

**A COMPARISON OF ROAD AND RAIL TRANSPORT FOR THE  
BENEFIT OF THE INDEPENDENT TIMBER GROWERS OF NATAL  
COOPERATIVE TIMBERS**

by

**MERISHA BEPAT**

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SUPERVISOR: DR B J WAUGH

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## DECLARATION

I Merisha Bepat, student number 32921330, declare that **“A Comparison of Road and Rail Transport for the Benefit of the Independent Timber Growers of Natal Cooperative Timbers”** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I have not previously submitted this work, or part of it, for examination either at UNISA for another qualification or at any other higher education institution.

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Merisha Bepat

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Date

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## List of abbreviations

<b>CSCMP</b>	Council of Supply Chain Management Practitioners
<b>CSIR</b>	Council for Scientific and Industrial Research
<b>DAFF</b>	Department of Agriculture, Forestry and Fisheries
<b>DOT</b>	Department of Transport
<b>DWAF</b>	Department of Water Affairs and Forestry
<b>ERP</b>	Enterprise Resource Planning
<b>FSA</b>	Forestry South Africa
<b>GDP</b>	Gross domestic product
<b>ICFR</b>	Institute for Commercial Forestry Research
<b>JCSE</b>	Johannesburg Centre for Software Engineering
<b>KZN</b>	KwaZulu-Natal
<b>NCT</b>	NCT Forestry Co-operative Limited
<b>PBS</b>	Performance Based Standard
<b>SEIFSA</b>	Steel and Engineering Industries Federation of Southern Africa
<b>RTMS</b>	Road Transport Management System
<b>TFR</b>	Transnet Freight Rail

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## ABSTRACT

The objective of this study was to investigate and compare the brokered transport costs of road and rail transport for the independent timber growers of NCT Forestry Co-operative Limited in Kwa-Zulu-Natal. Reliability, flexibility, visibility, rates and total transport time were evaluated for each mode of transport. The impact of the carbon emissions was also considered and the option of performance based standard vehicles investigated.

During the period 2000 to 2003, rail was the dominant mode of transport. However from 2004 onwards, due to the diminishing service levels and the high tariff structures of rail transport, road became the preferred mode of transport. The results of the survey conducted for the purposes of this study showed that although road transport outperformed rail transport, rail transport scored significantly higher than road transport as a cost-effective mode of transportation. Rail transport was shown to be a far less carbon intensive mode of transport than road transport, while there were substantial cost savings and benefits from performance based standard vehicles.

**Keywords:** NCT, road transport, rail transport, timber, supply chain, logistics, opportunity cost, economies of scale, carbon emissions, performance-based standard vehicles

# CHAPTER ONE

## INTRODUCTION TO LOGISTICS AND THE TIMBER GROWER

---

### 1.1. BACKGROUND TO THE STUDY

The South African timber growers, who are affiliated members of NCT Forestry Co-operative Limited, play a key role in the forestry sector of the economy through the planting of trees and the processing of these trees into wood chips for the export market (Naidoo & Chasomeris, 2013). However, one of the main challenges facing the timber farmers in the forestry sector is the significantly high transportation costs associated with the transportation of the timber from the farm to the market (Naidoo & Chasomeris, 2013). In light of this, the background to the study will cover the important contributions made by the forestry sector to the South African economy. The role of logistics and its impact on the primary sectors of the economy such as the forestry sector will be identified. There will be an introduction to the challenges facing the timber industry of the forestry sector, highlighting the reasons why logistics costs, in particular, the cost of transport, need to be reduced. Intermodal discussions and a switch back to rail transport will also be emphasised.

#### 1.1.1. Logistics and the forestry sector

Logistics is a significant cost and customer service element in the supply chains of both economic sectors and industries and, as such, the performance and costs of this element has a significant impact in a country. Transportation, as a key component of logistics, plays a significant role in these supply chains as do the key transportation-related decisions that supply chain managers must make (Chopra & Meindl, 2012:61), including decisions on the choice of transportation mode. According to the 10th Annual State of Logistics Survey for South Africa (CSIR, Imperial Logistics & Stellenbosch University, 2013:13), “the rising trend of logistics costs poses a real challenge to all concerned in South Africa”. The defining role of logistics is to supply services or products to customers at the right time, in the right quantity, in the right quality, at the right cost and at the right place (Wakeham, 2010). The performance of the logistics industry, and the cost of logistics generally and transportation in particular, also affects

a country's economic growth and development (CSIR, Imperial Logistics & Stellenbosch University, 2013:13; Havenga, Simpson, De Bod & Viljoen, 2014).

Economic growth and development are a critical goal for any country (The World Bank, 2014) with a country's various economic sectors and industries playing a key role in its overall gross domestic product (GDP). In South Africa, various sectors make a contribution to the country's GDP, including the agriculture, forestry and fisheries industries in the primary sector, which are deemed to be crucial to South Africa's socio-economic development (DAFF, 2014:8). According to Statistics South Africa (2014:8), the agriculture, forestry and fisheries industry contributed 2.3% to GDP growth in South Africa with the forestry sector (forestry and forest products) contributing approximately 1% (Department of Government Communication and Information Systems, 2014–2015:18), thus highlighting the importance of these industries in respect of both employment and sustainability in the country. Logistics performance and costs have a significant impact on the global competitiveness and the profitability of these primary sectors of the economy (Badenhorst-Weiss & Waugh, 2014:284). Transportation is a significant element of the total logistics costs (Chopra & Meindl, 2012). The excessive dependence on road freight transport has resulted in rising logistics costs for the primary sectors of the economy, industry and business (University of Stellenbosch, 2015). According to the Department of Environmental Affairs (2014), rail transport has been given considerable attention as an alternative transport option due to the high logistics costs associated with road transport, with the business sectors and industry being encouraged to consider cost-effective transport options such as rail (Department of Environmental Affairs, 2014).

One of the main areas of concern for businesses in the forestry sector is the reduction in transport costs for the timber industry (Van Zyl, 2014). There has thus been a significant focus on a switch from road to rail transport (Van Zyl, 2014). Consequently, in view of the importance of the forestry industry to the South African economy (Department of Government Communication and Information Systems, 2014–2015:18; Godsmark, 2013), logistical solutions such as a switch from road to rail transport will have to take into account cost savings and the resultant impact on the economic, social, safety and environmental aspects of the country (Grant, Trautrimis & Wong, 2015), as well as on the profitability of the timber growers and their supply

chain partners (Van Zyl, 2014). According to Wakeham (2010), logistics cost savings are possible through an efficient transportation system which is an essential requirement for the effective distribution and utilisation of the country's products and resources, which plays an important role in economic development. Thus, as the timber industry members benefit from logistics cost savings, this can in turn lead to improved productivity, thus benefiting the forestry sector and the economy overall (Havenga et al., 2014, Forestry South Africa, 2012a).

### **1.1.2. The forestry industry and the timber grower**

The forestry industry involves the processing of timber (i.e. production of round wood, charcoal, pulp and paper) and the processing of timber into wood (Lebedys, 2004; Quesada, Gazo & Sanchez, 2012) into value-added timber products through a process of manufacturing. According to the forestry and sawmilling directory, “[t]imber growers are the primary sector of the forestry industry in that they provide the raw material for the forestry processing and manufacturing sectors who depend on timber for their products” (Wood Southern Africa, 2015:5).

Timber growers are therefore regarded as the owners of land and, as such, they are entitled to receive any proceeds from the sale of the timber grown on that land (Jele, 2012:1). Timber suppliers (agents or buyers) such as NCT are engaged in the business of buying timber from the timber growers (commonly called growers) (Jele, 2012:1). The timber suppliers then resell the timber to pulp and chipping mills. This process involves the harvesting of timber from plantations throughout the country and then transporting the timber to various processing plants by road and rail transport (Louw, 2013). Agents such as NCT broker transport on behalf of their timber growers as a value-added service by arranging the loading and transport of round wood timber from farm to market (NCT Forestry Co-operative Limited, 2015a).

Once the timber has been delivered to the appropriate market, the timber is converted and processed into paper for printing and writing, tissue and container board, which all constitute an important component of the manufacturing process (Deloitte, 2011). Hence, the forestry industry supports manufacturing subsectors which include paper and pulp production, mining and construction (Department of Agriculture, Forestry and Fisheries [DAFF], 2014). The contribution of the agriculture, forestry and fisheries

sectors to GDP is presented in Table 1.1. The contribution of forestry to GDP is reflected as an independent component of agriculture and fishing and averaged R8955 million over the six-year period from 2008 to 2013. The monetary contribution made by forestry over the six-year period highlights its important contribution to GDP growth in South Africa.

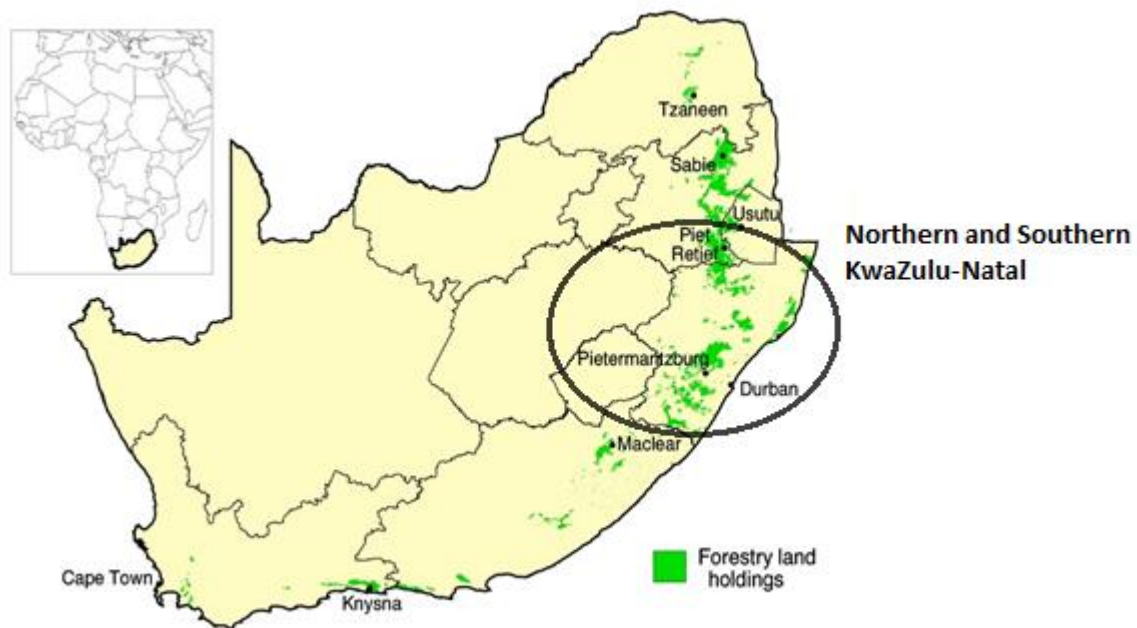
**Table 1.1:** Annual contributions to GDP growth in South Africa by the agriculture, forestry and fishing sectors

<b>Industry</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Agriculture, forestry and fishing	67 743	68 044	65 605	68 591	70 245	73 458
Agriculture	57 656	56 055	52 001	55 066	59 713	62826
<b>Forestry</b>	<b>7 741</b>	<b>9 523</b>	<b>10 838</b>	<b>10 729</b>	<b>7584</b>	<b>7319</b>
Fishing	2 347	2 466	2 766	2 795	2948	3313

**Source:** Statistics South Africa (2014:38). Values are depicted in million rands (Rm)

Another key variable that contributes to economic activity in a country is job creation/employment. In addition, transport employment also plays an important role for the forestry industry and it is therefore a goal of government to ensure the sustainable economic development of the sector in order to maintain employment levels (Department of Water Affairs and Forestry, 2013). According to a recent labour force survey for the 2015 period, the manufacturing industry reported a labour force of 1 779 000 people, the agriculture industry a labour force of 891 000, followed by mining with 443 000 people (Statistics South Africa, 2015:39). Forestry alone employs approximately 160 000 workers and provides about 62 000 direct jobs and 30 000 indirect jobs which contribute to supporting the livelihoods of 650 000 of the country's rural population (Department of Government Communication and Information Systems, 2014–2015:18). KwaZulu-Natal (KZN) in particular is noted as having the highest employment levels in the country as a result of the 364 245 hectares of hardwood and 138 967 hectares of softwood in the province (Godsmark, 2013). This results in the high levels of timber production in KZN, which accounted for 11.4 million m<sup>3</sup> of timber processing in 2013 (Forestry South Africa, 2015). Figure 1.1 provides a geographical depiction of the timber plantations in South Africa which are plotted in

green. This study focused on the timber growers based in the zones serviced by NCT in the Pietermaritzburg, Greytown and Vryheid areas.



**Figure 1.1:** Timber plantations in South Africa

**Source:** The South African Forestry Industry's Perspective on Forestry and Forest Products Statistics – FSA 2014

The two main indicators of the economic activity generated by various sectors in the country, namely contribution to GDP and employment, play an important role in the forestry sector (Lebedys, 2004:2). However, of equal importance to economic activity is the costs that have an adverse impact on GDP. According to a recent discussion on transport legislation for the agricultural business chamber, the logistics costs of transport are apparently the most significant cost hampering GDP (Nordengen, 2015). This also affects the forestry industry. According to a study on the challenges facing independent timber growers in KZN, the high cost of transport associated with the road transport of timber from farm to market is one of the major challenges they face (Naidoo, 2011:114). These high transport costs are therefore of serious concern to the forestry industry and for agents such as NCT with a membership of more than 2000 timber growers (NCT Forestry Co-operative Limited, 2015a). While the forestry sector in South Africa contributes significantly to the overall GDP and job creation in the country, the logistics costs associated with the transportation of timber are of concern for the industry and its stakeholders.



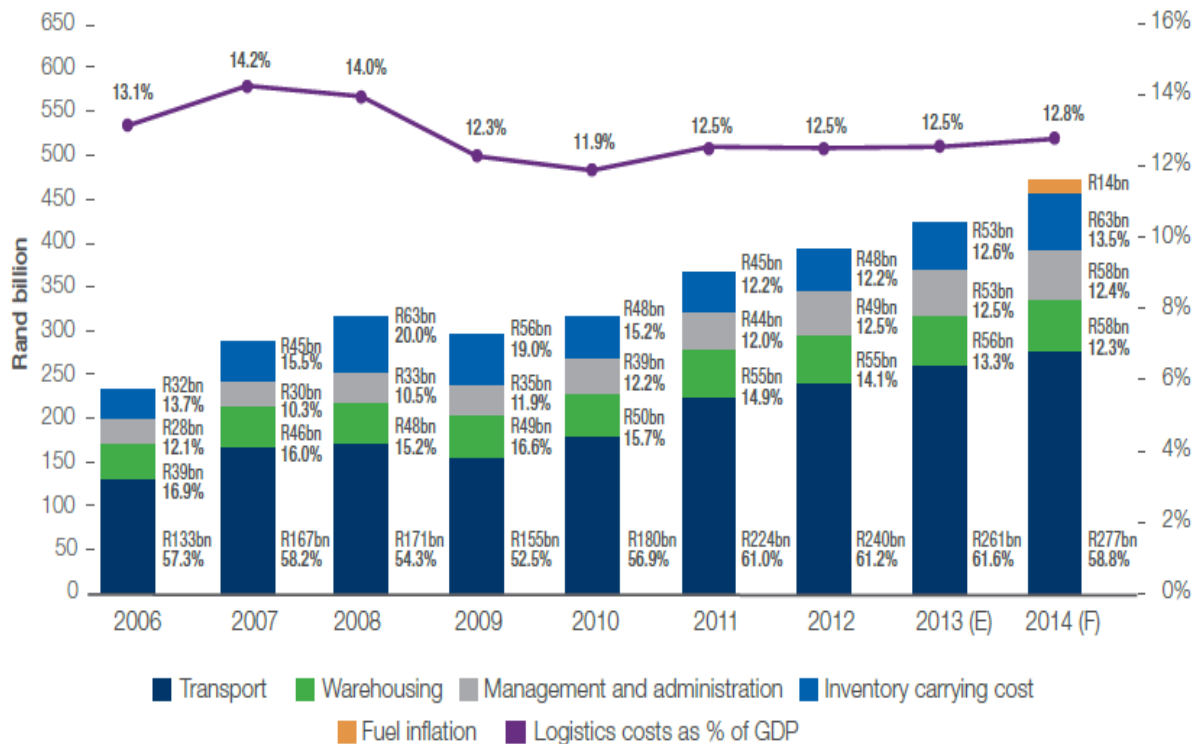
### **1.1.3. Logistics, transport costs and modal selection**

The efficient management of transport costs is essential for developing countries. Delivering goods at a low cost, at the right time and the right place, allows the economy as a whole to function more efficiently than may otherwise have been the case (Stukalina, 2014:9). However, because South Africa's economy is transport intensive the high transport costs are an issue of concern for the country (Ittmann, 2012; University of Stellenbosch, 2015). In 2012, South Africa's transport industry was responsible for 1.8 billion tons of freight which cost the economy R432 billion, excluding externality costs of R40 billion (Havenga et al., 2014). Externality costs are those costs which are associated with accidents, congestion, emissions, noise, policing and damage to road networks (Havenga et al., 2015). In view of the important contribution of the forestry sector to South Africa's GDP, it is essential to consider the impact of logistics costs on GDP.

Figure 1.2 presents the categories of the various components of logistics cost for South Africa for the period 2006–2014. The graph in the figure indicates that the total logistics cost comprised of transport costs, storage and ports costs, management administration costs and, lastly, inventory carrying costs. The high demand for road freight transport led to an increase in transportation costs from R133 billion in 2006 to R277 billion in 2014 and it is therefore considered to be the highest cost component of logistics for this time period (Havenga et al., 2014). The excessively high transport costs key driver was linked to the cost of fuel, which was in turn strongly driven by the price of crude oil (Havenga et al., 2014). In view of the fact that at the time of the study, over half a million tons of timber was being transported by road to markets in KZN alone (SA Forestry Online, 2012), NCT's timber transport cost had reached a staggering R160 million in 2015 (NCT Forestry Co-operative limited, 2015a:20).

According to an article on timber transport, road transportation, in particular, makes up the majority of the costs associated with timber operations (SA Forestry Online, 2012). Alternative modal choices such as rail transport should therefore be considered (CSIR, Imperial Logistics & Stellenbosch University, 2013). The high transport costs provided the motivation for this investigation into alternate modes of transport for timber in the forestry sector. According to Gibson, Hanna, Defee and Chen (2014), transportation cost always plays an important role in modal selection. "Transportation

costs include the rate charged for moving freight from origin to destination, plus any accessorial and terminal fees for additional services provided. As a result, considerable care needs to be taken when undertaking the modal decision-making process” (Gibson et al., 2014:164).



**Figure 1.2:** Total national logistics costs and components from 2006–2014

**Source:** The 10th State of Logistics Survey (2013)

In considering modes of transport such as road and rail, recent research suggests that it is essential that the high externality costs associated with road transport should also be taken into account (Department of Transport, 2015a:15, Jorgensen, 2013). A sustainable transportation mode is one that takes into account externality cost factors such as the emissions of hazardous particles, accidents affecting road users and wear and tear on infrastructure (Heljedal, 2013:11). According to the Road Traffic Management Systems (RTMS), there has been attention paid to reducing environmental impacts while road transporters in the timber industry have been encouraged to consider external costs in future transportation planning (Road Traffic Management Systems, 2015).

Thus, taking into account these cost factors, it is advisable that alternative transport solutions also be explored (Heljedal, 2013:11). The Institute for Commercial Forestry Research (ICFR) has been actively involved in trying to curb costs in the timber industry. Since 2011 the ICFR has promoted the use of performance based standard (PBS) vehicles, also referred to as smart trucks, with the objective of reducing transport costs, road wear and tear and carbon emissions, and improving the overall safety on roads (Wood Southern Africa, 2015). Various aspects of logistics, transportation costs, externalities and alternative transport solutions with regards to modal decisions, particularly in respect of the forestry sector and the timber growers' supply chains, are discussed in further detail in the literature review. In an attempt to reduce logistics costs, this study considered the feasibility of the KZN timber growers, who are members of the NCT, switching from road to rail transport. It is envisaged that improved decision-making with regards to modal choices for the timber industry will lead to lower logistics costs with a concomitant positive impact on both the industry profits (Van Zyl, 2014:7) and GDP which are critical to the welfare of the country and the economy (Department of Environmental Affairs, 2014).

## **1.2. RESEARCH PROBLEM STATEMENT, PURPOSE AND OBJECTIVES**

### **1.2.1. Problem statement**

As discussed in the previous sections, logistics activities and the costs incurred have a significant impact on the supply chains of various economic sectors and industries. The high logistics costs associated with road transport have led to substantial increases in road transport costs for timber transport with this resulting in reduced profit margins for the timber grower (Naidoo, 2011), which have had a negative impact on the forestry sector as a whole. High transport costs have placed immense pressure on the timber growers' profits. It is thus vital that this problem is addressed in the interests of the survival and growth of the timber industry in the forestry sector.

### **1.2.2. Research purpose**

The major purpose of the study was, therefore, to investigate and suggest ways in which to address the transport costs for the benefit of the timber growers who are members of NCT. This involved a comparison of road and rail transport for the timber growers of NCT, followed by a detailed analysis of NCT's road and rail volumes

transported over a 14-year period (2000–2014). The requisite data was retrieved from NCT's in-house Oracle software system. Data prior to the 2000 to 2014 period was unavailable from the database. However, this time frame catered for an appropriate sample size in order to analyse the trends in road and rail transport for the purpose of this study. In order to address the transport costs, a comparison of NCT's road and rail brokered timber transport costs was assessed for the 2012, 2013 and 2014 financial years, using NCT's annual operations reports to determine the feasibility of a volume switch from road back to rail transport. By using the three latest financial periods, the researcher was able to logically assess the prevailing status of road and rail transport costs. In view of the fact that externality costs have received increased attention since 2008 in South Africa, specifically the carbon footprint of road and rail transportation (CSIR, Imperial Logistics & Stellenbosch University, 2008), the carbon emissions were also calculated for the period 2008–2014. Finally, an investigation into timber transport was conducted using PBS vehicles for the 2015 financial year. During this time NCT conducted a trial set of deliveries using PBS vehicles which lasted approximately seven months to a year. The purpose of this initiative was to determine whether there were any benefits to be achieved for the timber grower with regard to an alternative solution to the problem of timber transport. The theory relating to the main components highlighted in the discussion of the research purpose are addressed in more detail in Chapters 3 of the study.

### **1.2.3. Research objectives and questions**

In order to fulfil the overall purpose of the study as outlined in the preceding section, the following primary and secondary objectives and questions were formulated:

#### **Primary objective**

The primary objective of this research study was to investigate and compare the brokered transport costs of road versus rail transport, and the savings that could be achieved specifically for the independent timber growers in KZN who are members of NCT.

## **Secondary objectives**

The following secondary objectives were identified for the purposes of the study.

- To investigate the transport options available in NCT's supply chain
- To investigate the periods and volumes of market share of NCT's road and rail transport for the period 2000–2014
- To determine the transport costs of using road and rail on a rand per ton basis
- To determine the transport costs for road and rail for the period 2012–2014
- To determine the opportunity cost of road transport if all volumes had been transported by rail for the period 2012–2014
- To determine the modal preference of NCT's timber growers
- To determine the carbon emissions of road and rail transport for the period 2008–2014
- To consider alternative transport solutions such as performance based standard (PBS) vehicles and to provide recommendations for the timber growers of NCT

## **Primary research question**

Will an intermodal switch from road to rail be beneficial to the independent timber growers of NCT?

## **Secondary research questions**

The secondary research questions that had to be answered in order to realise the secondary research objectives, and within the context of NCT's timber growers, are as follows:

- What are the transport options available to NCT's timber growers?
- During which period was rail considered to be the dominant mode of transport and what were the reasons for this trend?

- During which period was road considered to be the dominant mode of transport and what were the reasons for this trend?
- What are the transport costs of using road versus rail on a rand per ton basis?
- What were the differences in transportation costs for road and rail for the period 2012–2014?
- What would the opportunity cost of road transport have been if all volume had been transported by rail for the period 2012–2014?
- What are the other criteria to consider in deciding on the choice of transportation mode?
- What were the carbon emissions of road and rail transport for NCT for the period 2008–2014?
- What are the benefits of using alternative transport solutions such as PBS vehicles for the timber growers of NCT?

