GREEN SUPPLY CHAIN OVERVIEW AND A SOUTH AFRICAN CASE STUDY

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ABSTRACT

This paper investigates status quo concerning the environment and the human (economic) impact on its sustainability. It narrows in on the South African context and then focuses on the transport and supply chain's contributions. Green supply chain practices are highlighted and the GreenSCOR framework portraying green best practices and measurements is presented. This is followed by a specific case study in the South African grocery retail industry, that illustrates the impact that a specific variable: extra kilometres has in terms of additional costs and carbon pollutants added to the atmosphere and analyses the causes of extra kilometres with an eye on informing better supply chain decision making.

INTRODUCTION

The scientific evidence has irrefutably confirmed a rise in global temperature over the past hundred years. Increased greenhouse gas (GHG) concentrations caused by human activities, almost certainly drives this climate change (IPCC, 2007). In light of the current detrimental impacts and increasing negative effects expected on the planet's ecology and inhabitants, it is imperative that temperature increases be contained to between 2–2.4°C, which means that global emissions will have to peak by 2015 and then decline (IPCC, 2007). This is no longer simply a green issue; it confronts the core of our (economic) sustainability and inter-species survival. Accomplishing emission reduction will be exceedingly costly, but failure to act effectively will have ruinous effects, forcing major adaptation.

> The Stern Review has reported that the cost of adaptation for the world should no mitigation occur ('the cost of inaction') will be in the order of 5–20 times the cost of mitigation actions required (Stern, 2006).

South Africa emits one percent of the global annual CO_2 emissions[1], but it has an energy intensive economy. Both its GHG emissions per capita and GHG emissions per unit of GDP (emissions intensity) are nearly double that of the world average. Furthermore, South Africans, especially poor communities are particularly susceptible to countless potentially catastrophic climate outcomes (SBT, 2007). Therefore, even though the Kyoto protocol does not currently constrain developing countries, South Africa has an obligation for mitigation.

> "*It is clear that without constraints our emissions might quadruple by 2050. This is, in the most literal sense, not sustainable: If we continue with business-as-usual, we will go out of business. The alternative is a very challenging scenario – to make it our goal to achieve what is required by science of a developing country.*" – The Minister of the Department of Environmental Affairs and Tourism (DEAT), (Van Schalkwyk, 2008)

For South Africa to grow and develop to reduce poverty, while simultaneously retooling its economy to reduce GHG emissions, three areas need to be brought together into a coherent vision to be implemented (SBT, 2007):

[1] In 2004 the world produced about 49 000Mt CO_2-equivalent of which SA emitted 440Mt CO_2-eq, roughly 1% (SBT, 2007).

Technology:	Investment:	Policy:
Wider deployment of existing climate-friendly technology is necessary, together with commercialisation of emerging technologies and spending at scale on research and development of new technology	The sources, mechanisms and extent of investment in low-carbon society need to be found and actively pursued	The country will need clear guidance through policy frameworks that send sustained and legally-enforced messages to markets

In 2006 DEAT commissioned a process to examine the potential for mitigation of SA's GHG emissions, which culminated in the long term mitigation scenarios (LTMS) – a study to define and quantify the mitigation options and associated costs under several energy and economic futures. The mitigation options quantified by LTMS included:

- energy efficiency, in industry and other sectors
- electricity supply options
- carbon capture and storage
- **transport efficiency and shifts**
- mitigation by changes in industrial processes, agriculture, land use and forestation.

