.

Containers can be stored in the terminal for a specified number of days with zero charges being applied. Thereafter storage will be charged. The number of free days applicable is dependant of whether it is an import, export, transshipment container and on certain

agreements the container terminal operator has with its customers. The storage of containers will be discussed further in the next section.

Safmarine's terminal handling tariffs for South African ports as well as THC's for some of the European countries as charged by DAL shipping line can be viewed in Annexure A.

3.1.4 Storage of containers

The storage of empty and full containers is an activity that needs to be minimised in order to maximise the efficiency of the container industry. The repositioning of empty containers has to be done strategically in order to minimise the movement of empty units.

Although the above statement is true, the need to store containers will always be there. Inland container depots are operated for the purpose of storing containers between the various links in the supply chain where the need for a specific container is only at a future date. Container terminals are used to store export containers until the vessel arrives and import containers until importers arrange for their containers to be collected at the container terminal. Transshipment containers are stored from the time that the mother vessel discharges the container until the time the feeder vessel is available to load the container.

Some of the container depots in the Cape Town area are the South African Container Depot (SACD), Satti Container Depot, Grindrod Intermodal Container Depot, Culemborg Container Depot and Belcon Container Depot. SACD's service charges were researched online [84]. Their rates for storing and handling a container at a depot in 2010 can be found in Annexure A.

Cape Town Container Terminal's storage tariffs for the 2009/2010 financial year (1 April 2009 to 31 March 2010) are listed in Annexure A:

If one compares the cost of storing a 20 foot general container in a container depot to the storage in a container terminal, the container terminal's tariff structure turns out to be the less expensive one, as determined in the graph in Figure 17. This however is against the objective of a container terminal, which is to maximise the throughput of containers. The storage of containers can be detrimental to achieving a high efficiency in a container

terminal, because there is less flexibility in the container yard when the stacking area utilisation is high. During the last quarter of 2009 and most of 2010 when the recession affected the economy severely and volume throughput was low all over the world, the storage of containers assisted in generating income for terminals. Now that the volumes are increasing again, the function of storing containers should return to the container depots.

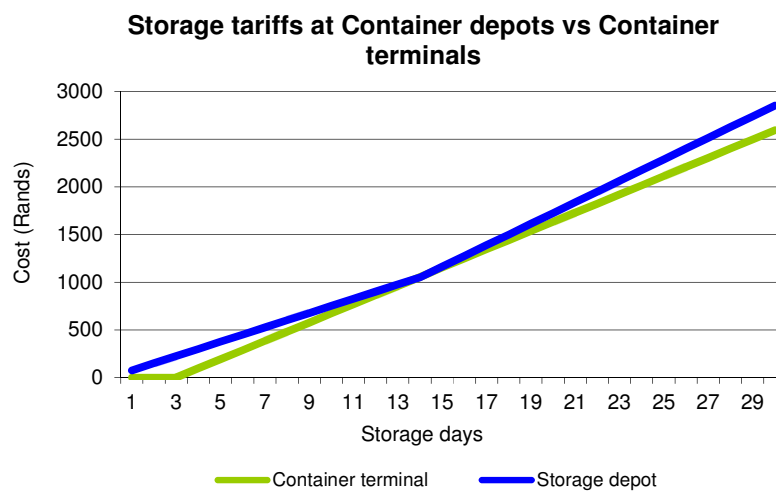


Figure 17 - Comparing the cost of storing a 20 ft. general container in a container depot to that of a container terminal

3.1.5 Rail Transporter

The rail transporters tariffs for 2009 to 2010 are given in Annexure A. For customers that can commit to high volumes, a discount of approximately 13% is provided.

3.2 Example – Cost to export a 40 FEU

An example is shown in Table 1 as an illustration of the abovementioned charges that the shipper is faced with when exporting a 40 FEU containing cargo to the value of R100 000. The tariffs listed in Annexure A were used in this example. The container is being exported from the Port of Cape Town to the Port of Hamburg.

Function	Amount
THC Cape Town Container Terminal	R 2 127.00
Cargo dues (Port of Cape Town)	R 2 134.00
Estimated THC Port of Hamburg	R 2 000.00
Estimated Cargo dues (Port of Hamburg)	R 2 000.00
Freight Tariff	R 23 588.28
Export Documentation	R 441.00
Transportation Documentation Fee	R 115.48
Local Hauling cost	R 3 500.00
Administration, management and profit	R 6 103.98
TOTAL	R 45 600.32

Table 1 - Example of a container exported to Europe

Figure 18 shows that the shipping line freight charges accounts for more than 50% of the transportation cost. This coincides with the study done by Mergeglobal Value Creation Initiative, where they state that providing and operating the vessels generate 50% of the container shipping industry’s revenue [39].

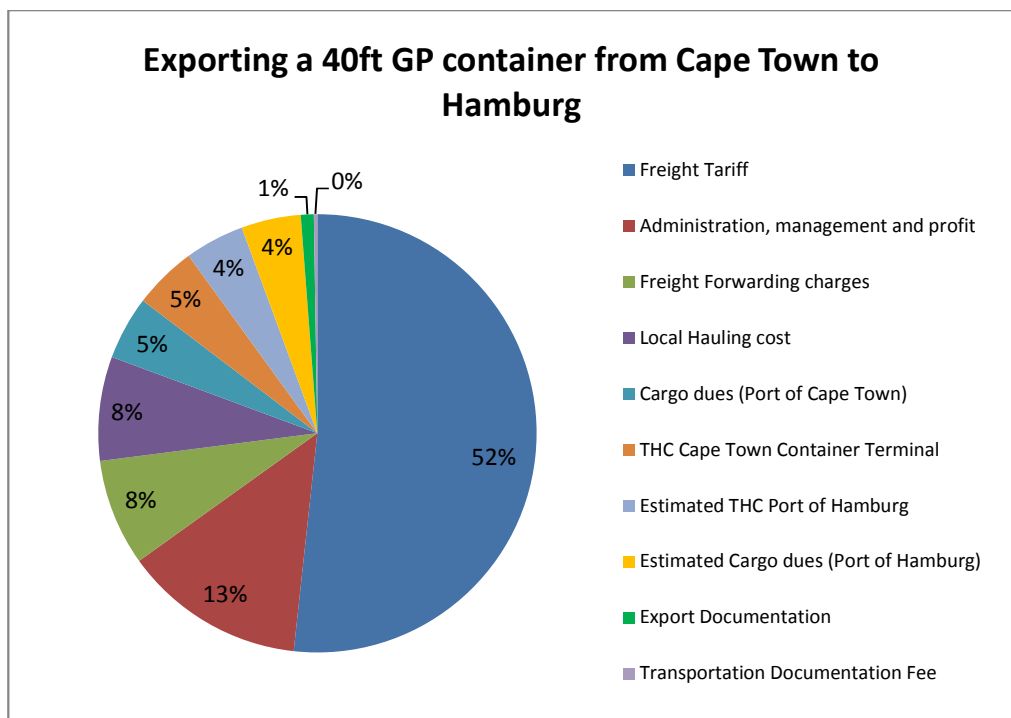


Figure 18 - Breakdown in terms of cost for exporting a 40 foot container from Cape Town to Hamburg

As previously stated in section 3.1.2, the shipping line's freight charge is not very flexible as most of the cost is allotted to operating the vessel. Improvements should be made throughout the rest of the container shipping supply chain to reduce the total cost of exporting a container. This will be investigated throughout the rest of the study.

The next chapter will discuss some of the inefficiencies that exist within the South African container shipping industry.

4. Inefficiencies in the South African container shipping industry

Several inefficiencies exist within the South African container shipping supply chain, but there is no platform for organisations from the entire industry to jointly discuss and deal with these inefficiencies. Some of the inefficiencies in the system will be identified and discussed in this section.

4.1 Inefficiencies identified

Inefficiencies were discussed in a focus group on 23 March 2010 consisting of managers and staff working for shipping lines, the container terminal operator, transporters and freight forwarders [65]. The representatives were mostly from Cape Town and Saldanha. Specific inefficiencies were listed as those that have the most impact on the container shipping supply chain. These inefficiencies were discussed and the outcomes summarised in the following paragraphs.

Some of the inefficiencies that are common in South Africa and in particular the Western Cape are [65]:

- Prior to 2007, little priority was assigned to investment in ports and container terminals such as new equipment and deeper berths that will be able to handle the demand and sustain growth in the container industry. The industry is currently catching up with new developments and is trying to keep up with the increased demand.
- Inefficient inter-modal facilities and inland terminals in South Africa.
- The lack of capacity causing congestion within ports and on the roads.
- The high unpredictability of the industry that affects all the organisations in the industry, as extra resources need to be allocated to plan for the unexpected. This is a problem especially in South African container terminals. Although the accuracy of forecasts generated throughout the chain is improving, it is still not at the level required to plan efficiently.
- Labour unpredictability due to strikes and union demands.

In a workshop attended by managers of Cape Town Container Terminal (CTCT) on 16 March 2011, all matters (internal and external) that influence the efficiency of the terminal

operations were identified and deliberated. Improvement initiatives were identified and are being tracked on a weekly and monthly basis by the responsible managers [64]. These issues can be found in Figure 19.

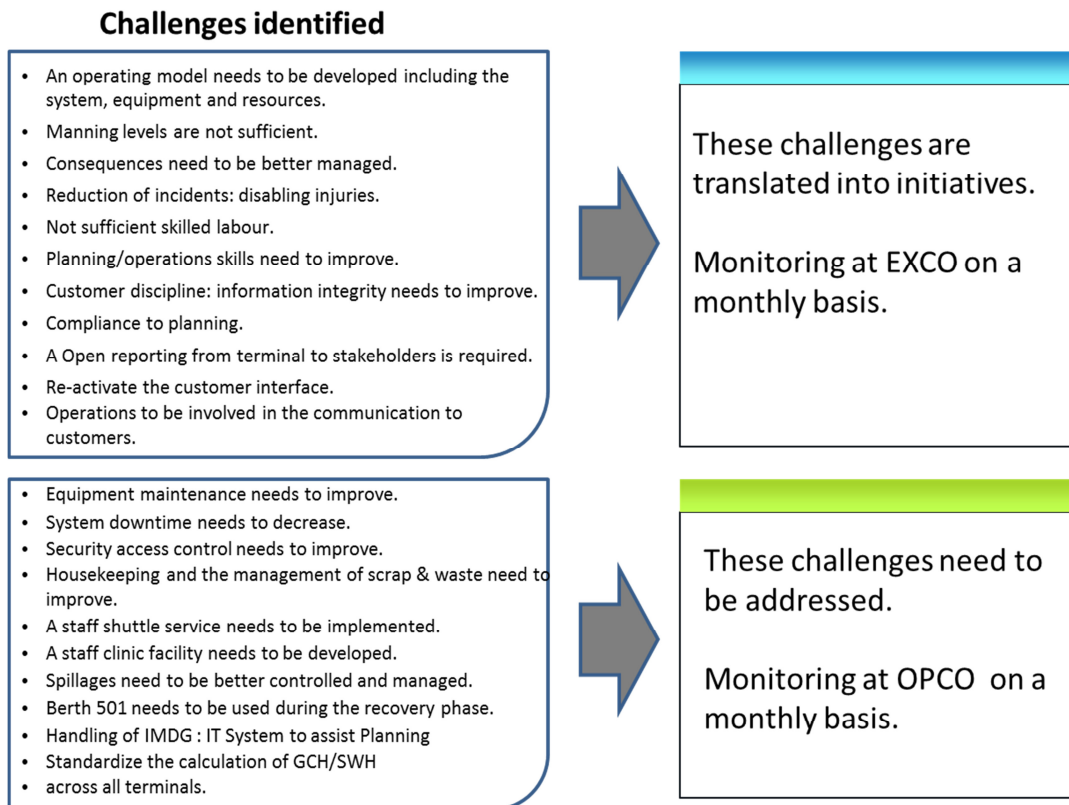


Figure 19 - Challenges identified at a workshop held on 16 March 2011

Communication with customers at CTCT is challenging items as relationships are not as established as they should be. The rest of the challenges identified seem to be mostly internal problems. These internal inefficiencies have an impact on overall efficiency.

The following sections will discuss some of the inefficiencies in more detail. These inefficiencies are:

- Information integrity.
- Access to the hinterland.
- Vessel congestion at ports.
- The percentage of cargo being transported by rail.

4.1.1 Information integrity

Some of the challenges were identified by both the focus group and the CTCT managers. Customer discipline and information integrity are two inefficiencies that were identified by both. This is a major challenge in the supply chain as all parties rely heavily on information supplied by the predecessors in the chain. Information supplied by shipping lines for example plays a major part in the daily operations of the container terminal.

The shipping industry is “a highly fragmented, complex, paper-intensive process that is filled with inefficiencies” [68]. Information is still transferred manually in a lot of instances in the shipping industry in South Africa. There is not enough integration between the information systems of the various organisations. Physical paper is handled and information then needs to be recaptured. This takes time and causes delays within the supply chain. Mistakes can be costly if for example a container is wrongly exported to Rotterdam instead of Antwerp because the port of discharge was captured incorrectly. Very few customers, apart from the larger shipping lines, make use of Electronic Data Interchange (EDI) and most information is exchanged via telephone or fax [68]. Bloom [68] reports that this inefficiency is estimated at a value more than five billion US dollars per annum.

Importing a container into South Africa takes an average of 35 days, while exporting a container takes an average of 30 days. Documentation preparation and customs clearance contributes to more than 50% of the total cycle time in both the cases of importing and exporting a container and this is mainly due to inefficiencies that exist within the system such as the capturing of inaccurate information [77].

Transnet Port Terminals started to implement a national terminal operating system, Navis SPARCS (Synchronous Planning and Real Time Control System) in 2008 that will integrate all South African ports as well as the rail operations. The last container terminal, Durban Container Terminal, implemented and started using Navis SPARCS in March 2011. The rail operation, run by the Transnet division, Transnet Freight Rail, started to systematically switch over from June 2011 and will complete the project in December 2012. Customs are also scheduled to be linked to Navis within the next few years [6261]. Most of the shipping lines are either using Navis SPARCS or their operating system is

compatible with Navis SPARCS. The container terminals and shipping lines are now able to transfer information via EDI.

According to Mr V. de Jongh, Acting Chief Planning Manager at CTCT, managers at CTCT have been challenged in getting shipping lines to provide at least a 90 percent accurate forecast on volumes expected. This information is essential for the container terminal operator as stacking area has to be reserved for a vessel. The layout of these containers also has to be planned before the containers arrive at the gate in order to load the vessel as efficiently as possible. Shipping lines cannot provide a more accurate volume forecast, because they still accept bookings to load cargo onto a vessel on the last day that the stack is open. This is essential for the shipping lines as they need to maximise capacity utilisation on their vessels [62].

Christopher [3] refers to the Pareto rule when he made the statement that 80% of a business' profits will be generated from 20% of its customers. A business should therefore know who that 20% of its customers are and focus on building relationships and serving these customers' needs. As can be seen in Figure 20, 22% of CTCT's customers generate 78% of the revenue (data is based on period 1 April – 31 May 2011), which is very close to the Pareto rule. The 22% consist of four customers which are Safmarine, Mediterranean Shipping Company, Mitsui O.S.K. Lines (MOL) South Africa and K-Line Shipping. These are the customers that CTCT managers should focus on to increase their information accuracy [55].

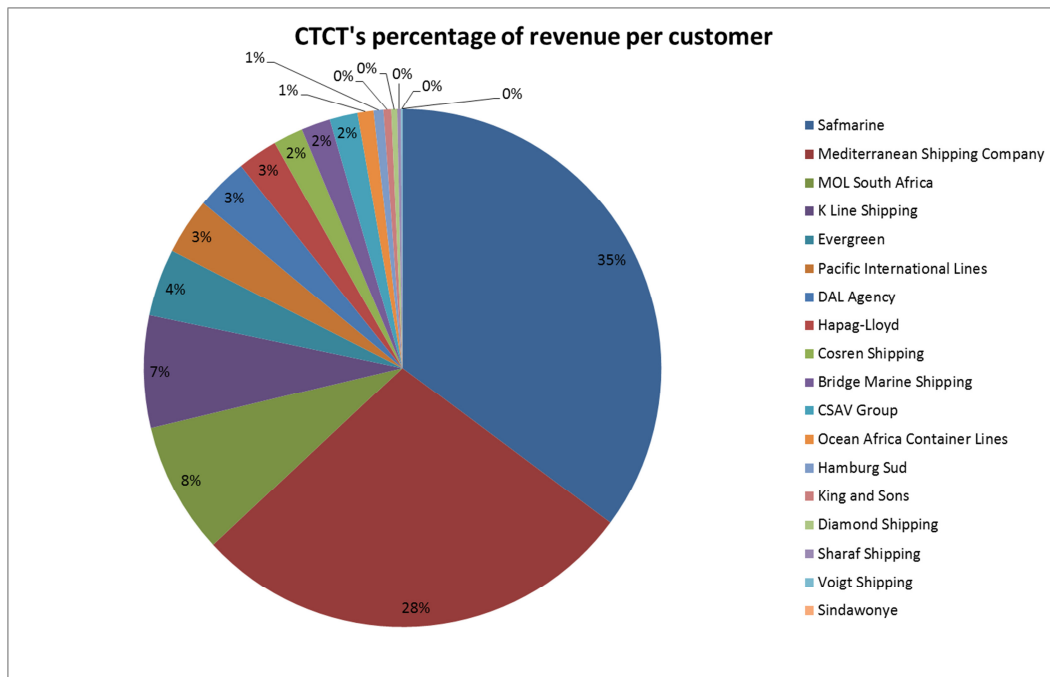


Figure 20 - CTCTs revenue per customer

4.1.2 Access to the hinterland

Access to and from container terminals in some of South-Africa's ports to the hinterland is also a contributor to the inefficiencies in the industry. Congestion at the entrance to the port is a big concern. Transportation contributes 50% to the total logistics costs of South Africa. Congestion contributes approximately 2% to South Africa's transportation cost and amount to nearly one billion rand⁶ as shown by research done by the CSIR [24].

South Africa's ports lack multiple access points to the ports. Most of the ports are situated in metropolitan areas where the traffic density is already high without the container trucks adding to this congestion. Access from the ports to the hinterland and vice versa becomes very difficult during peak traffic periods. The Soccer World Cup in June 2010 was a great concern to all parties with thousands of added vehicles that were going to be on the roads. This was combated through planning and by having alternative transfer methods of soccer fans to stadiums. According to the King *et al.* [25], a way to combat congestion is to create value-adding activities such as storage depots, truck staging areas and cooling rooms

⁶The calculation is based on the estimated congestion cost of R34 billion which equals 2.85% of the total transportation cost calculated by the CSIR in the Sixth Annual State of Logistics Survey [24].

closer to or inside the port boundaries. Another manner would be to streamline the inter-modal transport system with that of the port by utilising the periods during the day when traffic on the roads are less dense.

According to the container terminal managers in Cape Town, it has always been a problem that most of the industry only operates in normal business hours, while the South African container terminals operate 24 hours per day, seven days per week. This means that the roads are congested between 06h00 to 18h00. This load could have been spread over the 24 hour period, thus alleviating some of the congestion on the roads.

CTCT managers decided to open the terminal gates during the night shift on the request of some of the larger trucking companies. The idea was to alleviate some of the congestion during the day by allowing transporters to drop-off and collect containers during the night shift when the roads are generally quieter. Resources were assigned during the night shift seven days per week, but only between five and 20 trucks on average made use of this period. This concession was made to no avail because the rest of the supply chain was not prepared. Importers, exporters and container depots were not prepared to absorb the extra cost of opening their facilities during the night shift. Trucking companies therefore could not collect containers during this period as they would have nowhere to take the container to be off-loaded. It was not cost effective for the container terminal to maintain this concession. A notice was sent to the relevant parties that the gates will be re-closed during the night shift. This is a perfect example of where all the parties had to meet to discuss how this decision would influence them and come to a solution that would benefit all.

In order to align the operating hours of importers, exporters and transporters to that of the terminals, management is currently considering implementing an appointment system at the South African container terminals. This will mean that only the trucks that make a reservation for that specific hour may arrive at the terminal at the specified time. The container terminal can then spread the appointments across the 24 hour period and therefore manage port congestion [62].

4.1.3 Vessel congestion at ports

King *et al.* [25] stated in 2007 that “South Africa falls on the secondary north/southbound routes served by smaller vessels and it is unlikely that any of the major container vessels will call at a South African or African port in the near future”. Currently the maximum vessel size that can dock at South African container ports is increasing. Durban Container Terminal (DCT) can handle vessels with a maximum length of 330 metres, while Cape Town Container Terminal (CTCT) can handle a vessel with a maximum length of 325 metres. This is mostly due to the fact that the port basins were recently dredged to a deeper level as part of Transnet Port Terminal’s expansion project [62].

With the increase in the maximum vessel size, more vessels are berthing at the South African ports. Port and terminal congestion is becoming a critical issue. This is a concern to everyone in the supply chain; from the shipper to the shipping line and container operator.

There can be various reasons for vessel congestion [25], such as:

- Inclement weather conditions.
- The bunching of vessels.
- Inefficient road or rail transport systems.
- Inefficient cargo handling at container terminals.
- Customs clearance problems.

A delay at a port is a serious problem for shipping lines. According to the Logistics Manager at the Mediterranean Shipping Company’s (MSC) branch in Cape Town, a delay of one day can cost a shipping line approximately US\$ 50,000 [48]. The rest of the voyage schedule is also disrupted and extra fuel needs to be burnt to make up for lost time. King *et al.* [25] stated that DCT experienced severe port congestion from 2003 to 2005. Shipping lines had to add a congestion surcharge of US\$ 100 to their container tariffs in order to recover some of their costs. They envisaged that the surcharge would encourage better performance from the terminal, but unfortunately, this surcharge was only passed onto the cargo owner and eventually to the final consumer.