### **1.3. RESEARCH METHODOLOGY AND DESIGN**

#### **1.3.1. Research methodology**

The research methodology is organised around the steps that form part of the research process for both quantitative and qualitative research (Kumar, 2011:18), while the research design refers to the type of inquiry that is carried out in qualitative, quantitative and mixed method research (Creswell, 2014:12). A mixed approach was used for the purpose of this study and combined both qualitative and quantitative research. Qualitative research methodology is concerned with understanding the processes as well as the social and cultural contexts which underlie various behavioural patterns and focuses primarily on exploring the “why” questions of research (Maree, 2010). On the other hand, quantitative research deals with the interrelated constructs of analysing data which help to explain a phenomenon between two or more variables (Creswell, 2014:87). For the purposes of this study, both the qualitative and the quantitative research were based on considering an intermodal switch from road to rail transport and using a case study to address the primary and secondary research questions highlighted in section 1.2.3.

In order to address the research questions, (which also link to the research objectives) outlined in section 1.2.3 of the study, interviews and survey-based questionnaires were used in order to gather the primary data. The secondary data was retrieved from NCT's in house software system, Oracle software, and company reports. Two separate semi-structured interviews, one conducted with the logistics manager of NCT and one with the operations manager of NCT, were qualitatively analysed while the historical data and the survey findings were quantitatively analysed. Using both qualitative and quantitative methodologies in tandem is considered to be a sound approach when the researcher is drawing a comparison between two components or variables of a study (Creswell, 2014:273), such as between road and rail. Accordingly, this study adopted a mixed approach using both qualitative and quantitative methods of analysis while the literature review involved an evaluation of the theory of the main components cited in the purpose of the study noted in section 1.2.2.

### **1.3.2. Research design**

The research design is the plan that provides the structure of the investigation of the research problem (Salkind, 2010). It is important that the research design selected is appropriate to the generation of the type of data required to answer the research questions posed (Maree, 2010:70). Thus, research design provides the framework for conducting the research in order to increase validity and reliability of the research findings (Wiid & Diggins, 2011). The main framework and structure for investigating the research problem in this study were based on constructing a case study of NCT's road and rail operations using a mixed method research design. For the purpose of the study, the exploratory research included an examination of the theory pertaining to road and rail studies as well as the collection of qualitative data from two separate, semi structured interviews which were conducted with the logistics manager and the operations manager of NCT. For the purposes of the explanatory research, quantitative approaches were used to analyse the historical data and surveys using descriptive statistics. Two formulas were also used in the study. The first formula was used to calculate the opportunity cost of transport and the second formula was used to calculate the carbon emissions of road and rail transport.

Finally, a triangulation analysis involved the cross checking of the quantitative and qualitative results to validate the findings of the study. Triangulation is used in mixed

method research studies to ensure the convergence of the data sources (Creswell, 2014) and thus the historical data and the findings from the interviews and surveys were triangulated in the case study. In order to address the research questions, a literature review was undertaken (§ i below) as a basis for conducting the mixed research approach used in the study (§§ ii–iv).

### **(i) Literature review**

The literature review focused primarily on existing literature on road and rail transport which stemmed from addressing the theoretical framework of transport and its role in supply chain management and logistics. The literature review provides a framework for the research study in question and answers the important question(s) identified in the study (Seuring & Gold, 2012). Selecting and evaluating literature on research conducted by other researchers provides a way in which to narrow down the research questions and objectives of the study (Seuring & Gold, 2012). Therefore to address the primary research question of the study, namely, '*Will an intermodal switch from road to rail be beneficial to the independent timber grower of NCT?*' the literature review considered the central issues, concepts and facts pertaining to road and rail transport. The transport costs as well as the advantages and disadvantages of each mode were considered in order to acquire a greater understanding of the criteria and factors which should be taken into account when deciding on an intermodal switch from road to rail transport. Hence, modal preferences, performance and cost of road and rail were examined as important components of the efficiency and effectiveness of transport operations. The literature study also provided an overview of externality costs with a specific focus on carbon emissions and the approaches used in carbon calculations. The role of PBS vehicles in transport was investigated and discussed under the theories of economies of scale. Overall, the modal options available to the NCT supply chain were investigated with the goal of establishing whether there should be an intermodal switch from road to rail transport by the timber growers in the forestry industry.



## **(ii) Case study**

The main objective of a case study is to become familiar with a phenomenon and gain insights into exploratory or formative studies (Dhawan, 2010). In logistics research case studies provide a rich account of logistics processes and may include both facts as well as the implicit knowledge of the logistics employees (Trautrimis, Grant, Cunliffe & Wong, 2012). The case study approach allowed the researcher to gain in-depth insights into the road and rail operations of NCT using primary and secondary data sources. According to Maree (2010), the case study approach is a good approach to adopt for a study on a particular organisation. Case studies examine specific questions, themes or issues pertaining to a study (Creswell, 2014). Thus, for the purposes of this study the case study measured the results of the research questions outlined in section 1.2.3 and with a concluding framework summarising the findings of the research questions which will be dealt with in Chapter 5 of the study.

## **(iii) Data collection – participants and instruments**

The main methods of data collection used in this study included primary and secondary data sources. Secondary sources of data may be retrieved from internal and external sources such as databases, industrial association enterprises, government bodies and/or the staff of an enterprise (Wiid & Diggines, 2011). The secondary data in this study came predominantly from the company database, Oracle software, as well as company reports and with the aim of obtaining data on road and rail transport operations from the period 2000 to 2014. Oracle software is considered to be a sophisticated software program that provides reliable performance measurements of the day-to-day operations of a company (Oracle software, 2012:6). The program played a key role in accumulating the secondary source of historical data for the purpose of the study. The advantages of using secondary historical data is that such data is less time consuming to collect, it is a cost-effective method and several datasets may be compiled (Koziol & Arthur, 2007). It is for these reasons that the the Oracle software database was used. The aim of historical data is to provide descriptive information on a particular industry, environment or company based on historical events (Wiid & Diggines, 2011:3). Historical research explores, summarises and reports on past information (Kalaian, 2008). Thus, the historical data collected

provided a basis for describing the past and present performance of NCT’s road and rail transport over a 14-year period. This information was summarised and reported on in the case study chapter to enable the researcher to determine the trends in the road and rail operations of NCT and, in particular, to determine the reasons why the shift in volumes from rail to road had occurred.

In addition to the historical data, primary data was also collected. One of the notable benefits of primary research is that interviews and questionnaires may be tailored to suit the research being conducted and to address the key research questions pertaining to the study (Saunders, Lewis & Thornhill, 2012). The primary data collection process comprised two separate semi-structured interviews, one interview with the logistics manager and one with the operations manager of NCT. A further six, survey based questionnaires were issued to staff members of NCT in the Greytown, Vryheid and Pietermaritzburg areas. Thus, a total sample size of eight participants was chosen for the study. These participants were identified as a key source of primary data due to their expertise in dealing with the NCT timber growers and brokered transporters. The information gleaned from these interviews and surveys formed part of the data analysis conducted.

**(iv) Data analysis and presentation**

The data collection methods, data analysis and presentation used in the study are summarised in Table 1.2 below.

**Table 1.2:** Methods of data analysis

<b>Data collection</b>	<b>Method</b>	<b>Population: NCT</b>	<b>Data Analysis</b>	<b>Presentation</b>
Secondary	Historical research: Oracle software (Quantitative)	NCT (road and rail operations: 2000–2014) <b>Sample size: Large</b>	Descriptive statistics (SYSTAT 13) Microsoft Excel 2010 (a) Future value formula (b) Activity based approach	Graphs, tables and detailed calculations in the case study



Data collection	Method	Population: NCT	Data Analysis	Presentation
Primary	Interviews (Qualitative)	<u>Two Interviews</u> One interview with the NCT logistics manager One interview with the NCT operations manager <b>Sample size: 2</b>	Transcribing of recordings (themes) Triangulation of historical data with interview findings	Verbatim reporting in the case study with quotations
	Surveys (Quantitative)	<u>Surveys</u> NCT staff members: (2 from Greytown) (2 from Pietermaritzburg) (2 from Vryheid) <b>Sample size: 6</b>	Total weighting of key criteria measured using Anova/IBM SPSS Statistics 20. Triangulation of historical data with survey findings	Statistical tables. Comments from surveys.

The historical data was first analysed in order to make comparisons between road and rail transport. “Data analysis is used to determine the patterns that emerge and relationships that exist between variables and the interaction between categories of data” (Saunders et al., 2012:308). Descriptive data may be used as a basis for measuring and describing patterns and variations (Flick, 2011), for example, between the road and rail data in this study. Statistical software packages such as SYSTAT 13 and Microsoft Excel 2010 were used for this purpose. Mathematical and statistical measures are frequently used in logistics studies to measure the performance of organisations for the purpose of case studies (Wang, 2013). Two formulae were also included as part of the data analysis study. These formulae are outlined below as (a) and (b) respectively.

**(a) To determine the opportunity cost of transport, the future value formula is shown as:**

$$FV_n = PV_0 \times (1+i/m)^{(n \times m)}$$

where:

$FV_n$  = future value at the end of period n

$PV_0$  = present value  $aV_0$

i = rate of interest earned per period

- n = the total number of periods of the investments
- m = the number of times interest is compounded per period

Using the future value formula, the opportunity cost of using road transport will be calculated to show the savings that can be achieved if all volume were to go by rail. This formula is used for economic decision-making that provides for the higher value alternative of any choice and it was therefore considered important in the decision-making regarding the switch from road to rail transport.

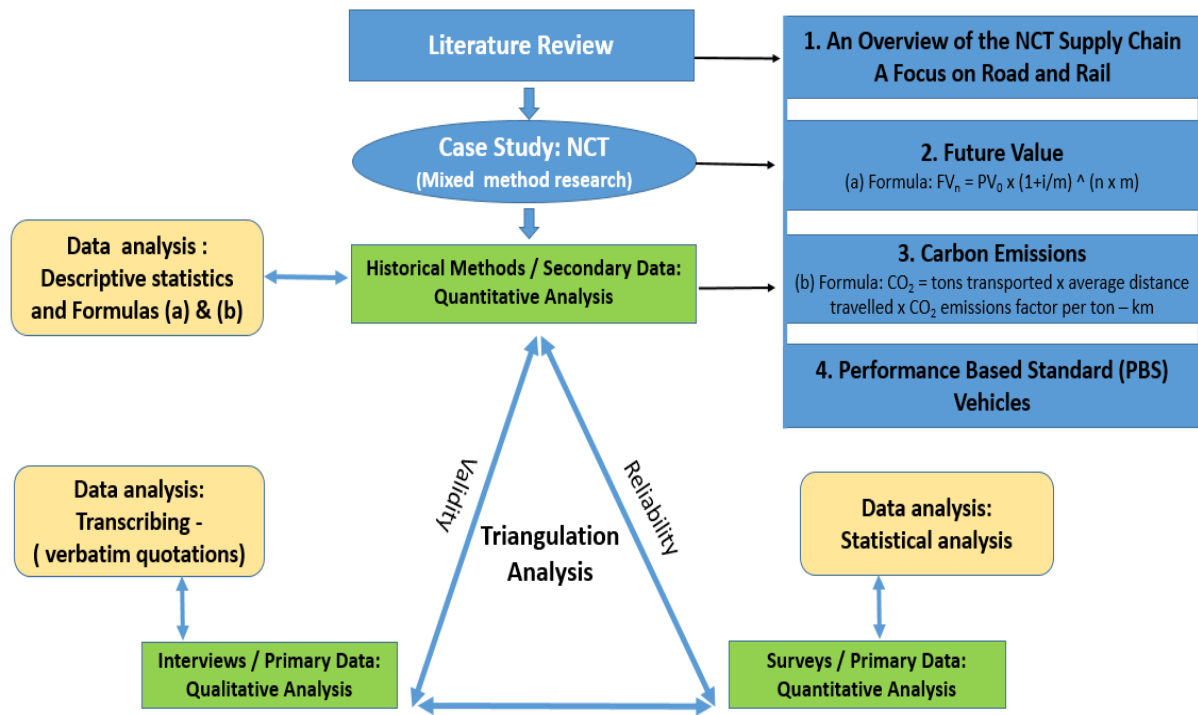
**(b) To calculate the carbon emissions, the activity based approach was followed as shown below:**

$$\text{CO}_2 = \text{tons transported} \times \text{average distance travelled} \times \text{CO}_2 \text{ emissions factor per ton – km}$$

As highlighted in the literature review (§ 3.7.1), the activity based approach has been adopted in a number of studies to calculate carbon emissions and therefore it was used in this study to determine the carbon emissions for NCT's road and rail transport. The two semi-structured interviews – one with the logistics manager and one with the operations manager – were analysed in detail. The correct approach to analysing interviews involves the process of transcribing by analysing, rephrasing, reflecting and comparing the research findings (Trautrim et al., 2012). Once this was complete, the interviews were triangulated to the historical data to reveal the meanings of the 'what' questions as outlined in section 1.2.3. The results of the interviews are presented in Chapter 5 and are cited in line with the NCT's logistics manager and operations manager.

Lastly, the survey-based questionnaires were quantitatively analysed and compared to determine the modal performance for road and rail transport based on selected criteria. The numerical indicators reflecting performance in respect of each of these criteria were totalled to measure/weight the performance of each mode in relation to the selected criteria. According to Heeringa, West and Berglund (2010), the application of weights is frequently used for the analysis of survey data with numerical rating scales being used to reflect the perceptions of the respondents on a scale of 1 to 10, with 1 reflecting poor and 10 good (Saunders et al., 2012). The ratings from the survey

on road and rail transport were compared in the case study as part of the data analysis process. ANOVA was used to measure the variance in the performance of road and rail transport.



**Figure 1.3:** Structure of the study

**Source:** Researcher

Figure 1.3 provides an overview of the structure of and methods used in the research study. The literature review is discussed in Chapters 2 and 3 of the study. These chapters provide a broad theoretical framework of key supply chain concepts which narrows down the study to addressing the key points 1 to 4 as presented in Figure 1.3. The NCT case study was constructed by means of three methods of data collection, namely, historical data, interviews and surveys, and using a mixed methods approach of quantitative and qualitative data analysis to address the key points 1 to 4 in Figure 1.3. The secondary sources of historical data and the primary data from the interviews and surveys were triangulated to confirm the findings of the study. The historical data and the survey findings were quantitatively analysed using statistical methods while the interview findings were analysed qualitatively and transcribed with the use of verbatim quotations in the case study. These mixed methodologies are examined in greater detail in Chapter 4 of the study. The results of the case study are presented in

Chapter 5 and address the primary and secondary research questions of the study, which will in turn correlate with points 1 to 4 of Figure 1.3.

#### **1.4. LIMITATIONS OF THE STUDY**

NCT acts as an agent to timber growers by brokering a large amount of timber by road and rail transport as a value-added service to the timber grower. It was, therefore, necessary to consider cost saving options for the timber growers of NCT from the perspective of a transport broker. The first limitation of the study was that an in-depth calculation of transport costs was not available for the purposes of the study as NCT does not own any transport fleets and is therefore not involved in the fixed and variable costs associated with the transport function of a haulier or transport operator. Thus, transport costs such as the costs of delays, waiting times, lifecycle costs and other hidden costs were not included in the calculations of transport costs made in this study. Road and rail costs were compared and calculated based only on the brokered transport costs offered to the timber growers of NCT. However, the background to transport cost is included in the literature review chapter of the study and this section was deemed to be an important element of this study.

The second limitation of the study was that a full environmental impact analysis of the externality costs linked to transport was not conducted for the purpose of this research study. This was due to the extensive amount of information required on the scope of externality costs such as accidents, congestions, noise, policing and land use related to the flow of transport in South Africa (Havenga et al., 2015). Furthermore, as alluded to above, NCT does not have ownership of any fleet and thus no operational truck data was available in order to calculate costs such as accidents, congestions, noise, policing and land use costs. However, because it is not possible to regard externality costs as an isolated topic when considering an intermodal switch, carbon emissions, which is considered to be the highest externality cost in the timber industry (Jorgensen, 2013), were calculated for the purpose of the study. The data used to calculate the carbon emissions for road and rail transport was available.

Finally, it is important to state that the research study was based on a case study of an organisation directly associated with the researcher. In order to avoid any bias on

the part of the researcher in this regard, triangulation facilitated the cross verification of the findings to corroborate the results of the study through the use of multiple data collection sources. Accordingly, historical data, interviews and surveys were triangulated in the case study to ensure the validity of the findings.

## **1.5. ETHICAL CONSIDERATIONS**

Ethical consideration arise when a researcher seeks access to information from organisations and individuals (Saunders et al., 2012:183) and, hence, the appropriateness of the researcher's behaviour and the rights of the participants in the study constitute an important element of ethical considerations. In light of this, the ethical considerations concerning the data used for the purpose of this study were signed off by the management of NCT. In addition, information pertaining to the study could be accessed only via usernames and passwords from the Oracle software database that had been used exclusively for the purpose of this research. Ethical clearance letters detailing the purpose and objectives of the research were issued to all eight of the participants involved in the interviews and surveys. These letters were accompanied by consent forms for each participant which were signed off and sent back to the researcher. Further details on the ethical considerations applied in the study are discussed in Chapter 4.

## **1.6. SUMMARY OF THE STUDY**

As outlined in the discussion on the purpose of the study and alluded to in the problem statement, logistics in the context of the study included the crucial process of transporting timber from the growers' farms to the desired market. In light of this, it is important that NCT constantly ensures the most cost-effective transport mode being deployed in order to maximise the growers' net profit. The high costs associated with road transport have led to considerations regarding an intermodal switch from road to rail. This issue is not exclusive to NCT only but to the forestry industry at large. The reasons for this may be attributed to the reduced profit margins associated with the high costs of road transport, which are a concern for the sustainability of both the timber grower and the forestry industry. Coupled with this, the environmental impacts associated with road transport such as overloading, accidents, congestion and excessive carbon emissions have become increasingly important logistics and should

also be considered when evaluating modal choices. An important component of this research study was therefore to determine whether the switch from road to rail would be feasible, taking into account the inherent strengths, weaknesses, performance and costs of each transport mode. Thus, this research study attempted to construct a decision-making framework that should be considered by the independent timber growers in the timber industry.



## CHAPTER TWO

### OVERVIEW OF THE NCT SUPPLY CHAIN

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#### 2.1. INTRODUCTION

This chapter provides an overview of the role of NCT's logistics operations and includes a more in-depth description of the main participants in the NCT supply chain. The chapter also discusses the operations involved in timber transport from the timber farm to the market and highlights the problem of the high transport costs which is a dilemma for the timber growers of NCT. The main supply chain participants involved in the study are listed below:

- NCT
- South African timber growers (members of NCT)
- Road and rail transport
- The timber processing plants also known as local markets
- Export markets (buyers of the wood chips).

#### 2.2. THE NCT SUPPLY CHAIN

The supply chain process begins with the timber grower, who is responsible for arranging the harvesting of the timber from the plantation (Figure 2.1). Once this has been done, transport must then be organised for the timber from the plantation to the market. It is at this point that NCT facilitates the brokering of such transport using either road or rail transport. Thus, a timber grower places his/her order for transport either telephonically or in person through a regional district office of NCT in order to schedule delivery of his/her loads for the month from plantation to processing plant. NCT staff members capture these requests. The NCT's logistics department would then use a number of transport carriers to facilitate the movement of timber from the plantation to the processing plant/local market – the end user of the product. At the processing plant the timber is chipped into a chip pile and the wood chips are loaded onto a ship via a conveyor system at the processing plants based at the ports of Durban and Richards Bay. These wood chips are shipped for export to China and Japan – the main buyers of the product (NCT Forestry, 2012). Figure 2.1 depicts the NCT supply chain from the

timber grower to the export market which is end users of the product in the supply chain (NCT Forestry, 2012). For the purpose of this study the transport cost from timber farm to the processing plant was examined. The supply chain at the point of shipping and extending into the overseas markets was not factored into the transport cost analysis conducted in the study.



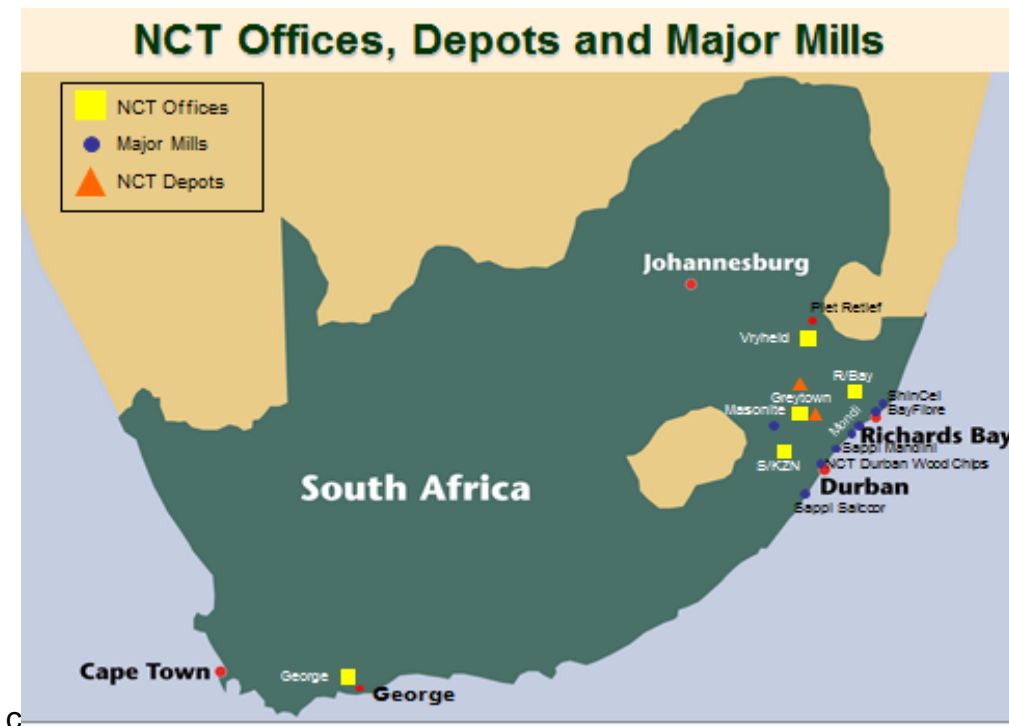
**Figure 2.1:** The NCT supply chain

**Source:** NCT Logistics Scope of Operations, 2012

### 2.2.1. The role of NCT in the forestry industry

The main role-players in the forestry industry include Komatiland Forests (main shareholder is government represented by the Department of Public Enterprises which manages 187 320 hectares of timber plantations), Mondi South Africa (owns and manages 307 000 hectares of timber plantations), Sappi Forests (owns and manages 561 000 hectares of timber plantations (Fibre Processing Manufacturing Sector Education and Training Authority, 2014:3) and NCT which represents 300 000 ha (21% of the afforested land in South Africa) (NCT Forestry Co-operative Limited, 2015a).

As an agency to the timber growers, NCT sources suitable markets for the timber and arranges for the transportation of the timber to the desired market (Farrow & Ferguson, 1999). NCT is recognised as the largest forestry marketing organisation in Southern Africa and is an international supplier of quality round wood timber and woodchips (NCT Forestry Co-operative Limited, 2015a). Figure 2.2 below depicts the scope and presence of NCT’s operations in South Africa.



**Figure 2.2:** NCT scope of operations  
**Source:** NCT Logistics Scope of Operations, 2012

NCT’s core area of operation in the timber industry is KZN. According to the NCT Annual Report (2015b), the Co-operative caters for the marketing of timber on behalf of its timber growers to three major markets in KZN, namely, BayFibre, ShinCel and Durban Wood Chips, which are also owned by NCT. Timber is chipped locally at these plants and then exported by sea to Japan and China, the buyers of the wood chips. NCT is the biggest supplier of woodchips to Japan in the world. According to Naidoo (2011), “[i]n 2009, around 75% of the woodchips exported from South Africa originated from independent tree farmers, 68% came from NCT Forestry Co-operative's 2000 members”. Thus, NCT plays a key role in the forestry sector of South Africa.