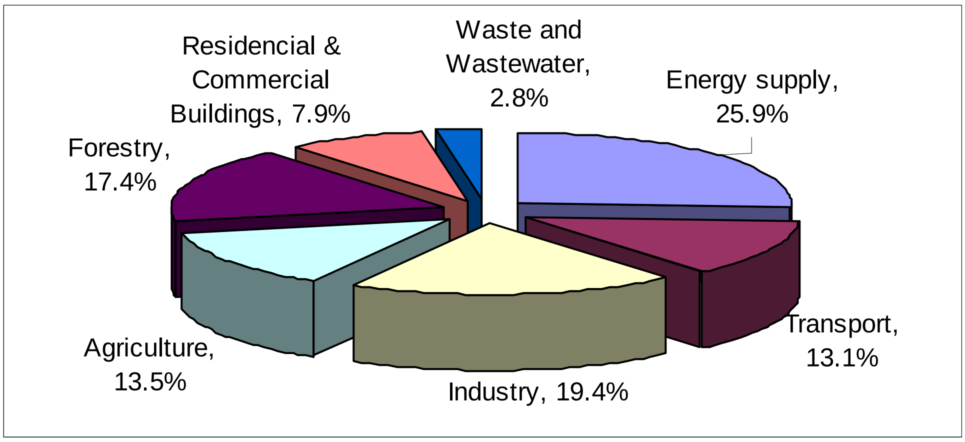


Figure 1: Global GHG emissions contribution per industry, 2004 – Barker et al., 2007

As can be seen in Figure 1 above, transport was responsible for 13.1%, and industry (excluding forestry and agriculture) for 19.4% of global GHG emissions in 2004.

In South Africa, up to 75% of most companies' carbon footprints come from transportation and logistics (van Kerken & Katz, 2008). This places a heavy burden on the supply chain to accept responsibility, invest and take the required measures towards a green supply chain.

A **green sustainable supply chain** can be defined as "the process of using environmentally friendly inputs and transforming these inputs through change agents – whose by-products can improve or be recycled within the existing environment. This process develops outputs that can be reclaimed and re-used at the end of their life-cycle thus, creating a sustainable supply chain." (Penfield, 2007)

TRANSPORT

For South Africa to meet the "required by science" targets – i.e. reducing annual emissions by 1300Mt CO_2-equivalents per year by 2050 – its transport sector will have to be boldly transformed (SBT, 2007). In its energy efficiency strategy of 2005 the government advocates a 9% final energy demand reduction for the transport sector by 2015 (Xia, 2008).

Transport is the fastest growing emitting sector. It poses the most complex challenges, because it encompasses fuels, vehicle technology, infrastructure, as well as behavioural changes. Bio-fuels alone cannot solve the problem at any scale. An overall package needs to be designed, addressing a range of interventions in the sector. This package would have to look at the two large mitigation wedges as principal motivators (SBT, 2007):

- modal shifts in the way human and freight movement is achieved, and
- technology transfer away from petrol and diesel.

THE SUPPLY CHAIN

The motivation to re-engineer supply chains to become green is driven by factors such as: (van Kerken and Katz, 2008) (Dutta and Westenhoefer, 2008) (Luke, 2008)

- Sustainability rationales
- Shrinking resource availability:
  - Fuel
  - Energy
- Government mandates and regulation
- Competitors – Without investing in green initiatives companies will lose market share as competitors gain the early-adopters advantage
- Market forces
- Company internal persuasions, such as:
  - Cost reductions
  - Improved efficiencies
  - Waste/pollution elimination
  - Corporate social responsibility
  - Brand reputation enhancement
- Consumer-pressure – a green supply chain constitutes competitive differentiation in the eyes of the customer

The perception persists that transforming to a sustainable, green supply chain results in reduced profit margins, by increasing the cost burden faced with new eco-friendly equipment and technology, and additional process measures. However research and case studies of actual business implementations are proving opportunities to increase value and save money by reducing energy consumption and waste, and improving efficiencies and performance – i.e. return on green investment (ROGI).

> Many of the opportunities to reduce emissions carry no net life-cycle costs – the upfront investment more than pays for itself through lower energy or material usage.
> – Climate change and supply chain management,
> www.mckinseyquarterly.com