The risk for congested container terminals is that shipping lines may decide that they will by-pass the port and transport the cargo to another port via road, rail. This is a last resort as both the shipping line and the container terminal lose; the terminal loses the cargo and the shipping line has the extra expense of rerouting the vessel. If a shipping line decides that a vessel will by-pass the terminal and that the containers will be shipped on the next vessel on that trade route, the container terminal has to store the containers in the terminal for an extended period. This increases the yard utilisation and reduces the flexibility of the terminal.

Another factor impacting on vessel congestion, especially in Cape Town, is strong wind. The safe operating limit for operating the ship to shore cranes at CTCT is 80 km/h. If the wind speed is above this limit, the cranes are not allowed to be operated due to safety reasons. Vessels subsequently have to wait until the wind speed drops to below 80 km/h before the discharge/load operation can continue. This causes delays and a build-up of vessels waiting to be berthed.

4.1.4 Percentage of cargo being transported on rail

The transportation of cargo via rail is an on-going challenge in South Africa. The problems that the rail transporter, Transnet Freight Rail (TFR), faces are [61]:

- A shortage of rolling stock.
- Unreliable rolling stock.
- Unpredictability when it comes to scheduling of rail cargo.
- Security threats on cargo while in transit.
- Eskom power failures.
- A shortage of resources (on TFRs side as well as the container terminal).
- Delays at the container terminals due to the handling of rail cargo receiving a lower priority than vessel operations at the container terminals.
- Cable theft/damages on rail lines.

These issues need to be addressed in order to attract cargo from the roads to the rail. Transnet has started an approach whereby the various routes and commodities transported via rail are divided into seven corridors. These corridors each have a team managing them in order to improve the efficiency thereof [57]. The corridors include:

- Sishen/Saldanha iron ore corridor.

- Export coal-line (via Richards Bay Coal Terminal).
- Capecor (Western Cape corridor).
- Northern Cape/Port Elizabeth corridor.
- Gauteng/Port Elizabeth corridor.
- Natcor (KwaZulu-Natal corridor).
- Gauteng/Maputo corridor.

Some of the efficiency improvement initiatives of TFR on the various corridors are [50]:

- Increasing the stacking capacity of the City Deep Container Depot.
- Implementing a joint planning office between Transnet port Terminals (TPT) and TFR to increase the reliability of train schedules.
- Dedicating train resources per corridor (including locomotives, wagons and shunting equipment).
- Improving the interfaces between divisions.
- Improving stack flow management between TFR depots and the ports.

These efficiency improvement initiatives mostly focus on improving the reliability of the rail service in order to attract more cargo to rail.

Items that are being measured for each corridor are:

- Volume performance per commodity.
- Key commodity flows.
- Rail resource reliability.
- Port resource demand availability.
- Corridor safety and security.
- Human capital per corridor.⁷
- Status of capital investment projects for each corridor.
- Corridor revenue.

⁷ Transnet divided its transportation network in seven main trade routes, called corridors. The seven corridors were listed earlier in this section. The KPI, Human capital per corridor, measures the number of Transnet employees directly involved in a specific corridor.

Figure 21 shows the budgeted vs. actual volumes for the period May 2010 to April 2011 [50]. Container transport on the Cape Corridor was under the budgeted volumes by an average of approximately 7,000 TEU's for the first six months (May 2010 to October 2010), mainly because the industry was still recovering from the recession that occurred in 2009. Thereafter the volumes increased to above the budgeted volume for the period from November 2010 to April 2011. This increase can primarily be attributed to the fact that the volume of containers containing fruit for the export market was much higher than initially anticipated. The peak season for fruit exports starts from November until April.

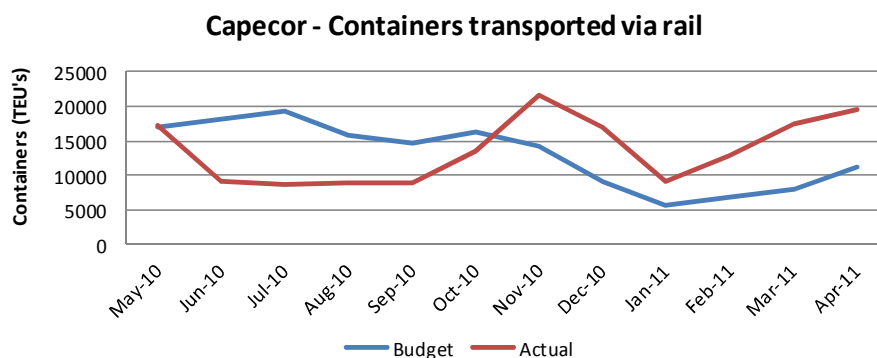


Figure 21 - CapeCor budgeted volumes vs. actual volumes

According to data analysed by the CSIR in 2009, the market share for tons of cargo transported by road is 88.7%, while the market share for tons of cargo transported by rail is 11.3% [19]. The roads have to carry approximately 50% more tons per km than the rail system, which has a damaging effect on the condition of South Africa's roads.

Transnet has set specific objectives for the various corridors. Various capital expenditure projects are under way and efficiency improvement initiatives are being implemented. The joint planning office for TPT and TFR was implemented at Cape Town Container Terminal at the end of May 2011 [62].

The next chapter will discuss the details of performance measurement systems (PMS) and existing PMSs. These PMSs will be analysed to see whether a PMS will benefit the

container industry in South Africa. Existing survey studies will also be studied to determine what needs to be measured.

5. *Performance measurement systems for supply chains*

The goal of this research study is to develop and determine whether a performance measurement system for container shipping will be feasible and how it will be managed. This section will analyse the reasons for requiring a general and macro measurement system for the overall container shipping industry. Different performance measurement systems that are available are investigated to identify and adapt a system that will be applicable to the container shipping industry.

5.1 *Measuring supply chains*

Saslavsky *et al.* [35] stated that international logistical competitiveness is based on six areas of performance, namely:

- Efficiency of the clearance process by customs and other border agencies.
- Quality of transport and information technology infrastructure for logistics.
- Ease and affordability of arranging international shipments.
- Competence of the local logistics industry.
- Ability to track and trace international shipments.
- Timeliness and frequency of shipments in reaching destinations.

This finding is based on the logistics performance of 150 countries. This logistical competitiveness of organisations operating in container shipping needs to be measured so that these firms in the supply chain can have an idea of their individual effectiveness and the effectiveness of the supply chain as a whole.

5.1.1 *The importance of measuring a supply chain*

A lot of emphasis has been placed on how supply chains are being managed and how effective they are. Firms strive to achieve strategic objectives and according to Frohlich [16], the importance of having an integrated supply chain with stable and close relationships with suppliers and customers have grown over the past 10 to 15 years. Firms also look for continuous improvement in their business and implement initiatives to achieve this, but without measurements there is nothing to determine the return on investment [17] and how close to achieving the company objectives they are.

A survey performed in the United Kingdom (UK) revealed that 40% of the UK's gross domestic product was spent on activities relating to logistics and distribution. By the late 1980's outsourcing in the United States contributed close to 60% of the total product cost [17]. Measuring performance, especially performance related to logistical activities, is becoming more important.

5.1.2 Identifying the measurements

Supply chain measurements can consist of quantitative and qualitative measurements. System performance is often rated in a qualitative manner such as excellent, good, average or poor. These measurements are very vague and cannot be utilised to pinpoint exactly how far or close one is to achieving the company objectives [10]. Supply chain performance needs a more specific measurement. Quantitative measurements give an impartial assessment of how a process, department or business is performing. It is calculated from raw data and cannot be manipulated. Quantitative measurements are often perceived to be only financial measurements such as profit, cost per product and cost of waste. However, there must be a balance between financial and non-financial performance measurements for a measurement system to have the desired effect [17]. Only focusing on operational measurements will cause the financial factors to be omitted. Gunasekaran *et al.* [17] states that "while financial performance measurements are important for strategic decisions and external reporting, day to day control of manufacturing and distribution operations is often better managed with non-financials measured". A balance between the two is therefore important.

5.1.3 The number of performance measurements required

Choosing which aspects to measure can sometimes be difficult. Companies may have hundreds of different processes and outputs that change as the business evolves. Managers often add more measurements to the company's performance measurement system based on suggestions from employees, customer and suppliers [18]. They neglect to see that only the critical key performance indicators (KPIs) that have the biggest impact when improved should be focused upon. Managers need to decide on the amount of measurements that the business will focus on. When there are too many measurements, people tend to lose focus and do not use it as a tool to help implement continuous improvement initiatives.

5.1.4 How to measure a supply chain

The question that is asked is where to start measuring the supply chain and where to end. Should supplier and customer performance be included in the performance measurement system? Supply chain management is applying “a total systems approach to managing the entire flow of information, materials, and services from raw material suppliers through factories and warehouses to the end customer” [2]. According to Frohlich [16], “the effective integration of suppliers into product value/supply chains will be a key factor for manufacturers in achieving the necessary improvements to remain competitive”. Integration with customers allows a manufacturer to know exactly what the needs of his customers are and to respond quickly to changes to those needs.

Frohlich [16] stated that integration should take place on two levels; information integration and delivery integration as shown in Figure 22. The forward form of integration involves coordinating activities and the physical flow of materials and products from supplier to manufacturer to customer. The backward form of integration relates to information that must be fed back from the manufacturer to the suppliers. This is necessary and is made possible by information technology that allows “multiple companies to coordinate their activities in an effort to truly manage a supply chain” [16]. Information technology that assists in integrating various companies is Electronic Data Interchange (EDI), which makes it possible for companies to share information electronically. Traditional planning and control systems are also used widely to integrate manufacturers and suppliers.

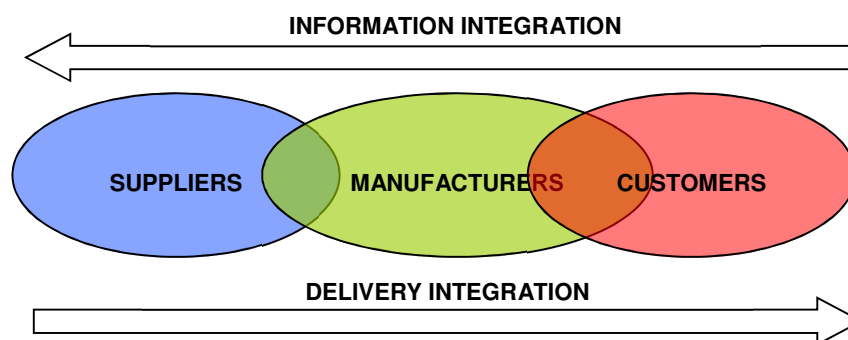


Figure 22 - Integration in the supply chain

Measurements should be grouped according to three levels of management authority [18]. Operational level measurements should include measurements that can be done on a daily basis based on accurate data. These measurements influence the decisions made by low level managers and if met, “can lead to the achievement of tactical objectives” [17]. Tactical measurements deal with higher level targets and influence the decisions of middle managers. These include measurements such as resource utilisation and customer compliance. Meeting the tactical objectives leads to achieving results on a strategic level. Strategic measurements are those measured and managed by top level managers. These measurements are usually linked to the company strategy and objectives and more often than not refer to the budgeted profit to be earned. These measurements look at the long term plans for the company and how the company can excel in terms of competitiveness. These are objectives that lower level managers do not focus on.



Figure 23 - Levels of management authority

Lee [28] states that “the best supply chains aren’t just fast and cost-effective. They are also agile and adaptable, and they ensure that all their companies’ interests stay aligned.” He calls this type of supply chain a “Triple-A Supply Chain”.

All the role players in the shipping industry should adopt this type of supply chain. Agility is an important aspect of the industry as challenges and problems often arise that requires current processes to be modified and new procedures and processes to be implemented. It is an industry where changes to plans have to occur seamlessly and speedily as time wasted means money wasted for everybody.

5.2 Performance measurement systems

Performance measurement systems (PMS) have moved away from the traditional approach of measuring only quantitative elements to a more innovative approach (see Table 2) [30].

Traditional PMS	Innovative PMS
Based on cost/efficiency	Based on value
Trade-off between performances	Compatibility of performances
Profit oriented	Client oriented
Short term orientation	Long term orientation
Individual metrics prevail	Team metrics prevail
Functional metrics prevail	Transversal metrics prevail
Comparison with the standard	Monitoring of improvement
Aimed at evaluation	Aimed at evaluation and involvement

Table 2 - Evolution of performance measurement systems

Some of the documented performance measurement tools will be studied in this section to determine whether they can be applied in the container shipping industry.

5.2.1 The balanced scorecard

The balanced scorecard (BSC) is a concept developed by Robert Kaplan and David Norton [6]. It is a performance measurement tool that provides managers a summary of specific measures about the organisation. BSC is widely accepted for its ability to integrate financial and non-financial measures into one system [36].

Managers must be able to identify the key performance indicators in an organisation or a supply chain before a BSC can be developed. The BSC model is divided into four perspectives: a financial perspective, the customer's perspective, the internal business perspective and the innovation and learning perspective (Figure 24) [6].

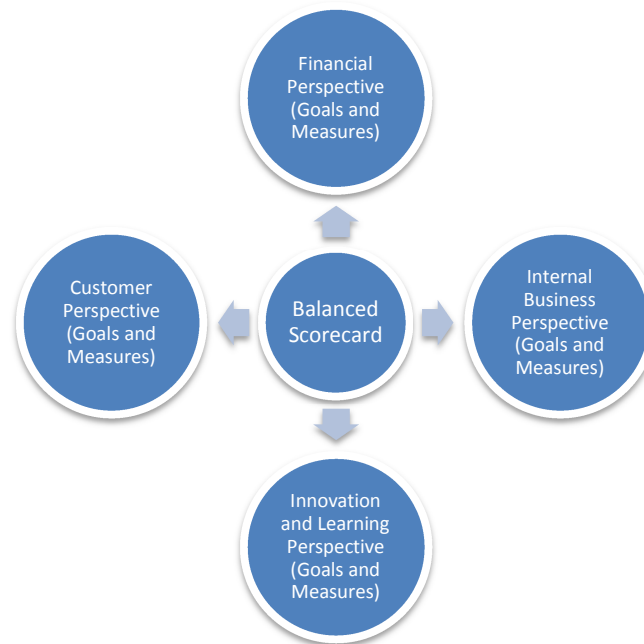


Figure 24 - The balanced scorecard

The benefit of implementing a BSC is that a limited number of KPIs will be used to monitor the performance of an organisation or supply chain. This makes decision-making and the management of the organisational processes easier. All important aspects that are included into the scorecard are considered jointly whenever a decision needs to be made. Another benefit is that an organisation's progress towards its goals can be monitored. Greater customer satisfaction and more transparent financial reporting are two more benefits of the BSC method. The fact that innovation and learning is promoted by management through the BSC motivates employees to be committed to achieving the set objectives. The BSC method is not just a performance measurement tool, but is a tool that management can use to filter strategic goals down the chain to the employees responsible for the daily operations [88]. Examples of measurements that can be used in each of the four perspectives are listed in Figure 25 [6].

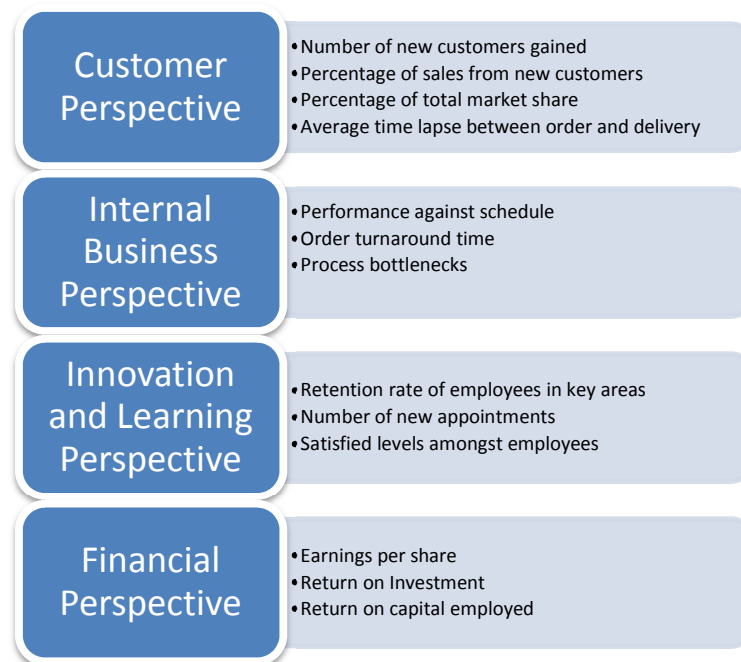


Figure 25 - Relevant performance measures for each of the four BSC perspectives

5.2.2 Supply chain operations reference (SCOR) model

The SCOR model is an operations reference model developed by the Supply Chain Council (SCC), primarily focusing on the processes in a supply chain. SCOR includes both quantitative and qualitative measurements and offers a standardised way of viewing supply chains [30]. The SCOR model was developed to facilitate supply chain management across various industries, to benchmark across these industries and to compare the processes, technology and best practices used [30]. It provides a scorecard framework that is used to develop performance measures and goals. The scorecard is used to help define a business strategy, align the activities of the partners and to identify the business value that is obtained through the improvement in operational efficiency. It forces managers to take responsibility for these processes and to focus on what needs to be improved in order to reach the specific objectives on the scorecard. The SCOR model forces a business or supply chain to have a more horizontal approach, where the focus is on the activity or process and therefore the customer's requirements, and not the specific parties who will be executing the activity. This model, if used correctly, can lead to increased process maturity, and increased process maturity leads to "increasing levels of predictability, capability, control, effectiveness and efficiency" [30].

The SCOR model consists of three levels (Figure 26). Level one refers to the type of process, which is categorised as planning, execution and ensuring infrastructure availability. The second level deals with the process categories which are broken down further into the third level. The third level focuses on specific process elements. The fourth level is not within the scope of the SCOR model but focuses on the specific steps in the implementation of each process element [31].

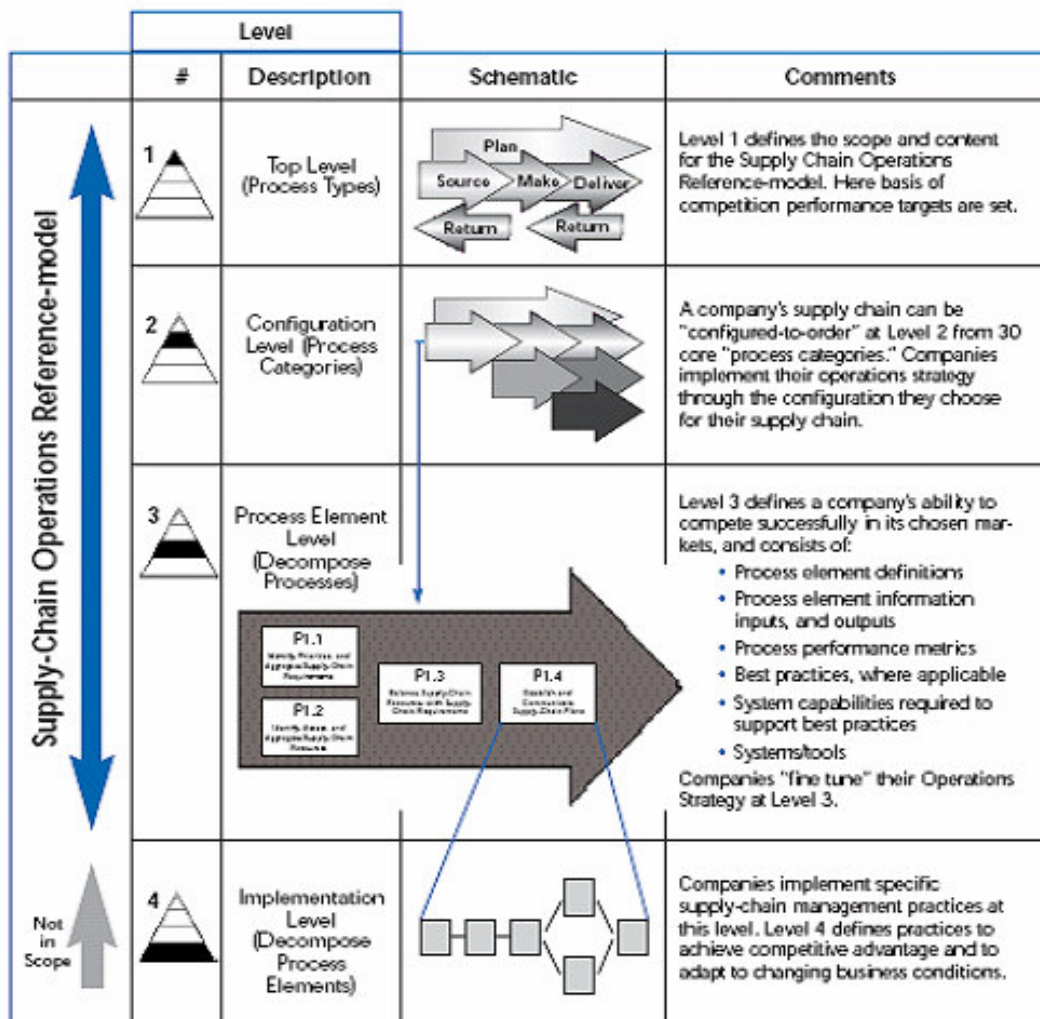


Figure 26 - Three levels of the SCOR model

The nine performance measurements listed in Figure 27, which are categorised under the supply chain competitive attributes of delivery reliability, responsiveness, agility, cost and

assets, form the basis of the SCOR model and can be implemented in almost any production industry [15].