### **2.2.2. The South African timber grower**

Timber growers are the owners of the land used for timber farming and they are, therefore, eligible to receive any proceeds from the sale of timber from that land (Jele, 2012:1). There are approximately 2000 timber growers who are members of NCT, representing 300 000 ha (21% afforested) of land in South Africa (NCT Forestry Co-operative Limited, 2015a). The Co-operative manages the procurement and transport for the marketing of their members' timber (Lehtonen, 2012) on an ongoing basis. The timber production process used in the supply chain for the farmer involves the harvesting of the trees, transport to the roadside in some cases and then extended transport to the plant or local markets using either road or rail transport (Louw, 2013). An important cost component that affects timber productivity is therefore related to transport costs (Lusso, 2005, Naidoo & Chasomeris, 2013, Van Zyl, 2014).

### **2.2.3. The markets**

The markets are accessed through an agreement between the timber farmer and the market to supply a specified amount of timber (Cairns, 2000) or, alternatively, by the timber farmer becoming a member of a timber cooperative such as NCT. The timber growers may sell their timber directly to forestry companies or via timber suppliers or agents who then sell the timber to pulp and chipping mill markets (Jele, 2012). Thus, the growers are paid a price for their timber. Some of the main markets that the timber growers supply through NCT include:

- BayFibre: Owned and operated by NCT with a capacity of 1.2 million tonnes per annum (p.a.)
- ShinCel: Owned and operated by NCT with a capacity of 0.5 million tonnes p.a.
- NCT Durban Wood chips: Owned and operated by NCT with a capacity of 0.5 million tonnes p.a. (NCT Forestry Co-operative Limited, 2015a).

NCT provides convenient market access to the timber growers as NCT has full ownership of the above-mentioned chipping mills (Naidoo, 2011). In addition to this market access, NCT also provides the transport for the timber from the plantation to the market (NCT Forestry Co-operative Limited, 2015a).

#### **2.2.4. Transportation in forestry**

Timber transport is used as the main medium and link between the forest and the market by making use of either road or rail transport (Eeronheimo, 2011). NCT brokers transport timber on behalf of the timber growers by using either road or rail transport (NCT Forestry Co-operative Limited, 2015a). This is a value-added service offered to the timber growers who become members of NCT transport (NCT Forestry Co-operative Limited, 2015a). NCT logistics have brokered high volumes of transport on behalf of their timber-growing members in the last 14 years and have offered good tariffs, thus affording them higher profit margins and returns. However, although NCT logistics is in a strong position to negotiate good tariffs and rates on behalf of their members, the high cost of road transport is an issue of concern (Van Zyl, 2014). Research conducted on the challenges facing timber farmers in southern KZN (Naidoo & Chasomeris, 2013) indicate that road and rail are the main modes used for the transportation of timber, however, road transport is the dominant mode and is associated with high transport costs for the timber growers (Naidoo & Chasomeris, 2013).

In view of the high fuel costs associated with road transport, the shift back to rail could potentially offer cheaper tariffs for timber growers (Van Zyl, 2014:8). However, the rail system in South Africa has been characterised by poor service delivery for several bulk good industries such as NCT (Department of Transport, 2015b). A report in 2013, which addressed the service levels of rail transport for the timber growers of NCT, highlighted that due to the poor service provided by rail transport, Transnet Freight Rail (TFR) had embarked on an initiative to regain the market share lost to road by committing itself to improving service delivery and offering competitive tariffs (Forestry South Africa, 2013). According to the report, the new pricing was accepted and implemented by the industry from 1 December 2013. As a result, volumes have started to increase on the branch lines, although TFR has struggled to meet this demand (Forestry South Africa, 2013). The main reasons for this situation included a shortage of resources in terms of train drivers, traction power and ST type wagons (Forestry South Africa, 2013). Specifically aimed at the timber growers of NCT, this study included a pricing analysis of the tariffs for road and rail transport (§ 5.5). These tariffs were evaluated and compared to determine whether there would be potential transport

cost savings resulting from a switch from road to rail. Studies conducted on freight transport pricing indicate that the traditional approach is to charge users per kilometre distance for the movement of freight (Strandenes, 2013). Hence, in order to determine the savings in transport pricing, the freight charges of road and rail on a rand per ton basis for a given volume were analysed in the literature review chapter from a theoretical perspective and then applied in Chapter 5 of the case study (see Figures 5.4 and 5.5).

Research has also suggested that that the switchover from road to rail transport for the timber industry would remove 80 000 heavy trucks from South Africa's roads per year, thus reducing the impact of the damage to the country's road networks (Chapman, 2012; Forestry South Africa, 2012b). An article on transportation in forestry further stated that a good transport network is a prerequisite for sustainable timber transport and that the transport network should, therefore, be preserved over the long term to ensure efficient road transport (Ackerman, Pulkki & Gleasure, 2015). In addition, the shift from road to rail transport may significantly reduce the impact of carbon emissions (Engineering News, 2015). The excessive traffic volumes on roads, accident rates, congestion, overloading and toxic emissions are regarded as externality costs which may soon become a cost incurred by the road user (Department of Transport, 2015a:15). In view of the fact that carbon taxes may be implemented in the near future (Engineering News, 2015) this study also considered the externality costs associated with carbon emissions for both road and rail. Lastly, there has also been significant interest in the forestry industry in PBS vehicles (Wood Southern Africa, 2015). Accordingly, this study investigated this option as an alternative recommendation for timber transport in the study. This will be provided in section 5.10 of the study.

### **2.3. CONCLUSION**

This chapter discussed the NCT supply chain and the associated transport costs which are an issue of concern for the timber industry and, specifically, the independent timber growers of NCT. The chapter also highlighted some of the developments relevant to the NCT supply chain which have an important bearing on the discussions in Chapter 3.

# CHAPTER THREE

## LITERATURE REVIEW: A FOCUS ON ROAD AND RAIL

### 3.1. INTRODUCTION

Chapter 2 contained an overview of the NCT supply chain as an introduction to the literature review. This chapter focuses on road and rail transport. Background information related to the integrated nature of supply chain management, logistics and transport are also discussed as is the theory on transport costs, showing the fixed and variable components of transport costs. The literature review also addressed cost saving opportunities for road and rail transport and highlighted the use of PBS vehicles as a cost reducing option in transport.

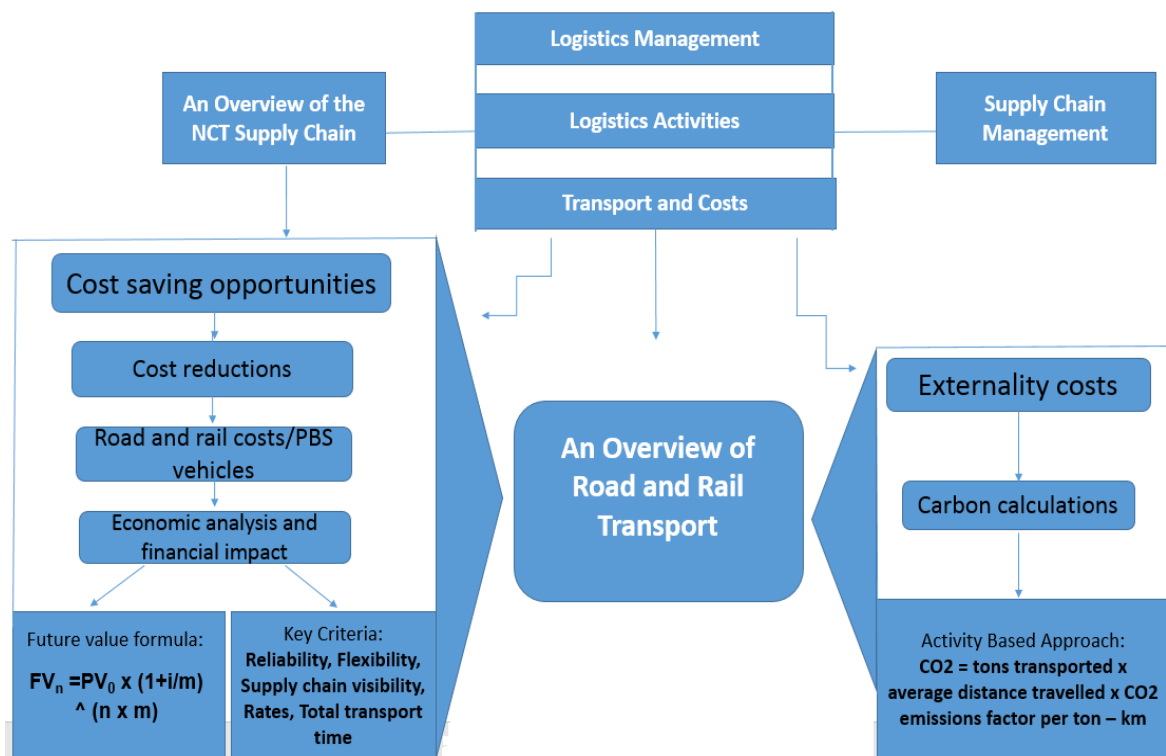


Figure 3.1: Structure of Chapter 3

Source: Researcher

The economic impact of road and rail transport was also discussed, highlighting the opportunity cost of switching from road to rail using the future value formula. Key criteria regarding an intermodal switch from road to rail were also explored. In addition,

the chapter contained an overview of road and rail transport in order to explain the advantages and disadvantages associated with each mode of transport. Finally, the chapter discussed externality costs and carbon calculations using the activity based approach and as a link between road and rail transport.

### **3.2. THE ROLE OF SUPPLY CHAIN MANAGEMENT**

The purpose of focusing on the theory and principles of supply chain management is to identify how cost savings may be achieved for the timber growers of NCT. The Council of Supply Chain Management Professionals (CSCMP) defines supply chain management as follows: “Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies” (CSCMP, 2014). There is an extensive body of literature sources on the topic of supply chain management with each source offering similar, but varying, explanations of the concept. For example, Harrison and Van Hoek (2011) explain that a supply chain is a network of partners who collectively convert a basic commodity (upstream) into a finished product (downstream) that is valued by the end customers. Handfield, Monczka, Giunipero and Patterson (2009:10) maintain that “[s]upply chain management involves proactively managing the two way movement and coordination of goods services, information, and funds (i.e. various flows) to the end user”.

The movement of goods, as described in these definitions, translates into economic activity based on relationships with partners up or down the supply chain (Meersan & Van de Voorde, 2013). By forming these relationships the supply chain aims to achieve quality movement of goods from the point of origin to consumption at the lowest possible cost (Meersan & Van de Voorde, 2013). However, this is possible only through control of the logistics function and whereby economic value is created through the supply chain by using the functional activity of transport and other logistics activities to satisfy demand (Meersan & Van de Voorde, 2013). Further studies on the relationship between logistics and supply chain management indicate that logistics is



part of the supply chain process that plans, implements and controls the efficient and effective flow of goods, services and information from the point of origin to the point of consumption and involves transport as the activity which facilitates this process flow (Grant et al., 2015). This means that a significant degree of control is required in the logistics function of a supply chain. For example, Wakeham (2010) argues that logistics is not a once off activity and that, in order for logistics to be efficient and effective, there has to be a constant flow of goods, services and information through the supply chain. The success or failure of an organisation will therefore greatly depend on the effective and efficient management of a supply chain (Wisner, Tan & Leong, 2012) and its important link to the logistics function.

### **3.3. LOGISTICS MANAGEMENT**

The conceptual framework of logistics was assessed in order to understand the activities of logistics and the accompanying costs. Once these were identified transport, as a component of logistics, was discussed further.

#### **3.3.1. Common definitions of logistics**

In Chapter 1 of the study it was noted that, at a macro level, South Africa's high logistics costs have been significantly influenced by the cost of transport. The following definitions of logistics are therefore examined in order to understand the relationship between logistics and transport as the high costs of transport are both the focus of this study and a concern for NCT's logistics operation. There are various definitions of logistics. The CSCMP uses the following definition: "Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements" (CSCMP, 2014:117).

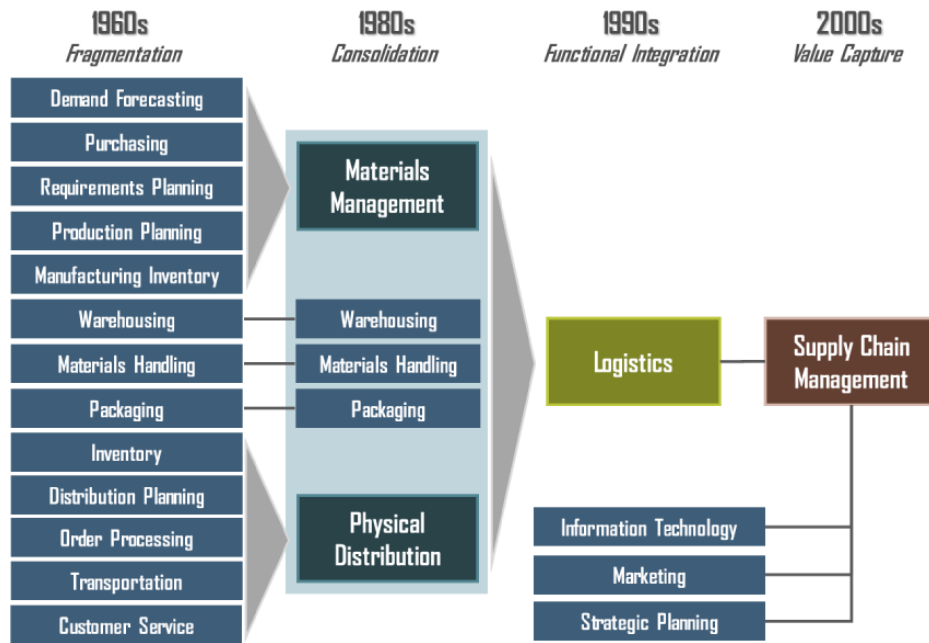
This definition was affirmed by Crandall, Crandall and Chen (2015), who agree that logistics facilitates the flow of goods along the supply chain, which involves the transport of goods and services from the point of origin to consumption. "In some instances, logistics is often used synonymously as a term to describe the transport, storage and handling of goods from raw materials through the production system to

the final point of consumption” (McKinnon, Browne & Whiteing, 2012:3). The following sections elaborate further on the various aspects of logistics in the supply chain.

### **3.3.2. Logistics activities and costs**

The transformation of logistics from the 1960s to the 2000s has developed through various activities such as fragmentation, consolidation, functional integration and value capture in the supply chain, as shown in Figure 3.2 (Rodrigue, 2013). During the 1960s and 1980s the various supply chain activities and processes were considered as independent connections in a supply chain. However, during the 1990s there was an increasing emphasis on the functional integration and importance of logistics while, the 2000s, the era of value capture, showed a fully integrated connection between logistics and all its main activities. It is important to note that the physical distribution function includes transport (e.g. trains and trucks) and is connected to logistics which is then integrated into supply chain management as a value related concept (Bantwini, 2010). Supply chain management and logistics thus share a close relationship with the transport function. Since supply chain management is involved in satisfying the needs of members and customers both upstream and downstream in a supply chain, transportation is a significant activity that satisfies such needs as it provides the movement of goods and services required to satisfy the demands of the customer (Bantwini, 2010; Rodrigue, 2013; Wakeham, 2010).

The activities depicted in Figure 3.2 (see below) result in certain logistics costs. In addition to transport costs there are also other logistics costs which include administration, ordering, inventory and safety stock costs (Beuthe, 2011). Havenga et al. (2014) indicate that logistics cost comprises three main elements, namely, transport, storage and handling. This is an indication that transportation is both an essential activity and a cost component of the logistics function. Two commonly used modalities of transport are road and rail, which often compete to meet demand in freight transport (Kadiyali, 2016:11; Schönsleben, 2016:763). Road and rail transport costs are therefore important components of this study.



**Figure 3.2:** The activities and process of logistics and supply chain management

**Source:** Rodrigue (2013)

Against this backdrop it is important to note that NCT provides the role of a broker to its timber growers and that it endeavours to provide the mode of choice, road or rail, which best benefits the timber grower (NCT Forestry Co-operative Limited, 2015a). Transportation brokers are organisations or people who arrange for the transportation of goods at reduced costs (Wakeham, 2010:49), such as NCT. They are not involved in vehicle ownership and act as intermediaries on behalf of the customer and carrier (Wakeham, 2010:49). Thus, since NCT is a co-operative that fulfils the role of a marketing agent and brokers timber transport on behalf of its timber growers, the co-operative is not involved with the inbound logistics functions of a manufacturing or production related concern (NCT Forestry Co-operative Limited, 2015a). According to Stukalina (2014:18), “[i]nbound logistics involves the activities of receiving, storing, distributing and transporting of raw materials for use in production” whereas “[o]utbound logistics is the process related to the storage and movement of the final product and the related information flows from the end of the production line to the end user”. In view of the nature of NCT’s operation, highlighted in section 2.2, the cooperative is only involved with the outbound logistics process that facilitates the movement of timber from the plantation to the processing plant/local market – the end user of the product.

The objective of outbound logistics is to minimise the costs involved in physically moving products from the point at which they are produced to the point at which they are consumed (Lai & Cheng, 2009:38). It is then the role of transport (road and rail) to bridge the gap between the point of production and the point of consumption (Kadiyali, 2016:11). Similarly, it is the role of NCT to bridge the gap between the timber grower and the local market by using the choice of mode (road or rail) which is the most appropriate and cost-effective for the specific set of circumstances of each timber grower (Van Zyl, 2014:7). Thus, both modes should be used in the best way possible in order to utilise the advantages of each (Schönsleben, 2016:764).

For the purpose of this study, after a careful inspection of the key components and activities of the supply chain management concept, Table 3.1 was constructed to show the main supply chain determinants of NCT Forestry. The timber grower supplies timber through NCT which then fulfils the role of an agent to various timber growers. NCT arranges transport and sources suitable market for the timber growers, using road or rail transport at the best possible rates as a value-added service to the timber growers who are members of NCT. The need for cost savings in road and rail transport was therefore assessed to determine whether there would be any benefits from considering a switch from road to rail transport for the timber grower.

**Table 3.1:** The main supply chain determinants for NCT

<b>Supply chain</b>	<b>Logistics</b>	<b>Transport</b>	<b>Cost savings</b>	<b>Timber grower</b>
Timber growers NCT Transporters Markets	NCT Brokered Transport (Logistics services)	Road and rail	Road to rail switch (Rand per Ton)	Benefits/ Savings?

There are several activities linked to the logistics function. The relevance of these activities, specifically in the case of NCT, have been noted in the preceding discussion. However, the function of transport as a logistics activity is the focus of this study. Cost reductions in the physical outbound movement of timber from farm to market are explored in the study, thus the next section discusses transport costs.

### **3.3.3. Transport costs**

Transport costs are mainly variable or fixed, which impacts on the per freight ton charge to users of the transport service (O'Byrne, 2014). This is relevant to NCT's operation as the timber growers are charged on a rand per ton basis for the transporting of timber from farm to mill. Accordingly, this section discusses the issue of costs as costs are an important component of transport pricing. In order to gain an understanding of the relevant costs involved in transport it is necessary to separate fixed costs and variable costs (O'Byrne, 2014). Fixed costs are those costs which are incurred whether the vehicle is used or not and include depreciation, insurance, licence fees, overheads such as workshop facilities as well as the costs relating to crew, offices and depots (Myers, 2012; Bína, Bínová, Březina, Kumpošt & Padělek, 2014). Fixed costs remain the same, irrespective of output whereas variable costs change with the levels of output (Mallard & Glaister, 2008). Variable costs include fuel, tyres, wages, maintenance and toll fees (Myers, 2012; Bína et al., 2014). These costs vary depending on the distance travelled, the nature of the terrain and the degree of difficulty of the operation (Myers, 2012; Hutton, 2013).

One of the major costs in transport is the fuel or energy that goes into providing a transport service (Grant et al., 2015). Fuel (a variable cost) has been identified as one of the biggest costs for transport operators which results in higher tariff charges to the transport users (Havenga et al., 2014). This has led to significant increases in South Africa's transport costs from 155 Rm in 2009 to 277 Rm in 2014 (Havenga et al., 2014). It is therefore recommended that alternate options be considered in relation to the more efficient transport of goods in the supply chain (Havenga et al., 2014). In light of the above findings, the impact of transport on the South African timber grower is an important concern. According to an article on timber transport, up to 50% of the gross value of timber can be attributed to transport costs, which was driven by the high fuel prices (Van Zyl, 2014:7). Transport costs have thus placed immense pressure on the timber growers' profits and are regarded as one of the major costs to the timber grower (Naidoo & Chasomeris, 2013). In view of the fact that NCT is involved in the brokering of transport on behalf of the timber growers of NCT as a value-added service, it is essential that transport costs are taken into account when deciding between road or rail transport. The role of a transport broker is to achieve lower transport costs for

customers by negotiating the best possible rates with carriers (Handfield et al., 2009). Thus, NCT's logistics should be aware of the cost structures associated with transport operations since these costs also have an impact on the contract management of the various carriers servicing the NCT supply chain. Consequently, cost savings in the field of transport need to be explored in the interests of those entities involved in transport planning (Kockelman, Chen, Larsen & Nichols, 2013:2), for example NCT which is facing the challenge of dealing with high timber transport costs.

### **3.4. COST SAVING OPPORTUNITIES AND BENEFITS IN TRANSPORTATION**

A well-designed supply chain can offer substantial cost savings in various areas such as purchasing, production, warehousing and transportation (Kumar & Balaji, 2013). However, Gibson et al. (2014) maintain that measuring various areas is not always possible in a supply chain because it focuses on so many key performance metrics which prevent an organisation from achieving its goal. This may be due to the fact that supply chain management encompasses such a broad link to so many business disciplines and costs (Wesley & Mello, 2012) and thus there are numerous factors to consider. In addition, these factors are also constantly changing. It is therefore difficult to adopt a total cost approach because of all the dynamics of costs that should be considered in a supply chain (Mitchell, Nørreklit & Jakobsen, 2013).

The most appropriate method for determining costs reductions in a supply chain is dependent on the type of industry involved (Rantasila & Ojala, 2012). In the timber industry transport costs have been highlighted as one of the major costs to the timber growers of NCT. The price per ton of timber has had a substantial impacted on the profitability of timber growers (Van Zyl, 2014). In considering cost savings for the timber growers of NCT, it is important to acknowledge that the aim of transport is to move supplies physically in a reliable and safe manner, on time and in a cost-effective and efficient way to the desired destination (Logistics Operational Guide, 2015; Ortuzar & Willumsen, 2011), thus highlighting the important role of transport in a supply chain. Efficiency is a cost-related advantage while effectiveness is based on customer-responsiveness in supply chain management research (Borgström, n.d.). In other words, both the cost and the service elements are important aspects of

transportation and they will both be addressed when considering transport cost savings for the timber growers of NCT.

### **3.4.1. Cost reductions**

In order to determine cost saving reductions in transport, this study evaluated the pricing of road and rail transport. According to Blecker, Kersten and Ringle (2013: 323), cost reductions in supply chains of transportation systems require a price performance analysis to determine whether it is possible to achieve cost savings between the two parties concerned and thus between NCT's brokered road and rail transport. This cost reduction translates into either a per unit cost or overall costs, or the use of substitute items at a lower cost in areas such as transportation (Crimi & Kauffman, 2002; Saridogan, 2012:). The study identified the rand per ton charges for road and rail transport from the historical data in order to determine the unit cost and overall cost reductions on road and rail transport. Regarding substituting items at a lower cost, the switching of road volume back to rail transport was analysed to determine whether it would be possible to achieve savings for the timber growers of NCT. Handfield et al. (2009:715) are of the view that companies should take note of cost change strategies using changes in pricing structures and volume to decrease supply chain costs, for example ***[(New Price – Prior Price) X Estimated Volume]*** may be used to reduce costs (Handfield et al., 2009:715). Similarly, in this study, the cost change strategy from road to rail transport was analysed by considering the difference in road and rail transport, namely, ***[Pricing X the volume of timber transported]***. A typical function of transport brokers is the ability to consolidate volumes to achieve lower costs (Bowersox & Closs, 1996), which is the role of NCT. These cost saving strategies are explored in Chapter 5 of the study.

Research into the high cost of transport, resulting from excessive fuel hikes, shows that there are other cost reduction strategies in the field of transport. These range from reducing the number of kilometres to ensure closer market access, improved package designs that reduce weight and increased shipment density for more economical packaging and using economies of scale in the interests of larger and less frequent shipments (Russel, Coyle, Ruamsook & Thomchick, 2014). Distance, density and shipment size are, therefore, key factors to consider in cost reduction strategies in transportation. These key factors are examined further in the study in section 3.4.2. In

light of the primary objective of the study, namely, to investigate and compare transport costs between road and rail transport and the savings that may be effected, one of the main cost reduction strategies explored was the intermodal switch from road to rail transport. The price of transport for the timber grower is thus an important factor in relation to cost reductions. According to Crimi and Kauffman (2002), cost reduction strategies consist of three categories. The first category identifies major cost drivers. The second category develops cost reduction activities/programmes and the third category measures costs over time. This is indicated in Table 3.2 which is relative to the NCT supply chain.