Green Supply Chain Practices

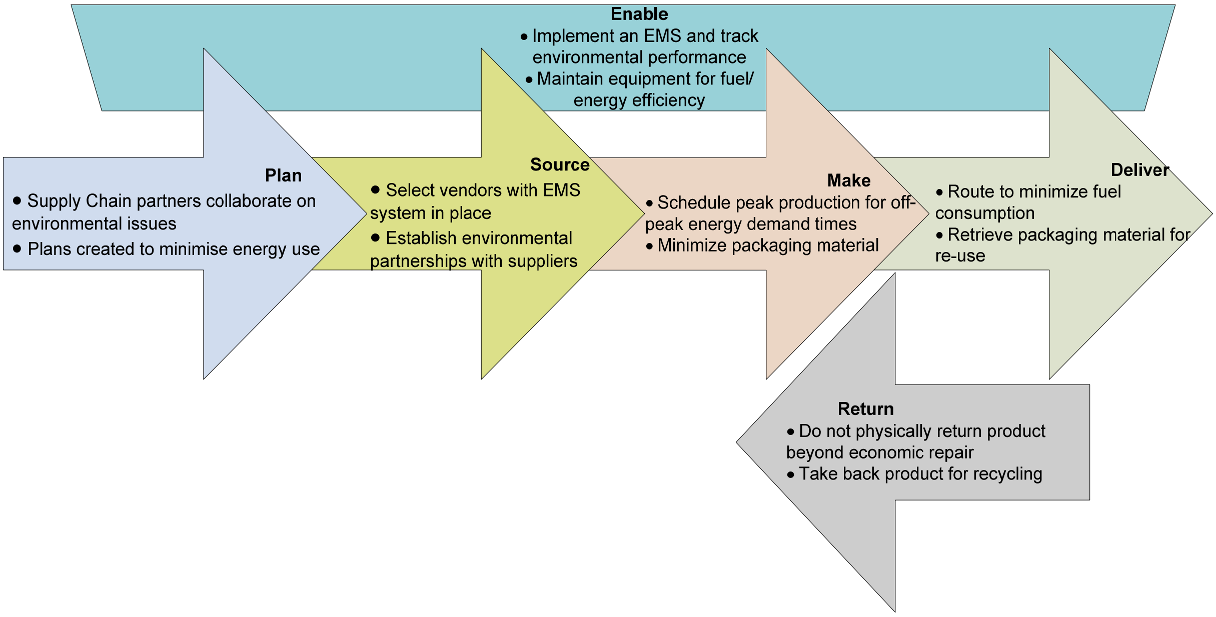
Green supply chain practices represent actions and programmes – spanning across firms – that improve environmental performance, remediate problems and minimize environmental burden. The challenge often lies in the inter-firm cooperation and integration of supply chain management and technology required to effectively implement such practices. According to Klassen and Johnson (2004), there are five possible green supply chain management practices, which are (in order of increasing span/complexity):

- environmental certification,
- pollution prevention,
- reverse logistics,
- life-cycle assessment and
- design for the environment.

The authors also found that the more mature/integrated a supply chain is (moving away from transactional-, through partnership-, towards a network-orientation), the more enabled it becomes to leverage complex green supply chain practices (and ultimately design for environment). With limited inter-firm collaboration, companies are restricted to programmes that involve little cooperation from up- or downstream parties, such as recycling and **environmental certification**. For **reverse logistics** and the associated remanufacturing or re-use programmes to succeed, stable long-term relationships are needed between implementing partners, to support the cost-efficient upstream flow of goods and the development of steady demand for the reversed goods – therefore a transactional (silo) orientation between partners won't suffice. **Design for the environment** and **life-cycle assessment** have the potential to enable the biggest span of benefits from the integrated chain covering product management from cradle to grave with potential opportunities such as: **waste reduction, improved productivity, increased customer satisfaction, lower total costs,** and **risk elimination** (Klassen and Johnson, 2004). It is, however, imperative to take a holistic approach in the analysis of environmental programmes, for example: even though reverse logistics is a critical theme in green logistics, the need for reverse flows can potentially be mitigated if supply chain systems are effective.

GreenSCOR

GreenSCOR is a modification of the Supply Chain Council's SCOR structured model, which integrates environmental considerations (processes, metrics and best practices) into the supply chain management (SCM) process and focuses on the impacts of SCM in each stage of the product life cycle. The figure below indicates examples of green best practices for reducing the environmental footprint in each (SCOR) stage of the supply chain



[2]

Figure 2: Green best practices – GreenSCOR, Supply Chain Council 2008

In order to assess and benchmark the environmental footprint of the supply chain and the effect of green improvements, accurate standardised metrics are required. The figure below specifies example green metrics for each (SCOR) stage of the supply chain.