	Attributes	Level 1 strategic metrics
Customer	Reliability	Perfect Order Fulfilment
	Responsiveness	Order Fulfilment Cycle Time
	Agility	Supply Chain Flexibility
Supply Chain Adaptability		
Internal	Cost	Supply Chain Management Cost
		Cost of Goods Sold
	Assets	Cash-to-Cash Cycle Time
		Return on Supply Chain Fixed Assets
		Return on Working Capital

Figure 27 - SCOR supply chain competitive attributes and standard level 1 matrix

The reliability of a supply chain includes “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” [31]. Supply chain responsiveness includes the speed at which a customer is served. Supply chain agility is measured as the ability of a supply chain to respond to market changes in order for the supply chain to gain or retain a competitive advantage. Supply chain costs simply refer to the cost of operating the supply chain and supply chain asset management refers to the efficiency at which the supply chain assets are managed and utilised [31].

According to Joe Francis, the executive director of the SCC, companies usually experience six major benefits from successfully using the SCOR model [14]. The six benefits are that:

- The SCOR model helps them to manage the business by providing detailed visibility into how work actually gets done.
- The model helps companies compete more effectively through its system of metrics that are objectively linked to business processes.
- SCOR's end-to-end supply chain focus points companies toward real and practical process improvements, as opposed to just moving bottlenecks from one place to another.
- The use of SCOR metrics and attributes usually improves cost, cycle time and reliability.
- The SCOR roadmaps help streamline and accelerate business change by mapping out the process improvement cycle.
- SCOR promotes team building. Each team member needs to know the business processes and what is expected from himself and his teammates.

5.2.3 Economic value added

Economic Value Added (EVA) can be used as an overall measure of organisational performance. It can form the basis for a larger performance measurement framework. EVA is a financial performance metric with the objective of creating value for the shareholder. The definition of EVA is the net operating profit of an organisation or supply chain less an appropriate charge for the opportunity cost of all the capital invested in the business [23]. The mathematical definition can be found in the following formula.

$$\text{EVA} = \text{Net Operating Profit after Taxes} - \text{Total Cost of Capital}$$

Equation 1 - Calculating economic value added

EVA is a single measurement that can be used on its own or as part of the balanced scorecard framework to assist managers to make decisions that will create the most value to the organisation. EVA includes metrics such as the cost of goods sold, selling and distribution expenses, asset value, liabilities and more (Figure 28). If managers understand how each of these metrics influences the total EVA, decisions can be made to reduce risk in the business, reduce costs and increase growth. Measuring EVA in a supply chain

environment may have the effect of better managing inventory or service levels within the supply chain as high stock levels and resource levels reduce EVA. Measuring EVA may also increase the sharing of ideas and improvement techniques in order to make a larger profit for the supply chain [34].

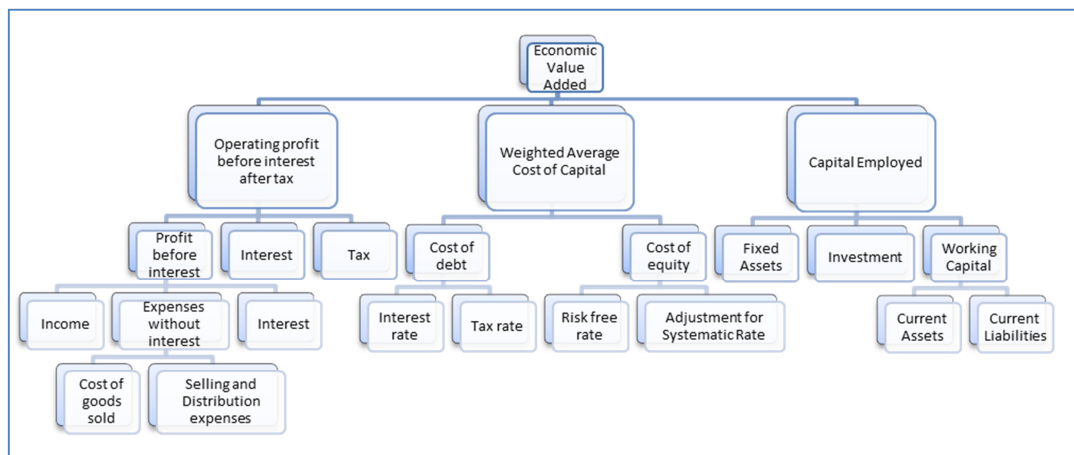


Figure 28 - Economic value added measurement model

5.2.4 Analytical hierarchy process

Kinra *et al.* [25] states that an Analytical Hierarchy Process (AHP) can be used to develop a model to measure elements of a multi-criteria decision making supply chain. The AHP approach can result in an illustrative model that assesses the level of performance of supply chains at a macro level.

The decision-making process in a supply chain can be differentiated into strategic, tactical and operational decisions, typically for and between the different parties in the supply chain. However, structuring these aspects and measuring how effective decisions are made is still a problem. The available literature does not clearly state how the effectiveness of decisions between different parties of a supply chain can be measured. It is important to know and understand all the constraints that exist between these parties [25].

AHP is a methodology that is used to prioritise various elements. It can be used in various applications such as prioritising strategic objectives, assigning weights to the measurement items of a PMS and in decision making activities, for example supplier selection. In this

instance AHP could be used to assign weights to each of the key performance indicators that will be identified for the container industry.

AHP consists out of five main steps, which are listed below [51]:

1. Modelling the decision problem by breaking it down into a hierarchical structure of criteria and detailed criteria.
2. Developing judgmental preferences for the decision alternatives for each criterion and judgmental importance of the decision criteria by pair-wise comparisons.
3. Calculating relative priorities for each of the decision elements.
4. Checking the consistency property.
5. Aggregating the relative priorities to get a final priority ranking.

AHP can be used in conjunction with a system such as BSC or SCOR that stipulates the structure and hierarchy of a PMS. In this way management can be certain that the correct areas are being measured and that the correct priority is assigned to each KPI.

5.3 Previous surveys performed to identify key performance areas

Three surveys that were previously performed by researchers worldwide are discussed in this section. Methodologies used in developing a PMS are discussed and compared. Contributions of these surveys are used to develop a set of measurements applicable to the shipping supply chain.

The three surveys that are discussed cover the following topics:

1. Rating the importance of specific performance metrics.
2. Integration in a supply chain.
3. Agile supply chains.

These three surveys are discussed due to the relevance to the container shipping industry. Survey 1 gives an insight to what measurement elements are deemed as important, whereas Survey 2 shows how important the integration aspect between the different links in the supply chain is. The container shipping industry is affected by numerous factors, whether that is global phenomena or local challenges. The industry therefore needs to be agile and should be able to respond to sudden changes to a market. Survey 3 gives insight to what is required for a supply chain to be considered agile.

5.3.1 Survey 1 – Rating the importance of specific performance metrics

A survey was developed by Gunasekaran *et al.* [17] where 150 large companies in the shipping industry were asked to rate the importance of certain strategic performance elements. Table 3 shows the results of this survey. The measurements are divided in the following four sections of container shipping:

- Plan (including strategy).
- Source/supply (order).
- Produce (make/assemble).
- Deliver (to customer).

This survey looked into what functions companies perceive as being important. A less important function does not mean that the function is unimportant, but that it has a lower priority. The finding of the survey shows that the majority of companies are very customer-orientated. Most of the customer orientated metrics were perceived as being very important. Supplier-related measurements were mostly rated as being moderately important. This shows that companies do not only focus on internal performance, but also on the performance of their customers and suppliers.

Assessment	Planning metrics	Sourcing metrics	Production metrics	Delivery metrics
Very important	Level of customer perceived value of product	Supplier delivery performance	Percentage of defects	Customer query times
			Cost per operation hour	
			Capacity utilisation	
Moderately important	Variances against budget	Supplier lead time	Range of products of services	Product development cycle time
	Order lead time	Supplier pricing		
	Information processing cost	Efficiency of purchase order cycle time		
	Net profit vs. productivity ratio			
	Total cycle time			
	Total cash flow time			
Less important	Level of energy utilisation	Efficiency of cash-flow method	Utilisation of economic order quantity	Accuracy of forecasting
		Supplier booking-in procedures		Planning process cycle time
				Order entry methods
				Human resource productivity

Table 3 - Importance of performance metrics as rated by survey participants

5.3.2 Survey 2 – Integration in a supply chain

A service provider or manufacturer needs to be integrated with its suppliers and customers. The degree to which an organisation is integrated with its suppliers and customers is measured in terms of the “Arc of Integration”, which is illustrated in Figure 29. The hypothesis for this study is that companies with a larger arc of integration will have the largest rates of performance improvement [16]. A survey was performed by Frohlich *et al.* [16] to determine how well the different links in a supply chain are integrated. The performance metrics listed in Table 4 were used in the survey.

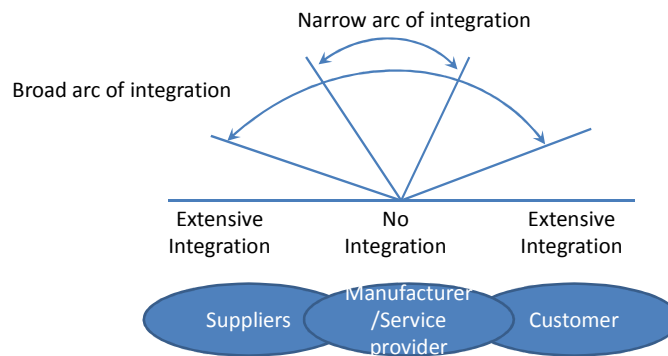


Figure 29 - The arc of integration in a supply chain

The arcs of integration of 322 companies were investigated and compared based on 19 performance measurements. These performance measurements are listed in Table 4. Five different levels of integration were identified, which are:

- Inward-facing - Focus on internal performance measurements.
- Periphery-facing - Limited focus on both supplier and customer metrics.
- Supplier-facing - Focus on supplier metrics.
- Customer-facing - Focus on customer metrics.
- Outward-facing - Main focus on supplier and customer relations.

Marketplace indicators	Productivity indicators	Non-productivity indicators
Market share	Average unit manufacturing cost	Customer service
Profitability	Materials and overhead total cost	Customer satisfaction
Return on investment	Manufacturing lead time	Conformance quality
	Equipment changeover time	Product variety
	Procurement lead time	Speed of product development
	Delivery lead time	Number of new products developed
	Inventory turnover	On-time deliver
	Worker productivity level	Supplier quality

Table 4 - Performance indicators used to compare 322 organisations that participated in the survey

The results show that manufacturers with the most supplier and customer integration (outward facing organisations) perform at a higher level in terms of the 19 performance measurements listed in Table 4 [16]. This implication is also supported by Lam [44]. Possible reasons for this are that organisations with a high level of supplier and customer integration have better control over the supply chain and can coordinate the functions throughout the chain better. They are also able to identify waste and eliminate non-value adding activities throughout the supply chain.

5.3.3 Survey 3 – Agile supply chains

The concept of the survey performed by van Hoek *et al.* [38] was to measure the ability of a supply chain to adapt to market changes. Agile supply chains are able to respond to changes in demand and supply whilst still delivering on-time [28].

Lee [28] states that an agile supply chain needs to:

- Share information with its suppliers and customers.
- Collaborate with its suppliers.
- Build in postponement into its production line.
- Include sufficient inventory.
- Improve its logistics activities.
- Have the necessary contingency plans in place.

The results of this survey show that the organisational structure has to change from a vertical focus to a horizontal integration with the supply chain partners in order for the supply chain to become more agile. Figure 30 illustrates the four main elements of an agile supply chain, which are [38]:

- Customer focus - Understanding the market.
- Network integration - Organisations need to cooperate.
- Process integration - Managing process changes and process optimisation across the supply chain.
- Virtual integration - Making information available for the supply chain.

All four of these elements will be addressed by implementing a PMS. The corridor performance has a direct impact on customer satisfaction. The performance of all the organisations in the supply chain should be known by all parties. This will improve the network integration within the supply chain. The flow of cargo can be better monitored if open communication channels between the organisations chain are in place. Corridor performance statistics should be made available to the organisations in the supply chain.

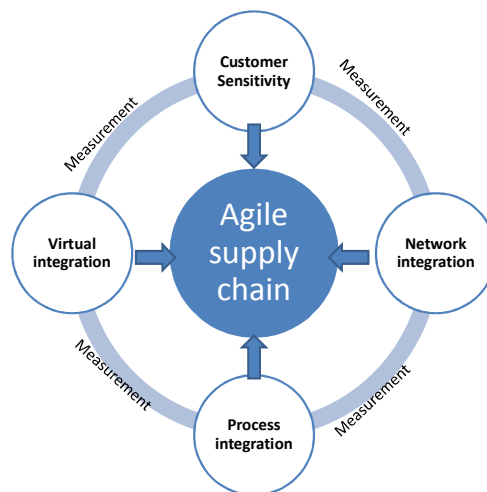


Figure 30 - Elements of an agile supply chain

Agility needs to be built into the processes of an organisation or a supply chain. The supply chain should be able to deal with unexpected changes and still achieve the targets set for that specific period.

5.4 Conclusion

The reasons for the development of a performance measurement model should always be clear and communicated to the individuals that will be responsible for developing the system as well as the individuals that will be responsible for achieving the set targets. The chosen KPIs should have a direct impact on the efficiency of the supply chain or business if improved and should be limited to only a few KPIs.

Various general PMS models are available, but no system specifically focusing on South African container shipping was found in the available literature. The results from the surveys discussed in the previous sections can be used in the development of a performance

measurement model for container shipping in South Africa and more specifically, the Western Cape region.

Container shipping operates mostly in silos, each optimising the individual link in the supply chain. The industry needs a measurement system that is more integrated and assists in improving the industry. Measuring the supply chain will encourage the different organisations within a supply chain to:

- Communicate more effectively.
- Work together to improve the entire supply chain's performance.
- Eliminate inefficiencies that may exist between organisations.
- Work towards a common goal.

The surveys discussed in the above sections all have one conclusion in common. Organisations that have connections with their suppliers and customers are more productive than those that work in silos. Supply chains that share information with regards to inventory levels, raw materials, resource availability, lead times and improvement initiatives throughout the chain compete at a higher level than those that do not share any information at all [44].

It is very important within the container shipping industry that service providers can cooperate to bring down the cost of doing business. The shipper (exporter/importer) experiences the benefit from a supply chain that is established and integrated [43]. Delays and breakdowns within the chain are reduced and economies of scope can be applicable when multiple organisations work together.

Frohlich *et al.* [16] said that “if the 1980's were about vertically aligning the operations with the business strategy, then the 1990's have been about horizontally aligning operations across processes”. The current challenge is to horizontally align organisations throughout a supply chain.

The next chapter will discuss the development of a container industry performance measurement system. The information that was collected prior to the development of the system will be deliberated. Previous research on the topic will be mentioned and the benefits of implementing such a system will be listed.

6. Development of a container shipping performance measurement system

This chapter deals with the development of a performance measurement system. Questionnaires were sent to representatives working in the South African container industry and the results were used as valuable input to the development of the PMS model. There are various parties that are currently busy with similar studies, which emphasises the need for a performance measurement system for the container shipping industry. Previous research on this topic will be briefly discussed. Suggestions will be made on how the system should be managed and the benefits of the system are listed. The key performance areas and targets for the measurements are identified; where after the development of the performance measurement system is deliberated.

6.1 Questionnaires sent to the South African shipping industry

The surveys discussed in section 5.3 are all based on global organisations. They can be used as a guide, but it should not be taken for granted that the same situation applies to South Africa, considering the fact that South Africa is a developing country. Two questionnaires were therefore developed and sent to representatives of organisations within the South African container shipping industry.

The first questionnaire focuses on items currently being measured in terms of the customer, supplier and also the performance of the organisation itself. The second questionnaire focuses on the fruit export industry specifically because it is so different to any other corridor. It has variables that other container corridors do not include, for example, the temperature regulation of the container.

6.1.1 Measuring supplier, customer and internal performance

The questionnaire was sent to a total of 133 managers in the South African shipping industry, mainly covering the shipping lines, container terminals, trucking companies and port authority and 31 were completed after a round of reminder emails were sent. The 31 completed questionnaires covered most of the channel partners and it was felt that the information can be used as a representative of the supply chain. The questionnaires requested information on the performance measurement of suppliers, customers and the organisations' own operation and can be found in Annexure B.

Supplier performance

A supplier is any company or individual that delivers a commodity or service to another business. A supplier's supplier, for example, should also be part of the supply chain integration as their performance may have an impact on the organisation. Approximately 50% of the organisations measure supplier performance actively. Some of the measurements for suppliers are:

- Lead time
- Dedicated capacity of truckers to a shipping line
- Minimum notice time for a trucking company
- Accuracy of invoicing
- Response time to queries
- Delays
- Cost
- Productivity

An average of 78% of the organisations share internal information with suppliers. Information regarding staffing levels, cost, progress and results as well as service shortcomings that were experienced is shared. Meetings with suppliers are the main platform for the information sharing in this industry. 66% of the organisations monitor supplier pricing against industry norms. Most of the companies make use of requests for quotations from multiple suppliers and compare tariffs. All the representatives from the organisations felt that their suppliers assist in problem solving through jointly coming up with solutions, and most felt that their communication with the suppliers are very good.

Operations performance

Operations performance refers to the internal performance of the business. Some internal operations measurements as listed by participants included:

- Vessel productivity (container terminals)
- On time delivery (trucking companies)
- Down time
- Man hours lost
- Equipment delays
- Trucks turn-around times
- Productivity losses due to delays

21% of the organisations consider the way their employees perceive their business through employee questionnaires. The majority of the participants do not measure internal capacity utilisation, especially the utilisation of human resources. Container ports do focus on equipment utilisation rates and shipping lines do measure capacity utilisation of vessels. Most trucking companies stated that they do not measure utilisation specifically, but they strive to keep their trucks busy and on the road as much as possible.

Customer performance

A customer is any organisation or individual that receives goods or a service from another organisation. Measurements in terms of customer performance included:

- Customer satisfaction questionnaires.
- Customer feedback (verbal and written).
- Accuracy of information provided.
- Performance measurement of customer representatives.
- Claims processing and reduction in claims.
- Percentage of issues resolved (problem solving).

All of the organisations inspect their own delivery lead times to their customers as well as their delivery performance.

6.1.2 Performance measurement in the South African fruit export industry

A similar questionnaire was sent to role players in the fruit export industry. This questionnaire was sent to 91 representatives (mostly at management level) of 77 organisations in the industry. Six questions were asked and initially only seven responses were received. Another round of emails was sent to role players and 17 additional responses were received. This improved the survey response rate to 26 percent. Seven of the responses can be found in Annexure C. All seven companies are exporters responsible for the logistics activities required when shipping fruit. Three of the organisations (Companies 5, 6 and 7) are fruit producers undertaking to do the logistical function internally.

Internal performance measurements within these companies focus mainly on the fruit quality, but this is something that is affected throughout the supply chain. Financial returns, market access and market share are also main focus areas of organisations in the fruit export industry. Six of the logistics companies also measure the accuracy of their volume forecast to the shipping lines. This is important as shipping lines depend on this forecast to reserve sufficient slots on their vessels and container operators require this information to plan efficiently and reserve space in the container terminal.

Supplier measurements listed in the questionnaire are based on two key measurements: time and temperature. The time allocated to the various organisations is being measured by exporters. For example the scheduling and timing of land transport, terminal handling, sea freight and overseas harbour clearing are the critical stages that are being measured. Temperature discrepancies throughout the chain are an important aspect that needs to be measured in order to manage and eliminate this inefficiency from the chain.

Customer measurements are mainly customer surveys and customer satisfaction reports. The quality of the fruit plays a huge role here as any irregularities will impact the organisation negatively.

6.2 Measuring integration between organisations

The level of integration between the various organisations in a supply chain needs to be measured so that improvement in this area can be tracked. Section 5.3.2 discussed the

importance of integration between organisations in a supply chain. Currently there is no measurement that specifically measures the level of integration in this industry.

All of the industry role players will be requested to perform a survey on a monthly basis to determine the level of integration of their organisation with its suppliers and customers. The survey rates each of the following integration activities for both the suppliers and customers on a level from 1 (no integration) to 5 (extensive integration):

- Access to planning systems.
- Sharing of production plans.
- Joint EDI access/networks.
- Knowledge of the organisation's capacity levels.
- Weekly/monthly meetings to discuss performance levels.

The level of integration of an organisation will be calculated by averaging the survey results for that specific organisation. This figure will indicate the organisation's level of integration with its suppliers and customers. The survey can be found in Table 5 [16]. The target for each organisation should be to achieve a level five, which is extensive integration with both customers and suppliers.

Integration activities	Suppliers					Customers				
	No integration		Extensive integration			No integration		Extensive integration		
Access to planning systems	1	2	3	4	5	1	2	3	4	5
Sharing of production plans	1	2	3	4	5	1	2	3	4	5
Joint EDI access/networks	1	2	3	4	5	1	2	3	4	5
Knowledge of the organisation's capacity levels	1	2	3	4	5	1	2	3	4	5
Weekly/Monthly meetings to discuss performance	1	2	3	4	5	1	2	3	4	5

Table 5 - Integration between an organisation and its customers and suppliers

6.3 Previous research performed

Two government departments, the Department of Public Enterprises (DPE) and the Western Cape Department of Economic Development and Tourism (DEDAT), are currently involved in developing a PMS for the container shipping industry.