**Table 3.2:** Cost reductions in the NCT supply chain

<b>Cost reductions categories</b>	<b>NCT supply chain</b>
Identify major cost drivers	High transport costs associated with road transport for the timber growers of NCT
Develop cost reduction activities/programmes, e.g. continuous improvement	Road transport switch to rail transport
Measure costs over time	Future value savings. Statistical analysis of road and rail transport

**Source:** Adapted from Crimi and Kauffman (2002)

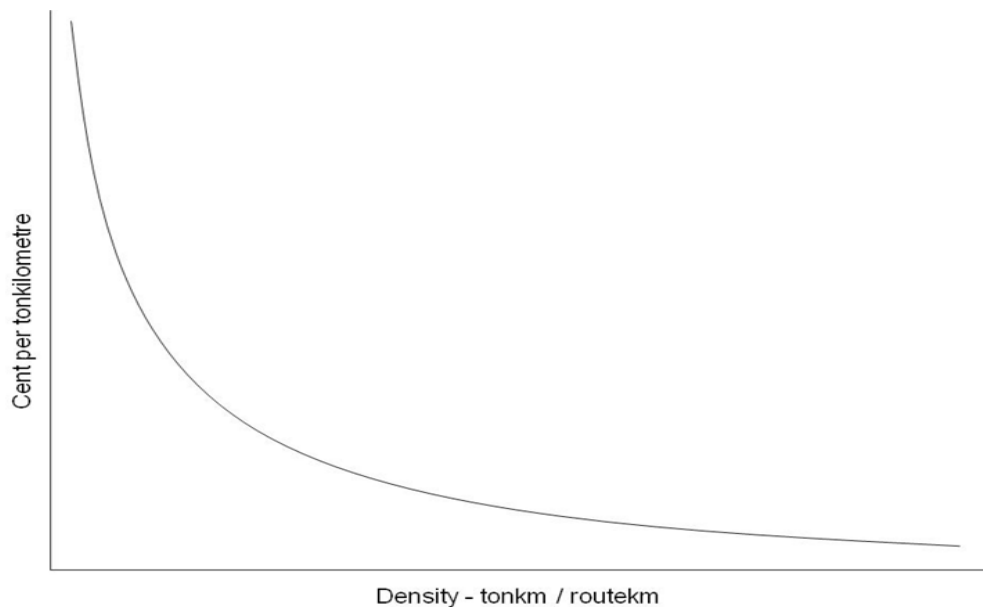
Table 3.2 indicates that transport costs have been identified as the main cost driver for the timber growers of NCT. This was alluded to in Chapters 1 and 2 of the study. The suggested cost reduction activity involves considering an intermodal switch from road to rail transport. A statistical analysis measured these costs over time (Chapter 5) and the future value savings of transport was determined.

### **3.4.2. Road and rail transport costs**

Cost is a key determinant in managing performance in supply chains (Gibson et al., 2014). In view of the fact that transport costs, in particular, are quantified on a cost per shipment, mile, delivery and per ton basis, the cost per ton of road and rail transport may then be used to manage performance (Gibson et al., 2014). This is evident in studies conducted on modelling freight costs which indicate that the cent per ton kilometre on rail transport is a far cheaper option than road transport (Van der Mescht, 2006; Havenga, 2012). In addition, studies on road versus rail transport costs in the United States of America show that, over longer distances, rail transport is a far more cost-effective option than road transport (United States Department of Transport,



2015). Studies conducted in South Africa also indicate that rail transport is almost 60% cheaper than road transport (CSIR, Imperial Logistics & Stellenbosch University, 2013). Some of the reasons for this are evident in the economic curve in Figure 3.3, which indicates that the greater the distance travelled the lower the cent per ton kilometre. This has also been demonstrated in the rail systems in both the United States and South African (Havenga, 2012).



**Figure 3.3:** Cent per ton kilometre for rail transport

**Source:** Havenga (2012)

The reason why rail transport is cheaper over the longer distances is due to factors such as energy, distance and weight. These are key components of transport cost efficiency (Shi, Stapersma & Grimmelius, 2008). Road transport, on the other hand, has become an increasingly expensive mode of transport due to the rising costs in fuel. In addition, rail transport is considered to be three times more energy efficient than road transport (Herold, 2012) and accordingly it offers substantial cost reductions. Unlike road transport, which is subject to weight restrictions as well as mass and capacity constraints in terms of axle lengths (National Roads Agency, 2015), rail transport is able to move a ton of freight far more efficiently than road transport. This may be attributed to several technical factors associated with friction, engine size and the aerodynamics of the train which allow for greater fuel efficiency (Palmer, 2014). The steel-wheel-on-steel-rail contact mechanics allow for the vertical and lateral force components which enable heavy axle loading at high speeds whereas with road

transport, supporting heavy axle loads on wide surfaces is illegal (Department of Transport, 2015b).

The technology associated with rail transport is known as the bearing, guiding and coupling of trains. Bearing is related to the axle-load and is, therefore, indicative of the volumes that may be maintained, guiding indicates the wheel-on-track differentials, which allow for the speed of movement while coupling means longer trains may be accommodated (Havenga, 2012). Thus, rail transport competes against the two to three degrees of freedom of movement which are not offered by any other mode of transport in order to achieve heavy axle, high speed and long length trains (Department of Transport, 2015b). A study on rail transport revealed that one of the key economic principles of rail transport is the ability to offer economies of distance and density, meaning more ton-km per route-kilometre (Havenga et al., 2014). Similarly, according to Pienaar (2013), “[e]conomies of density exist when the total cost to transport units of freight from their points of departure (i.e.) distance, to their intended destinations decreases by increasing utilisation of existing vehicle fleet and infrastructure capacity within a given market area”.

This is possible with rail transport because rail transport users are able to make use of the longer distances travelled which effectively reduce the fuel utilisation and per ton-kilometre of rail in comparison to road transport (Van der Mescht, 2006). This means that the longer distance offered by rail track provides for a reduced unit cost, thus allowing a more affordable pricing structure for rail transport compared to road transport. As highlighted earlier, economies of fleet size also exist with longer trains allowing for a greater economic benefit. With train lengthening, several wagons may be added when an extra locomotive is employed to keep the train and traction power efficiently in place. This allows for benefits such as maintaining one locomotive crew only, creating a more simple and safer system than having to operate several small trains with more than one crew and, finally, the utilisation of the railway line is optimised (Pienaar, 2013). This, however, means that Transnet is unable to fund the capital outlay of the rail systems due to the large initial investment required by the rail provider (Proost & Van Dender, 2010).

In South Africa the lifecycle of a wagon is between 15 to 30 years, depending on the durability of the wagon body (Buthelezi, 2013). The initial outlay of capital costs is high for wagons and tracks, thus making rail networks an expensive fixed cost for the rail provider to maintain (Herold, 2012). Over shorter distances, road transport is deemed to be a cheaper option than rail transport (Wisner et al., 2012) whereas, over the longer distances, the high fixed costs of rail may, as highlighted by Pienaar, (2013), be exploited. However, a substantial volume of freight is required in order to capitalise on these economic benefits and, at the time of the study, the South African rail system was associated with a poor service delivery and with little market share to sustain high volumes (Department of Transport, 2015b). In view of the poor service delivery associated with rail transport, timber growers have switched over 32% of the timber volume to road transport with relatively little timber being moved by rail (Forestry South Africa, 2012b). An analysis of these volumes is provided in Chapter 5.

Road transport, on the other hand, offers a low fixed cost and a high variable cost and thus it competes more favourably with rail transport for short to medium distances (Pushparaj, 2012, Wisner et al., 2012). The high operating costs and absence of own facilities and terminals make the running costs higher in relation to distance for rail transport (Pienaar, 2013). Nevertheless, with road transport, the vehicle maintenance costs are cheaper than the maintenance costs involved in rail transport, while road transport does not require expensive fixed lines or tracks on which to run in order to meet the accessibility requirements of markets and customers (Palekar, 2012). Thus road transport is an accessible and more reliable mode of transport with a high market share in comparison to rail transport (Department of Transport, 2015a). Table 3.3 illustrates that cost savings increase with additional axles for road transport with the higher weight transported lowering the cent per ton of road transport (Button, 2010). A standard 35 tonne payload truck offers 5 to 7% savings whereas a 45-ton payload truck benefits from almost double the savings due to the extended axles (Button, 2010).

**Table 3.3:** Savings on increased vehicle lengths for road transport

Maximum weight	Axles	Savings %
35 tons	4 axles	5–7
38 tons	5 axles	5–9
40 tons	5 axles	7–14
42 tons	5 axles	9–13
45 tons	6 axles	11–13

**Source:** Button (2010)

According to an article on boosting fleet profitability, there were significant cost savings on fuel consumption for the transport operator as a result of increasing the truck's payload from 37 000 kg to 48 000 kg (De Bruyn, 2012). The reason for this is that the running costs associated with fuel, oil, crew, maintenance and wear and tear increase less than proportionally to an increase in vehicle size (Pienaar, 2013). Originating in Australia, New Zealand and Canada, these longer length vehicles, also known as PBS vehicles, have also been shown to have a reduced impact on both road infrastructure wear and on carbon emissions (Hassall & Thompson, 2011). This has also resulted in improved driver safety and productivity, with a more optimal use of existing road networks (Nordengen, 2013a) as these vehicles reduce the number of trips on the road for a transport operator (Thorogood, 2009).

The countries of Finland and Sweden support the initiative of using longer, heavier vehicles (LHVs) and indicate that the increased payloads have significant cost savings for operators, industries and consumers (Christidus & Leduc, 2009). In South Africa, the extra 10 to 12 tons per trip not only show cost benefits to timber growers in the forestry sector but also mean fewer vehicles on the road, reduced road damage, reduced fuel consumption and reduced carbon emissions (SA Forestry Magazine, 2011). Although vehicles are subject to structural restrictions, PBS vehicles operate outside the current standard structural limits through the use of special permits from the Road Traffic Management Systems (RTMS) (Nordengen, 2013b). This makes these vehicles an efficient and effective mode of transport due to the benefits of the heavier payload of the truck (Nordengen, 2013b). In light of the various applications of

economies of scale discussed above for road and rail transport, these economies of scale show that, by adding a higher payload factor for a given distance, the cost structure becomes non-linear and a non-increasing function of the volume shipped (Akunal & Ebru, 2015). The price per unit weight of cargo can thus be manipulated by larger quantities transported (Chopra & Meindl, 2012:288) and by distance travelled (Pienaar, 2013), thereby capitalising on economies of density and distance.

Chapter 5 of the case study determines the opportunities for savings by considering the economic benefits offered by road and rail transport. The volume in relation to distance and cost per ton kilometre for road in comparison to rail transport is examined to show which mode offers more ton-km per route-kilometre (economies of density and distance). This is accompanied with an analysis of deliveries done using a standard 35-ton payload axle versus a 45-ton payload axle, the latter being the PBS vehicles. The next section considers the opportunity cost of transport using the future value concept.

### **3.4.3. Economic analysis and financial impact of transport decisions**

An economic analysis is the term used to assess a project's economic value (Kockelman et al., 2013:7). This study focused on an intermodal switch from road to rail transport. Road and rail transport are a significant component of the NCT supply chain. It is important to note that supply chains offer the opportunity to achieve cost savings and are, therefore, considered to have a financial impact on an organisation and this has an impact on the stakeholders (Coyle et al., 2013). Transport is therefore deemed to be a direct outcome of economic activity, whereby a derived demand occurs for the activities associated with the movement of people, raw materials, parts and finished products on various transport modes. In other words, transport is a function of both production and consumption (Rodrigue, 2013).

This means that cost savings in transport have a financial and economic impact in a supply chain. One of the ways in which to curb costs in the field of logistics is thus through a switch from road to rail transport (Russel et al., 2014). Studies conducted on the measurement of transport costs confirm that traditional costing approaches are based on both economic and financial accounting measures (Wood, 1984). Output is a key economic function of transport activity (Meersan & Van de Voorde, 2013) and it

is suggested that economic costs be shown by averages instead of individual transactions using measurement errors as a preferred approach (Wood, 1984). Accordingly, in this study, average volumes (tons) will be examined with histograms to graphically explain the levels of significance that exist between road and rail using error bars to measure the p-value. This is also referred to as an input-output analysis (IO Modelling) – a popular method in economic analysis which is used to determine how costs have changed as a result of transportation system enhancements (Kockelman et al., 2013:7). Similarly, Chapter 5 will also determine the changes and variations in transport costs between road and rail. Moving averages (means) and standard deviations will be used to reflect the spread and dispersion of values associated with the outputs of volumes and costs (economic activity) for NCT's road and rail transport.

From a financial perspective, accounting functions are also used in the measurement of transport costs which in turn are the result of customer decisions regarding the mode of transport used (Wood, 1984 Kockelman et al., 2013), for example, a switch from road to rail transport. Other studies on transport costs suggest that accounting estimates are often used as the basis of economic decisions (Griff, 2014). In an attempt to address the switch from road to rail transport, the future value formula will be used as an accounting function to calculate the opportunity cost of road transport. The future value formula accounts for the opportunity cost of money based on customer decisions (Dorman, 2014:61) and should provide a strong basis for deciding which transport mode is more beneficial to the timber growers of NCT from a financial perspective.

In economic terms, opportunity cost is defined as the value of an activity forgone when an alternative activity is chosen (Dorman, 2014:61) and the accompanied returns on capital an organisation may have achieved if the organisation invested in the alternative activity (Russel et al., 2014:324). It is therefore a valuable tool in economic decision-making which provides for the higher value alternative of any choice (Callan & Thomas, 2010). Research conducted on forestry economics indicates that opportunity cost is an important consideration in future decision making as values are calculated for the forgone opportunity in order to provide foresters with a strong basis for determining an investment yield at a future point in time (Helles, Strange &

Wichmann, 2003). Opportunity cost, therefore, considers the loss or gain from the best alternative choice of a project which may be derived by using the future value formula (Griff, 2014). In order to address the primary research question as to whether *an intermodal switch from road to rail transport will be beneficial to the independent timber grower of NCT*, the future value formula was used as a basis for calculating the opportunity cost of road transport so as to determine the higher value alternative savings that may be achieved for the timber growers of NCT. In other words, the future value formula was used as an accounting tool to determine the future savings that may be achieved by considering a switch from road to rail transport. This formula may be defined as the value of a present amount at a future date after applying compound interest over a specified period and is devised as follows (Baker & Powell, 2005:75):

$$FV_n = PV_0 \times (1+i/m)^{(n \times m)}$$

**Where:**

$FV_n$  = future value at the end of period n

$PV_0$  = present value  $aV_0$

i = rate of interest earned per period

n = the total number of periods of the investments

m = the number of times interest is compounded per period

In a study conducted in the United States of America, using the future value formula, an estimated 2.7 billion dollar savings was achieved by using an alternative mode of transport (Transport Research Board, 2008:189). In another study based on the economics of transportation systems, the future value formula was adopted as a modelling tool for both future transportation decisions and for transport related project evaluations (Kockelman et al., 2013). A further two publications on transport related studies have also used the future value formula to determine cost saving options, particularly with regard to road and rail transport in South Africa, namely, 'The road versus rail debate' (Jaarsveld, 2012) and 'Logistics opportunity costs' (Jaarsveld, Heyns & Kilbourn, 2013). Similarly, in this study, the intermodal switch from road to rail transport was determined by comparing the transport cost for the period 2012 to

2014 for road and rail transport. The difference in transport costs was then substituted in the future value formula to determine both future and potential cost savings.

The following steps were followed:

- Step 1: Determine the transport cost for road and rail for each year from 2012 to 2014
- Step 2: Determine the transport cost if all tons had been moved by rail transport from 2012 to 2014
- Step 3: Determine the transport cost difference for each year
- Step 4: Substitute the difference *PVo* in the formula
- Step 5: Calculate the equation using the current market related interest rate

The use of the future value formula may, therefore, be justified on the basis of the following. Firstly, in view of the fact that the future value formula has been used in other transport related studies on road versus rail transport, it was, therefore, considered to be an applicable method for considering cost savings for the timber growers of NCT. Secondly, it has also been highlighted that economics-accounting models may be used jointly in measuring transport costs. Road and rail transport costs were quantified using economic measures derived from the historical data and it was, therefore, considered appropriate to include a financial formula as an accounting tool for the purpose of this study. As highlighted above this catered for a joint cost modelling both from an economic and financial perspective. Thirdly, because opportunity cost is also an economic term which is defined as the value of an activity forgone when an alternative activity is chosen (Dorman, 2014:61), the switch from road to rail transport can be addressed to determine the opportunity cost of road transport by using the future value formula. Hence, these three reasons presented a strong case in favour of using the economic analysis and financial impact of transport decisions such as a switch from road to rail transport for the timber growers of NCT.



#### **3.4.4. Criteria when considering an intermodal switch from road to rail transport**

Although cost savings play an important role in evaluating an intermodal switch from road to rail transport, there are also other criteria to consider when selecting the appropriate mode. Criteria related to performance dimensions are equally important in relation to the adequacy and availability of a transport mode (Chopra & Meindl, 2012). Thus, from time to time, trade-offs in supply chains are considered by compromising one area of performance for another (Gibson et al., 2014). However, supply chain chains should not reduce performance in one area to accommodate results elsewhere (Gibson et al., 2014: 180). Transportation is a significant component of logistics costs and service and affects a supply chain's efficiency and responsiveness (Chopra & Meindl, 2012: 62). There are many costs that may be used to measure performance in a supply chain – both financial and non-financial. This has an important link to the total cost of ownership model which takes into account all the costs associated with delivery, price and quality (Arsan, 2011). These include service costs, reject costs, failure costs, administrative costs, lifecycle cost maintenance, repair, downtime, idle time and price (Arsan, 2011). This is a comprehensive approach to follow. However, organisations often underestimate or ignore these non-value-added costs as they are considered complex to implement and maintain in an ever-changing environment (Arsan, 2011). When there are other decision making factors to consider in relation to opportunity cost, decision making may become complex (Mitchell et al., 2013). The reason for this is that there are a number of variations of opportunity cost which impact on transport, such as the opportunity cost of poor service, lost travel time, lost productivity and downtime (Handfield et al., 2009; Button, 2010). For the purpose of this study, the only variable used to determine the opportunity cost of transport was the actual transport costs using the future value formula.

Handfield et al. (2009:629) argue that selecting a mode of transport based purely on cost ignores the total cost approach, which plays a significant role in transport decision making. Selecting a transport mode on the basis of lower freight cost alone ignores customer service implications. For example, the transport mode that offers the lowest cost may not provide reliable delivery, thus resulting in other costs associated with delivery failure (Handfield et al., 2009). Therefore, to ensure that a scientific framework

was used in selecting the appropriate mode of transport for the timber growers of NCT, it was important to identify the main criteria involved in evaluating the performance of road and rail transport. There is a broad range of variables and criteria that may be measured. Research suggests that some of main criteria include considering factors such as flexibility, service, loss and damage, transport time and freight rates (Stander & Pienaar, 2002; Jothimani & Sarmah, 2014). Handfield et al. (2009) assert that cost, speed, reliability, capability and accessibility are also some of the key considerations in modal choice.

A study on building sustainable transport in Europe identified and surveyed ten criteria that were considered to be the most important in determining a suitable choice of mode. These included security, safety, volumes, tracking and tracing visibility, speed, reliability, flexibility, legislation and travel time costs (Perrels, Himanen & Gosselin, 2008). Studies on perspectives of freight movement in South Africa (Stander & Pienaar, 2002), on performance measures for road networks in Canada (Transportation Association of Canada, 2006) and on factors influencing the choice of transport mode (Heljedal, 2013; Logistics Operational Guide, 2015) have suggested the use of surveys as a basis for measuring key performance criteria for road and rail transport. The use of the survey method to rank key criteria provides a reliable measurement tool in tracking performance and identifying opportunities for improvement (Arsan, 2011). This was also evident in studies conducted in New Zealand, which preferred the survey method to rank the main criteria in modal choices (Kim, Nicholson & Kusumastuti, 2014). The method is often used in conjunction with a weighted point system by scoring each performance category and totalling each score to determine the final rating (Arsan, 2011).

Transport brokers are also involved in selecting the most suitable mode of transport with the aim of reducing supply chain costs. This is achieved by carefully assessing each mode of transport and negotiating the best possible price by the transport brokers acting as intermediaries to various organisations and carriers (Hugo, Badenhorst-Weiss & Van Biljon, 2009). Organisations such as NCT, which are involved in the brokering of transport services to the timber growers of NCT, should therefore carefully consider the main criteria for selecting a suitable transport mode. This is critical to ensuring an uninterrupted supply of transport service to the timber growers and is an

important function of a transport broker (Coyle et al., 2013). A survey based questionnaire was used in this study as a way of addressing the main criteria used in evaluating a switch from road to rail transport. The following performance criteria were selected and were evaluated to determine the mode of transport most beneficial to the timber growers of NCT.

**Reliability:** Refers to the capability of the transport system to provide the expected level of service quality and has an important bearing on travel time (Transportation Research Board, 2016). Reliability is seen as one of the main criteria that ensures both customer commitment (Bowersox & Closs, 1996) and that customer expectations are met (Hugo et al., 2009). The reliability of the transport services impacts on the ability of the specific transport mode to deliver the product in the supply chain effectively (Wakeham, 2010). In addition, a transport mode that is reliable offers convenience to the customer as well as a quality-related service (Rodrigue, 2013).

**Flexibility:** The ability of the specific transport mode to provide for uncertainty in terms of demand (Chopra & Meindl, 2012). A flexible transport mode enables an organisation to provide a high level of service and customer responsiveness (Chopra & Meindl, 2012). Operational flexibility refers to an organisation's ability to address extraordinary customer service requests and resonates closely with a transport mode's ability to satisfy customer requirements (Bowersox & Closs, 1996). Flexibility also refers to the several functions a vehicle is able to perform, for example, the ability of a vehicle to offer a higher capacity (Rodrigue, 2013). There will always be a need for flexibility and adaptability in order to satisfy customer needs in a changing environment (Wakeham, 2010).

**Supply chain visibility:** Identifies the performance of the transport mode, location and tracking delivery status in order to become more responsive to customer service (Chopra & Meindl, 2012). The ability of the customer to know where products are at any point in the supply chain is important to both logistics managers and supply chain participants (Logistics Management, 2016).

**Rates:** The prices paid for transportation services (Rodrigue, 2013). Rates are based on the amount to be charged for the movement of goods and are a significant factor

in ensuring the competitiveness of transportation mode (Chopra & Meindl, 2012). In freight transport rates are regarded as one of the main criteria influencing competitive pressure between the transport modes (Rodrigue, 2013).

**Total transport time:** Refers to the time from when an order is placed to the time the product arrives and is closely linked to supplier reliability (Chopra & Meindl, 2012). Total transport time is also driven by the speed of the transport mode and is based on the performance cycle completion of a shipment (Bowersox & Closs, 1996). The travel time taken is impacted upon by factors such as characteristics of the driver, type of vehicle, interaction of drivers in the network, weather, accidents and traffic management systems (Bowersox & Closs, 1996). Travel time is, therefore, an important factor to be taken into account in the cost benefit analysis of transportation (Transportation Research Board, 2016).

In view of the fact that each mode of transport varies in terms of degrees of performance, trade-offs are often considered in the decision making process in relation to transport services. According to Hugo et al. (2009), trade-offs occur when a disadvantage of one transport activity is consciously accepted in the interests of a significantly greater advantage for the transportation system as a whole. This often involves substituting one transport service for another (Hugo et al., 2009). However, Wakeham (2010) argues that, when considering the level of service, it is imperative that there is a positive trade-off between service and cost. Transportation cost and customer responsiveness are two such activities that are frequently traded off in the transport context. However, the goal is still to minimise costs while still maintaining customer service and responsiveness (Chopra & Meindl, 2012). Both cost and service elements therefore have an important bearing on the rating of the key criteria addressed in the surveys of Chapter 5 in this study.