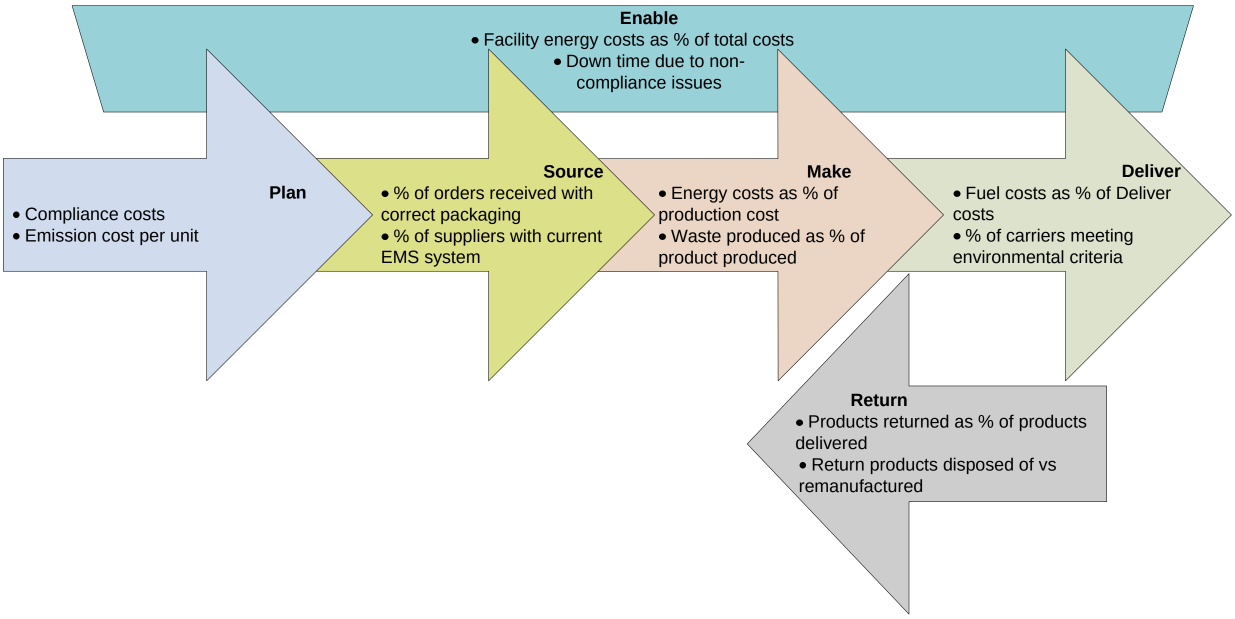


Figure 3: Green metrics – GreenSCOR, Supply Chain Council 2008

[2] EMS – Environmental Management System

CONCLUSION

The effective greening of the supply chain necessitates a holistic systems and network assessment that leads to life cycle optimisation. The entire supply chain is analysed for inputs and outputs at each stage, right back to the (product/process) design stage (where the big scale long-term impacts can be most effectively achieved) and forward to customer use and disposal. Raw material, energy and financial inputs to the system as well as waste outputs are minimised, while production and financial outputs are maximised. The desired result is green-gold, where green supply chain management drives cost savings and process improvement.

With the planet's shrinking natural resources and real concerns around sustainability, environmentally responsible behaviour can no longer be a 'nice to have' for any business venture. With transport being a substantial contributor to greenhouse gasses supply chains can make a significant impact by auditing their environmental footprints and aligning to green practices. The green business mentality need not be a financial burden, since principles of optimally managed resources, energy and waste reduction have decreasing cost implications. Not only do green strategies speak directly to the bottom-line, but can also provide a competitive advantage as consumers and regulation demand greener products and manufacturing practices.