The Centre for Supply Chain Management (CSCM) at the University of Stellenbosch in conjunction with the DPE is currently in the process of developing an IT system that will be

used to measure and monitor the seven corridors that were identified by Transnet (see section 4.1.4). The seven corridors are grouped into five commodities [57]:

- Containers
- Automotive industry related cargo
- Steel, metals and mining commodities
- Bulk liquids
- Agro-processing

The project team at the CSCM is in the process of identifying measurements that will be of benefit to the various industries and will also give the DPE a tool to measure the performance of Transnet and its divisions [57]. The system that the CSCM is developing is internet based. Any participating organisation will have access to the system to monitor the performance of the different corridors (as listed in paragraph 4.1.4). The CSCM has been contracted by the DPE to manage the system for the first two years. Thereafter the DPE must assign a party to manage the system on their behalf.

A meeting with Mr H. Jonker, manager of marine sectors industry at the Western Cape DEDAT, confirmed that the DEDAT is currently starting an initiative to develop a system that will look at logistics efficiency from a supply chain perspective [66]. The project team will be focusing on the container industry as well as the oil and gas industry in the Port of Cape Town as a start. They are interested in developing a system similar to the one developed in this thesis in order to determine an efficiency measurement for the industry. The DEDAT have the responsibility of marketing the Western Cape region and Cape Town specifically as an economic business centre. In order to prove that South African ports and more specifically the Port of Cape Town are efficient when compared to the competition, they require a benchmark figure that will summarise the efficiency levels. The direct competitors of the Port of Cape Town are the other South African ports (Durban, Port Elizabeth, East London and Richards Bay) as well as the Port of Walvis Bay in Namibia and the Maputo Port in Mozambique due to the close proximity to the markets in the northern part of South Africa. Both of these government departments are working independently and are currently unaware of the progress of the other party [66].

In 2006 the Global Institute of Logistics (GIL) developed a benchmarking tool, called the Container Terminal Quality Indicator (CTQI), to measure container terminal efficiency and

port performance [41]. CTQI is a tool that was developed to establish an international standard against which container terminals and ports can be benchmarked. Container terminals need to supply detailed information on specific performance indicators if they would like to apply for CTQI certification. CTQI certification requires data on current performance levels, throughput levels, the amount of equipment, the age of the equipment, the size of the terminal, container dwell times, vessel turnaround times, truck turnaround times, the number of human resources, and many more indicators related to container ports and terminals. The PMS system developed during this research project would in future assist in providing some of the historic data required for CTQI certification.

6.4 Management of the container shipping performance measurement system

The PMS managing party will have the responsibility of communicating with the industry. The managing body will communicate new initiatives to the industry in forums where the issues can be discussed. They will consolidate plans and assist in managing the implementation of new initiatives. At the moment changes in the port and terminals are raised at forums such as the Port Liaison Forum (PLF), the Container Liners Operating Forum (CLOF), the Harbour Carriers Association (HCA), the Freight Forwarders Association (FFA) and the Chamber of Commerce. The shortfall is that these forums are not representative of the entire supply chain. Each of the forums represents a specific link in the chain and their focus is on improving that part of the chain. The managing party of this PMS will need to establish a forum that will focus on corridor performance management and improvement initiatives throughout the chain. These initiatives may not always benefit all the parties, but if it improves the corridor efficiency, all the parties should comprehend that and cooperate.

The container performance measurement system (PMS) will need to be managed by a body that is independent from all the participating parties in order for the reporting to be impartial. A suggestion emanating from this research study is that this role be played by a government department such as the DPE or the DTI. A management fee can be charged for the service provided as all parties will benefit from the corridor focused PMS.

The recommendation is that the DPE manages the PMS. The mission of the DPE is to provide each State Owned Enterprise (SOE) with [73]:

- Clear mandates.
- Simple, understandable and implementable governance systems.
- Effective performance management.

The PMS therefore falls directly within the area of responsibility of the DPE. The PMS developed in this research focuses on the Cape corridor (Capecor), but may feed into the complete PMS that is currently under development by the CSCM at the University of Stellenbosch.

6.5 Benefits of the performance measurement system

The benefits of participating in the PMS are that:

- Organisations will be able to benchmark their individual performance against that of the corridor.
- Areas in need of improvement can easily be identified.
- Improvement initiatives can be suggested and accepted throughout the corridor.
- A common goal can be strived towards.
- A common strategy can be established and applied throughout the entire corridor.

All the role players would benefit from the implementation of such a system. In order for the benefits to be reaped, cooperation from all parties is required. Information needs to be submitted on a monthly basis in order to monitor the performance of the various parties. This information can be dealt with in a confidential manner and only corridor averages can be advertised. The managing body would have the discretion of informing organisations that are not meeting their targets that they are influencing the corridor negatively.

6.6 Key performance areas

The Key Performance Areas (KPA) that were identified by the CSCM are [57]:

- Process efficiency
- Availability
- Customer Service
- Economic Utility
- Capacity Utilisation
- Asset productivity

The same KPAs are used for this metric system for the Cape corridor container supply chain. The KPAs are explained in the following paragraphs and examples of Key Performance Indicators (KPIs) under each KPA are mentioned:

- Process efficiency - This KPA refers to the efficiency levels of all processes within the supply chain such as the inland transportation, the loading and off-loading of the vessel and rail transportation.
- Availability - The availability of resources (people and equipment) is an area that needs to be measured, especially in the case of container terminal and rail operators.
- Customer service - Customer service measures the service provided against the service requested. Shipping lines, for example, demand a certain productivity level from container terminals and shippers demand reliable delivery dates from shipping lines.
- Economic utility - The cost and revenue produced per supply chain link is an important driver in supply chain improvement and need to be measured. This however is not always possible as companies are very reluctant to share financial information for fear of competitors using it against them.
- Capacity utilisation - The maximum capacity of a supply chain or corridor is determined by the link in the chain with the lowest capacity. It is imperative that the capacity of each link in a chain is measured so that the areas in need of expansion can be identified.
- Asset productivity - Asset productivity is a measurement for how effective assets are utilised. This is usually a measurement per equipment type measured against a specific utilisation target.

The six KPAs listed in the previous paragraph can be directly linked to the four categories of the BSC, namely the internal business processes, customer focus, financial focus and innovation and learning as shown in Table 6. The fourth category of the BSC, which is innovation and learning, is not specifically included in the CSCM KPA's. Innovation and learning in an organisation should be measured internally by each organisation in order to keep the amount of KPIs included in the PMS to only a few critical KPIs.

BALANCED SCORECARD CATEGORIES	CSCM KPAs
Internal business processes	Process efficiency
	Availability
	Capacity Utilisation
	Asset productivity
Customer focus	Customer Service
Financial focus	Economic Utility
Innovation and learning	Process efficiency
	Customer satisfaction

Table 6 - Relationship between the balanced scorecard and KPAs identified by the CSCM

The SCOR model was also incorporated into the PMS. The relationship between the SCOR Model and the KPIs identified by the CSCM is shown in Table 7. The SCOR model is categorised in the following five focus areas (section 5.2.2):

- Delivery reliability
- Supply chain responsiveness
- Agility
- Cost
- Assets

The PMS will have an element of both the BSC and the SCOR model. All the key performance areas measured in the BSC and SCOR models will be included in the PMS.

Table 7 shows how the SCOR model attributes correspond to the CSCM KPAs. Process efficiency, availability and capacity utilisation contribute towards delivery reliability. Process efficiency KPIs such as on-time delivery, on-time departure, vessel and truck turnaround

times directly influenced delivery reliability. Responsiveness and agility refers to how a business deals with changes in demand. The customer service measurement measures the customer's perception of how the business deals with the changes. The customer has to complete a survey and rate the following categories in terms of an organisation's performance:

- Productivity
- Billing accuracy
- Claims management
- Complaints/queries attended to
- Response to changes

SCOR Model	CSCM KPAs
Delivery reliability	Process efficiency Capacity utilisation Availability
Responsiveness Agility	Customer Service
Cost	Economic Utility
Assets	Asset productivity

Table 7 - Relationship between the SCOR Model and KPAs identified by the CSCM

It was important to adhere to the following guidelines set up by McKay [45] in developing a PMS for container shipping:

- Measure the right things.
- Align measurements with strategic goals.
- Do not have too many measurements.
- Display the results.
- Reward the achievement of these goals.

6.7 Key performance indicators

The results of the two questionnaires⁸ that were completed by industry role players and the research performed on existing PMSs were used to develop a KPI matrix (Table 8) for the Cape corridor. All the KPIs are of a quantitative nature, except for the “customer satisfaction survey” KPI and the “Level of integration” KPI. Customers rate an organisation’s service level in the customer satisfaction survey and organisations rate their level of integration with customers and suppliers in the level of integration survey (see section 6.2).

⁸ Both questionnaires were about performance measurements used within the organisations. The first questionnaire was sent to organisations in the Cape Town region such as shipping lines, trucking companies, the rail transporter and freight forwarders. The second questionnaire focused mainly on the fruit industry and was sent to specific organisations that play a role in the import and export of fruit.

KPAs	KPIs	Supply chain organisation	Description of KPI
Process efficiency	Truck turnaround time	Container terminal	Time from the in-gate to the out-gate
	Berthing delays	Port Authority	Vessel arrival time to berthing time
	Vessel turnaround time	Port Authority Container terminal	Berthing time to sailing time
	Average container dwell time	Container terminal	Container arrival time to departure time
	Rail turnaround time	Rail operator Container terminal	First container handled to last container handled
	On-time delivery	Rail operator Trucking company	Total on-time deliveries divided by total deliveries
	Idle time	Shipping line Trucking company	Total non-productive time
	Level of integration (with suppliers and customers)	Port Authority Container terminal Rail operator Shipping line Trucking company	Survey rated by organisations
Availability	Berth occupancy	Port Authority Container terminal	Berthing hours per week divided by total hours per week
	Equipment availability	Container terminal	Operational time divided by total demand (including breakdowns)
	Rail trucks availability	Rail operator	Operational time divided by total demand (including breakdowns)
	Locomotive availability	Container terminal	Operational time divided by total demand (including breakdowns)
	Customer service index	Container terminal Rail operator Port Authority Trucking company Shipping line	Survey rated by customers
Customer Service	Response time to queries	Container terminal Rail operator Port Authority Trucking company Shipping line	Time of query received to query attended to

KPAs	KPIs	Supply chain organisation	Description of KPI
Economic Utility	Terminal handling charge	Container terminal	Tariff for handling a container
	Port, tonnage and cargo dues	Port Authority	Port dues – Charges levied by the port to all ships entering the port till the time it leaves the port Tonnage dues – Charges paid by the vessel operator to a port for the usage of the port. Cargo dues – Charges for using the port facilities for movement of the cargo through it
	Rail transportation tariff	Rail operator	Tariff for transporting a container via rail
	Trucking charges	Trucking company	Tariff for transporting a container via road
	Freight charge	Shipping line	Line for shipping a container
	Value of claims	Shipping line Trucking company Port Authority Container terminal	Total cost of claims such as damages and errors
	Throughput achieved against budgeted volumes	Container terminal	Total container volume handled divided by total container volume budgeted
Capacity Utilisation	Stacking capacity utilisation	Container terminal	Stacking area used divided by total stacking capacity
	Total vessel slot utilisation	Shipping lines	Vessel slots utilised divided by total slots
	% Vessels on schedule	Shipping lines	Voyages on schedule divided by total voyages
	Ship to Shore (STS) crane utilisation	Container terminal	Operating hours divided by total hours
Asset Utilisation	Yard crane utilisation	Container terminal	Operating hours divided by total hours
	Rail truck utilisation	Rail operator	Operating hours divided by total hours
	Locomotive utilisation	Rail operator	Operating hours divided by total hours

Table 8 - Categorisation and specification of KPIs

Table 9 shows how the KPIs identified in Table 8 can be categorised in the SCOR supply chain competitiveness attributes, which are delivery reliability, responsiveness, supply chain agility, assets and cost.

Delivery reliability	Responsiveness	Agility	Cost	Assets
Truck turnaround time	Customer service index	Stacking capacity utilisation	Terminal handling charge	Equipment availability
Berthing delays	Response time to queries	Total vessel slot utilisation	Port dues	Rail trucks availability
Vessel turnaround time	Level of integration		Rail transportation tariff	Locomotive availability
Average container dwell time			Trucking charges	Ship to Shore (STS) crane utilisation
Rail turnaround time			Freight charge	Yard crane utilisation
Container on-time delivery			Throughput achieved against budgeted volumes	Rail trucks utilisation
Vessel Idle time			Value of claims	Locomotive utilisation
Berth occupancy				
% Vessels on schedule				

Table 9 - KPIs categorised per the SCOR supply chain competitiveness attributes

The identified measurements are illustrated in Figure 31 per supply chain role player. Even though the measurements listed cover some aspects of the container supply chain, some of the measurements are not mutually exclusive. Measurements ideally need to be mutually exclusive and collectively exhaustive (MECE) for them to be included in a PMS and in order to analyse the measurements statistically [2]. An example of two measurements that are not mutually exclusive is vessel turnaround time and berth occupancy. The berth occupancy is dependent on the vessel turnaround time. These measurements are not MECE and therefore one of these KPI cannot be included in the final PMS.

It was decided to exclude the economic utility measurements from the PMS, because organisations do not want to disclose financial information for fear of competitors using it to their own advantage. The Port Authority's KPIs are also not included. Berthing and sailing delays will be seen as idle time by the shipping lines and form part of this KPI.

Each organisation should have a customer satisfaction survey that the customers complete on a monthly basis. Asset utilisation KPIs are important indicators to indicate where the bottlenecks are and when an organisation needs to invest in additional assets. Rail truck and locomotive utilisation are included in the rail operators KPIs and ship to shore crane utilisation is included in the container operators KPIs.

The KPIs provide a clear insight to how efficient the container shipping industry is and where there might be inefficiencies that need to be addressed.

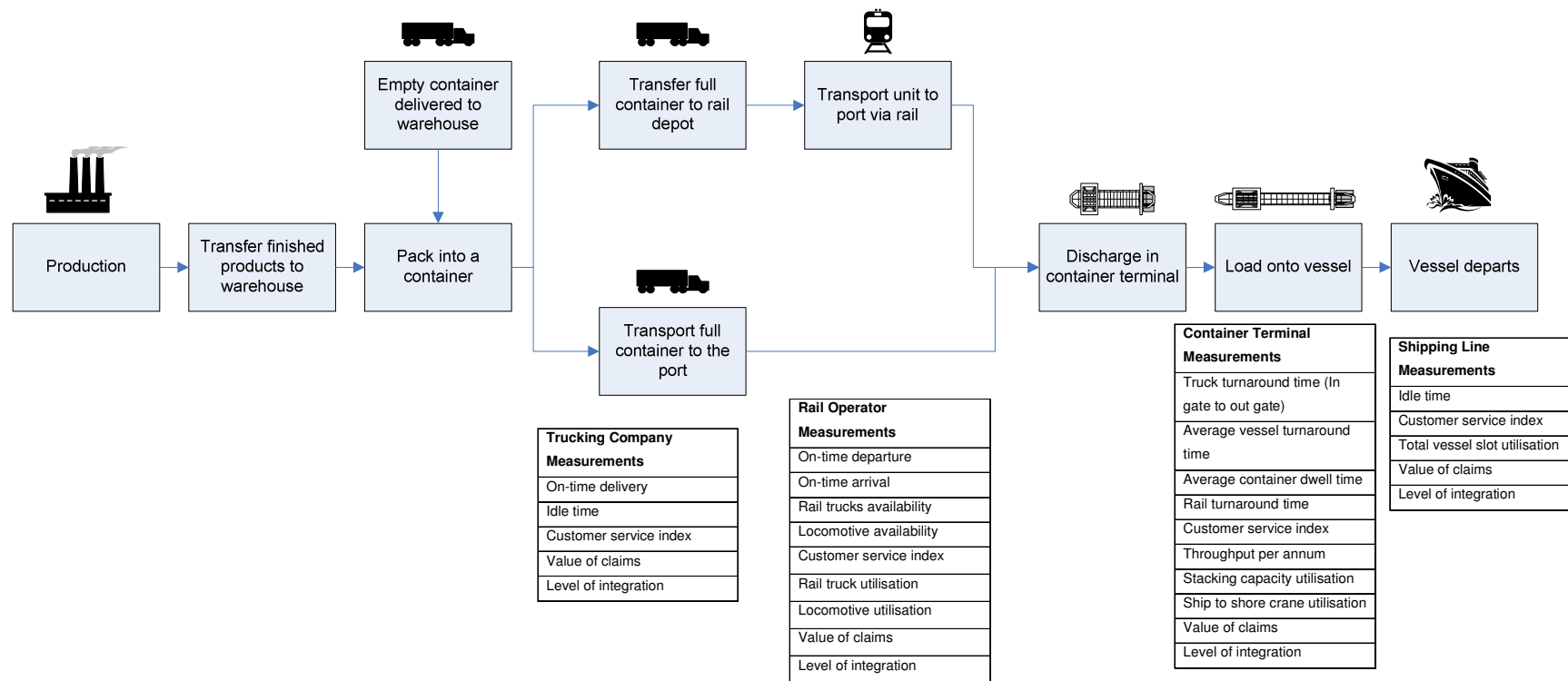


Figure 31 - The selected key performance indicators for an outbound container supply chain

6.8 KPI targets

The specific targets per KPA are listed in the following tables. Targets were determined by approaching managers within the industry and enquiring about their current performance measurement targets. In the cases where managers did not want to disclose the company's targets, targets were estimated based on historical data. These are the targets that the different parties will be measured against if the PMS is implemented in this financial year (1 April 2011 to 31 March 2012). These targets need to be reviewed on a yearly basis and adjusted in the PMS.

6.8.1 Container terminal targets

The container terminal plays an important role in the chain and delays can have an enormous impact on the corridor. The container terminal therefore has the most measurements. Table 10 lists CTCT's targets for the current financial year. It is a Transnet policy that there is no budget for claims. Each division must strive to keep the cost of claims as low as possible. If there are claims, it is deducted from the division's profit.

KPAs	KPIs	Target
Process efficiency	Average vessel turnaround time	40 hours
	Truck turnaround time (In gate to out gate)	30 minutes
	Rail turnaround time	2 hours
	Level of integration	Level 5
Customer Service	Customer service index	85%
	Value of claims	0
Capacity Utilisation	Percentage of budgeted volumes achieved	100%
	Stacking capacity utilisation	65%

Table 10 - Cape Town Container Terminal's performance measurement targets

6.8.2 Shipping line targets

The shipping line targets are as listed in Table 11. These three KPAs cover the main focus areas of shipping lines. They need to minimise their idle time, keep to their pre-determined schedule, transport as many containers as possible and satisfy customer demand. Shipping lines therefore also strive to have no claims and do not allocate a budget to claims.

KPAs	KPIs	Target
Process efficiency	Idle time	5%
	Level of integration	Level 5
Customer Service	Customer service index	85%
	Value of claims	0
Capacity Utilisation	Total vessel slot utilisation	95%

Table 11 - Shipping line targets

6.8.3 Rail operator targets

The rail operator targets are listed in Table 12. The process efficiency measurements are all time based. These measurements are what the customers want to measure and what affect the supply chain the most. Delays anywhere in the rail system may have devastating effects on a customer's business. Idle time due to shunting delays, standing en route due to faulty locomotives, wagons or rail lines, and shortage of resources all affect the on-time arrival and departure of trains. These delays need to be tracked so that problem areas are identified.

KPAs	KPIs	Target
Process efficiency	On-time arrival (Average minutes delayed)	184 minutes
	On-time departure (Average minutes delayed)	238 minutes
	Level of integration	Level 5
Availability	Rail trucks availability	100%
	Locomotive availability	85%
Customer Service	Customer service index	85%
	Value of claims	0

Table 12 - Rail operator targets

6.8.4 Trucking company targets

The trucking company measurements are listed in Table 13. Trucking companies need to transport as many containers as possible per day. Delays and breakdowns are therefore to the detriment of the company and should be kept to a minimum. The aim is to keep the

customer satisfied by delivering the cargo at the correct place and time as agreed by both parties.

KPAs	KPIs	Target
Process efficiency	On-time delivery	2 hours
	Level of integration	Level 5
Customer Service	Customer service index	85%
Asset Utilisation	Idle Time	5%

Table 13 - Trucking company targets

6.9 Development of the PMS

A generic PMS was developed for the container shipping industry. The PMS looks at the entire process from the transportation to and from the container terminal via road or rail, the container terminal activities as well the shipping line's portion of the supply chain. The system can be adapted to include more detailed commodity specific measurements. Targets and actual figures are captured on a monthly basis and the entire year's data can be viewed in graph form. This is crucial in order to identify emerging trends in the industry.

The PMS was developed in Microsoft Excel using macros and Visual Basic Programming. The aim was to make it as user friendly as possible. The main worksheet is the "PMS" sheet where the monthly KPI targets and actual figures are entered. Instructions on how to use this sheet can be found in Figure 32. The KPIs used in the PMS were identified in sections 6.6 to 6.8. The managing party should review the KPIs on a regular basis and make the necessary changes.

An actual figure of a KPI, notated as a (3) in Figure 32, is shown as a green or a red cell. Green means that the target was achieved and red means that the KPI is below the set target for that specific period. It was decided that a KPI target should only be displayed as red or green, therefore 'achieved' or 'not yet achieved'. In dashboards where there is a middle or amber state, companies end up using it as a default state and seem to get stuck in this middle state [89]. KPIs usually remain in this state for longer periods than is necessary. Managers feel that they are working towards the target when they are in this state, but the pressure is not as high as when a KPI is in the red state.