Studies on supply chain performance suggest that satisfaction surveys are often used to rate the effectiveness of supply chains. The results of these surveys are an important link between measuring non-financial criteria and the intangible dimensions of performance (Jothimani & Sarmah, 2014). Thus, it was an important component in measuring the intangible dimensions of performance associated with NCT's supply chain. However, it may not address the total concept in view of the complex nature of

using a total cost of ownership model. Nevertheless, it endeavours to take into account some of the main criteria involved in an intermodal switch between road and rail transport. An overview of the performance of road and rail transport based on some of these criteria, which also highlight the advantages and disadvantages of each mode, is given later in the study.

### **3.5. OVERVIEW OF ROAD TRANSPORT**

Road transport is one of the most widely used modes of transport in South Africa (CSIR, Imperial Logistics & Stellenbosch University, 2013) and it is an essential provider of door-to-door transportation. Road transport is usually used to transport primary products of an organic nature such as timber, agricultural products (vegetables, livestock, fruit and dairy) as well as semi-finished and other finished goods (Stander & Pienaar, 2002). The road freight industry, which comprises of public and private transport carriers, is responsible for approximately 87.9% of all tonnage moved in South Africa (CSIR, Imperial Logistics & Stellenbosch University, 2013:41). This is a strong indication that the dependence on road transport in South Africa appears to be excessively high (Havenga et al., 2014; Walters & Mitchell, 2011:242). Road transport is regarded as an important mode of transport providing social and economic upliftment and development in South Africa (Walters & Mitchell, 2011:242). The road transportation industry was deregulated in 1993 and, since then, road freight operators have been relatively free to operate their businesses and set prices without government intervention (Mallard & Glaister, 2008).

Deregulation can be defined as the “loosening of government controls of an industry” (Mallard & Glaister, 2008). The deregulation of the road transportation industry worldwide has given rise to huge surges in road operators globally. The Deregulation Act 80 of 1988 (Republic of South Africa) allowed for the more free and unrestricted movement of goods, thus providing road transport with the freedom to compete with rail transport (Jaarsveld et al., 2013). Today road transport is the one of the main modes of transport used in South Africa with approximately 264 000 km of road networks linking the main economic centres of the country (Walters & Mitchell, 2011:242). There is also a strong reliance on road transport in the timber industry with over 500 000 tons of timber being transported to markets in KZN annually (SA Forestry

Online, 2012). Road transport is regarded as the preferred mode of transport due to the many advantages it offers. These are highlighted in section 3.5.1, as are the disadvantages of road transport.

### 3.5.1. Advantages and disadvantages of road transport

Table 3.4 presents the various advantages and disadvantages associated with road transport.

**Table 3.4:** Advantages and disadvantages of road transport

ADVANTAGES	DISADVANTAGES
High flexibility	Associated with high costs
Good speed	Cannot be used for large volumes
Reliability	
May be used for “just in time” transport (JIT)	
There is potential to negotiate rates due to the high levels of competition	
Versatility (able to carry a variety of goods)	Limited carrying capacity
Offers a door-to-door service	Loads are limited in terms of regulation
Not limited to fixed routes	High environmental impact – noise, damages roads and creates air pollution
Prompt delivery	Vulnerable to the environment (such as traffic congestion, accidents, weather)
Little handling because of the direct nature of deliveries	Conditions and road construction may delay deliveries
Few transhipments	Shared right of way as others use the same road (increases the risk of accidents, delays and theft)
Adaptable carrying capacity	Possibility of hijacking, particularly in South Africa
High frequency of service	High energy consumption which may be expensive
reliability of service	
Little damage or loss to cargo	
Ability to operate according to customer timeframes as opposed to provider timeframes	
Cost-effectiveness (although as a result of its reliability and door-to-door service, it is more expensive than rail transport)	

**Source:** Handfield et al. (2009); Wakeham (2010)

Recent research on modes of transport indicate that some of the inherent characteristics of road transport is its link with good network coverage offering high flexibility, speed, door to door and specialised transport services such as refrigerated trucks (Gleissner & Femerling, 2014). However, in the 24 years since the economic deregulation of road freight transport in South Africa, there has been considerable concern about the number of commercial vehicles on the roads, their respective sizes, the vehicle mass and the external costs (Pienaar, 2010), with these high numbers

resulting in traffic congestion, accidents, pollutants and excessive carbon emissions (Nordengen, 2013a). These externalities were reviewed in the 10th State of the Logistics Survey (CSIR, Imperial Logistics & Stellenbosch University, 2013) and in the National Freight Logistics Strategy (Department of Transport, 2015a). It was suggested that these indirect costs should be borne by the user and transport operator in future. The migration of timber transport from road to rail has also raised concerns about these externalities in the forestry sector, especially in relation to the congestion, road safety, deterioration of road networks as well as undue carbon emissions (Godsmark, 2011; Jorgensen, 2013). The impact of these externalities has been highlighted as a noteworthy disadvantage of road transport and is addressed later in the chapter.

### **3.6. OVERVIEW OF RAIL TRANSPORT**

Rail technology became available only in the 18th century during the Industrial Revolution (Rodrigue, 2013). Rail transportation is used to transport people as well as multiple product lines, including commodities, coal, timber and grains (Heizer & Render, 2014). Railway transport is best suited to long distance, bulk transport as it allows for better pricing as compared to road transport (Pushparaj, 2012) and, hence, it is favoured over long distances for heavy and bulky shipments (Wisner et al., 2012). The railway networks in South Africa carry almost 180 million tons of cargo annually and are the eleventh largest in the world covering 22 298 route kilometres with a total track distance of 30400 km (Department of Transport, 2015b). South African railways were the indirect product of the railway boom in England in the 19th century and the first lines were opened from Point to Durban in 1860 and Cape Town to Eersterivier in 1862 (Stander & Pienaar, 2005:1029). Products such as iron ore and coal were the main industries serviced by rail and, hence, the emergence of the Richards Bay Coal Line and the Sishen–Saldanha Ore Line (Stander & Pienaar, 2005).

In South Africa, the opening up of industrial and agricultural markets in the early 1900s led to the Regulation Control and Management Act of 1916 which provided a mandate to the South African railways and harbours to invest in rail infrastructure with government funding the major investment in rail (Development Bank of Southern Africa, 2012). There was thus significant commercialisation of the rail sector. However,

since the deregulation of transport in the 1980s, there has been a steep decline in rail transport and this led to a decline in rail investment (Development Bank of Southern Africa, 2012). According to Havenga, Pienaar and Simpson (2012), little attention was paid to the rail system – a highly regulated system – but which failed with the deregulation of road transport. Thus, South Africa’s rail system came to be regarded as a failure of rail economics due to the deregulation of road transport in the 1980s, while intermodal solutions and the demand for freight were not taken into account (Steyn et al., 2012). From 1985 onwards, rail transport steadily lost market share to road transport (Stander & Pienaar, 2002). At the time of the study rail transport’s market share comprised 12.1% only of all the tonnage moved in South Africa (CSIR, Imperial Logistics & Stellenbosch University, 2013:41)

Since 1990, many frustrated and dissatisfied customers have threatened to migrate to road transport due to the lack of service delivery by the rail system (Van der Mescht, 2006). In addition, capacity constraints, old malfunctioning locomotives and a lack of rolling stock (wagons) led to the majority of rail freight moving to road transport (Jaarsveld, 2012). According to Forestry South Africa (2012), the reasons for rail losing market share in the timber industry were strongly related to the exorbitant tariff increases, sub-standard services and branch line closures. The ageing infrastructure of Transnet has attracted attention only from 2006 while, prior to 2005, there was little investment in the infrastructure for rail transport (CSIR, Imperial Logistics & Stellenbosch University, 2013). Track quality has also decreased significantly since 2005, especially on the branch lines and this has compromised both cost and service in respect of the timber supply chain (Forestry South Africa, 2012b). Thus, although South Africa’s rail system is ranked eleventh in the world by route kilometres (Department of Transport, 2015b), many of the routes are underutilised as a result of dilapidated infrastructure.

A report on railway corporate governance suggested that, in an attempt to regain market share, Transnet Freight Rail should consider focusing on providing tailored services to meet customer needs at competitive prices and that it abandon unprofitable business (Pienaar, 2010). Whether this would include timber is uncertain as efforts to ensure that Transnet supports and sustains rail services for timber transport have been in negotiation for several years, especially with regards to improving the



deteriorating branch lines, deficient wagon supplies and inadequate service levels (SA Forestry Online, 2012). According to the National Green Paper, Department of Transport, (2015b), there are many notable challenges facing rail such as the rehabilitation of branch lines, over age equipment, underutilised infrastructure and assets, low performance and a lack of skills development (Department of Transport, 2015b). The next section explores the advantages and disadvantages of rail transport.

### 3.6.1. Advantages and disadvantages of rail transport

Table 3.5 presents the various advantages and disadvantages of rail transport.

**Table 3.5:** Advantages and disadvantages of rail transport

ADVANTAGES	DISADVANTAGES
Lower cost as compared to road	Limited access to rail transport
Able to cater for a wide range of items	Longer in terms of transit and lead times
Piggyback service increases flexibility	Less flexible than road
Direct links between cities	
Safe for hazardous material	
Able to handle virtually any commodity	No door to door service
Able to handle large quantities of goods	Fixed track which requires intermodal transport
Reduces pollution and eases road congestion	Damage record as a result of shunting
Not vulnerable to traffic congestion and weather conditions	Strong packaging is required and this increases costs
Difficult to hijack and freight cars cannot be stolen	Users perceive rail transport to be of inferior quality (not always true)
Ideally suited to handle hazardous goods	Limited service, based on predetermined and universal time schedules
Cost and energy efficient, especially when carrying capacity is fully utilised over long distances	Vulnerable to pilferage in marshalling yards and between stations
Cheaper on a weight basis than road	A high degree of empty running, which may have an impact on pricing.
Makes use of high average speed over long hauls when shunting is not required	

**Source:** Handfield et al. (2009); Wakeham (2010)

Rail is still one of the only modes that are able to perform under various degrees of economies of scale. It is especially suitable for large bulky goods and is considered to be a far more environmentally friendly mode than road transport (Gleissner & Femerling, 2014). However, the disadvantage of rail transport is that it is unable to offer door-to-door delivery and, therefore, the customers who make use of rail transport are those who are the least sensitive to service elements such as reliability and time (Gleissner & Femerling, 2014). At the time of the study, Transnet Freight Rail

was in the process of rehabilitating the railways together with new policy positioning and investment strategies aimed at providing a high performance rail network for the country (Department of Transport, 2015b). This indicates that from a strategic point of view, the railways in South Africa are going to improve in time to come.

### **3.7. EXTERNALITY COSTS**

External costs are often referred to as the unaccounted for or unpriced costs of an action that results from certain decisions (Delucchi & McCubbin, 2011). These involuntary costs are also incurred in the freight transport of goods (Swarts, King, Simpson, Havenga & Goedhals-Gerber, 2012) and are linked to the economic, social and environmental sustainability problems which connect to three domains namely, vehicle, infrastructure and user (Yigitcanlar & Kamruzzaman, 2014). A recent report has suggested that, when evaluating modal choice, it is imperative that externality costs are also considered (Department of Transport, 2015a). For the purpose of this research study an overview of externality costs was included in the literature review and a carbon emission calculation was conducted on NCT's road and rail transport (Chapter 5).

#### **3.7.1. Categories and impacts of external costs**

A review on the externality costs in South Africa indicated six costs related to accidents, emissions, roadway, policing, noise and congestion, which all occur during the voluntary exchange of goods and services (Swarts et al., 2012). External costs are also regarded as costs that are not included in the market price of transport and are costs which are not borne by the user (Proost, 2011). This was also confirmed by Strandenes (2013), who indicated that transport pricing disregards external costs to the user. However, recent studies suggest that this may in time become a cost centre for many of the companies and users benefiting from the exchange of goods and services (Swarts et al., 2012; Department of Transport, 2015a).

There are several different external costs that result from using transport and which have an impact on both society and the environment (McKinnon et al., 2012). For example, congestion costs are associated with the additional travel and opportunities that are forgone due to delays; the discomfort of crowding which impacts on travel

time; uncertainty; and the reliability/unreliability of arrival and delivery times (Delucchi & McCubbin, 2011). Accident costs include medical costs, property and damage costs, loss of productivity, emergency service costs and nonmonetary costs such as injury, pain and suffering (Delucchi & McCubbin, 2011). The increased number of trucks on road networks and traveling at high speeds may increase the frequency of accidents (Piecyk, Cullinane & Edwards, 2012). Virtually all transport modes emit air pollutants which harm health, damage materials, reduce visibility and impact adversely on crops and forests (Delucchi & McCubbin, 2011). Therefore, the atmospheric emissions resulting from air pollution impact on the environment, causing acid rain and smog (Piecyk et al., 2012).

The costs associated with noise occur when roadways carrying large volumes of traffic cause high levels of noise and disturbance, disrupt activities, impact negatively on productivity and hinder both work and the ability to learn. These may all lead to stress (Piecyk et al., 2012). In addition, vehicle vibrations caused by heavy vehicles result in damage to roads due to the pressure which is redistributed below ground level, causing architectural and structural damage to road networks (Piecyk et al., 2012). Climate change costs occur as a result of the harmful pollutants that are emitted by the various transport modes (Delucchi & McCubbin, 2011) with these having an impact on global climate change. These harmful pollutants are also known as greenhouse gas (GHG) emissions and may include carbon dioxide (CO<sub>2</sub>) methane, nitrous oxide, carbon monoxide, nitrogen oxide, ammonia and others (Delucchi & McCubbin, 2011).

According to the Road Traffic Management Systems (2015), transport operators are now obliged to comply with regulations governing overloading. Overloading results in damage to road infrastructure, thus causing the hazards and accidents (Maina, 2010; Kumar & Chandrakar, 2012) that also have the potential to impact on supply chain costs. A case study on the impact of bad roads on the economy indicated that a bad road increased the cost per ton of wheat being transported from R2.25 to R3.59 per ton (Bean, 2010). According to the study, a deteriorating road may result in an increase in vehicle vibrations that may cause damage to the load. The maintenance costs of roads also increases, for example, the average maintenance cost for a good road in South Africa is estimated at R0.96 per kilometre while a bad road costs approximately R2.11 per kilometre to repair (Nordengen, 2013a:8). This may force the transport

operator to increase their rates and impacts on the consumer price (Bean, 2010) and, ultimately, hampers the economy (Jorgensen, 2013).

**Table 3.6:** Estimated externality costs of the Kwa-Zulu Natal forest industry for roundwood traffic

	Sector	Railway		Roads	
	<i>Present charges</i>	*		**	
1	Av rate per tonne-km	30c		60c	
	<i>External Costs</i>		% of Increase		% of Increase
2	Accidents	0.12c/t-km	6.63	6.00c/t-km	38.39
3	Congestion	***		2.50c/t-km	15.99
4	Emission	1.44c/t-km	79.56	6.39c/t-km	40.89
5	Noise	0.25c/t-km	13.81	0.43c/t-km	2.75
6	Policing	Nil		0.31c/t-km	1.98
7.	TOTAL	1.81c/-km	100.00	15.63c/t-km	100.00
	Revised Rate	31.81c/t-km		75.63c/t-km	
	Percentage increase	6.03%		26.05%	

**Source:** 32nd South Africa Transport Conference (2013)

The latest logistics survey estimated that accident costs equated to R15.5 million, followed by emission costs at R11.9 million, noise costs at R4.6 million, congestion costs at R4.2 million and land and policing costs at a consolidated R4.2 million (CSIR, Imperial Logistics & Stellenbosch University, 2013). The report also showed that these costs were not taken into account in the financial statements of companies. However, emission tax has been gaining considerable attention and, if implemented, would add a further R12 billion to South Africa's transport costs alone (CSIR, Imperial Logistics & Stellenbosch University, 2013). Throughout the world there has been an increased awareness on the way in which transportation projects are impacting on greenhouse gasses and emissions (Schipper, Cordeiro & Shiuen, 2007). In order to ensure sustainable logistics decision-making concerning a modal switch, the external costs of road and rail transport should be compared. These costs for the forestry sector are reflected in Table 3.6 above.

Road externality costs have increased by 26.05% in comparison to rail costs which have increased by a conservative 6.03%. It is important to note that emission costs are considered to be the highest component of road transport costs, totalling 6.39c/t-km of total externality costs whereas rail accounted for 1.44c/t-km. Of these external

costs, according to a recent Transnet press release, the carbon emission tax was to be implemented in 2016 (Sigonyela, 2015). Industries are therefore being encouraged to consider the cost of carbon emissions for road and rail freight transport in South Africa. External costs are, therefore, of concern as transport operators will be forced to charge higher rates (Jorgensen, 2013) with this impacting on the brokered rates offered to the timber growers of NCT in time to come. External costs may also hamper time delivery to NCT markets through delays and congestions at mills (Van Zyl & Mohanlal, 2012).

According to Strandenæs (2013), it is in the interests of sustainability and business continuity to have an alternate mode which decreases the impact of road deliveries so that externality costs are reduced. Accordingly, in Denmark a modal split from road to rail transport was highly recommended (Abate, 2011). The European Union also expressed concern, indicating that the transport system of road haulage at the time of the study required policies to safeguard mobility as well as to reduce greenhouse gases significantly (Meersan & Van de Voorde, 2013). The shift from road to rail transport is also recommended for South Africa due to the high externality costs associated with using road transport (Swarts et al., 2012; CSIR, Imperial Logistics & Stellenbosch University, 2013).

Research conducted on the transfer of freight to greener modes of transport suggests the use of rail as a preferred choice of transport (McKinnon, Browne, Whiteing & Piecyk, 2015). In view of the unpredictable congestion on road networks, which is largely attributed to excessive carbon emissions, the mobility of rail impacts less on carbon emissions than road (McKinnon, Browne, Whiteing & Piecyk, 2015). Furthermore the use of a rail network may possibly provide greater reliability and variation in freight transport (McKinnon et al., 2012). However, in South Africa, there are many challenges associated with the reliability of the railways (Department of Transport, 2015b). Companies may also benefit from marketing their use of “greener” modes as part of good corporate governance (McKinnon et al., 2012) and sustainable logistics decision-making (Swarts et al., 2012). One such option is the use of PBS vehicles, which aims to reduce vehicle trips and congestion on road networks (Nordengen, 2013b). The externality costs of road and rail transport should therefore

not be considered as an isolated topic in respect of future decision making regarding modal choices.

Timber from sustainable forests is considered to be carbon neutral because, in the production process, wood actually absorbs CO<sub>2</sub> from the atmosphere rather than emitting it (Wood Foundation, 2012). Because carbon emissions are considered to be the biggest, contributing externality costs of transport (Jorgensen, 2013), it is vital that the actual transport of timber takes into account the carbon emissions emitted. Transport operators, investors and businesses would probably prefer to be able to estimate the impacts of carbon dioxide emissions, considering that the transport sector is one of the biggest contributors to carbon emissions globally (Schipper et al., 2007). For the purpose of this study the carbon emission calculation for road and rail transport was conducted as one of the secondary objectives of the study as it was proposed that carbon taxes were one of the externality costs that were to be implemented in 2016 (Engineering News, 2015, Sigonyela, 2015).

There are two approaches used in the calculation of carbon emissions, namely, the bottom up and the top down approaches (McKinnon et al., 2015). The top down approach considers data at an aggregate level whereas, with the bottom up approach, the data on individual processes may be monitored with specific energy requirements for each component being measured from the bottom (McKinnon et al., 2015). The impact pathway approach has been noted as one of the best practice bottom-up approaches according to a report on the externalities of energy methodologies (European Commission, 2005). A research paper on calculating the externality costs for South Africa cited the impact pathway method approach as a notably credible methodology for calculating carbon emissions. However, it was also understood to be a highly data intensive method which considers the holistic chain of causal relationships and impacts through emissions, diffusion, chemical conversion in the environment and its receptors (Swarts et al., 2012:211). In another study on carbon emission calculations, the energy approach was considered. In terms of this approach the CO<sub>2</sub> calculation is based on the amount of fuel used by each freight truck and then multiplied by the carbon dioxide emission factor per litre of diesel (Abiero, Ochieng & Odalo, 2015). However, this requires a detailed analysis of fuel receipts, showing quantity and type of fuel, direct measurement of fuel use, financial records of fuel

expenditures and emissions related to empty runs and backhauls (McKinnon et al., 2015). Given the fact that NCT does not own a fleet of trucks the NCT was not in possession of such data.

The energy approach is therefore considered to work well for companies with in-house transport (McKinnon & Piecyk, 2011). One of the approaches that did suit with NCT was the activity based approach, a bottom up approach to calculating emissions which considers ***[tons transported x average distance travelled x CO<sub>2</sub> emissions factor per ton kilometre]*** (McKinnon et al., 2015). This formula was, therefore, cited in Chapter 1 as the method used for NCT's carbon emission calculation. The activity-based approach has also been used for the measuring and managing of carbon emissions in Europe's chemical transport. Although the energy approach is one of the most accurate methods of calculating carbon emissions, data accessibility may be a problem depending on the nature of the transport operations. For organisations using the activity based approach, however, it is relatively easy for them to retrieve data from their enterprise resource planning systems (ERP), which provide data on the tonnages moved and the average kilometres travelled (McKinnon et al., 2015).

The activity based approach was also recommended for studies on the carbon emissions of Kenya's road freight transport (Abiero et al., 2015). In addition a further two studies on transport related studies have also used the activity based approach to determine the carbon emission calculations of road and rail transport (Jaarsveld, 2012; Jaarsveld et al., 2013). Another development in carbon calculations has been the launch of a carbon footprint calculator application – an online tool which was released in August 2015 and developed by the Johannesburg Centre for Software Engineering (JCSE) and the University of the Witwatersrand to encourage various industries, including the timber industry, to use the carbon calculator for the purpose of determining the carbon emissions savings on road and rail transport (Engineering News, 2015). This calculator does not include all externality costs but only carbon emissions as, according to a Transnet press release, South Africa was proposing to implement a carbon tax in 2016 at an estimated R120 a metric ton of CO<sub>2</sub> equivalent and to be levied by the government on the use of fossil fuels (Sigonyela, 2015; Engineering News, 2015). Based on the analysis of these methodologies and the

applications available, the activity-based approach was selected for the purpose of determining the road and rail transport carbon emissions for NCT.

### 3.8. CONCLUDING FRAMEWORK FOR THE LITERATURE STUDY

Considering the nature of this study, it was important to ensure that a suitable framework was used in the determination of an intermodal switch from road to rail transport. The approach presented in Table 3.7 which lists several key criteria in modal choice considerations was adapted from studies on an intermodal switch where a similar matrix of key criteria was evaluated (Arsan, 2011, Heljedal, 2013; Kim et al., 2014, Logistics Operational Guide, 2015, Perrels et al., 2008, Transportation Association of Canada, 2006).

The structure of this chapter addressed the criteria listed in Table 3.7 and cross referenced below. Firstly, in section 3.4.2, the theory on transport costs was examined and the costs of road and rail transport compared, showing the benefits of the cent per ton savings achieved through the economies of scale in transport. The key modal criteria were discussed in a way that centred on the total cost concept to determine which of these key criteria were considered to be most applicable in measuring the performance of road and rail transport for the timber growers of NCT. These criteria included reliability, flexibility, supply chain visibility, rates and total transport time, as noted in section 3.4.4

**Table 3.7:** Key criteria when considering an intermodal switch

Criteria	Literature reference	Road	Rail
Reliability	Section 3.4.4		
Flexibility			
Supply chain visibility			
Rates			
Total transport time			
Cent per ton/km	Section 3.4.2		
Advantages	Sections 3.5.1 and 3.6.1 Tables 3.4 and 3.5		





Criteria	Literature reference	Road	Rail
Disadvantages	Sections 3.5.1 and 3.6.1 Tables 3.4 and 3.5		
<b>Other Criteria</b>			
Opportunity cost	Section 3.4.3		
Carbon emissions	Section 3.7.1		
Performance based vehicles	Section 3.4.2, Table 3.3		
Transnet freight rail	Sections 2.2.4 and 3.6		

**Note:** See Table 5.24 for populated road and rail details

**Source:** Adapted from Logistics Operational Guide (2015)

The advantages and disadvantages of each mode were listed in sections 3.5.1 and 3.6.1 and other considerations addressing opportunity costs discussed in section 3.4.3. Section 3.7.1 addressed externality costs with a focus on carbon emissions while section 3.7.2 discussed PBS vehicles. Similarly, in Chapter 5, the same criteria are assessed and a similar matrix tabulated based on NCT's road and rail transport operations. The findings for this matrix are then populated accordingly and presented. The intention behind examining this framework of criteria in the case study was also to link the framework back to what was discussed in this literature review to ensure that the literature studies are aligned to the results from the case study. There are several factors to consider when comparing road and rail transport with the elements of the efficiency and effectiveness of each mode were noted as important considerations for the timber growers of NCT. Both cost and service elements were therefore considered for the purpose of this study as well the other considerations highlighted in the literature review.