CASE STUDY: 'EXTRA KILOMETRES' DIAGNOSIS AND IMPACT ON THE SUSTAINABLE PERFORMANCE OF A MAJOR SA FMCG PLAYER'S SUPPLY CHAIN

Background

Cardiff University and the CSIR scoped this case study in light of freight transportation's heavy burden on a green supply chain (as described above) and (in line with GreenSCOR) the need to accurately assess the impact of specific, measurable, variables on the supply chain – in terms of its effect on both the environment (green) and the bottom-line (gold). The variable chosen was extra kilometres, which can be defined *as the difference between the number of kilometres vehicles actually run, and the kilometres they would have needed to run if transport planning is undertaken with accurate and timely information on the volumes to be moved, and/or no operational failures disrupt the delivery process*. The economic impact of these extra kilometres can be described in terms of additional fuel needed to complete a delivery, and the environmental impact in terms of more CO_2 produced. Strong parallels exist between this extra distance moved and the concept of non-value adding transport in the lean manufacturing literature, and Figure 4 illustrates how this measure can be directly linked to non-value adding transport kilometres.

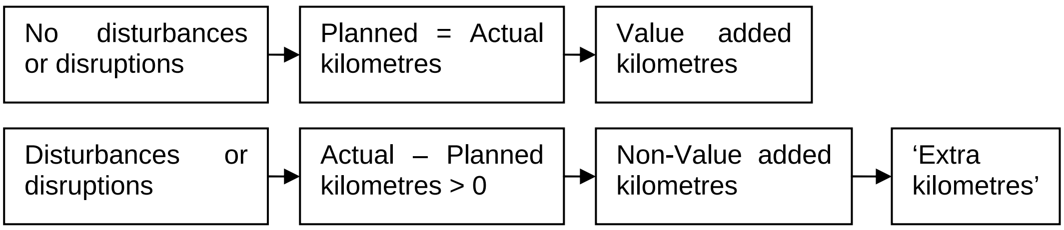


Figure 4: Value added and non-value added kilometres

Previous research by Cardiff University indicated that the difference between the ideal and the actual kilometres run were the result of various uncertainty-causes which impact on the sustainable performance of the supply chain. Through focus groups, Cardiff University empirically determined different causes of supply chain uncertainty impacting on transport operations in the UK. The main causes were: delays within the supply chain, variable demand and/or inaccurate forecasts, lack of supply chain coordination and delivery restrictions. (Sanchez-Rodrigues et al., 2007)

The SA case study set out to identify the uncertainty-causes and quantify their consequences in terms of resulting extra kilometres in the supply chain of a major grocery retailer in South Africa. (While similar logistics challenges might exist between European countries, additional challenges unique to South Africa/developing countries may create different causes of uncertainty (King, 2008). Applying the extra kilometres/miles tool in both the UK and SA allows international comparison, which aids generalisation.)

Context and Methodology

The concept of extra kilometres was applied to the secondary distribution network of a SA grocery retailer with over 200 outlets throughout the country, serviced by a network of 3 distribution centres (DCs). The warehousing operation is run by the retailer, while the transport operations within this network are outsourced to a third-party logistics service provider (3PL).

The extra kilometres data used for the analysis was gathered from distance-based archival data and focused on the major Johannesburg DC. The week of 5-11 January 2009 was selected, as – according to staff – it represented a typical or average week and a fair sample of what happens over a year period. Typical case sampling was applied, as – according to Saunders et al (2003) – ‘typical case sampling is usually used in a research project to provide an illustrative profile using a representative case’.

Using attribute-based activity sampling, all incidents that originated extra kilometres (the common attribute) were identified and captured from two reports: the additional volume report (which summarises the extra trips run due to short-notice volume increases) and the summarised extra trip report (which sums up the additional runs due to operational failures at the distribution centre, stores and within the delivery process). Interviews were held with managers and transport planners from both the logistics service provider (LSP) and retailer to confirm the accuracy of the data collected and to understand the root causes of extra kilometres. Incidents were then analysed and their causes categorised as follows:

- The number of extra kilometres originated by each supply chain uncertainty source was calculated.
- For each source of extra kilometres, frequency and impact was determined.
- The cost and carbon emissions of extra kilometres originated by all the uncertainty sources were estimated using the average running cost per kilometre and the average fuel consumption given by the LSP

Thereafter the week’s extra kilometres were extrapolated to annual estimates.

The results were used to perform risk assessments and recommendations were made.