The total corridor efficiency is calculated by averaging the efficiency levels of all the role players in the corridor and is notated by the cell numbered (5). The main role players in the example in Figure 32 are the shipping line, container terminal, rail operator and the trucking companies.

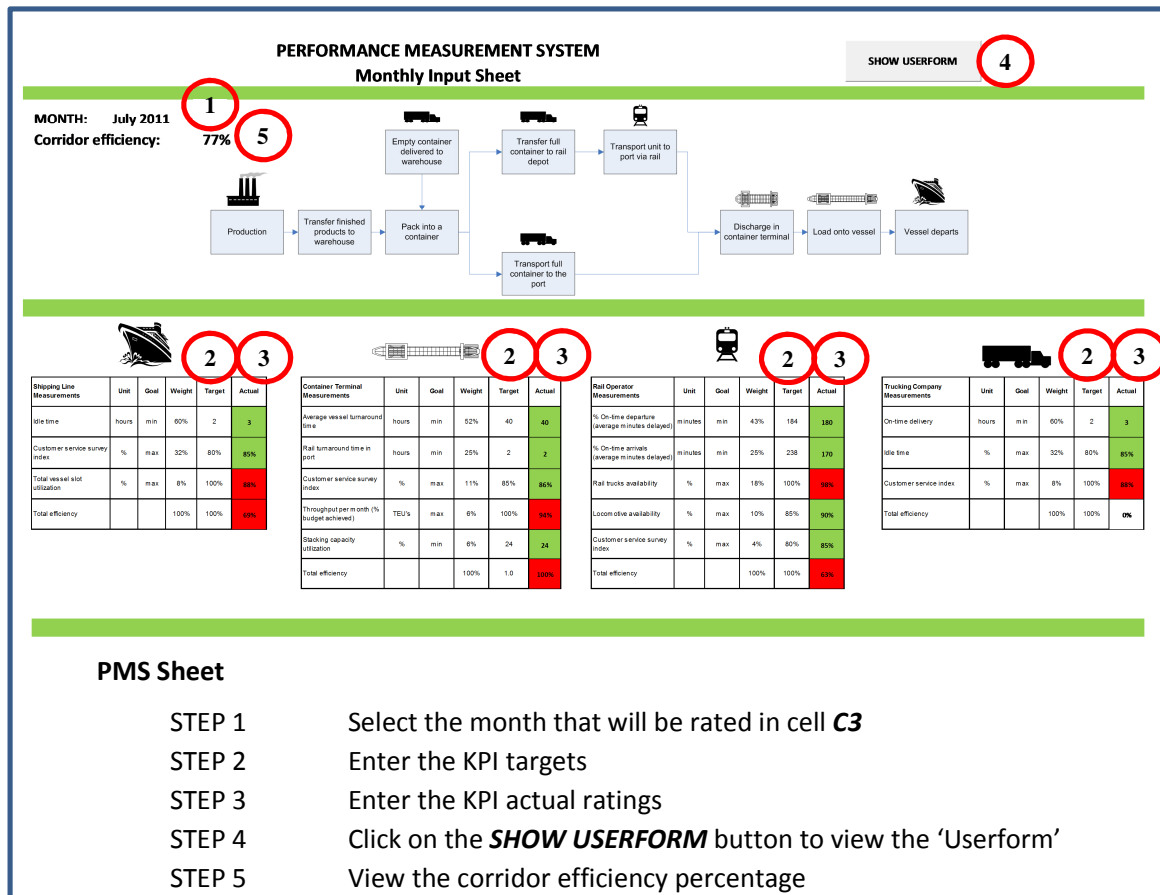


Figure 32 - Instructions for the PMS worksheet

The PMS will allow a user to:

1. Update the current month's KPIs
2. Update the performance history
3. View the performance history
4. Update the weights allocated to each KPI

The weight assigned to each KPI is calculated using the Analytical Hierarchy Process (AHP). As described in Paragraph 5.2.4, AHP is a multi-criteria decision making method that assists

management in decision making and prioritising activities and projects. In this instance, AHP was used to prioritise the KPIs by assigning a weight to each KPI.

Management representatives from the participating organisations were asked to complete a survey comparing each KPI with the rest of the KPIs. The survey can be found in Annexure D. They had to rate the importance of each of the KPIs by comparing it with the rest of the KPIs.

The survey results are then converted into a pairwise comparison matrix. A scale of one to nine is used when comparing two KPIs. The pairwise comparison matrices of the individuals that completed the survey are averaged in order to calculate the final pairwise comparison matrix that will be used in the AHP calculations. A list of the variables used in the AHP calculations can be found in Table 14. An example of a pairwise comparison matrix (A) can be found in Table 15. The interpretation of the pairwise comparison ratings is listed in Table 16 [8].

Variables	Description
A	Pairwise comparison matrix
n	Number of KPI's
A^n	Normalised pairwise comparison matrix
w	Priority matrix containing the weights per KPI
λ_{max}	Step 2 of the consistency check
i	Counter

Table 14 - Variables in AHP calculation

		KPI j				
		Vessel TAT	Rail TAT	CSI	Throughput	Stack capacity utilization
KPI i	Vessel TAT	1.00	5.00	4.00	1.00	3.00
	Rail TAT	0.20	1.00	3.00	1.00	4.00
	CSI	0.25	0.33	1.00	1.00	3.00
	Throughput	1.00	1.00	1.00	1.00	6.00
	Stack capacity utilization	0.33	0.25	0.33	0.17	1.00

Table 15 - Pairwise comparison matrix (A)

Rating	Interpretation (Comparing KPI i with KPI j)
1	Equally important
3	Slightly more important
5	Strongly more important
7	Very strongly more important
9	Absolutely more important
2, 4, 6, 8	Intermediate values. 2 for example means KPI i and j are not equally important, but i is less than slightly more important than j.

Table 16 - Interpretation of pairwise comparison ratings

The next step in the AHP is to normalise the pairwise comparison matrix by dividing each entry in column i by the sum of the entries in column i. The matrix in Table 15 is used as an example to illustrate the AHP. The normalised matrix (A^n) can be found in Table 17. To determine the weight per KPI, the average of each row of the normalised matrix is calculated. The weights (w) per KPI can be found in Table 18.

		KPI j				
		Vessel TAT	Rail TAT	CSI	Throughput	Stack capacity utilization
KPI i	Vessel TAT	0.36	0.66	0.43	0.24	0.18
	Rail TAT	0.07	0.13	0.32	0.24	0.24
	CSI	0.09	0.04	0.11	0.24	0.18
	Throughput	0.36	0.13	0.11	0.24	0.35
	Stack capacity utilization	0.12	0.03	0.04	0.04	0.06

Table 17 - Normalised pairwise comparison matrix (A^n)

KPIs	Weight
Vessel TAT	0.42
Rail TAT	0.19
CSI	0.12
Throughput	0.21
Stack capacity utilization	0.06
Total weight	1.00

Table 18 - The priority matrix (w) contains the KPI weights

A consistency test is performed on the final pairwise comparison matrix to determine whether the individuals that rated the importance of the KPIs in the survey, made logical and informed choices. The consistency check is based on the fact that if an individual rated KPI1 to be twice as important as KPI2, and KPI2 to be three times more important than KPI3, then KPI1 should be six times more important than KPI3. The consistency ratio (CR) is used to

determine whether the pairwise comparison matrix is consistent enough to give useful estimates of the weights per KPI. CR is calculated by dividing the consistency index (CI) by the random index (RI). The step by step formulae for performing a consistency test can be found in Table 19 [8]. The RI is a constant number for each value of n and can be found in Table 20. The matrix is consistent enough if CR is less than 0.1 and inconsistent if CR is greater than 0.1.

Step	Formulae
1	Aw
2	$\lambda_{max} = \frac{1}{n} \sum_{i=1}^n \frac{i^{th} \text{ entry of } Aw}{i^{th} \text{ entry of } w}$
3	$CI = \frac{(\text{Step 2 result}) - n}{n - 1}$
4	$CR = \frac{CI}{RI}$

Table 19 - AHP consistency check formulae

n	RI
1	0.00
2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49
11	1.51
12	1.48
13	1.56
14	1.57
15	1.59

Table 20 - Values of the Random Index (RI)

The results of the consistency check of the example in Table 15 can be found in Figure 33. The results show that the pairwise comparison matrix was consistent enough. AHP should therefore not be applied to this pairwise comparison matrix to calculate the priority matrix. The entire process then starts again by developing new pairwise comparison matrices until the consistency check is successful.

Number of KPIs (n) =	5.000
Lambda max (λ_{max}) =	5.751
Random Index (RI) =	1.12
Consistency Index (CI) =	18.78%
Consistency Ratio (CR) =	0.167702895
CR > 0.1, thus comparisons were NOT consistent enough	

Figure 33 - AHP consistency check

If the consistency check is successful, the priority matrix (w) is used to assign a weight to each KPI. The managing party of the PMS needs to follow the process of calculating the KPI

weights when the priorities of the supply chain changes. A help file on how to use the PMS can be found in Annexure E.

This generic PMS was adapted to suit the BMW import corridor in the case study that follows in Chapter 7. This commodity has specific elements that need to be monitored. The focus on the BMW corridor is reliability seeing that the BMW Rosslyn plant operate on a JIT system. The focus areas for the fruit export industry are time as well as temperature. The cargo needs to get to the market on-time and in a good condition; therefore a constant temperature needs to be maintained.

Background information on the BMW import corridor and the fruit export corridor will be discussed in the following chapter before applying the PMS to these corridors.

7. Case studies

Two case studies were identified that will benefit from a performance measurement system. The inbound supply chain to BMW's manufacturing plant in Rosslyn was studied as an example of an integrated supply chain. Ideas on how it can be monitored and improved will be discussed in section 7.1. The second case study is the fruit export industry in the Cape Town region which will be discussed in section 7.2. These two case studies are models of an inbound process (BMW case study) and an outbound process (fruit export industry). The PMS will need limited adjustments in order to be applied to other commodities and industries.

7.1 Case study 1: BMW Rosslyn

The inbound supply chain to BMW's manufacturing plant in Rosslyn was chosen as a case study due to the high level of integration within this supply chain. The following sections will provide some background information on BMW's inbound supply chain before the PMS will be applied to the corridor.

7.1.1 Background to the BMW Rosslyn supply chain

In 1973 BMW opened its first foreign plant in Rosslyn, South Africa [12]. The Rosslyn plant currently produces the BMW 3 Series model, both for the local and export markets. 33% of the 55 000 cars produced annually is sold locally, while the remaining 67% is exported to the US, Asia and Australian markets, as seen in Figure 34. Parts are mostly imported from Germany and the UK, with the assembly function being the main role in Rosslyn [54].

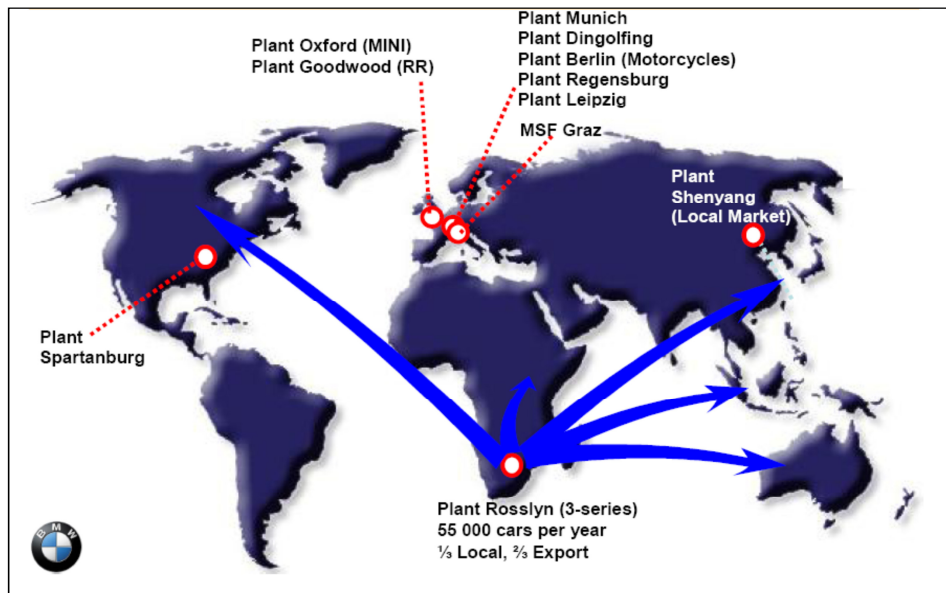


Figure 34 - Export of BMW 3 series from the Rosslyn plant

BMW Rosslyn imports 82% of the 3 Series car parts as seen in Figure 35. The bulk of this 82% is imported through Cape Town Container Terminal (CTCT). Only 15% is manufactured by local manufacturers, with the remaining 3% being produced by companies that form part of automotive supplier parks. Figure 35 shows that 51% of the imported parts are delivered in a JIT manner and that the remaining portion is stored in bulk [54].

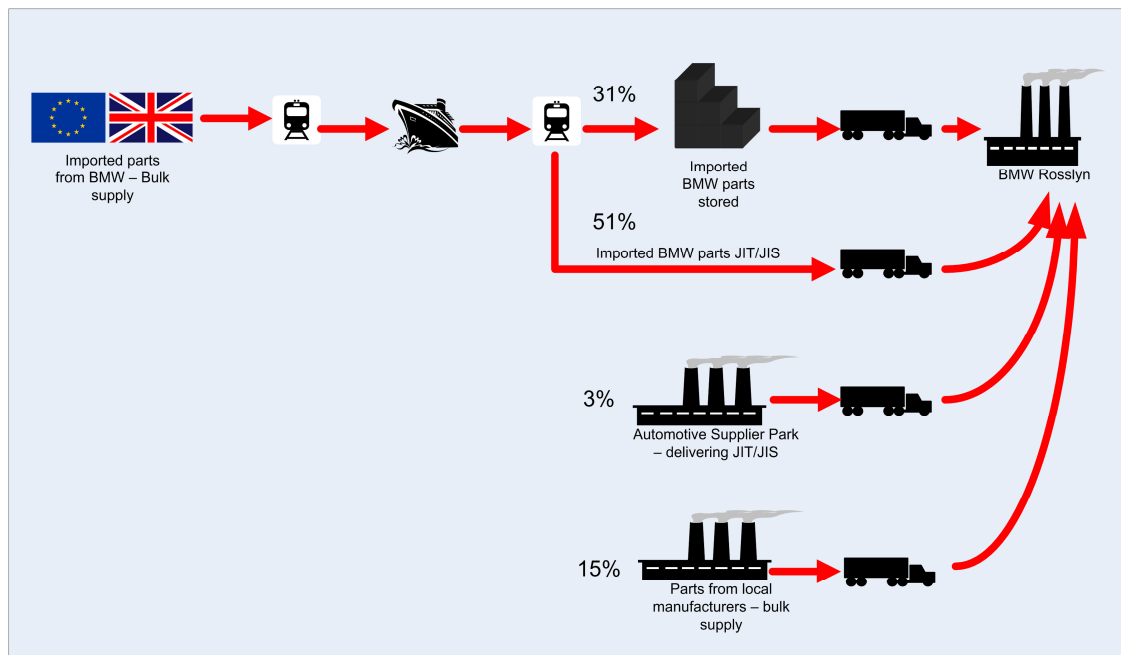


Figure 35 - Breakdown of imported vs. local parts to the Rosslyn plant

According to Ambe *et al.*[9] the Rosslyn plant's order and assembly system is as follows:

- Customers can order a BMW on a built-to-order basis at any BMW dealer.
- This information is communicated to Munich (Germany) and is captured in a central database.
- Bill allocation is done to determine cost of manufacturing and deciding where the car will be manufactured.
- This will be determined by the customer's specifications, the requested lead time and cost limitations.
- Parts are imported at the Cape Town Container Terminal.
- They are transported via rail to the Rosslyn plant in Pretoria where the assembly takes place.
- Thereafter it is taken to a warehouse from where it is transported to the dealers ready for collection by the customer.

7.1.2 The BMW Rosslyn supply chain

The Mediterranean Shipping Company (MSC) and BMW have a contractual agreement that has been renewed every year for the past 10 years. MSC ships all BMW parts from Europe to the Port of Cape Town.

MSC has an agreement with Transnet Port Terminals for the last 10 years that states that the BMW containers will be given a priority status above other containers. The agreement states that the container terminal will load the BMW containers directly onto a train immediately after they are discharged from the vessel. These containers will not be placed in a stacking area. This cuts approximately 24 hours from the total process, because once the boxes are placed in the stacking area with the rest of the imports, they cannot be extracted until all the discharge work is completed for safety reasons. The only stipulation from Transnet Port Terminals is that these containers be stowed together on the vessel so that the discharge of these containers can occur consecutively. This allows for all the containers to be transported to the train consecutively, which increases resource utilisation at the rail. One vessel can carry anything from 30 to 150 BMW containers, depending on the demand for parts. Figure 36 shows the shipments per vessel from January 2011 to June 2011 [56]. For this period 28 vessels called at CTCT with an average BMW call size of 88 containers.

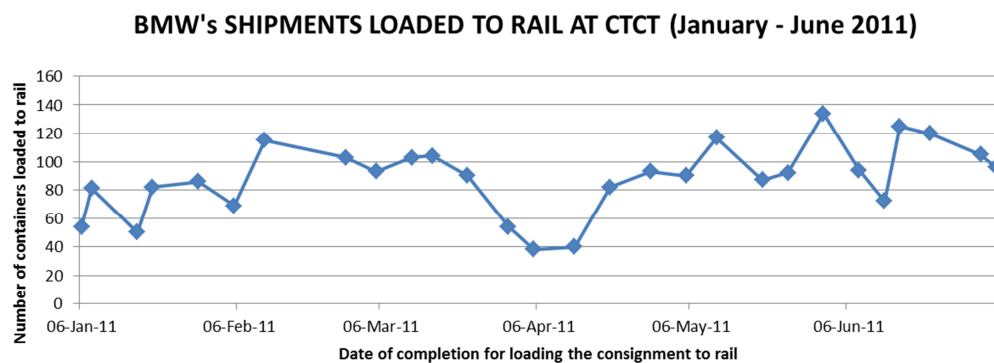


Figure 36 - Figure 38 - BMW's loaded to rail at CTCT for period January 2011 to June 2011

MSC's agreement with Transnet Freight Rail also states that the BMW containers must receive preference over other cargo and that the rail wagons should at all times be readily available to transport these containers upon discharge.

MSC has a total of seven vessels on this trade route with one vessel calling at the Port of Cape Town per week. The length of these vessels is 275 to 304 metres with capacities in the region of about 8,000 TEU's. Travelling at 21 knots, it takes these vessels about 14 days to travel the 6,416 nautical miles from the Port of Hamburg to the Port of Cape Town.

The BMW transportation process was explained in an interview with Mr M. Hendricks, a logistics manager at MSC's Cape Town branch [63]. The transportation process for the BMW parts can be seen in Figure 37. The process after the vessel arrives at the Port of Cape Town is as follows:

- The containers are discharged in Cape Town Container Terminal (CTCT). All the BMW containers will on average be off-loaded within the first six hours after the operation starts.
- The containers are transported directly to the rail terminal.
- The containers are then transported by rail to Rosslyn in block trains of 50 wagons.

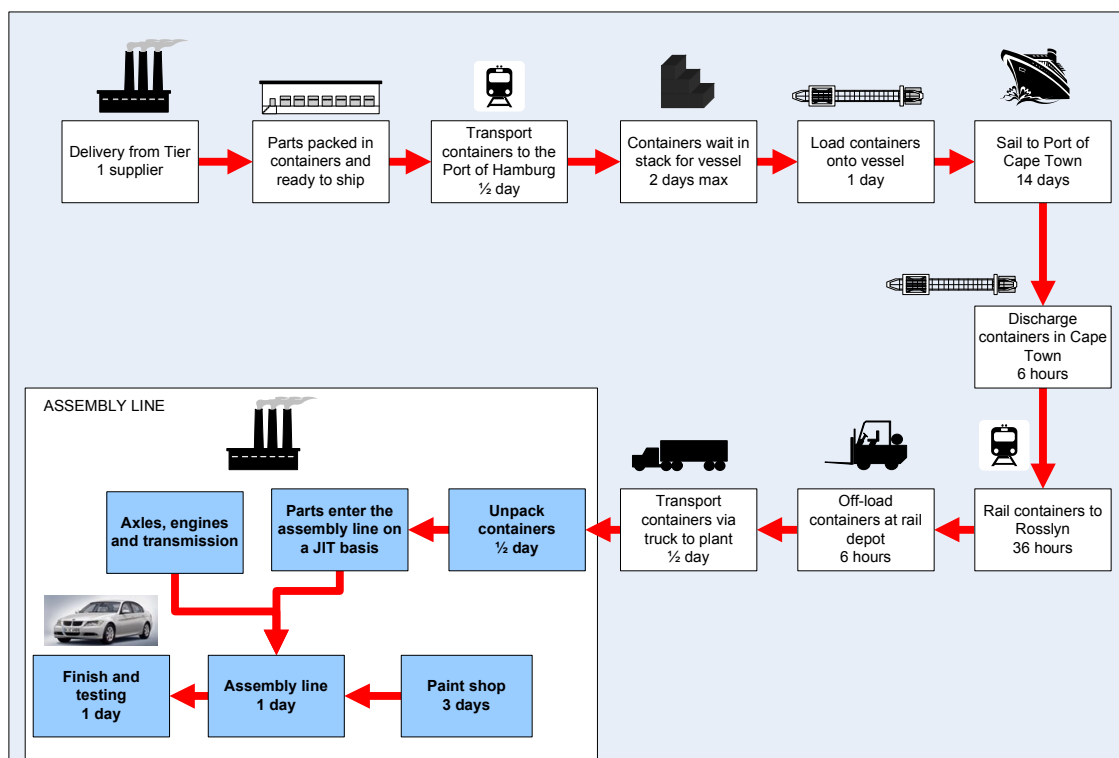


Figure 37 - Inbound supply chain to the BMW Rosslyn plant

The containers are discharged in Cape Town and not Durban, which is closer to the Rosslyn plant, because transporting the containers via rail from Cape Town to Rosslyn is quicker. The containers arrive in Rosslyn before the vessel arrives in Durban (see Figure 38). The total duration of transporting the containers via rail to Rosslyn takes on average 36 hours, whereas transporting the containers via sea to Durban and then via rail to Rosslyn would take on average 104 hours. This journey consists of the voyage between Cape Town and Port Elizabeth (36 hours⁹), cargo operations in Port Elizabeth (12 hours), the voyage between Port Elizabeth and Durban (30 hours⁹), cargo operations in Durban (6 hours) and the rail transportation between Durban and Rosslyn (20 hours). Transporting the containers in via rail from Cape Town to Rosslyn is therefore the optimum solution in terms of time.