## **CHAPTER FOUR**

### **RESEARCH DESIGN AND METHODOLOGY**

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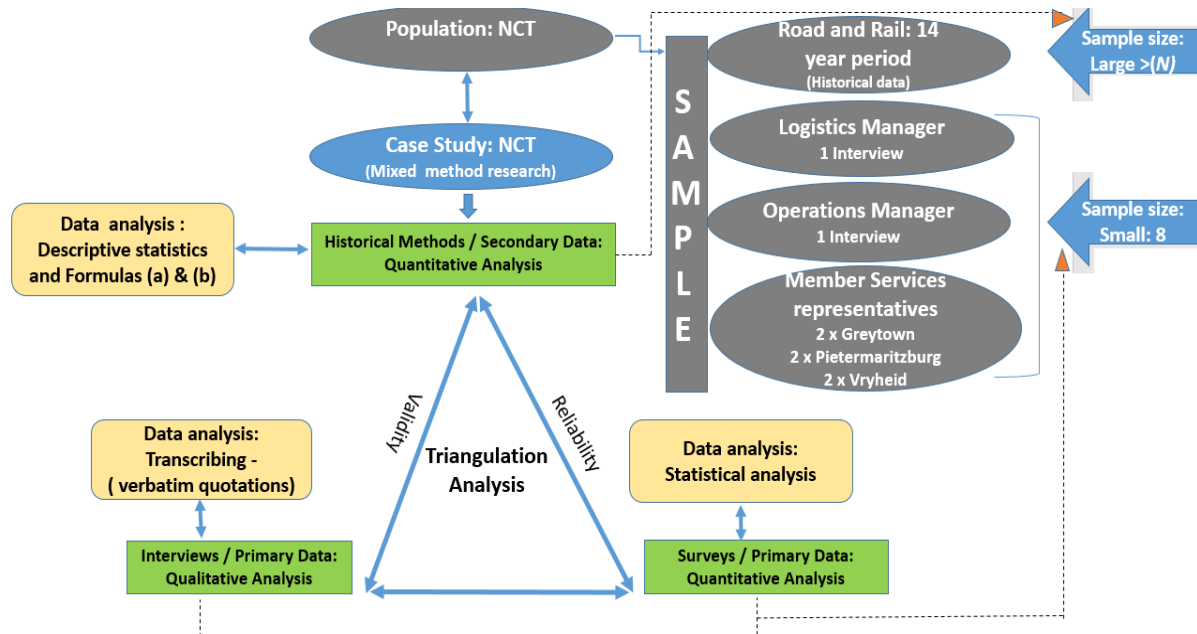
#### **4.1. INTRODUCTION**

The aim of this chapter is to outline the framework and research design used in the study. This included the data collection instruments, data collection analysis and strategies used. The various stages and processes involved in the study were also explained. The methodology used in the study was a mixed approach as the case study was designed using historical data, interviews and surveys as the main methods of data collection for scoping the study. In order to gain a holistic picture of the case study, the historical data and the findings from the interviews and surveys were triangulated as a means of converging the findings from these data sources. A purposeful sample frame was chosen for the purposes of the study which included historical data sources over a 14-year period and eight key participants involved in road and rail operations for the timber growers of NCT. This sample frame is presented in Figure 4.1 below and depicts the structure of the study. The evidence collected from the samples is presented in Chapter 5 using data set(s) and verbatim quotations from the interviews.

#### **4.2. RESEARCH METHODOLOGY**

Research methodology deals with defining a problem within the scope of its dimensions. This involves analysing the problem, interpreting the information and then formulating a conclusion (Phophalia, 2010). In order to analyse the problem within the scope of its dimensions, a methodology should be designed that is appropriate to finding solutions to specific research problem(s) (Salkind, 2012) such as considering an intermodal switch from road to rail transport for the independent timber growers of NCT. This required a formulation of the research questions which were outlined in Chapter 1, as well as deciding on a suitable design and scope for the study (Bradley, 2010). Previous studies conducted on research methods in supply chains have considered theory building, surveys, questionnaires and historical data to be integral for conducting such research (Kotzab, Seuring, Muller & Reiner, 2005; Gammelgaard & Flint, 2012). As shown in Figure 4.1, the research methods for constructing this case

study will include the use of historical data, interviews and surveys. The research strategy and design will examine the chosen methods for this particular scope of study along with the reasons for its application.



**Figure 4.1:** Structure of the research

**Source:** Researcher

### 4.3. RESEARCH STRATEGY AND DESIGN

According to Ambe (2012), research strategy provides the road map for exploring research which examines methods of data collection such as experiments, surveys, histories, analysis of archived information and case studies. The research strategy also provides a basis for evaluating data collection methods which are used to guide the research and answer questions of interest (Kalaian, 2008). Therefore, in order to address the questions pertinent to NCT’s road and rail transport, a case study design was used, as were data collection strategies such as historical data, interviews and surveys.

#### 4.3.1. Case study

A case study allows for the close examination of a person or group with the aim of providing a rich account of past or present events (Salkind, 2012). A case study is also useful in research into a particular organisation (Maree, 2010). The organisational case study in this study was constructed around NCT’s road and rail transport

operations using a mixed method approach. The reason for using a case study was that it enables the researcher to combine multiple data collection methods through a mixed research approach (Kotzab et al., 2005; Zauszniewski, 2012). The multiple data collection methods utilised in this case study made use of historical analysis, interviews and surveys which provided a strong basis for both qualitative and quantitative data analysis, highlighted in section 4.3.3. Thus, in the case study, each of the research questions and objectives noted in Chapter 1 were outlined and investigated using the three data collection methods highlighted in Figure 4.1. The historical data and the results from the surveys were examined using a statistical analysis to establish the quantitative groundwork for constructing the case study whilst the interviews made up the qualitative groundwork for constructing the study.

A mixed research methodology approach allows the researcher to combine a variety of data in the suggested field setting (Spens & Kovačs, 2006). In this case study the field setting was NCT. Studies on research trends in logistics suggest that case studies augment qualitative and quantitative research through a process of triangulation (Craighead, Hanna, Gibson & Meredith, 2007). There may be a triangulation of methodologies within the context of the case study whereby questionnaires, interviews and observational research are all combined in the context of a clear research framework (Zauszniewski, 2012). Thus, with triangulation it is not uncommon to analyse transcribed interviews together with data sources to ensure that the evidence obtained is corroborated (Anney, 2014). The essence of triangulation is that multiple techniques are used in parallel so that they provide overlapping information, thus making it possible to check the results from more than one viewpoint (Saunders et al., 2012). Similarly, in this case study, historical data (secondary data) was converged with the findings from the interviews and surveys (primary data) in order to gain a more in-depth understanding of road versus rail transport for the independent timber growers of NCT and thus address the research objectives of the study as outlined in Chapter 1. The fact that triangulation also provides a basis for validating the results and facts presented in the study is the main reason why researchers often use triangulation in mixed research studies (Jonsen & Jehn, 2009). Finally, two formulae were also addressed in the study. Further details on the justification for using these formulae were provided in sections 3.4.3 and 3.7.1.

The disadvantages of case studies include the fact that they do not take into account wider population groups (Burton & Bartlett, 2005). In addition, they may be time consuming (Salkind, 2012) and are often focused on a system or action rather than on an individual (Maree, 2010). Although one entity only was used in this case study, the high volumes of transport brokered on behalf of the timber growers, who comprise over 2000 shareholding members known as the timber growers of NCT (NCT Forestry Co-operative Limited, 2015b), were examined as part of the historical data, thus making the data measurable in a wider context for the 14-year period. The population sample frame for the secondary sources of historical data  $> (N)$  was, therefore, large in comparison to the primary sources of data which included a population sample of eight participants only. In order to adequately address the research questions outlined in Chapter 1, the following secondary research questions were addressed in the case study.

- What are the transport options available to NCT's timber growers?
- During which period was rail considered the dominant mode of transport and what were the reasons for this trend?
- During which period was road considered the dominant mode of transport and what were the reasons for this trend?
- What are the transport costs between using road versus rail on a rand per ton basis?
- What are the differences in the transportation costs for road and rail for the period 2012–2014?
- What would the opportunity cost of road transport be if all volume had gone by rail for the period 2012–2014?
- What are the other criteria that should be taken into account when determining the choice of transportation mode?
- What were the carbon emissions of road and rail transport for NCT for the period 2008–2014?
- What are the benefits for the timber growers of NCT of using alternative transport solutions such as PBS vehicles?

To conclude Chapter 5, a summarised framework of the results from questions 1 to 9 is provided. It is hoped that the results of the framework will assist timber growers to determine whether an intermodal switch from road to rail transport would be beneficial to the independent timber growers of NCT. Thus, should a timber grower need to evaluate a suitable transport option for his/her specific needs, the choice of mode which is most appropriate and cost-effective for each timber grower's specific set of circumstances may be assessed based on the comparisons made between each mode. The most important aspect of a case study is that it involves the examination of a single or individual group in an organisation in order to provide a detailed narrative of what is being studied (Kalaian, 2008). The case study was therefore deemed to be the most appropriate strategy for examining the road and rail transport operations of NCT.

#### **4.3.2. Data collection**

For the purpose of this study, three methods of data collection were used, namely: historical data, interviews and surveys (see Figure 4.1). These findings of these three methods resulted in both a qualitative and a quantitative data analysis. The intention behind collecting qualitative data is to obtain extensive information from a small sample while the intention behind collecting quantitative data is to obtain a large spread of data ( $N$ ) for the purpose of statistical analysis (Creswell, 2014:222). Likewise, in this study, the qualitative data was obtained from a small sample consisting of two participants only. This involved two separate semi-structured interviews, one with the logistics manager and one with the operations manager of NCT. These interviews provided the researcher with extensive information on both road and rail transport. In addition, the historical data and the results from the surveys were also able to provide a large spread of data on the performance of road and rail transport, which was then statistically measured. Thus, the historical data enabled the testing of large amounts of data relevant to the study and is examined in closer detail below.

##### **(i) Historical research methods**

Historical research provides insights into and links to the past and provides a contextual understanding of the present (Lundy, 2008). Historical research also

provides a basis for the drawing of conclusions by analysing and critically examining the data sources (Lundy, 2008). For example, in this study the historical research into NCT's logistics operations from 2000 to 2014 provided valuable insights into and links to the past and present performance of road and rail transport. Thus, the historical data collected on the past performance of road and rail transport over this period provided a strong basis for addressing the research questions outlined in Chapter 1 of the study. Historical data collection frequently uses secondary data sources such as company data, reports, records of accounts, articles and reference guides (Lundy, 2008). On the other hand, secondary data is used for fact finding. Computer technology (Salkind, 2012) is regularly used to discover trends in an organisation using large volumes of data (Tran, 2013).

The secondary data in this study consisted of the data retrieved from the company's database, Oracle software (an enterprise resource planning system) as well as company reports such as NCT's annual contract price adjustments for road and rail, NCT's road and rail annual operations reports and NCT's brokered operations rates. However, the main sources of data were retrieved from the Oracle software database.

Since 1980, NCT's main purpose in using a database has been to manage day to day operations and thus to ensure a more accurate management of the daily transactions which was previously done by hand (Farrow & Ferguson, 1999 :44). Oracle software supports manageability, performance and data scalability for organisations such as NCT (Oracle software, 2012:6). NCT's Oracle software database therefore provided a strong basis for conducting the historical research. The primary advantage of using the database was that it provided data on all the timber deliveries done by the timber growers to various markets through the tracing of delivery notes (NCT Forestry Co-operative Limited, 2015a). This afforded the researcher the opportunity to trace multiple records of road and rail deliveries over a 14-year period. The details obtained from the Oracle software database included:

- modal split of road and rail transport for the period 2000–2014
- road and rail volumes transported for the period 2000–2014
- average monthly tons transported for the period 2004–2014

- tons transported in relation to the number of trucks for road and rail transport for the period 2000–2014
- number of standard trucks and PBS trucks for the period 2015 for Markets 1 and 2
- monetary savings when using PBS vehicles for the period 2015 for Markets 1 and 2
- number of road and rail trucks used over a 14-year period.

The historical data for the road and rail deliveries done over a 14-year period were retrieved from Oracle software and analysed using descriptive statistics to produce the results presented in Chapter 5. NCT's financial figures regarding transport costs, contract prices and operational data were retrieved from company reports and also analysed using descriptive statistics and cited in Chapter 5. Bearing in mind that historical research involves data evaluation and analyses to review the impact of a situation (Lundy, 2008), the impacts of road and rail transport for a 14-year period were evaluated and analysed to determine whether any cost savings and benefits would be achieved by considering an intermodal switch from road to rail transport. Therefore, a clear advantage of historical research is that it enables problems and trends to be detected, for example in relation to such as a switch from road to rail, thus allowing for sound decision-making (Donna, 2011). However, historical research is also associated with the following shortcomings, for example the availability of data may become a limiting factor as it is not always accessible to the researcher and retrieving the data may be a time-consuming and costly task (Salkind, 2012). In fact, retrieving the historical data from the Oracle software database was extremely time consuming, although it was fairly accessible and no additional costs were incurred in obtaining the data.

## **(ii) Questionnaire and interviews**

Questionnaires are generally used to collect data in order to provide answers relevant to the research question(s). Questionnaires allow the researcher to collect detailed viewpoints from the participants in order to explain the trends in the results of the data findings (Creswell, 2014:47). Questionnaires and interviews are also incorporated into case study research in order to identify and explore key variables and links to the study



(Kotzab et al., 2005). Researchers make use of questionnaires to sample a population's characteristics or beliefs through a process of self-reporting (Marshall & Rossman, 2008). Questionnaires and surveys are often deployed as methods to understand and explain complexities in supply chain networks as these methods of data collection tap into the actual working knowledge of logisticians that would not be possible to obtain via pure observation (Gammelgaard & Flint, 2012). This study used semi-structured interviews to obtain a human perspective on the road and rail transport situation and to confirm facts and opinions in respect of the road and rail transport operations of NCT. Two separate semi-structured interviews were conducted, one with the logistics manager and one with the operations manager of NCT. When using semi-structured interviews, the researcher has a list of the questions or themes to be covered. However, there is a certain degree of flexibility as to the way in which the questions and themes are approached and this may vary depending on the flow of the interview (Saunders et al., 2012: 320). With a structured approach, there is no deviation from the set of questions posed whereas with an unstructured approach, the role of the interviewee is minimal and there is an open topic of debate that allows the exchange to flow freely (Saunders et al., 2012: 320). Thus, although the interview schedule (Appendix A) outlined a specific set of questions, the nature of the interviews conducted followed a semi-structured process which allowed the interviewee to divert from these questions in order to explore key themes and confirm facts for the purpose of the study. In order to address the primary research question of the study: *Will an intermodal switch from road to rail transport be beneficial to the independent timber grower of NCT?* it was felt that it was critically important that the questions outlined in Appendix A be posed to both the logistics manager and the operations manager of NCT.

### **(iii) Surveys**

The second series of questionnaires took the form of a survey. This survey was emailed to six staff members of NCT who were responsible for servicing timber growers in their respective geographical areas, specifically Greytown, Pietermaritzburg and Vryheid.

A survey provides a quantitative or numeric description of the trends, attitudes or opinions of a population (Creswell, 2014:201). This study used a survey to evaluate the performance of road and rail transport based on the opinions of six staff members of NCT. The survey included the use of a rating scale consisting of five key criteria, namely, reliability, flexibility, supply chain visibility, rates and total transport time. This set of survey criteria was based on a study of perspectives on the freight movement by road and rail transport in South Africa (Stander & Pienaar, 2002), performance measures for road networks in Canada (Transportation Association of Canada, 2006) and freight transport modal choices in New Zealand (Kim et al., 2014). Rating scales provide a direct understanding of the respondents' perceptions using numbers to indicate the powers of measurement that relate to the levels of satisfaction (Saunders et al., 2012). Studies on supply chain performance suggest that satisfaction surveys are often conducted in order to rate effectiveness in supply chains which provide an important link to measuring both the non-financial and intangible dimensions of performance (Jothimani & Sarmah, 2014). These non-financial and intangible dimensions of performance may range from attributes and criteria such as the reliability, responsiveness, agility and costs, which are often associated with the supply chain operations reference model known as SCOR. This model is frequently used in business process re-engineering, benchmarking and the performance measurement of organisations (Jothimani & Sarmah, 2014). In light of this surveys were considered to be an appropriate way in which to appraise the performance of road and rail transport. The survey contained in Appendix B was sent to the Greytown, Pietermaritzburg and Vryheid district offices of NCT.

The survey in Appendix B shows the key criteria that were measured for the purpose of this study and was based on an ordinal scale rating of 1 – poor, 2 – average, 3 – good and 4 – excellent. Ordinal scales such as these are commonly used to rank/rate attitudes, preference and order of liking (Wiid & Diggines, 2011). In view of the numerous factors which affect the performance of business, ordinal scales allow for a multivariate of criteria to be measured and they are, therefore, used to manage operations and processes over time (Evans & Lindsay, 2015). The benefit of such scales is that they may statistically be analysed to increase the validity of the survey results (Wiid & Diggines, 2011).

In order to gain an in-depth understanding of the road and rail transport operations of NCT, both interviews and surveys were considered to be appropriate methods of data collection. Surveys are considered to be more confirmatory while interviews are more exploratory (Harris, 2010). In addition, both methods are practical and may be used to align and understand the data collected, especially in studies and research in the field of logistics (Harris, 2010; Trautrimis et al., 2012).

The research strategy process depicted in Table 4.1 presents the main methods of data collection used, the data analysis techniques used and the measurables and also specifies how the presentation and findings were addressed.

**Table 4.1:** The research strategy process pertaining to the study

<b>Data collection</b>	<b>Method</b>	<b>Data analysis</b>	<b>Measurable</b>	<b>Case study presentation and findings</b>
Secondary data	Historical research: Oracle software (Quantitative)	Descriptive statistics and SYSTAT 13 Microsoft Excel 2010 (a) Future value formula (b) Activity based approach	Volume transported: road vs. rail transport (trends)	Graphs, tables and detailed calculations in the case study
Primary data	Two interviews (Qualitative)	Transcribing of recordings (themes). Triangulation of historical data with interviews.	To determine whether an intermodal switch would be beneficial to the timber growers of NCT	Verbatim reporting provided in the case study with citations
Primary data	Six surveys (Quantitative)	Total weighting of key criteria measured using Anova/IBM SPSS and Statistics 20. Triangulation of historical data with surveys.	Modal performance	Statistical tables Comments from surveys

### 4.3.3. Data analysis

The data analysis was based on a mixed approach, which included both a qualitative and a quantitative analysis of the data collected. According to Saunders et al. (2012: 165), “mixed methods approach is the general term for when both quantitative and qualitative data collection techniques and analysis procedures are used in a research design”. The research strategy design for the data analysis in this study is presented

in Table 4.1. According to an article on logistics research, the incorporation of both qualitative and quantitative research analysis develops holistic and systematic thinking (Näslund, 2002). The quantitative and qualitative analysis techniques are discussed separately below in order to show the holistic approach used for the analysis of data pertaining to the study.

### **(i) Quantitative analysis**

As indicated in Table 4.1 the quantitative analysis included the use of descriptive statistics and formulae.

#### Descriptive statistics

Descriptive statistics provide a strong basis for quantitative research and also play a diagnostic role in case study research. Descriptive statistics make it possible to report, compare and measure the data which has been collected (Vogt, Gardner, Haeffele & Vogt, 2014). Quantitative approaches regularly incorporate a descriptive framework of statistics to identify the variables, components, relationships, themes and issues of central concern in a research project (Saunders et al., 2012). This is done by measuring and describing an occurrence on the basis of numbers and calculations (Dudovskiy, 2014) bringing meaning to the raw data whether the researcher's choice is standard deviations and means or rich descriptions of ordinary events (Kuckartz, 2014:5). This may be facilitated by the use of statistical software packages (Kuckartz, 2014), such as Microsoft Excel 2010 (Microsoft, Washington, USA) and SYSTAT 13 (Systat Software Inc, California, USA). These software packages were used in this study to provide a descriptive analysis of NCT's road and rail transport operations. Statistics in research is a valuable scientific method for collecting, analysing and presenting data which is then used to draw conclusions relating to the research problem (Phophalia, 2010). For the purpose of this research study, the descriptive statistics were presented using histograms. Figure 4.1 provides examples of two histograms to show the way in which the data analysis and presentations were presented in Chapter 5.

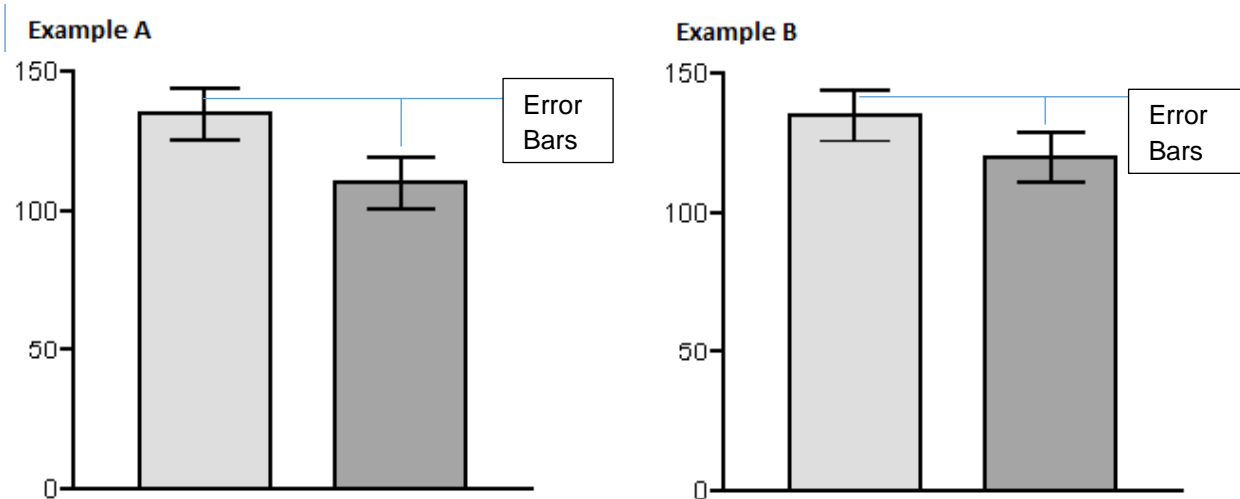


Figure 4.2: The link between error bars and statistical significance

Source: Motulsky (2002).

As depicted in Figure 4.2, Chapter 5 makes use of histograms showing the standard error bars between two groups, for example, between road and rail transport. In example A, the standard error (SE) bars do not overlap, hence there is no certainty that the difference between two means is statistically significant ( $p = 0.09$ ) (Motulsky, 2002). In example B, the standard error bars do overlap, thus indicating that the difference between the two means is not statistically significant. However, if 95% error bars do not overlap, the difference is statistically significant ( $p < 0.05$ ) (Motulsky, 2002). A 95% confidence level denotes that, 95% of the time, the range will include the population experimental condition mean and that the population experimental condition mean will not fall within the specified range of 5% of the time (Motulsky, 2002; Rutherford, 2011). Therefore, the p-value is used to determine the significance of the results based on the standard error bars between two groups. This is illustrated in Table 4.2 below.

Table 4.2: Standard of error and corresponding p value conclusions

Standard of error (SE)	Statistical significance	P value
When the standard error bars (SE) do overlap	The two means is not statistically significant	( $p > 0.05$ )
When the standard error bars (SE) do not overlap with a 95% confidence interval (CI)	The difference is statistically significant of the wider mean	( $p < 0.05$ )

Source: Motulsky (2002), Rutherford (2011)

The reason for providing an overview of these statistical analysis methods was to ensure greater clarity when the results were assessed in Chapter 5 and, in particular, the interpretation of the p-value. Thus, the use of descriptive statistics allows for a more scientific and technically correct study than may otherwise have been the case. This assisted with logical decision-making such as the decision regarding an intermodal switch from road to rail transport.