5.3 Results and Analysis

Table 1 summarises the overall impact of extra kilometres on the Johannesburg secondary DC in a typical week and annualised. Extra kilometres account for 6.71% of the total annual kilometres run. The two main causes of extra kilometres are **distribution centre failures** – mainly due to picking delays (which result in 312 440 extra kilometres annually) and **short-notice volume increases** from the retailer – mostly in long-life products (which result in 287 560 extra kilometres annually).

Table 1: Summarised findings of extra km assessment from sample week

Extra km source	Fre-quency	%	Extra km	%	Total km	Cost (R)	Carbon (kg)
Distribution centre failures	26	40	6 008	52		65 400	9 400
Short-notice volume increases	39	60	5 530	48		60 000	8 700
Week Total	**65**		**11 538**		**172 000**	**125 400**	**18 100**
Annualised Total	**3380**		**599 976**		**8 944 000**	**6 520 800**	**941 200**

Distribution centre failures were found to be the main source of extra kilometres. According to the staff involved this source of extra kilometres is caused by **picking delays** due to a shortage of staff to pick the products. The DC is operated by the retailer, not the LSP.

Short-notice volume increases from the retailer were the second major source of extra kilometres found and significantly the most frequent source. According to the LSP staff involved, this issue primarily occurs since the **demand forecast of volumes** to be moved (which is the responsibility of the retailer) is **not sufficiently accurate**.

Risk can be measured in terms of its outcome and probability – if the frequency of an event is low but its outcome can have a highly detrimental impact on the supply chain the occurrence of such an event represents a considerable risk to the supply chain. Due to their high impact and medium probability of occurrence, both these sources of extra kilometres constitute a high risk and need to be closely monitored and controlled. A **distribution centre failure** generates in average just over 185 extra kilometres and occurs about 1.85% of the time, or approximately five times a day. Therefore the picking process in the DC should be evaluated and reengineered in order to reduce this extra kilometre source. A **short-notice increase in volume from the retailer** originates just over 142 extra kilometres and happens around 1.75% of the time, or approximately five times a day. This extra kilometres source is caused by inaccurate volume forecasts, hence in order to minimise it the product demand forecast process needs to be revised. This risk assessment was discussed with the retailer and LSP management with an eye on informing future decision making.

Recommendations

This case study defined extra kilometres as any non value-added kilometres run within a distribution network. The extra kilometres assessment applied can be used as a diagnostic tool in other transport operations (especially within the grocery/FMCG industry) to assess the efficiency of the transport function within distribution networks in terms of extra kilometres, or unnecessary vehicle usages. It can also be used to determine the causes of unnecessary kilometres and estimate the risk that they represent – in this way, a more explicit link can be made between supply chain uncertainty and deviations in transport execution/performance.

According to the SA case study findings the extra/non-value adding kilometres account for more than R 6.5 million additional costs and 941 additional tons of carbon pollution. The two main extra kilometres sources found are distribution centre failures and short-noticed volume increases. In order to reduce extra kilometres the LSP and retailer need to collaborate to find mechanisms to improve the volume demand planning and product picking processes.

The fact that the transport operation is run by the LSP, while the DC is run by the retailer could present a significant barrier between the two supply chain functions. Therefore, both companies need to jointly review the warehousing process to improve the coordination between the DC and the transport network, and the process of demand management from the retailer's stores to the LSP. While this active collaboration process will provide overall supply chain benefits, these may not be evenly distributed between the parties. Beier (1989) has argued that the shipper, carrier and customer should work together and share benefits, through a concept termed the logistics triad. This would enable all to benefit from a reduction in extra kilometres.

Before embarking on any extra kilometres reduction programme, the LSP should monitor extra kilometres for a longer period of time. The findings are based on data gathered over a fairly average week, therefore the exercise needs to be extended in order to verify findings before basing future decision making on these results.

The extra kilometres tool needs to be further tested in other transport operations and other industries. However, since information on the efficiency of transport operations vary from company to company, it is necessary to review how information on the efficiency of the transport function is recorded by each company before applying the extra kilometres tool, so that data can be gathered in the most effective way.

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