Figure 38 - Rail vs. sea and rail option for transporting BMW containers to Rosslyn

⁹ The voyage duration is based on an average sailing speed of 60 knots.

The normal process is to transport the containers via rail on a train consisting of fifty 40 foot wagons (therefore fifty 40 foot containers or eighty 20 foot containers per train) from Cape Town to Rosslyn (Figure 39). This takes approximately 36 hours (as stated in the previous paragraph). The road travel distance is approximately 1,600km, which will take a truck driver traveling at an average speed of 80 km/h about 20 hours to get to Rosslyn in Pretoria. This is faster than transporting by rail, but more expensive.



Figure 39 - BMW containers loaded onto rail

According to the Fleetwatch database, it costs on average R12.20 per km to operate a truck and trailer on long distance transportation [78]. This amounts to an operating cost of R19,520 to travel to Rosslyn, not including any breakdowns and delays that might occur. Rough estimates of transporting a 40 foot container from Cape Town to Rosslyn via rail amounts to R9,871 (see Annexure A). Rail is thus the cheaper option.

If there are delays anywhere in the supply chain, BMW will transfer the more urgently required containers to road freight to speed up the process. The cost of a line stoppage is much more expensive than the road transport costs [63]. This is just one of the ways in which BMW Rosslyn shows how agile they are. They have the ability to “respond to short term changes in demand or supply quickly” [28].

BMW Group announced another R2.2 billion investment in the Rosslyn plant in 2009. This investment was followed by the introduction of the 2009 model car and better

production technology at the plant and within the local supplier network. It also increased the plant's maximum capacity from 60,000 to 87,000 [69].

Stark *et al.*[37] states that BMW Rosslyn has started a program where the delivery of imported parts has to change from a JIT supply to a Just In Sequence (JIS) supply. Currently a supplier produces in bulk and delivers to the BMW sequencing centre on site. The parts are then sequenced and sent to the assembly line when it is required, therefore in a JIS manner. Non-value adding activities such as the sequencing of parts need to be eliminated. BMW therefore wants the suppliers to accept the responsibility of sequencing the parts and delivering these parts JIS. The JIS supply process can be viewed in Figure 40. The responsibility of delivering parts exactly when it is required lies completely with the supplier.

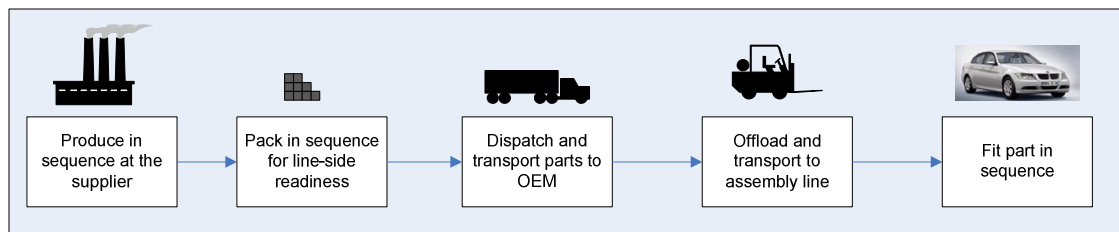


Figure 40 - Just in Sequence process of the BMW Rosslyn plant

BMW's supply chain starts with the supplier and ends with the customer. This is the definition of an integrated supply chain and is one of the success factors of BMW. Some of the main efficiencies of the BMW Rosslyn supply chain are [37]:

- Flexible and agile manufacturing processes.
- Integration with suppliers.
- A high level of information sharing with suppliers and customers.
- A lean supply chain.
- The delivery of quality products.
- A JIT supply chain.

BMW tries to keep cost down as much as possible without compromising on quality. This is where lean manufacturing principles are used to eliminate all wastage with the supply

chain. BMW has managed to not only make its internal processes agile, but the entire supply chain.

BMW has been utilising MSC for importing parts for the past 10 years and this has resulted in a close cooperation between the two organisations. BMW Rosslyn operations managers are in close contact with MSC operations managers in the ports where parts are imported. This makes it possible for BMW to communicate with MSC whenever they have problems or part shortages on a certain line and containers need to receive priority status. Because BMW operates in a JIS manner, this happens frequently. MSC then rearranges their schedule when possible to suite their client's needs. BMW has succeeded in building a relationship with one of its main service providers, adding to its successes.

7.1.3 Applying the PMS to the BMW Rosslyn inbound supply chain

There is currently no integrated measurement system that focuses specifically on the performance of the BMW corridor. An average of approximately 5,000-6,000 BMW containers are moved through CTCT per year. This amounts to an estimated revenue earning of R5,000,000 to R6,000,000 per annum to CTCT. TFRs earnings amounts to approximately R32,355,000 to R38,826,000 per annum.

The PMS can be applied to the BMW corridor in order to monitor the performance of this specific corridor. Currently the various entities involved do not have a tool to benchmark their performance. Each link in the corridor simply aims at improving their part of the corridor, disregarding whether it is improving the performance of the entire corridor. This PMS will assist the different entities to see where the problem areas are. The organisations can collaborate to solve specific problems or challenges. Improvement initiatives can be tackled together in order for all to benefit from a more efficient corridor. An additional benefit will be that all the organisations will strive towards a common goal (see section 6.5). Objectives for the corridor can be set at the beginning of each year and a common strategy can be established.

The BMW PMS can be found in Figure 41. As stated in section 6.9, the green cells denote that the targets have been reached while the red cells denote that the targets have not yet been reached. The BMW supply chain was 84% efficient in April 2011 as seen on the

dashboard. This efficiency level will be tracked on a monthly basis to see whether this performance can be maintained or if it can be improved.

During this month the shipping line achieved a 55% performance level. This was due to excessive delays along the chain. The idle time accumulated to eight hours during this month, which is more than the allowable five hours delay. The total vessel slot utilisation was also below the target at 79%. This impacted heavily on the supply chain efficiency.

The only other KPIs that did not reach the target during this month are the volume throughput achieved at the container terminal and the rail truck availability at the rail operator. Both these KPIs are only marginally under the target. The rest of the KPIs at the container terminal and rail operator all exceeded the targets.

The model is set up so that efficiency levels do not exceed 100 percent. This is because the targets throughout the chain are chosen to support a constant movement and flow. It therefore does not improve the chain should only one party exceed their targets. An example of where this might occur is if the container terminal discharges a vessel sooner than it's predetermined time, but the rail trucks are not available to load the containers. This does not make the corridor more efficient.

PERFORMANCE MEASUREMENT SYSTEM Monthly Input Sheet

MONTH: May 2011
CLIENT: BMW

Corridor efficiency **79%**

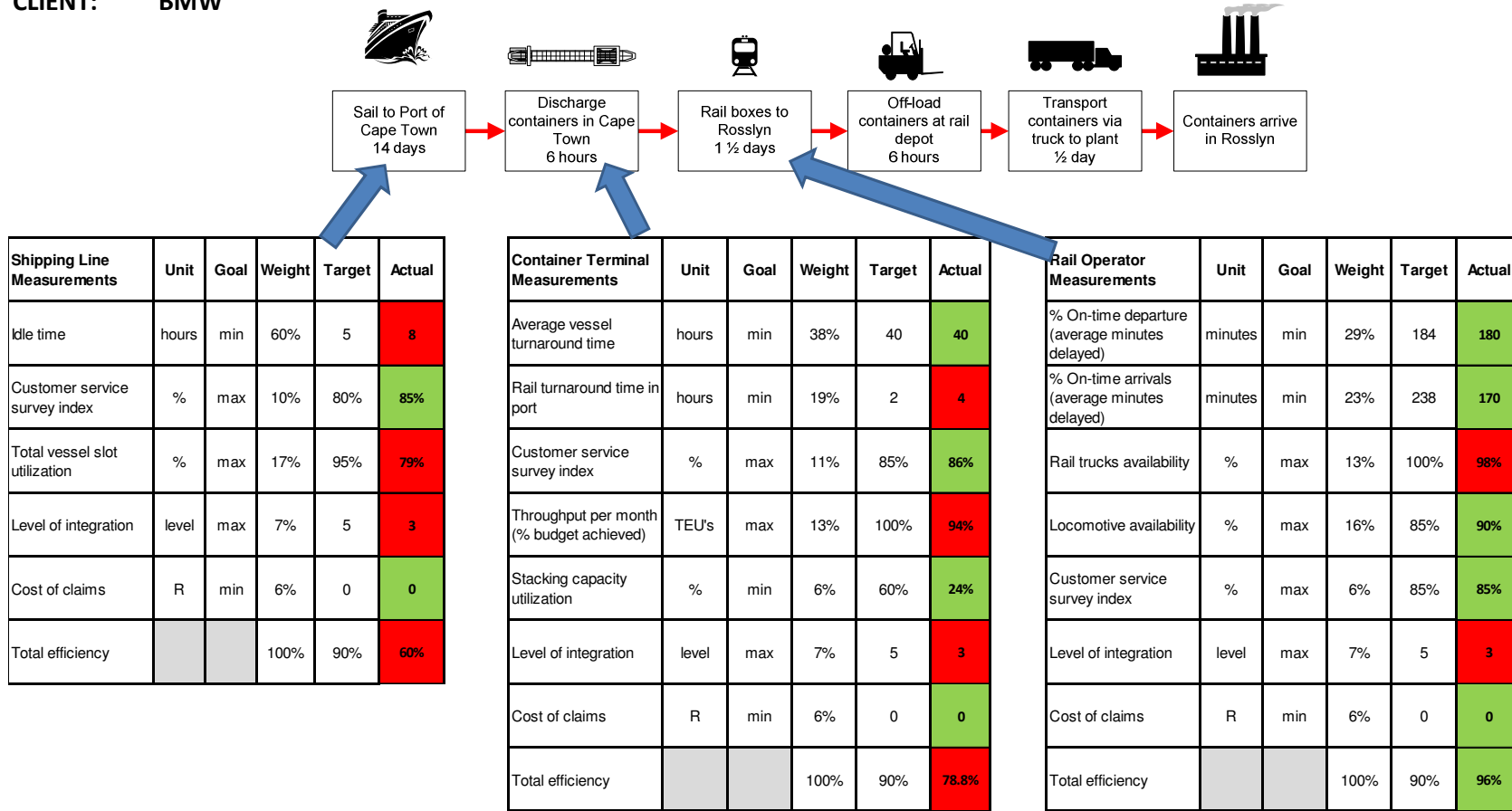
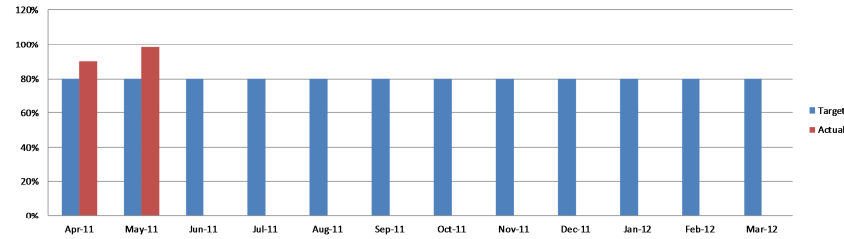


Figure 41 - BMW inbound supply chain performance measurement system

Figure 42 shows the year to date performance data of the rail operator. The year to date performance data of each KPI is displayed in a graph form as well as the total corridor performance. All the role players' year to date performance will be displayed in this manner so that trends can easily be spotted and acted upon. These graphs should be displayed within the organisations so that the employees can be informed about the performance of the industry.

RAIL OPERATOR CORRIDOR EFFICIENCY

Month	Target	Actual
Apr-11	80%	90%
May-11	80%	99%
Jun-11	80%	
Jul-11	80%	
Aug-11	80%	
Sep-11	80%	
Oct-11	80%	
Nov-11	80%	
Dec-11	80%	
Jan-12	80%	
Feb-12	80%	
Mar-12	80%	
Average	80%	94%

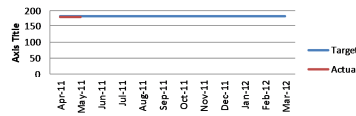


SHOW USERFORM

% On-time departure (average minutes delayed)

Month	Target	Actual
Apr-11	184	160
May-11	184	180
Jun-11	184	
Jul-11	184	
Aug-11	184	
Sep-11	184	
Oct-11	184	
Nov-11	184	
Dec-11	184	
Jan-12	184	
Feb-12	184	
Mar-12	184	
Average	184	180

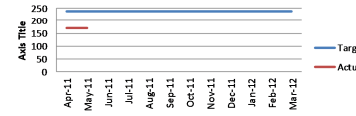
On-time departure (average minutes delayed)



% On-time arrivals (average minutes delayed)

Month	Target	Actual
Apr-11	238	170
May-11	238	170
Jun-11	238	
Jul-11	238	
Aug-11	238	
Sep-11	238	
Oct-11	238	
Nov-11	238	
Dec-11	238	
Jan-12	238	
Feb-12	238	
Mar-12	238	
Average	238	170

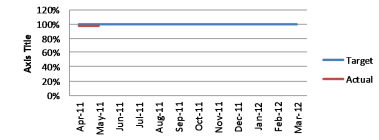
On-time arrivals (average minutes delayed)



Rail trucks availability

Month	Target	Actual
Apr-11	100%	98%
May-11	100%	98%
Jun-11	100%	
Jul-11	100%	
Aug-11	100%	
Sep-11	100%	
Oct-11	100%	
Nov-11	100%	
Dec-11	100%	
Jan-12	100%	
Feb-12	100%	
Mar-12	100%	
Average	100%	98%

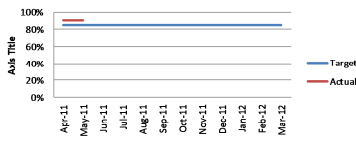
Rail trucks availability



Locomotive availability

Month	Target	Actual
Apr-11	85%	90%
May-11	85%	90%
Jun-11	85%	
Jul-11	85%	
Aug-11	85%	
Sep-11	85%	
Oct-11	85%	
Nov-11	85%	
Dec-11	85%	
Jan-12	85%	
Feb-12	85%	
Mar-12	85%	
Average	85%	90%

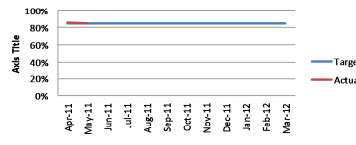
Locomotive availability



Customer service index

Month	Target	Actual
Apr-11	85%	86%
May-11	85%	85%
Jun-11	85%	
Jul-11	85%	
Aug-11	85%	
Sep-11	85%	
Oct-11	85%	
Nov-11	85%	
Dec-11	85%	
Jan-12	85%	
Feb-12	85%	
Mar-12	85%	
Average	85%	86%

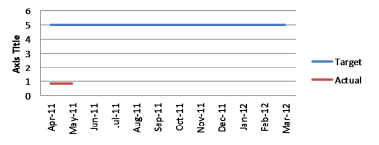
Customer Service Index



Level of integration

Month	Target	Actual
Apr-11	5	5
May-11	5	5
Jun-11	5	
Jul-11	5	
Aug-11	5	
Sep-11	5	
Oct-11	5	
Nov-11	5	
Dec-11	5	
Jan-12	5	
Feb-12	5	
Mar-12	5	
Average	5	5

Level of integration



Customer service index

Month	Target	Actual
Apr-11	0	12000
May-11	0	0
Jun-11	0	
Jul-11	0	
Aug-11	0	
Sep-11	0	
Oct-11	0	
Nov-11	0	
Dec-11	0	
Jan-12	0	
Feb-12	0	
Mar-12	0	
Total	0	12000

Value of claims

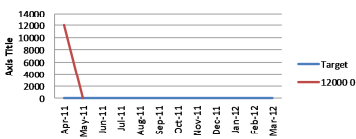


Figure 42 - The container terminal's year to date performance statistics

7.2 Case study 2: The fruit industry of South Africa

The fruit export industry was chosen as a case study due to the high volumes of fruit that is exported annually at CTCT. The following sections will provide some background information on the fruit export industry before the PMS will be applied to the industry.

7.2.1 Background to the fruit export industry

The South African agricultural industry boomed after the deregulation of the industry at the end of the Apartheid era. Before the deregulation, the industry was regulated by the Board of Marketing which is controlled by the government. The two main exporters were Outspan for citrus fruit and Unifruco for deciduous fruit. These two bodies merged after the deregulation to form Capespan [32]. South Africa saw an increase in fruit exporting companies, increasing the competition in the industry.

Fruit exported from South Africa includes mainly citrus fruit, deciduous fruit and subtropical fruit. “South Africa is amongst the world's top five exporters of avocados, grapefruit, tangerines, plums, pears and table grapes” [86]. The different types of fruits in these three categories can be found in Table 21 [47].

Citrus Fruit	Deciduous Fruit	Subtropical Fruit
Oranges	Apples	Mangoes
Mandarins	Apricots	Litchi's
Grapefruit	Grapes	Avocado Pears
Lemons	Peaches	Bananas
Limes	Pears	Melons
	Plums	Papayas
	Nectarines	Pineapples
	Cherries	Macadamia Nuts
	Olives	

Table 21 - Fruit exported from South Africa

The periods during which the various fruit are exported can be found in Table 22 [47]. From this it is clear that the export of fruit from South Africa takes place during the entire year.

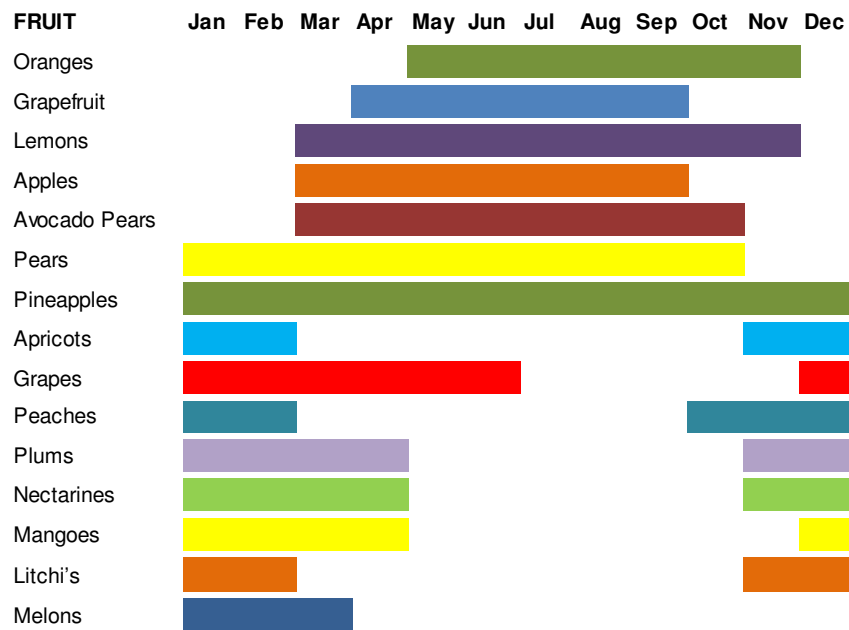


Table 22 - Periods for exporting various fruits

The role players involved in the exporting of fruit are:

- Farmers/Producers
- Pack houses
- Cold stores
- Customs
- Forwarding and clearing agents
- Container terminals
- Break-bulk fruit terminals
- Port Authorities
- Shipping lines
- Trucking companies
- Rail transporters

The primary agricultural industry contributed approximately three percent to the South African Gross Domestic Product (GDP) and seven percent if secondary production levels are included for the 2009/10 fiscal year. The fruit industry contributed approximately 12 percent of the gross value of agricultural production for this year [32].