## Formulae

Formulae are incorporated into quantitative research in order to address specific questions (Dudovskiy, 2014). In addition, the use of descriptive statistics and formulae also promotes the validity of the research as they provide checks of the adequacy of the measurements (Saunders et al., 2012; Kotzab et al., 2005). In an effort to address the primary research question, namely, 'Will an intermodal switch from road to rail transport will be beneficial to the timber growers of NCT?', the opportunity cost of road transport was used as a basis for determining whether rail transport would be a beneficial mode of transport for the growers of NCT. In economic terms an opportunity cost is defined as the value of an activity which is forgone when another alternative activity is chosen (Dorman, 2014:61). In this research study, the volumes of road transport were substituted with rail transport as the other alternative in order to determine the option that delivered the greater future cost savings for the timber grower. The future value formula was used to calculate the opportunity cost of transport. Opportunity costs relate to future events, and companies generally use the future value formula when deciding which projects to take on and which projects to reject, depending on the cash payoffs or savings in respect of the desired project or process (Welch, 2009). This indicates the benefits that should be realised from choosing one option instead of another (Griff, 2014) and is derived as follows:

### **(a) The future value formula**

$$FV_n = PV_0 \times (1+i/m)^{n \times m}$$

where:

- $FV_n$  = future value at the end of period  $n$   
 $PV_0$  = present value  $aV_0$   
 $i$  = rate of interest earned per period  
 $n$  = the total number of periods of the investments  
 $m$  = the number of times interest is compounded per period

The future value formulae have been used in a number of studies as was highlighted in the literature review in section 3.4.3. In this study the intermodal switch from road to rail transport was determined by comparing the transport cost for each mode for the period 2012–2014. The difference in the transport costs for each year was then substituted in the future value formula to determine future and potential cost savings in transport. The following steps were followed to calculate the opportunity cost of transport:

- Step 1: Determine the transport cost for road and rail transport for each year, namely, 2012, 2013 and 2014
- Step 2: Determine the transport cost if all tons were moved by rail for 2012, 2013 and 2014
- Step 3: Determine the transport cost difference for each year
- Step 4: Substitute the difference  $PV_0$  into the formula
- Step 5: Calculate the opportunity costs using current, market related interest rates

The second formula used in the study was based on the carbon emissions calculation. In view of the excessive overloading and carbon emissions of road transport in South Africa, it has been suggested that an intermodal switch from road to rail transport be considered (Department of Environmental Affairs, 2014). This possibility has gained increased attention in the timber industry in South Africa and was highlighted in the literature review. The carbon emission factor per ton-km was derived from United Kingdom based data (Department for Environment Food & Rural Affairs, 2011:41–45) as these factors are unavailable in South Africa and is derived as follows:

## **(b) The activity based approach**

CO<sub>2</sub> =

tons transported x average distance travelled x CO<sub>2</sub> emissions factor per ton-km

Alternative approaches were discussed in the literature review but the activity based approach was considered to be the most suitable for NCT.

## **(ii) Mixed analysis**

As indicated in Table 4.1, the qualitative analysis included the use of two separate semi-structured interviews – one with the logistics manager and one with the operations manager of NCT. The quantitative analysis included the use of surveys with NCT six staff members who were responsible for servicing timber growers in their respective geographical areas, specifically Greytown, Pietermaritzburg and Vryheid. The primary data collected for this research was thus subjected to a mixed analysis using both qualitative and quantitative methods.

Semi-structured interviews: Qualitative analysis

Although the future value formula considered potential savings, for example, for the timber growers, from a financial perspective by indicating the benefit of one choice instead of another from a monetary perspective, the problem associated with the future value formula is that other benefits are not measured and, therefore, non-financial benefits should also be considered (Griff, 2014). Industry knowledge, skills, expertise and human capital all provide a strong basis for problem solving in respect of the way in which performance may be improved (Gilley, Dean & Bierema, 2001) by providing a rich understanding of subjective ontology, especially in the fields of supply chain management and logistics (Gammelgaard & Flint, 2012). In light of this, two separate semi-structured interviews were conducted with both the logistics and operations manager of NCT in order to gain a more in-depth understanding of the benefits of each transport mode in the case.



Thus, for the purpose of this study, two semi-structured interviews were conducted. A mobile device was used to record both interviews. The recordings were then copied into media files for safe record keeping and also transferability purposes should these interviews need to be confirmed at a future date.

In Chapter 5, the findings of the two semi-structured interviews are presented and reported using verbatim quotations and citations as part of the triangulation process illustrated in Figure 4.1. The analysis of the data obtained from the interviews was conducted using an inquiry process of understanding (Maree, 2010). This involves a researcher developing a complex, holistic picture, analysing words and reporting on the detailed views of the relevant informants (Maree, 2010). According to Trautrim et al. (2012), the approach to analysing interview data involves the process of rephrasing, reflecting on and comparing the findings pertaining to the research. This also provided the researcher with a strong basis for triangulating the findings from the interviews with the historical data as presented in Chapter 5 of the study. For example, if the historical data reflected periods during which rail transport volumes were substantially higher than road transport volumes and vice versa, the questions posed in the semi structured interviews would have been used as part of the inquiry process to determine and reflect on the reasons for the changes in demand in the modal choice.

Once the interviews had been recorded, the information was transcribed from the media files into paper format. This was done using professional transcription services and a certificate of veracity was issued to confirm the findings of the audio file. The transcribing of recordings facilitates the analysis of detail for the aims of research by enabling the researcher to listen to and interpret the recordings. This is an important step in qualitative data analysis (Bailey, 2008). It is necessary for researchers to transform the data from the spoken text (structured, unstructured, or narrative interviews) into the written form for the purposes of analysis (Stuckey, 2014). In this study the transcriptions of the interviews were analysed in order to interpret and identify the main themes relevant to the NCT supply chain. The common themes were identified for triangulation purposes, for example timber growers and markets, modal performance, price and Transnet's service, while the detail was reported using verbatim quotations from the interviews and cited accordingly in the case study. Thus,

the interpretation of the interviews had an important bearing on the data analysis carried out for the purpose of this study.

#### Survey-based questionnaires: Quantitative analysis

Surveys may be conducted in the form of a questionnaire and using numbers to indicate different magnitudes, which rate or rank certain traits and behaviours (Meister, 2014). The survey results were analysed based on weighting the key criteria which had been identified for the evaluation of modal performance by road and rail transport (§ 4.3.2) and included reliability, flexibility, supply chain visibility, rates and total transport time. The evaluation of survey data is frequently accompanied by a statistical analysis which shows the relationship between variables, often expressed as numbers and numerical indexes (Salkind, 2012:204). The values of the overall rail and road scores for each geographical area were presented in Chapter 5. In order to show the mean percent scores for rail and road transport, the mean percent, the standard error of the mean and the minimum and maximum values observed were analysed.

A general analysis of variance (ANOVA) was performed to determine whether the rail and road scores (percentages) obtained from the respondents provided evidence of a statistically significant p-value. Statistical software such as ANOVA is used to analyse the variances of groups consisting of two or more categories by comparing the means and statistical differences between them (Saunders et al., 2012:451). In order to determine the p-value outputs of (ANOVA), the values that were used to analyse the survey results (§ 5.8) are presented in Table 4.3. The F-statistic is used to determine the level of variation between the sample means (Rutherford, 2011), and is reflected in the ANOVA table presented in Chapter 5 in order to determine the statistical significance of the results.

**Table 4.3:** Determining the p-value for the (ANOVA) F-test

<b>F-statistic</b>	<b>P-value</b>	<b>Statistical significance</b>
If the F-statistic is > than the 5%	( $p < 0.05$ )	The difference is statistically significant
If the F-statistic is between 1% and 5%	( $p > 0.05$ )	The difference is not statistically significant

**Source:** Rutherford (2011)

The analyses and results of the survey data are presented Chapter 5 of the study. The actual survey results for each of the six participants are contained in Appendices C to H of the study.

#### 4.4. POPULATION

A population is determined in relation to the problem that is being investigated and is termed the target population (Salkind, 2010:33). In light of the research objective of the study, namely, investigating and comparing the brokered transport costs of road and rail transport and the savings that may be achieved, specifically for the independent timber growers in KZN, who are members of NCT, the target population in the case used in this study was NCT. According to Salkind (2010:33), “samples should be selected from populations in such a way that the sample represents the population as much as possible”. This is illustrated in Figure 4.1 which outlines the main samples derived from the population and discussed in further detail below.

##### 4.4.1. Sampling

Sampling refers to the process of selecting specific groups of people or organisations for the purpose of research (Trochim, 2006). Thus, a sample size is influenced by the type of information required to conduct the research in question (Salkind, 2010:33). The sampling process comprises five key steps (Wiid & Diggines, 2011:195) and is illustrated in Table 4.4 below.

**Table 4.4:** Steps in the sampling process

Steps in sampling	Details
Step 1: Clearly define the population	NCT
Step 2: Define the sample frame	NCT – KZN Greytown, Pietermaritzburg and Vryheid
Step 3: Select a sample method	Purposeful judgemental
Step 4: Determine the sample size	Secondary data: large > n Primary data: Small, 8 participants
Step 5: Selecting the sample elements	The logistics manager of NCT The operations manager of NCT Six staff members of NCT

**Source:** Adapted from Wild and Diggines (2011)

To ensure that a systematic process was followed, steps 1 to 5 of the sampling process used for the purpose of this research study were followed. Step 1 involved defining the population. In view of the fact that the topic of the research was based on a comparison between road and rail transport for the benefit of the timber grower of NCT, NCT was selected as the population. NCT was established to cater for needs of the independent timber grower by acting as an agent to its members. As an agency, NCT sources suitable markets for timber growers and arranges for the transportation of the timber to the desired market (Farrow & Ferguson, 1999). There is also a large number of independent timber growers in South Africa who are affiliated to NCT (Naidoo 2011:7) and representing a total of 300 000 hectares of afforested land in South Africa (NCT Forestry Co-operative Limited, 2015a). Therefore it was decided that NCT was the chosen population sample for the study.

Once a population has been defined, the source of the sample frame needs to be identified. This is associated with the geographical units of the population (Wiid & Diggines, 2011). Thus, in Step 2, the source from which the samples was to be selected was defined as NCT offices geographically based in KZN. The elements of the population samples were based in Greytown, Pietermaritzburg and Vryheid. This is highlighted further in Step 5. NCT's core area of operation is based in KZN. This was also mentioned in the discussion of NCT's scope of operations contained in Chapter 2.

Step 3 involves the way in which the sample is selected. The samples were selected purposively. According to research based on case studies, purposeful sampling makes use of information rich sources from deliberately selected samples in order to provide the researchers with the insights necessary to learn about matters of central importance to the study in question (Emmel, 2013). Unlike probability sampling, which makes use of the randomisation of population samples, purposive sampling is a non-probability sampling method that is characterised by an awareness of the audience of the research study (Emmel, 2013). Purposive sampling was, therefore, considered to be the most appropriate sampling method to provide rich sources of information from the sample elements described in Step 5.

In Step 4 the sample size is determined. According to Creswell, (2014), the intention behind coming up with a measurable sample size is to develop specific samples of populations in order to ascertain whether it is possible to generalise the data obtained from a few individuals (in a qualitative phase) to a large sample of a population (in a quantitative phase). Similarly, in this study, the qualitative data samples were small in nature in comparison to the quantitative data samples. The secondary data sampling was large and consisted of data reporting over a 14 year period based on road and rail transport operations pertaining to the timber growers of NCT. Although none of the timber growers was directly involved in the study, the population of NCT was representative of the timber growers. Thus, the data relating to the timbers growers' road and rail deliveries constituted an integral component of the secondary data samples, as highlighted in section 4.3.2. The primary data was small in comparison to the secondary sources of historical data and consisted of eight participants – see below for more detail.

Finally, in Step 5, the sample elements are selected. This includes the actual persons, groups and objects being measured (Wiid & Diggins, 2011:214). The sample elements included a total of eight participants for the purpose of this research study. The criteria used for selecting the sample elements were based on using NCT staff members who were knowledgeable about the road and rail operations of NCT. The staff involved in other operations of NCT and who were not exposed to road and rail operations of NCT were excluded from the sample elements. As alluded to above, the sample method used was purposive in nature and, therefore, the researcher used personal judgment to select the sample elements directly involved in the road and rail transport operations of NCT. The sample elements included two staff members from the logistics department, namely, the logistics manager and the operations manager of NCT. A further six staff members from the member services departments of NCT in Greytown, Pietermaritzburg and Vryheid were also included as sample elements for the study. It was important for the researcher to use management as well as operational staff to ensure a clear picture of NCT's road and rail transport operations.

The logistics manager and the operations managers are both directly involved in the road and rail operations of NCT on a daily basis. These participants were considered to be subject matter experts due to their experience and expertise in the field of

transport. Separate semi-structured interviews were conducted with each of these participants. Six staff members – two staff members per district office from the Greytown, Pietermaritzburg and Vryheid areas – were also used as key participants in the surveys conducted. These NCT staff members are directly responsible for servicing the needs of the timber growers of NCT in each of the geographical areas mentioned. This includes the capturing of the timber growers' order requests for the scheduling of road and rail transport to a given market on a monthly basis. Due to their daily interactions with the timber growers' requests and the performance monitoring of timber supplies by road and rail transport, these NCT staff members were identified as key sources of information for the sample surveys.

Each of the eight participants was given an informed consent letter referring to their participating in the study and explaining their respective roles in the research process. This is discussed in greater detail in the ethical considerations in section 4.6.

#### **4.5. Quality of the research**

An important aspect of research methods is to ensure that the research possesses a high degree of validity and reliability. Thus, it is essential that the degree of error is explored to ensure that the quality of the research is not compromised.

##### **4.5.1. Reliability**

Reliability refers to the credibility of the research findings and the extent to which the data collection techniques and data analysis provide consistent findings (Saunders et al., 2012). The historical data used in this case study was retrieved from the company database, Oracle software systems. Thus, the reliability and credibility of the data was considered to be high as NCT's systems are audited and verified annually to ensure that data integrity is maintained. The Oracle software database also provides multiple users with the same set of data should this data need to be verified by an alternate user at a transaction level and, hence, the database has the added advantage of providing data consistency and concurrency to a number of users at any given point in time (Oracle software, 2012).

#### **4.5.2. Validity**

Validity refers to the extent to which the research findings accurately represent what has occurred or what is currently happening and thus aims to validate the claims of the researcher (Jonker & Pennink, 2010). The consistency of the findings was triangulated with the questionnaires and interviews conducted with the logistics manager and operations manager of NCT in order to provide an accurate account of the findings. Triangulation is used as a strong basis for strengthening both reliability as well as internal validity in research (Jonker & Pennink, 2010). Accordingly, historical data, interviews and surveys were triangulated in this case study.

The use of descriptive statistics and formulae also promotes the validity of research as they constitute checks of adequacy in the measurements (Kotzab et al., 2005; Saunders et al., 2012). Thus, the descriptive analysis and statistical software used provided a strong basis for validating the results of this study. Two formulae were constructed (§ 4.3.3). These formulae were adapted from a similar study on road and rail transport to determine transport cost savings and carbon emission savings for both modes of transport. These formulae were used in the case study to further validate the claims made by the research. The integrity and validity of the historical data used was of critical importance for this study and provided a strong basis for conducting the research.

Lastly, this research document was checked by a certified language editor to ensure the accuracy and conformance of the grammatical and structural content of the dissertation. A technical edit was also conducted by the editor to ensure compliance according to the Harvard referencing methodology as prescribed by the University of South Africa. A letter confirming the validity of this service is included in Appendix M.

In an attempt to ensure the validity and reliability of the research findings, as noted in sections 4.5.1 and 4.5.2, four evaluation criteria were used to authenticate the findings the study.

### 4.5.3. Criteria for ensuring the trustworthiness of research

In order to establish the trustworthiness of a study, four distinct criteria, namely, credibility, transferability, dependability and confirmability, as proposed by Guba and Lincoln (1982), are used in a case study design to ensure the reliability and validity of the research process (Tight, 2017). A study on evaluating the trustworthiness criteria in qualitative research highlighted that several students use quantitative inquiry to assess the rigour of qualitative inquiry by using the Guba and Lincoln approach (Anney, 2014). Students should be cognisant of the provisions that may be made to address issues such as credibility, transferability, dependability and confirmability. In view of the fact that a mixed approach was used for this study, these criteria are assessed in Table 4.5 and explained below.

**Table 4.5:** Criteria for ensuring the trustworthiness of research

Criterion	Strategy employed
Credibility	Peer engagement: face to face interviews and surveys Oracle software Triangulation
Transferability	Purposive sampling: (historical data, interviews, surveys). Case study Triangulation
Dependability	Oracle software Audio recording copies Survey copies
Confirmability	Statistical analysis Triangulation: (historical data, interviews surveys)

**Source:** Adapted from Anney (2014)

Credibility may be defined as the confidence that may be placed in the truth of the research findings (Anney, 2014). Thus, credibility is concerned with the validity of the conclusions that are drawn from the data and how these conclusions match the reality being reported (Tight, 2017). As indicated in Table 4.5, this was achieved through peer engagement during the interviews and surveys while the historical data was obtained from Oracle software. Since Oracle software provides a reliable platform (Oracle software, 2012), the credibility of the historical data was also strong. Peer examination and triangulation are both considered to be solid credibility criteria (Anney, 2014). Triangulation was used to corroborate the evidence from the historical data, interviews and surveys in order to validate the results of the conclusions drawn.



Transferability refers to the degree to which the results of qualitative research may be transferred to other settings (Anney, 2014). Similarly, according to Tight (2017:36), “[t]ransferability enables others to refer the relevance and applicability of the research findings (to other people, settings, case studies, organisation, etc)”. As indicated in Table 4.5, the purposive sampling used in this study catered for the process of transferability by using interviews which provided rich information to be transferred to the case study using verbatim quotations (Emmel, 2013). According to Creswell (2014), a researcher uses purposeful sampling to provide “thick descriptions” for the purpose of transferability. Likewise, the survey data set(s) and historical data were also reported in the case study and examined in detail.

Dependability refers to the extent to which similar findings would be obtained if the study were repeated or corroborated over time (Anney, 2014). Thus, if the findings of a research study required confirmation in the future, the process followed should be reputable (Tight, 2017). Should data need to be retrieved at any point, the Oracle software database would be able to provide and repeat the relevant data. The interview recordings and the survey data are also available for analysis and are being kept on file if the research results needed to be confirmed at a future point in time.

Confirmability refers to the degree to which results may be confirmed and are truly based on the data and not on the characteristics or preferences of the researcher (Anney, 2014). To confirm the results of the study, statistical analysis was used to ensure that a more scientific and technically correct approach was followed (Chapter 5) than may otherwise have been the case. Furthermore, triangulation is a strong method for confirming the validity of research and also strengthens the reliability of research results (Creswell, 2014). Triangulation was thus used to corroborate the findings of the research and present the evidence in Chapter 5.

The criteria listed in Table 4.5 were used to determine the trustworthiness of the research, thus providing a solid basis for evaluating the reliability and validity of the research conducted during this study.

#### 4.6. ETHICAL CONSIDERATIONS

It is important to ensure that ethical procedures are followed when research is conducted (Marshall & Rossman, 2008:137). There are three ethical considerations that should be considered, namely, informed consent, right to privacy and confidentiality (Kruger, Ndebele & Horn, 2014:37). The ethical procedures taken into account during this study are presented in Table 4.6 below.

Table 4.6: Reference to ethical procedures

<b>Ethical procedures</b>	<b>Reference</b>
Participant information sheet	Appendix I
Consent to participate in study:	Appendix J
Ethical clearance certificate: Unisa	Appendix K
Permission letter: NCT management	Appendix L

The informed consent of the participants is critical to research ethics. It is vital that every participant understands the nature and consequences of his participation in a study before engagement in the research process (Saunders et al., 2012). Each of the participants was issued with a consent form outlining their respective roles in the research process. These forms serve as acknowledgement that the participants have consented to engage in the study included in Appendices I-J.

With regard to anonymity, the right to remain anonymous was stipulated on the informed consent form. In light of this, the two primary participants involved in the interviews were referred to as the logistics manager and operations managers of NCT, while the participants involved in the survey were referred to as the staff members of NCT in the Greytown, Pietermaritzburg and Vryheid areas. The reason for this was primarily ascribed to ethical reasons and to ensure that a more technical approach was followed when referring to the participants in the study and to clearly direct the reader in Chapter 5 of the case study.

The research was considered to be a value-adding exercise that would be beneficial to the logistics operations of the company and it was, therefore, endorsed and given the go-ahead by the commercial services manager (see Appendix L). All the ethical considerations regarding the sensitivity of NCT information were signed off by both the management of NCT and the staff members of NCT. The confidentiality of the timber growers was respected and their names not disclosed in the study. This upheld their right to privacy as recognised by NCT. Furthermore, NCT's road and rail transport pricing schedules which were used to produce the results presented in Chapter 5 were not disclosed, specifically not NCT's brokered operations rates for 2015. This was due to the risk of placing prices on public record as this would have constituted a market risk to NCT and also a violation of its right to privacy. Informed consent was granted to access the Oracle software database with a username and password, which were used exclusively for the purpose of this research. An ethical clearance certificate to proceed with the research was also issued by Unisa (University of South Africa) (Appendix K). Ethical measures are imperative to the integrity and validity of a research process (Saunders et al., 2012). It was, therefore, important to ensure that every participant understood the nature and consequences of his/her participation on the study before engaging in the research

#### **4.7. CONCLUSION**

The methods chosen and discussed in this chapter provided a strong foundation for conducting the research. The main sources of the information obtained were secondary sources from NCT's database. In addition, semi-structured interviews and survey based questionnaires were used to triangulate the data findings and gain a perspective on the road and rail operations of NCT's timber growers. The methods of data collection selected are analysed and provided the main framework for reporting on the research questions and research objectives of the study.

# CHAPTER FIVE

## OVERVIEW OF ROAD AND RAIL TRANSPORT FOR THE TIMBER GROWER

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### 5.1. INTRODUCTION

The primary objective of this chapter is to investigate and compare NCT's brokered transport costs of road and rail transport for the period 2000–2014 and determine the cost savings that may be achieved for the independent timber growers of NCT in KZN, South Africa. As highlighted in the literature review, an important role of the transport broker is to achieve the lowest possible transport costs for customers by negotiating the best possible rates with carriers (Handfield et al., 2009) and also to select the most suitable mode of transport (Hugo et al., 2009). Research suggests that typical cost reductions translate to either a per unit cost or an overall cost, or by using substitute items at a lower cost in areas such as transportation (Crimi & Kauffman, 2002; Saridogan, 2012:113). Accordingly, in order to address the primary research question: *Will an intermodal switch from road to rail transport be beneficial to the independent timber growers of NCT?* a series of secondary research questions and research objectives were first investigated. Once these questions had been addressed, the primary research question and research objective were dealt with as a concluding question in the chapter. Research in the field of logistics suggests that historical research has become an important medium for interpreting trends in subjects and behaviours in order to address the research questions and objectives (Craighead et al., 2007). The following secondary research questions were therefore addressed below:

- What are the transport options available to NCT's timber growers?
- During which period was rail considered to be the dominant mode of transport and what were the reasons for this trend?
- During which period was road considered to be the dominant mode of transport and what were the reasons for this trend?
- What are the transport costs of using road versus rail on a rand per ton basis?

- What are the differences in transportation costs for road and rail for the period 2012–2014?
- What is the opportunity cost of road transport if all volume had gone by rail for the period 2012–2014?
- What are the other criteria to consider when choosing a transportation mode?
- What were the carbon emissions of road and rail transport for NCT for the period 2008–2014?
- What are the benefits of using alternative transport solutions such as PBS vehicles for the timber growers of NCT?

In addition, to ensure a valid research framework, two, separate, semi structured interviews were conducted – one with the logistics manager and one with the operations manager. The findings from these interviews were triangulated with some of the findings of the historical data that had been retrieved from NCT’s Oracle software system. The historical data was also statistically analysed using descriptive statistics. As highlighted in Chapter 4 the reasons for were to improve the validity of the results and to confirm the findings of the research study. Thus, this chapter systematically reports the results and findings pertaining to each of the nine secondary research questions (and, by default, the corresponding research objectives) in sections 5.2 to 5.10 as a way of addressing the primary research question.