7.2.2 The fruit supply chain

The process that fruit follows from harvesting until it enters the foreign market is as follows:

- The fruit is inspected after harvest and sorted at the farm into classes 1, 2 and 3 after harvesting.
- Classes 1 and 2 are used to make fruit juice or are sold within the local market and class 3 is exported. The class 3 fruit is packed into crates and is transported to the pack houses. Some farms have their own pack houses on their premises.
- At the pack house the fruit is inspected again to remove the remaining class 1 and 2 fruits. Class 3 fruit is packed into boxes and onto pallets.
- These pallets are loaded into trucks and are transported to a cold store. Some farmers may choose to bypass the cold store when the schedule to meet the vessel is tight or in order to save costs, but they then run the risk of breaking the cold chain of the fruit, especially if the fruit has to be transported for long distances or if there are any delays en route.
- There are two ways of handling fruit; on loose pallets and in refrigerated (reefer) containers. The pallets are either loaded onto trucks or packed into reefer containers.
- The cargo is then transported to the port via road or rail.
- The reefer containers are stacked in the container terminal and connected to a power source while they wait in stack until the vessel is ready to be loaded.
- Pallets or containers are loaded onto a vessel and sail to the foreign port.
- After a long journey the fruit finally enters the foreign market after being discharged at the overseas port.

A role player that investigates the fruit industry on a continuous basis is the Perishable Produce Export Control Boards (PPCEB). Their main purpose is to ensure that the perishable products that are exported are of a high standard. They monitor the cold chain and perform inspections throughout the supply chain to ensure that the specific temperature regulations of the cargo are being adhered to. The PPECB is currently busy with an initiative of developing a standard protocol for handling subtropical fruit. This document will state each role player's scope of responsibility and controls that should be in place for the fruit to be handled correctly in order for it to be successfully exported and sold for best value in the market. A list of specified temperatures for some of the fruits that are exported can be found in Table 23 [47].

FRUIT	TEMPERATURE (°C)
Apples, apricots, cherries, grapes, kiwi fruit, nectarines, peaches, pears, plums	-0.5
Litchi's	2
Avocado Pears	3
Oranges	3.5
Grapefruit, lemons, limes, other citrus fruit	7
Guava	7.5
Mangoes, prickly pears	8
Passion fruit	8.5
Papaya	10
Bananas, pineapples	12

Table 23 - Specified storage and transport temperature of some fruits

The fresh fruit industry is being monitored by various institutions in the industry. These institutions are investing in several research projects aimed at increasing the efficiency of the fruit export industry. The Fresh Produce Exporters Forum (FPEF) initiated a program with the Department of Technology and Science (DTS) to study various aspects of the fruit export industry. A total cost of R15 million was funded by the DTS and divided into eight smaller projects. The projects were formally initiated in October 2007 and took three years to complete.

Some of the projects identified by the FPEF are listed below [33]:

- Improving the packaging of fresh fruit.
- Temperature and humidity control in containers and the effect on fruit when breaking the cold chain.
- Using gamma irradiation technology to fight against fruit insects.
- Determining a non-destructive method for assessing fruit quality.
- Developing an information system to improve information flow within the South African fruit industry.
- Development of a carbon calculator for the fruit industry and benchmarking efficient energy usage at pack houses and cold stores.
- Increasing rail transportation in the fruit industry through the “Tonnage off Tar” project.

Two of these projects are linked to the development of a PMS: developing an information system and increasing the rail transportation in the industry. The PMS will assist in the information flow when it comes to sharing performance information, challenges and improvement initiatives. Rail volumes will improve as a result of the PMS when inefficiencies in the corridors are addressed and communication channels are more open.

Fresh fruit is mainly transported by road due to the uncertainty level of our rail network [61]. This causes congestion of the roads, which in turn increases the risk of breaking the cold chain. Reefer containers that are transported for short distances to the ports are sometimes not plugged into a power source. This poses a risk, because if there are any delays on the road and the reefer container is without power for an extended period, the quality of the fruit may be affected. The new corridor strategy of Transnet in conjunction with the “Tonnage off Tar” project of the FPEF has already delivered some results since the implementation in 2008. Currently the rail system is being utilised by the grape, avocado and citrus industries. Grapes are transported by rail from Kakamas in the Northern Cape, avocados are transported from Tzaneen in Mpumalanga and citrus fruit from Hex River Valley to the Cape Town Container Terminal. One fruit train eliminates approximately 32 trucks from the roads [33].

7.2.3 Applying the PMS to the fruit export industry

The fruit export industry currently does not have a performance measurement system in place that covers the entire corridor. Each organisation measures its own internal performance and in some instances they measure the performance of their direct clients and suppliers. This industry is in need of a system that is transparent, measures the correct aspects of the chain and attracts the participation of all or most of the big role players in the fruit export industry.

A performance measurement system will only be beneficial if the organisations realise the benefit that such a system can have on the industry and participate in the implementation of a performance measurement system. It is required of each organisation to submit their performance data. The data can be dealt with confidentially whereby only the party responsible for the management of the PMS will work with the unrefined data. Average figures for the fruit export industry can be advertised to all participating organisations and not specific organisation based statistics.

The benefits of implementing a PMS, as mentioned in section 6.5, are that the participating organisations will be able to monitor how the performance levels of the industry changes throughout the year. The fruit export industry is very seasonal and certain reoccurring inefficiencies or events might be identified. Organisations will be able to benchmark their individual performance against that of the corridor. It will also be possible to identify areas in need of improvement more easily. Improvement initiatives can be suggested and directed to the responsible parties for implementation.

The export of reefer containers has an additional measurement when compared to other corridors. The continuation of the cold chain is one of the main focus areas when it comes to reefer containers. Temperature deviations should therefore be included in the PMS for this corridor. If there are parties or processes within the supply chain who are responsible for breaking the cold chain and affecting the quality of the export fruit, the PMS will assist in identifying them.

The short shipment¹⁰ of reefer containers poses a big problem to all the parties concerned. Reefer containers can be short shipped due to various reasons such as:

- A faulty refrigeration motor on a reefer container that cannot be repaired before it has to be loaded on the vessel.
- Not declaring a reefer in time to overseas Customs agencies.
- Late arrival of a train or truck due to breakdowns en route.
- Negligence of the container terminal, shipping line, rail operator or trucking company when the correct process is not followed. Examples where this might occur are: incorrectly capturing a container booking into the Navis system, the container is omitted from a vessel plan, the trucking company fails to meet the advertised stack dates¹¹ or a reefer container is damaged while it is transported or being handled.
- Various other inefficiencies throughout the corridor.

If a reefer container is short shipped, it affects the value of the fruit that is to be sold to an overseas market. A short shipment will amount in a claim from the exporter to the shipping line. The shipping line in turn will claim from the party responsible for the short shipment. The value of claims is therefore an important KPI that will indicate how inefficient the industry is.

The KPI that measures the value of claims will cover all damages to reefer containers and the cargo inside the container. This will include temperature deviations within the reefer that will lead to claims. This KPI will ascertain how often the cold chain is broken and where the most temperature anomalies occur. The electronic on-board memory on most reefers stores temperature data so that historical data can be retrieved to determine whether the cold chain was maintained en route.

The performance measurement system can be found in Figure 43.

¹⁰ When a container is not shipped on the allocated vessel and is left behind in the origin port.

¹¹ The stack dates is a period of three days that the container terminal allows for containers to enter the port before a vessel arrives. These dates are widely advertised on a daily basis within the industry.

PERFORMANCE MEASUREMENT SYSTEM
Monthly Input Sheet

MONTH: May 2011
CLIENT: Fruit Export Industry

Corridor efficiency 81%

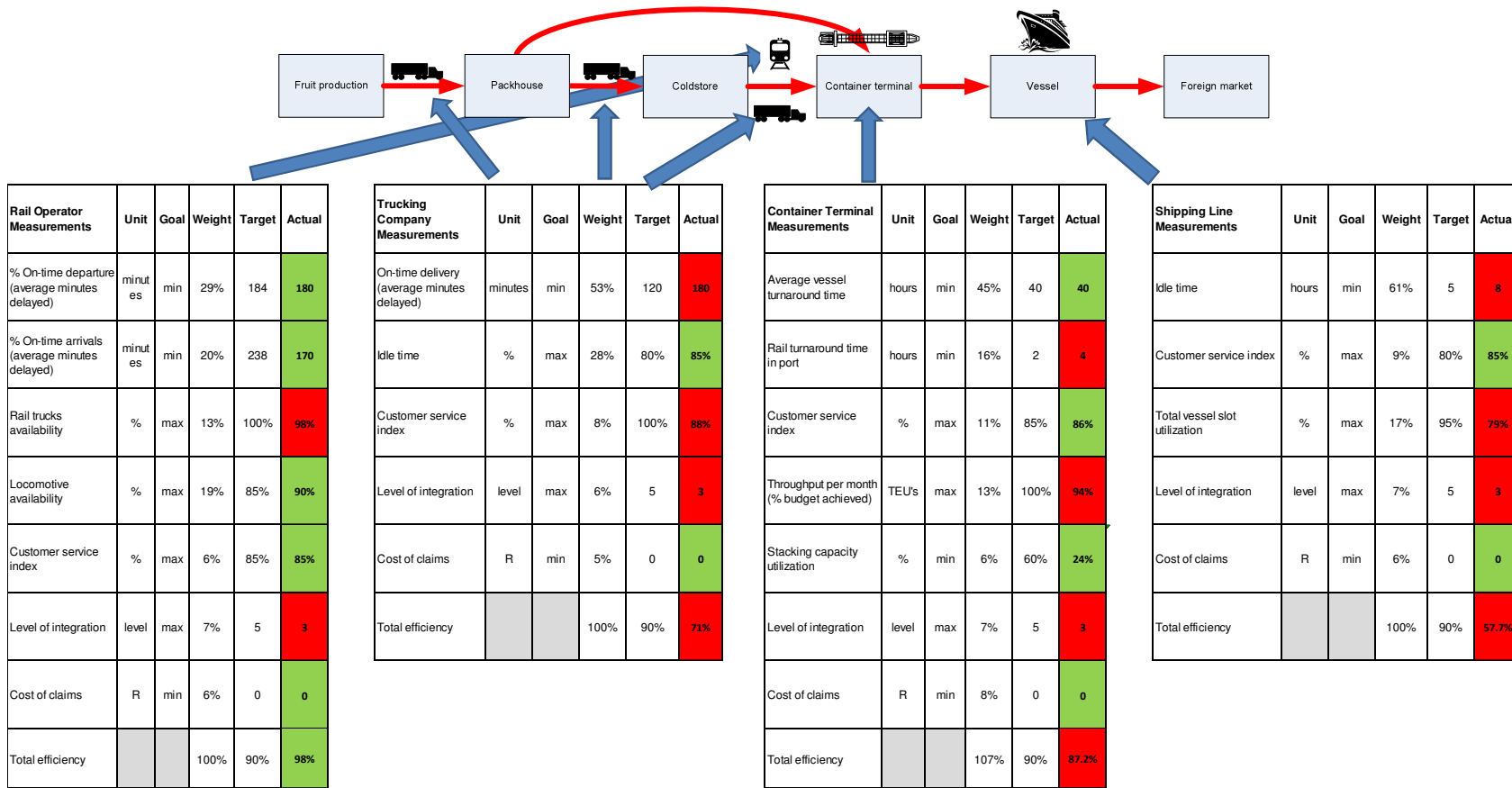


Figure 43 – The fruit export industry performance measurement system

8. Validation of the PMS

The PMS was presented on three occasions to various managers and employees working in the industry. The BMW example was explained as well as the benefits of implementing such a system. A total of 23 individuals attended the presentations. After the presentation they were asked to complete a short survey containing four statements to which they had to agree or disagree. The survey can be found in Table 24.

	Statement	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
1	The performance measurement system includes all the KPIs that need to be measured.	1	2	3	4	5
2	The performance measurement system will promote integration between organisations.	1	2	3	4	5
3	The performance measurement system will positively impact my organisation.	1	2	3	4	5
4	The performance measurement system will positively impact the industry.	1	2	3	4	5
5	Comments					

Table 24 - Validation survey

The PMS was presented to various managers working at the Cape Town Container Terminal, Transnet Freight Rail, Transnet National Port Authority, trucking company owners as well as vessel agents working for different shipping lines (Table 25).

Position	Number of people
Vessel agent (shipping line)	6
Container terminal manager	8
Trucking company owner	3
Rail operator manager	5
Port Authority manager	1
Total	23

Table 25 - Number of individuals that the PMS was presented to

A summary of the survey results can be found Table 26.

	Statement	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
1	The performance measurement system includes all the KPIs that need to be measured.	1 (0)	2 (2)	3 (3)	4 (14)	5 (4)
2	The performance measurement system will promote integration between organisations.	1 (1)	2 (1)	3 (5)	4 (12)	5 (4)
3	The performance measurement system will positively impact my organisation.	1 (0)	2 (0)	3 (3)	4 (10)	5 (10)
4	The performance measurement system will positively impact the industry.	1 (1)	2 (2)	3 (4)	4 (15)	5 (1)

Table 26 - Validation survey results

As seen in Table 27, 76 percent of the survey scores were allocated to “agree” and “strongly agree”, 16 percent was allocated to “not sure” and only seven percent was allocated to “disagree” and “strongly disagree”.

Strongly disagree	Disagree	Not sure	Agree	Strongly agree
2%	5%	16%	55%	21%

Table 27 - Percentage scores per survey option

The average score for all of the statements were in the region of 4 as seen in Table 28. This means that the individuals that completed the survey were of the opinion that the PMS included all the relevant KPIs, the PMS will promote integration between the organisations in a supply chain and the PMS will positively impact his/her organisation as well as the industry.

	Statement	Average score per statement
1	The performance measurement system includes all the KPIs that need to be measured.	3.9
2	The performance measurement system will promote integration between organisations.	3.7
3	The performance measurement system will positively impact my organisation.	4.3
4	The performance measurement system will positively impact the industry.	3.6

Table 28 - Survey results – Average score per statement

Some of the comments on the completed surveys were:

- The model has its advantages, but the entire supply chain needs to be involved before the industry will reap any benefits.
- It will assist organisations to benchmark their own performance against that of the industry.
- The PMS will assist in identifying problem areas in the chain.
- A system that will measure industry performance is a necessity.
- The system needs to be web-based so that it can be more accessible.
- The system needs to be implemented in more industries.

The overall conclusion can be made that the PMS will add value to the industry. The benefits of implementing a PMS, as listed in section 6.5, will be reaped.

9. *Project summary*

Currently the shipping industry in South Africa still operates in silos. There is not enough integration between the various companies in a supply chain. In order to promote integration, managers need to understand what the challenges are, and how to work towards overcoming them. Business processes must spread across the various organisations in the supply chain to achieve a common goal. The aim of the performance measurement system is to bring organisations closer together in order for them to work towards a common goal.

Two South African government departments are currently involved in developing a system that will measure logistics efficiency within the container supply chain: the Department of Public Enterprises (DPE) and the Western Cape Department of Economic Development and Tourism (DEDAT). The DPE is working on a project in conjunction with the Centre for Supply Chain Management (CSCM) at the University of Stellenbosch to develop a KPI measurement system from a supply chain perspective and the DEDAT is investigating the development of a similar system. The ideal situation would be for the two government departments to collaborate on this project instead of both departments spending money on the same problem. Both parties are still at the beginning of their research phases. The measurement system that was developed as an outcome to this master's thesis can be used as valuable input to the web-based performance measurement system they will be developed and implemented by the DPE and/or the DEDAT.

The main requirement to successfully implement the PMS system is the commitment and assistance of the participating organisations. The benefits need to be explained to representatives from the larger or more dominant organisations so that they can be convinced to participate in the PMS. This will encourage the smaller companies to join as well.

The combination of two methods was used to develop the PMS: the Balanced Scorecard and the SCOR model. The container shipping PMS should therefore yield some of the benefits of these two methods as listed in paragraphs 5.2.1 and 5.2.2.

These benefits are:

- Assisting in managing the business by providing detailed visibility into how the chain is performing.
- Competing more effectively through its system of metrics
- Pointing companies toward real and practical process improvements.
- Improving cost, cycle time and reliability
- Promoting team building.
- Monitoring the performance with only a few key measurements.
- Considering all the important aspects that are included into the scorecard in conjunction whenever a decision needs to be made.
- Monitoring an organisation's progress towards its goals.
- Achieving greater customer satisfaction.

In order to reap these benefits, complete cooperation is required from the participating organisations. The managers of the organisations need to make the information available so that an industry standard can be developed. It will benefit all organisations if they have a benchmark that they can compare their own performance against. Most of the parties are continually investing within their own organisations to improve their internal processes, but there is currently no indication of when additional improvements will have no impact on the logistics chain. Additional improvements in one organisation will not always make the chain more efficient. The PMS will point managers to the areas where improvement will have the greatest impact. It will uplift all the parties to a performance level where the gaps can be jointly identified. Improvements that are suggested by the entire chain can be implemented in collaborative project teams.

The PMS managing party can communicate new initiatives to the industry by arranging forums where the issues can be discussed. They can consolidate plans and assist in managing the implementation of new initiatives. The managing party of this PMS will need to establish a forum that will focus on performance management and improvement initiatives throughout the chain. These initiatives may not always benefit all the parties, but if it improves the supply chain efficiency, all the parties should comprehend that and cooperate.

This PMS is not a stagnant system. The managing body needs to review the system once a year. The KPIs may change as the focus of the supply chain changes, and the weight assigned to each KPI will change as priorities change within the chain.

As mentioned in section 6.3, if any of the South African container terminals want to apply for Container Terminal Quality Indicator (CTQI) certification in the future, the PMS system developed during this research project would assist in providing some of the historical data required. CTQI is a tool that was developed to establish an international standard against which container terminals and ports can be benchmarked.

A future research topic would be to determine a better method that organisations can use to update their own performance information. Currently the managing party of the PMS would be responsible for collecting and capturing all the performance data from the various parties. The collection of the data is one of the stumbling blocks that could hinder the success of the PMS system. Organisations fear that their performance information will fall in the wrong hands and would be used to their disadvantage. If the organisations are responsible to enter their own performance information, and only industry averages are advertised, they will feel more unperturbed in taking part in an industry wide performance measurement initiative.

Another future research recommendation will be to expand this research to more corridors. When all the corridors are covered, it will be possible to calculate an efficiency rating for each port as well as an overall efficiency rating for the South African container shipping industry. It will then be possible to benchmark the South African ports against each other. The PMS dashboard is not a perfected solution but needs to be developed further and adjusted through management experience to achieve an improved supply chain.

All over the world organisations are striving towards better supply chain integration. Professor Alan Waller Cranfield, the President of the British Institute of Transport and Logistics, said in Emmett *et al.* [5] that “The supply chain lies no longer with the individual company...We have been taught to compete, but nobody has taught us to work together.” This is where the focus should be within the next five to ten years; to improve and put the necessary systems in place to sustain that improved supply chain collaboration.

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Annexure A – Shipping industry tariff structure

1. Shipping line tariffs

Maersk's ocean freight rates for 2002 for shipping a full unit from Cape Town can be found in Table 29.

Port of Destination	Ocean Freight	Ocean Freight
	20 ft. container	40 ft. container
New York	\$2,350.00	\$3,840.00
San Francisco	\$2,800.00	\$4,000.00
Tilbury	\$925.00	\$1,850.00
Antwerp	\$925.00	\$1,850.00
Hamburg	\$925.00	\$1,850.00
Singapore	\$300.00	\$400.00
Bangkok	\$550.00	\$900.00
Hong Kong	\$300.00	\$400.00

Table 29 - Maersk's average ocean freight rates for shipping a container from Cape Town (2002)

2. Terminal handling tariffs

Safmarine's terminal handling tariffs for South African ports can be viewed in Table 30 [85].

	Container terminal	Currency	Container type/size			
			20 ft.		40 ft.	
			Dry	Reefer*	Dry	Reefer
General	Cape Town	ZAR	1025	1433	1515	2127
	Durban	ZAR	1025	1433	1515	2127
	Port Elizabeth	ZAR	1025	1433	1515	2127
	East London	ZAR	843	1272	1342	1987
Dangerous	Cape Town	ZAR	1431		2127	
	Durban	ZAR	1431		2127	
	Port Elizabeth	ZAR	1431		2127	
	East London	ZAR	1272		1987	

Table 30 - South African Ports Terminal Handling Tariffs for Safmarine (2010/2011)

The THC's for some of the European countries as charged by DAL shipping line can be found in Table 31 [87].

Country	Currency		GP container	Reefer container
Belgium	EUR		155	240
Denmark	DKK		900	1300
Eire	EUR		110	140
Estonia	EUR		100	160
Finland *	EUR		120	145
France	EUR		190	260
Germany	EUR		195	300
Greece	EUR			
Israel	USD	20 ft.	100	
		40 ft.	150	160
Italy	EUR		160	220
Latvia	EUR		100	130
Lithuania	EUR		100	130
Netherlands	EUR		190	265
Norway	NOK		900	1100
Poland **	EUR		85	85
Portugal	EUR		125	195
Russia	USD		250	300
Spain Peninsular	EUR		160	200
Spain Canary Islands	EUR	20 ft.	92	177
		40 ft.	117	212
Turkey	SUD			
Sweden	SEK		1125	1375
United Kingdom	GBP		120	170

Table 31 - Terminal Handling Fees in Europe - Tariffs valid from July 2010

3. Storage of containers

SACD's rates for storing and handling a container at a depot in 2010 can be found in Table 32

Service	Storage period	20 ft. container (Rand)	40 ft. container (Rand)
General container Storage	< 14 days	75.00	150.00
	> 14 days	112.50	225.00
Hazardous container storage	< 14 days	93.75	187.50
	> 14 days	140.60	281.25
High cube container storage	< 14 days	93.75	187.50
	> 14 days	140.60	281.25
Reefer container storage	< 14 days	300.00	600.00
	> 14 days	450.00	900.00

Table 32 - SACD Storage charges

Cape Town Container Terminal's tariffs for the 2009/2010 financial year (1 April 2009 to 31 March 2010) are listed in Table 33 [58].

Service	Storage period	20 ft. container (Rand)	40 ft. container (Rand)
General container including high cubes	≤3 days	Free	Free
	>3 days	96.00	193.00
OOG container storage	≤ 3 days	Free	Free
	Days 4 & 5	468.00	729.00
	Day 6 onwards	1 068.00	1 603.00
Reefer container storage	≤ 3 days	Free	Free
	Days 4 & 5	1 092.00	1 639.00
	Day 6 onwards	2 187.00	3 280.00

Table 33 - Transnet Port Terminals storage tariffs

4. Rail Transporter

The rail transporters tariffs are given in Table 34 in South African Rand [53].

Origin	Destination	20 ft. Light (0 – 13 tons) (Rand)	20 ft. Heavy (>13 – 22 tons) (Rand)	40 ft. Light (0 – 26 tons) (Rand)	40 ft. Heavy (>26 – 29.4 tons) (Rand)
Cape Town	Johannesburg	3 682	5 708	7 442	11 352
Port Elizabeth	Johannesburg	2 912	5 746	5 934	11 370
Durban	Johannesburg	2 462	4 565	4 784	9 231

Table 34 - Standard rates for container transportation by rail for main corridors

For the inter-modal companies that can commit to high volumes, a discount of approximately 13% is provided. These rates can be found in Table 35 [53].

Origin	Destination	20 ft. Light (0 – 13 tons) (Rand)	20 ft. Heavy (>13 – 22 tons) (Rand)	40 ft. Light (0 – 26 tons) (Rand)	40 ft. Heavy (>26 – 29.4 tons) (Rand)
Cape Town	Johannesburg	3 202	4 964	6 471	9 871
Port Elizabeth	Johannesburg	2 239	4 420	4 564	8 746
Durban	Johannesburg	2 141	3 970	4 160	8 027

Table 35 - Preferential rates based on a high volume commitment

Annexure B – Questionnaire completed by the container shipping industry

Questionnaire Supply Chain Performance Measuring

Questionnaire set up by: Kasper Frederik van Rooyen [60]
 Amended by: Taryn Olivier
 Industrial Engineering Master's Student
 Stellenbosch University
 Email: tarynolivier@sun.ac.za
 Date: 27/02/10

Study Leader: George Ruthven
 Senior Lecturer/Consultant
 Department of Industrial Engineering
 Stellenbosch University
 Email: gar@sun.ac.za
 Website: www.ie.sun.ac.za

I am currently busy with my master's thesis at Stellenbosch University. I am, under the leadership of Mr G Ruthven, studying the shipping supply chain in order to develop an integrated measuring system that can be used throughout the entire supply chain.

I would really appreciate it if you can assist me by completing this questionnaire. I will be sending the same questionnaire to the various links in the shipping supply chain. Responses will be used to determine the influence of one role player has on the other and develop a measurement tool that will promote more efficient communication between the various organisations.

**Please feel free to leave out specific questions that do not apply to you. The information that I am collecting will only be used for my Master's Thesis.*

SUPPLIERS		
	Question	Answer
1	Please list your major suppliers (e.g., container terminal, freight forwarders, etc. Company names are not necessary).	<ul style="list-style-type: none"> • • • • •
2	What performance measuring elements are measured in your Supply Chain with respect to your suppliers? (E.g. Supplier delivery lead-time, productivity)	<ul style="list-style-type: none"> • • •

		•																				
3	Do you monitor your supplier delivery performance? Yes/No: If yes, please state how the supplier delivery performance is measured.																					
4	What degree of information sharing takes place between your company and your suppliers?	<table border="1"> <tr> <td colspan="2">0 info shared</td> <td colspan="8">All info shared</td> </tr> <tr> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> <td>8</td> <td>9</td> <td>10</td> </tr> </table>	0 info shared		All info shared								1	2	3	4	5	6	7	8	9	10
0 info shared		All info shared																				
1	2	3	4	5	6	7	8	9	10													
5	What info is shared and how?																					
6	Do you monitor your supplier pricing against industry norms?	Yes/No																				
7	Do your suppliers provide mutual assistance in problem solving?	Yes/No																				
8	Do you feel there is enough communication between your organisation and its suppliers?																					

OPERATIONS

	Question	Answer
1	What performance measuring elements are measured in your organisation with respect to your operations/production? (E.g. Productivity, hours lost, etc.)	• • • •
2	Do you consider the way in which people (employees) perceive your business? Yes/No: If yes, please state how you measure what people think of your business:	• • • •
3	Do you measure the capacity utilisation of your production service? If yes, please explain how?	

CUSTOMERS

	Question	Answer
1	What performance measuring elements are measured in your organisation with respect to your customers? (E.g. Customers satisfaction, etc.) How is it measured?	• • • •

2	Do you inspect/analyse your own delivery lead time (to customers)? Yes/No:	Yes/No
3	Do you analyse the effectiveness of your delivery invoice method?	Yes/No
4	Do you inspect your organisations delivery performance? (E.g. number of faultless deliveries) If yes, please state how your delivery performance is measured:	Yes/No:

Annexure C – Questionnaire completed by the fruit export industry

Table 36 – Responses on the questionnaire sent to managers in the fruit export industry

Questions	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6	Company 7
1 What is the name of the company that you work for?	GOREEFERS LOGISTICS	Capespan SA	EXSA (pty)Ltd	SA Fruit Promoters (Pty) Ltd t/a SAFPRO	ALLIANCE FRUIT (PTY) LTD	AS Viljoen & Seuns Boerdery (Pty) Ltd	Southern Farms Investments (Pty) Ltd
2 Where does your company fit into the fruit export supply chain?	We do full logistics for fruit from farm gate to overseas receivers door	Exporter and logistical service provider	Producer, exporter and receiver	Fruit Exporter	Export of approximately 1 000 000 cartons or citrus to Europe, Russia, Middle East and Japan.	We are a producer of export grapes and intend shipping all of it ourself without using exporters, currently we ship 33% ourself.	We are a grape producer / exporter
3 What position do you hold within your company?	CEO	Head of Trading Division	General Manager	Owner / Managing Director	Logistics Manager	Marketing/Logistics manager	Finance director
4 What measurements do you have in place to track the efficiency of the role you play within the fruit export supply chain?	We have our own internal IT system designed by us for the fruit supply chain in SA	Competitive payments to suppliers, efficient logistical execution, good market access to blue chip customers, satisfied customers (buyers)	Risk analysis on fruit quality and logistics. Financial returns back to the producers, including cost analysis. Chris Ferandi report.	Satisfaction of Growers and Customers - if we supply the programs timeously and with consistent quality our customers are happy and grow their programs, and if we pay the growers good returns then they are happy and give us more fruit.	We use the Agriport Paltrack system	Cost chain analysis, yield maximisation and price performance relative to exporters.	Once the fruit has left the cold stores on our farm, we rely solely on cold chain service providers. Apart from monitoring the progress of the fruit through the system, we are not able to influence its success or failure.
5 Do you track the efficiency measurements of your suppliers? Please list the measurements that you focus on.	Yes - Various management reports from our system such as: Turn around time of export documents at government departments Truck reports Scheduling of trucks Deviation reports in the chain logged - ie temperature variances in a cold store, on a ship, delays on a vessel, etc. Forecasts to shipping lines for volumes expected.	Yes, 3rd party studies to measure competitiveness. Suppliers surveys	Most important is financial returns Communications Risk of claims General service	We monitor on a weekly basis what they are meant to pack against what they pack. We get feedback on arrivals on a "by grower" basis. Quality claims are as far as possible allocated to the growers responsible. Customer monitor us on a weekly basis on our deliveries versus their requirements, being fruit the variables on size, quality, phytosanitary issues. On a costs basis we run constant comparisons of freight by market, port and haulier to ensure we are using the best service at the most competitive price for each shipment. On Local Costs we do a similar analysis comparing all costs over which we have control to competitor quotes on a regular basis.	Quality, volume, and spraying of the correct pesticides etc.	No, no time to.	There are 2 primary measurements we use to monitor the progress of our product through the export system – time and temperature. Timing of land transport, dock handling, sea freight and overseas harbour clearing are the critical stages that are measured frequently by our freight forwarder and monitored by own staff. Temperature in the cold chain from our farm to the receivers depot through the above stages is vital to ensure the safe arrival of the product with its required shelf life.
6. Do you track efficiency measurements further down the supply chain (your customers and your customer's customers)? Please list the measurements that you focus on.	Yes, we have a live update of arrival times of vessels in the overseas ports on our website.	Yes, repeated programs on an annual basis Customer reviews	As far as receivers. We do know who their customers are but its gets to complex after that	We monitor these based on returns achieved from the market as far as possible. Costs are difficult as they may vary depending on market conditions, but certainly every account sale is reviewed for costs, and any excessive costs are queried. We cannot really track efficiencies past our customers.	We get a quality control report for each delivery within 48 hours after reaching the customer.	Only on the basis of comparing prices through quotes.	There is no measurement of product quality with our overseas customer base. We negotiate marketing and payment terms with them up front and pray that we arrive in a strong market, they pay us on time and the rand conversion rate in SA is not too strong.

Annexure D – Survey used to obtain pair wise comparison data

CONTAINER PERFORMANCE MEASUREMENT SYSTEM

SURVEY USED TO OBTAIN PAIRWISE COMPARISON DATA



Make an **X** under the chosen rating

Interpretation of ratings		Equally important		Slightly more important		Strongly more important		Very strongly more important		Absolutely more important
RATINGS		1	2	3	4	5	6	7	8	9
SHIPPING LINES										
1	How important to you rate IDLE TIME of the vessels against the CUSTOMER SERVICE INDEX ?			X						
2	How important to you rate IDLE TIME of the vessels against the SLOT UTILISATION of vessels?					X				
3	How important to you rate the CUSTOMER SERVICE INDEX against the SLOT UTILISATION of vessels?						X			
CONTAINER TERMINALS										
1	How important to you rate VESSEL TURNAROUND TIME against RAIL TURNAROUND TIME ?					X				
2	How important to you rate VESSEL TURNAROUND TIME against the CUSTOMER SERVICE INDEX ?						X			
3	How important to you rate VESSEL TURNAROUND TIME against the VOLUME THROUGHPUT ?						X			

Interpretation of ratings		Equally important		Slightly more important		Strongly more important		Very strongly more important		Absolutely more important
RATINGS		1	2	3	4	5	6	7	8	9
4	How important to you rate VESSEL TURNAROUND TIME against the STACK CAPACITY UTILISATION ?						X			
5	How important to you rate RAIL TURNAROUND TIME against the CUSTOMER SERVICE INDEX ?			X						
6	How important to you rate RAIL TURNAROUND TIME against the VOLUME THROUGHPUT ?				X					
7	How important to you rate RAIL TURNAROUND TIME against the STACK CAPACITY UTILISATION ?								X	
8	How important to you rate the CUSTOMER SERVICE INDEX against VOLUME THROUGHPUT ?			X						
9	How important to you rate the CUSTOMER SERVICE INDEX against STACK CAPACITY UTILISATION ?		X							
10	How important to you rate VOLUME THROUGHPUT against the STACK CAPACITY UTILISATION ?	X								
RAIL OPERATOR										
1	How important to you rate the ON-TIME DEPARTURE OF TRAINS against the ON-TIME ARRIVAL OF TRAINS ?				X					
2	How important to you rate the ON-TIME DEPARTURE OF TRAINS against TRUCK AVAILABILITY ?				X					
3	How important to you rate the ON-TIME DEPARTURE OF TRAINS against LOCOMOTIVE AVAILABILITY ?					X				

Interpretation of ratings		Equally important		Slightly more important		Strongly more important		Very strongly more important		Absolutely more important
RATINGS		1	2	3	4	5	6	7	8	9
4	How important to you rate the ON-TIME DEPARTURE OF TRAINS against the CUSTOMER SERVICE INDEX ?					X				
5	How important to you rate the ON-TIME ARRIVAL OF TRAINS against TRUCK AVAILABILITY ?					X				
6	How important to you rate the ON-TIME ARRIVAL OF TRAINS against LOCOMOTIVE AVAILABILITY ?				X					
7	How important to you rate the ON-TIME ARRIVAL OF TRAINS against the CUSTOMER SERVICE INDEX ?					X				
8	How important to you rate the TRUCK AVAILABILITY against LOCOMOTIVE AVAILABILITY ?						X			
9	How important to you rate the TRUCK AVAILABILITY against the CUSTOMER SERVICE INDEX ?						X			
10	How important to you rate the LOCOMOTIVE AVAILABILITY against the CUSTOMER SERVICE INDEX ?							X		
TRUCKING COMPANY										
1	How important to you rate ON-TIME DELIVERY of the vessels against the IDLE TIME ?			X						
2	How important to you rate ON-TIME DELIVERY of the vessels against the CUSTOMER SERVICE INDEX of vessels?					X				
3	How important to you rate the IDLE TIME against the CUSTOMER SERVICE INDEX of vessels?						X			

Annexure E – How to use the PMS system

1. How to use the PMS sheet

PMS sheet

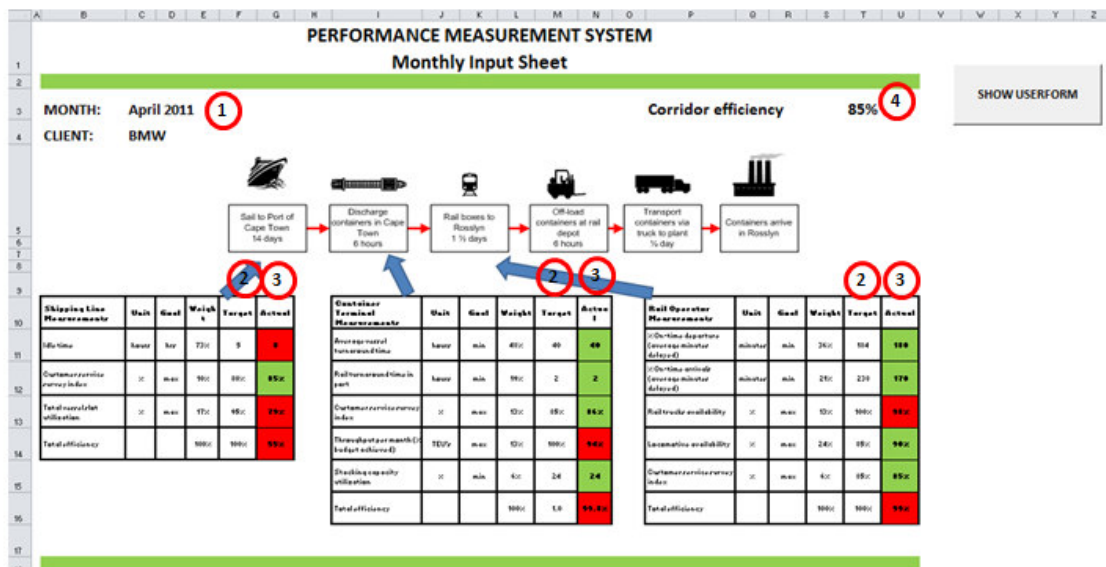


Figure 44 - PMS Sheet

The steps to follow in order to capture performance data into the PMS sheet are (the steps are indicated by red circles in Figure 44):

- 1 Select the month that will be rated in cell **C3**
- 2 Enter the KPI targets
- 3 Enter the KPI actual ratings
- 4 Click on the **SHOW USERFORM** button to view the “user form”

2. How to use the “User form”

The aim of the “User form” is make the PMS system as user-friendly as possible. It allows the user to navigate between the different sheets as easily as possible. The user has four options to choose from which are:

1. Updating the current months performance data
2. Updating a previous months performance targets and actual data
3. Viewing the year to date history
4. Updating the weights allocated to each KPI

Figure 45 - The "User form" of the PMS system

The steps to follow when using the "User form" are (the steps are indicated by red circles in Figure 45):

- 1 To view the PMS sheet, click on *View PMS*.
- 2 To update the selected months targets and KPIs click on *Update Monthly Target*. Information is now transferred to the Year to date sheets.
- 3 To update a specific month's target, select the month and click on *Capture Monthly Target* to enter the new targets in the PMS sheet. Click on *Update YTD* to transfer data to the Year to date sheets.
- 4 To update a specific month's actuals, select the month and click on *Capture Monthly Actuals* to enter the new actual data in the PMS sheet. Click on *Update YTD* to transfer data to the year to date sheets.
- 5 To recall a specific month's rating, select the month and click on *Recall selected month*.
- 6 Click on *Rail YTD*, *Container Terminal YTD* or *Shipping line YTD* to view the year to date data.
- 7 Click on *Update Weights* to change the weights allocated to each KPI.
- 8 Click on *HELP* view the help file.
- 9 Click on *EXIT* to exit the "User form".

3. How to use the Weights sheet

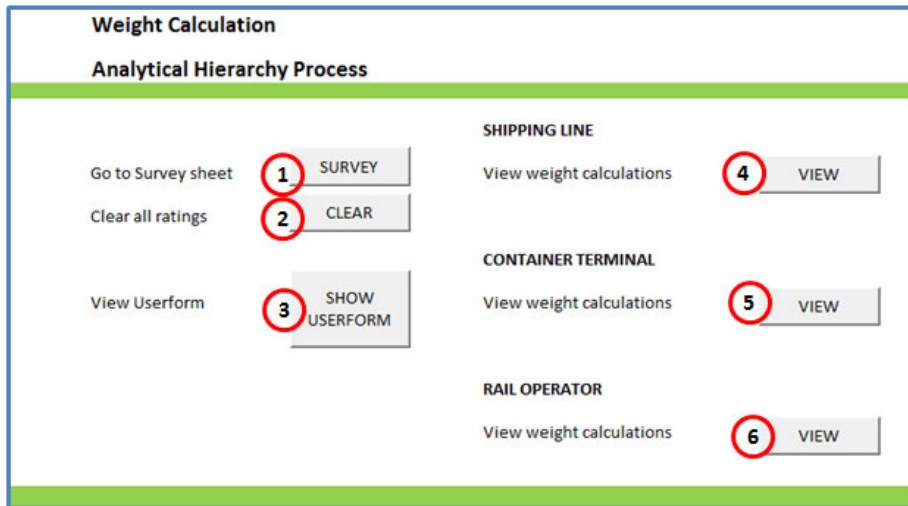


Figure 46 - The "Weights" sheet in the PMS system

The steps to follow when using the "Weights" sheet are (the steps are indicated by red circles in Figure 46Figure 45):

- 1 The weights are calculated using Analytical Hierarchy Process. Pairwise comparison ratings of the KPIs should therefore be obtained. A survey is used to do the pairwise comparison. Click on the *SURVEY* button to go to the survey sheet.
- 2 To clear all previous pairwise comparison ratings, click on the *CLEAR* button.
- 3 To go back to the "User form", click on the *SHOW USERFORM* button.
- 4 To view the shipping line's KPI weight calculations, click on *VIEW*.
- 5 To view the container terminal's KPI weight calculations, click on *VIEW*.
- 6 To view the shipping line KPI weight calculations, click on *VIEW*.

4. How to use the Survey sheet

The survey in Annexure C was developed to make it easier for the individuals to compare the key performance indicators. The survey results are then converted into a pairwise comparison matrix.

BMW CORRIDOR PERFORMANCE MEASUREMENT SYSTEM
SURVEY USED TO OBTAIN PAIRWISE COMPARISON DATA

Interpretation of ratings	Equally important	1	2	Weakly more important	3	4	Strongly more important	5	Very strongly more important	6	7	8	9	Absolutely more important
RATINGS		1	2	3	4	5	6	7	8	9				
SHIPPING LINES														
1	How important to you rate IDLE TIME of the vessels against the CUSTOMER SERVICE INDEX ?				X 1									
2	How important to you rate IDLE TIME of the vessels against the SLOT UTILIZATION of vessels?					X								
3	How important to you rate the CUSTOMER SERVICE INDEX against the SLOT UTILIZATION of vessels?						X							

STEPS

- 1 Complete the survey from the ratings received from industry representatives.
- 2 Click on the **RECORD DATA** button to transfer the data to the pairwise comparison matrices.
- 3 To add another individual's ratings, simply capture and click on the **RECORD DATA** button again.
- 4 Click on the **INDEX** button to go back to the Weights sheet.

2 **RECORD DATA**

3 **INDEX**

Figure 47 - Screen shot of the "Survey" sheet

The steps to follow when using the "Survey" sheet are (the steps are indicated by red circles in Figure 47):

- 1 Capture the survey results by making an **X** under the chosen rating.
- 2 Click on the *RECORD DATA* button to transfer survey results to the Pairwise Comparison Matrices.
- 3 Click on *INDEX* to go back to the Weights sheet.

Annexure F – Validation survey results

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Average per statement	
Statement 1	4	3	5	5	5	4	4	3	2	4	4	4	4	5	4	3	4	2	4	4	4	4	4	4	3.71
Statement 2	5	4	4	3	2	1	4	4	4	4	4	3	5	5	5	4	4	4	3	3	3	3	4	4	3.61
Statement 3	4	5	5	5	3	4	5	5	5	5	5	4	4	4	4	3	5	5	4	4	4	4	4	3	4.07
Statement 4	5	4	4	4	4	4	4	3	3	3	2	3	1	4	4	2	4	4	4	4	4	4	4	4	3.46
Total score per individual	18	16	18	17	14	13	17	15	14	16	15	14	14	18	17	12	17	15	15	15	15	15	16	15	15.48
Total % per individual	90%	80%	90%	85%	70%	65%	85%	75%	70%	80%	75%	70%	70%	90%	85%	60%	85%	75%	75%	75%	75%	75%	80%	75%	77%

Table 37 - PMS validation survey results