## **5.2. WHAT ARE THE TRANSPORT OPTIONS AVAILABLE TO NCT’S TIMBER GROWERS?**

The modes of NCT’s brokered transport on behalf of the timber growers are presented in Figure 5.1. Over a 14-year period, 56% of total tonnage was transported by road and 44% transported by rail. Thus, road transport retained the majority of the market share over rail transport for this period.

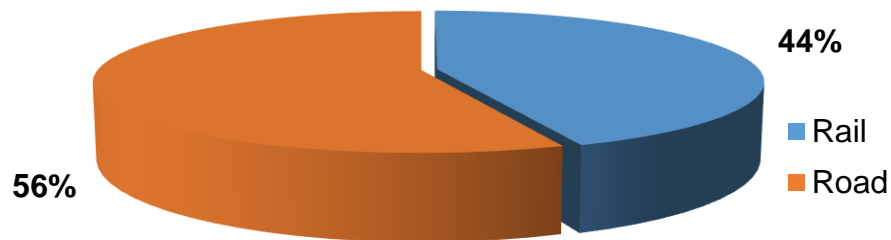


Figure 5.1: Modal split of road and rail transport for the period 2000–2014

**Source:** Adapted from: NCT Oracle software (2015)

According to the historical data, the consolidated details of the timber supplied for this period reflected that both road and rail transport played an important role in the NCT supply chain as options of transport for the timber grower. In order to gain an understanding of the reasons for the market share volumes for each mode, the tons transported by road and rail transport over a 14-year period are analysed.

### **5.3. DURING WHICH PERIOD WAS RAIL TRANSPORT CONSIDERED TO BE THE DOMINANT MODE OF TRANSPORT AND WHAT WERE THE REASONS FOR THIS TREND?**

Regarding the volumes transported by road and rail, the historical data from the years 2000–2003 shows that during this period, rail volumes were higher than road volumes as, from 2000 to 2003, rail transported between 374 291 and 52 125 tons more timber than road transport. The trends show that, for a typical year, orders for rail transport would range between 569 709 tons and 695 383 tons annually. In comparison to rail, from the year 2000, 255 163 tons were transported by road and that had gradually increased to 547 532 tons by 2003. Rail maintained market dominance during this four-year period (Table 5.1).

Table 5.1: Road and rail volumes transported for the period 2000–2014

Year	Rail tonnage	Road tonnage	Difference
2000	629 454	255 163	374 291
2001	569 709	355 584	214 125
2002	695 383	394 034	301 349
2003	599 657	547 532	52 125
2004	546 099	555 417	-9 318
2005	504 570	562 699	-58 129
2006	424 163	584 356	-160 193
2007	374 213	593 404	-219 191
2008	345 840	602 733	-266 701
2009	212 967	479 998	-267 031
2010	218 889	584 796	-365 907
2011	232 905	612 801	-379 896
2012	155 602	485 581	-329 979
2013	203 467	537 054	-333 587
2014	316 248	611 243	-294 995
Total	6 029 166	7 762 394	-1 733 229

**Source:** Adapted from: NCT Oracle software (2015)

The two separate semi-structured interviews that were conducted with the logistics manager and operations manager of NCT provided the following information as the reasons for using rail as a primary mode of transport for the period 2000–2003. Below are direct quotes from the transcriptions of the interviews.

### **The NCT supply chain: Rail as the dominant mode 2000–2003**

Timber Growers and markets: Preference – rail

- “In those days it was sixty percent rail and forty percent road. There was more on rail” (NCT Logistics Manager, 2015).
- During this period, “BayFibre (NCT’s market) had a much higher rail capacity. “The mills were geared to take more rail than what they are currently taking” (NCT Logistics Manager, 2015).
- During this period, “Rail provided flexible loading times for the timber grower. When a road vehicle arrives it needs to be loaded and departed within 1 ½ hours – 2 hours whereas, with the rail, you are given at least 24 hours to load the wagon. That was important for a lot of the smaller scale timber growers who did not have access to big capital equipment to load a road truck” (NCT Logistics Manager, 2015).
- Timber growers (members of NCT) preferred rail: “I think a lot of it also had to do with the members during this time” (NCT Operations Manager, 2015).

#### Modal performance rail: Price and service

- The “rates were good; the service was good” (NCT Logistics Manager, 2015).
- “If we were close enough to a railway siding, rail would have always been your best option” (NCT Operations Manager, 2015).

#### **Transnet’s services: Good**

- “There was a lot of collaboration between an entire industry and Transnet Freight Rail” during this period (NCT Logistics Manager, 2015).
- The project “Thuthihlathi became the benchmark for Transnet and that is what grew our volume so much during that time” (NCT Logistics Manager, 2015).
- There was commitment from TFR at the time “We had the key account managers” servicing the timber supply chain (NCT Logistics Manager, 2015).

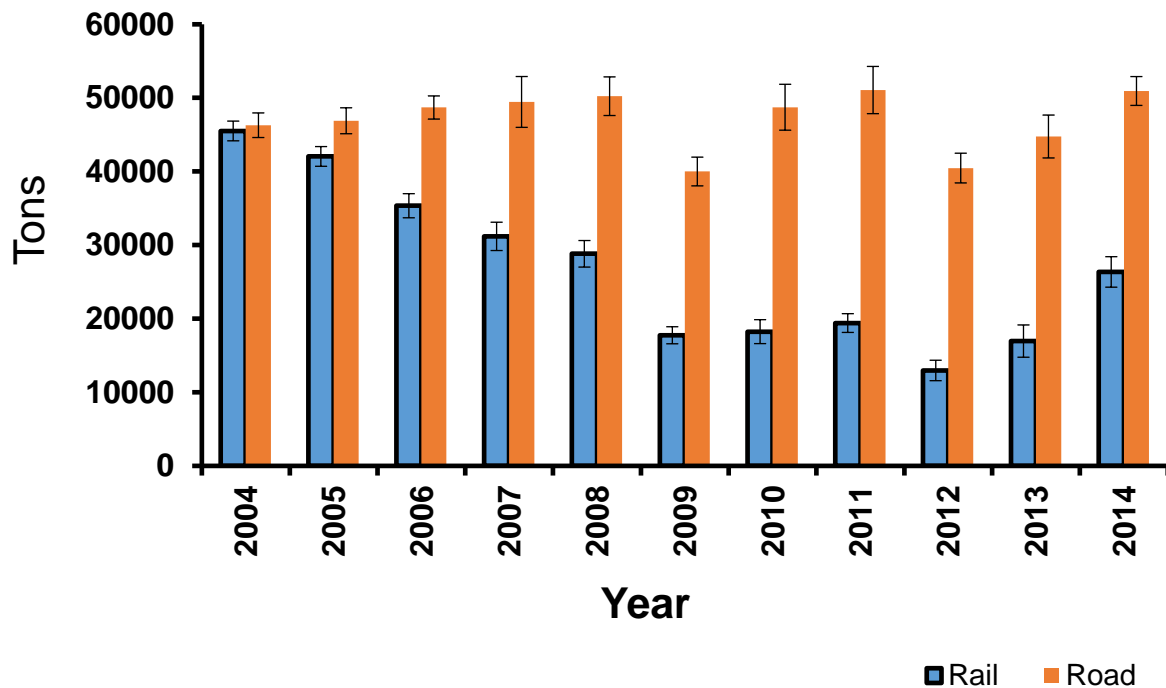


- “We had weekly interface meetings” with Transnet Freight Rail (NCT Logistics Manager, 2015).
- “We had monthly corridor meetings” with Transnet Freight Rail (NCT Logistics Manager, 2015).
- Because of “the focus and the collaboration” during this period, volume grew with rail (NCT Logistics Manager, 2015).
- Transnet Freight Rail was able to provide a good service and “actually service the trucks as much as they could” during this period (NCT Operations Manager, 2015).
- There was confirmed commitment by Transnet Freight Rail “and it was industry wide” (NCT Logistics Manager, 2015).

Based on the triangulation of the findings from the interviews with the historical data, it was evident that during this period rail was the preferred mode of transport owing to the high service levels, commitment and affordable tariff structures offered to the timber industry by Transnet Freight Rail (TFR), also known as Spoornet at the time. However, the variance between road and rail transport indicated in Table 5.1 also shows that, although road transport was substantially lower than rail from 2000 to 2002, from 2003 a smaller variance between the two of 52 125 tons was evident as compared to the previous year’s volumes. This was the start of a gradual shift of volume from rail back to road.

#### **5.4. DURING WHICH PERIOD WAS ROAD TRANSPORT CONSIDERED TO BE THE DOMINANT MODE OF TRANSPORT AND WHAT WERE THE REASONS FOR THIS TREND?**

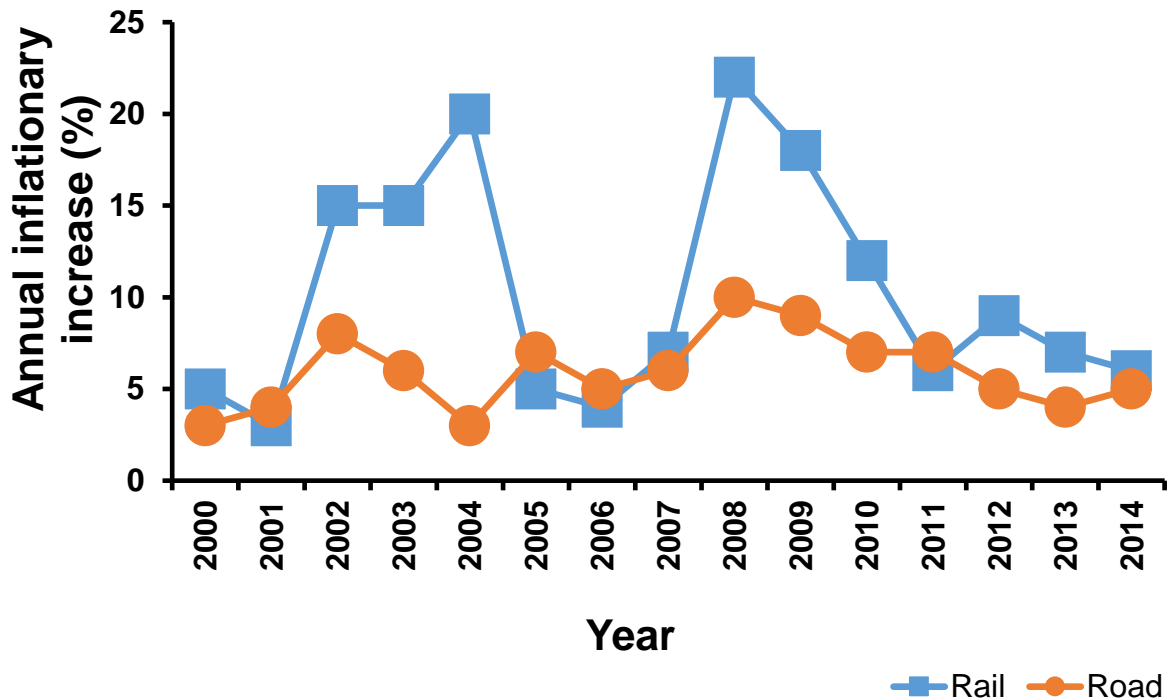
Although the volumes transported by rail remained high from 2000 to 2003, the road tonnages increased significantly over the same period – from 255 163 tons in 2000 (Table 5.1) above, to over half a million tons in year 2004. Since 2004, road transport steadily dominated market share until 2014.



**Figure 5.2:** Average monthly tons transported for the period 2004–2014

**Source:** Adapted from NCT Oracle software (2015)

It is clear from the statistical analysis of the historical data (Figure 5.2) that the standard error bars (SE) did not overlap at a 95% confidence interval (CI). This was an indication that the average monthly tons transported by road from 2005 onwards was significantly higher ( $p < 0.05$ ) than that transported by rail. This trend continued consistently until 2014, with obvious large differences in volume between road and rail transport. In order to address the reasons for using road as the primary mode of transport during this period, it was necessary first to investigate why the shift from rail to road transport had occurred. The shift from rail to road transport had an important impact on the annual inflationary increases to transport costs as highlighted in Figure 5.3. Cost components such as direct wages, tyres, fuel and spares for road transport and steel, electricity and foreign exchange for rail transport are factored into the annual contract price adjustments for road and rail transport (Forestry South Africa, 2012b; SEIFSA, 2015).



**Figure 5.3:** Annual inflationary transport cost increases for road and rail transport from 2000–2014  
**Source:** NCT (2015a)

For the period 2000 to 2001 the road and rail transport annual inflationary increases were more or less on par with each other at approximately about 7 and 8% (Figure. 5.3). However, for the period 2002 to 2004, the annual inflationary increases for rail transport increased to approximately 20% while road transport remained below 10% for this three-year period (Figure. 5.3). The gradual shift from rail to road transport started to occur around 2004 after these increases had been implemented by Transnet Freight Rail (TFR). It is evident from Table 5.1 that both modes of transport had competed quite strongly with each other in terms of volumes transported from the period 2003 to 2005, each retaining a market share of over half a million tons. The reason for this trend is that, during this period, the total inflationary increases for rail were approximately 40% whereas those for road transport increased to 16% only. There was therefore strong intermodal competition evident at this stage. From 2005 to 2014 rail transport encountered further substantial transport cost increases of approximately 96% in comparison to road transport which increased by 65% for this period. The differences in inflation prices between 2000 and 2014 for road and rail transport are presented in Table 5.2 below.

**Table 5.2:** Descriptive values for inflation price increase (%) for the period 2000–2014

Type	Maximum %	Minimum %	Average %	Standard deviation	P value (rail vs road)
Rail	22	3	10.27 ± 1.61	6.25	
Road	10	3	5.93 ± 0.54	2.09	0.021**

**Note:** \*\*p < 0.05

Based on the statistical analysis of the historical data, Table 5.2 shows that, on average, from 2000–2014 the annual inflation increases for rail transport were significantly higher ( $p < 0.05$ ) as compared to those for road transport for a given p-value of 0.021. Over the 14-year period, rail increased by 154% while road transport increased by 89% (Figure 5.3). The higher P value ( $p < 0.05$ ) may be a strong motivator for using road transport instead of rail transport. In addition to this result, the two, separate, semi-structured interviews that were conducted with the logistics manager and the operations manager of NCT provided the following information as to the reasons for using road as a primary mode of transport for the period 2004–2014. Below are direct quotes from the transcriptions of the interviews.

### **The NCT supply chain: Road as the dominant mode 2004–2014**

#### Price: Inflation and cost

- According to the logistics manager of NCT, the shift from road to rail “was price related. “It was inflation increases. That was year on year increases and, when you get twenty-two percent a year inflation, there is a problem” (NCT Logistics Manager, 2015).
- “You must remember as well, on the rail side, you have got a short haul cost, a double handling cost and, as soon as you calculate those increases, it brought the road and rail back to line. In some cases the rail was more expensive than the road” (NCT Logistics Manager, 2015).

## Timber growers and markets: Preference – road

- “Markets are geared more to accommodating road than rail” (NCT Logistics Manager, 2015).
- With road transport “We can service members that are further away. Road is the only option that they have got” to gain market access (NCT Operations Manager, 2015).
- “It is a lot more involved by doing rail than there is by road for the timber grower” (NCT Operations Manager, 2015) If a timber grower uses rail, “he has got to load it, he has got to take it to the railway siding, he has to sort out the railway side, he has got to consign it, he has got to release it” (NCT Operations Manager, 2015).
- With rail it takes longer to transport timber to markets for the timber grower – “it might take up to 7–12 days” (NCT Logistics Manager, 2015).
- Timber growers “are actually more geared up to be able to take road” (NCT Operations Manager, 2015).

## Modal performance road: Convenience, reliability speed and high cost

- Road transport is associated with speed “if you load on your farm this morning, a timber grower will be getting paid this afternoon effectively. Almost immediate gratification for the timber grower, your truck is over the weighbridge”, resulting in quicker turnaround times with road (NCT Logistics Manager, 2015).
- “Road is more expensive”, especially with rising fuel prices (NCT Operations Manager, 2015)
- Timber growers are willing to pay more for the convenience and reliability of road transport. Price and service are equally important, “price is important,

but, if you get really good service, your price could probably even be R5 more” for road transport (NCT Logistics Manager, 2015).

- Road is associated with “very quick turnaround”, times and is “reliable” (NCT Operations Manager, 2015).
- With road it has become about “convenience” (NCT Operations Manager, 2015).

Transnet’s services: Poor

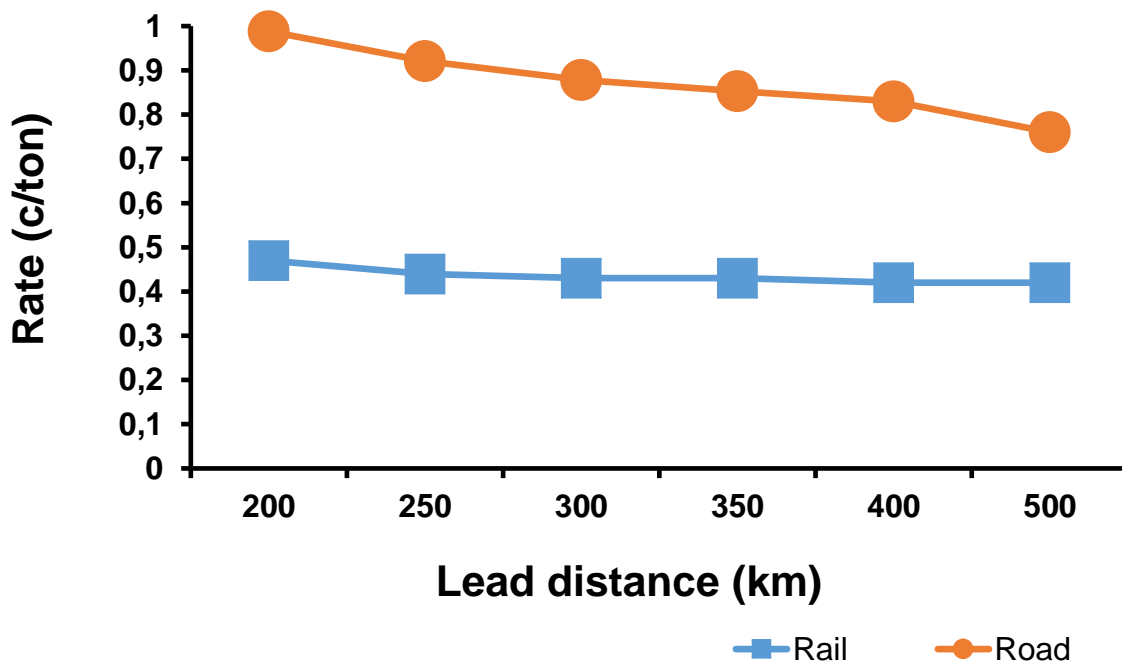
- “I honestly believe the current failing of rail is a staff issue. It is a management issue. If it was managed better, we would see much better results” (NCT Logistics Manager, 2015).
- “I also think that Transnet has been on a big centralisation drive. They have taken a lot of the responsibility and accountability away from the regions”, resulting in poor service (NCT Logistics Manager, 2015).
- “They should be making people accountable. Put the guys on the ground and say you are responsible to run this train” (NCT Logistics Manager, 2015).
- There are technical and service issues with TFR’s service. “Trains do not have the enough pulling power. They (TFR) are not maintaining their fleets correctly. They are not managing their fleets correctly. Until they get a whole change of business thought on how to manage it, then only can rail improve” (NCT Operations Manager, 2015).
- “There is a lot of reasons why people don’t do rail anymore. Something we haven’t even touched on was theft”. There is a safety issue there” (NCT Operations Manager, 2015).

Based on the triangulation of the findings from the interviews with the historical data, it was evident that the annual increases that had been imposed by Transnet were

uncompetitively high while service levels had also started to decline, resulting in road becoming a far more attractive option for timber transport than rail.

### 5.5. WHAT ARE THE TRANSPORT COSTS OF USING ROAD VERSUS RAIL ON A RAND PER TON BASIS?

Since 2012, a third of transport costs have been linked to the cost of fuel which increased to over 40% in 2014 (Havenga et al., 2014; CSIR, Imperial Logistics & Stellenbosch University, 2013:8). This has resulted in successive increases in timber transport costs. In the literature review, it was noted that cost reductions in supply chains often require a price performance analysis to determine whether it is possible to realise cost savings (Blecker et al., 2012). As suggested by Gibson et al. (2014), the cost per ton of road and rail transport may be used to manage performance and thus a pricing analysis of road and rail transport was conducted for the purpose of this study.



**Figure 5.4:** Rate per (c/ton) over lead distance (km) for road and rail transport: 2015

**Source:** NCT (2015b)

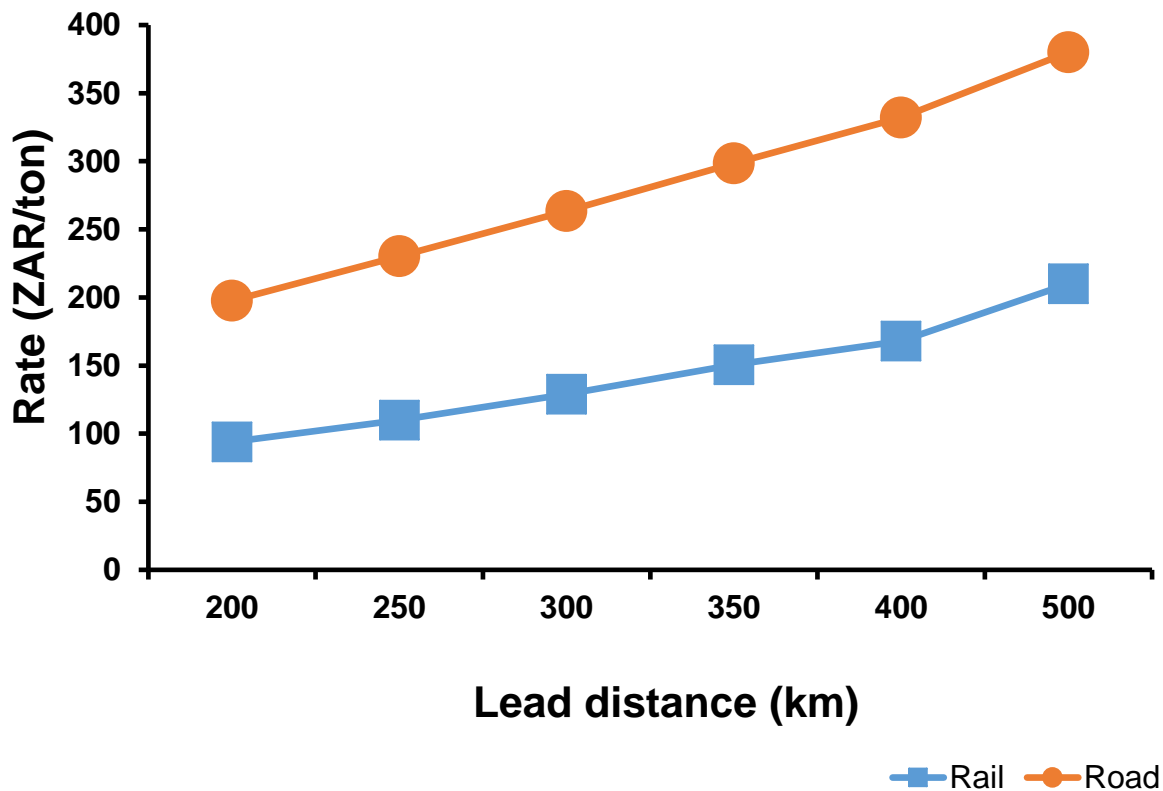
Figure 5.4 extrapolates the cent per ton kilometre costs of road and rail transport for NCT based on the volumes transported over specific lead distances at the time. The

cent per ton kilometre charge for rail (250-500km) ranged between 0.44 and 0.42 c/t, while the cent per ton kilometre charge for road (250-500km) ranged between 0.92 and 0.76 c/t. As stated by Crimi and Kauffman (2002) and Saridogan (2012), cost reductions may translate into either a per unit value or an overall cost in areas such as transportation. Figures 5.4 and 5.5 justify rail as a far more affordable transport option in comparison to road transport, especially over longer distances.

As alluded to in section 3.4.2, cost is a key determinant in managing performance in supply chains and thus the cost per ton of road and rail transport may be used to manage performance (Gibson et al., 2014). Figure 5.4 shows the cent per ton charges for road and rail over a given lead distance. At 200 kilometres the cost by road transport is approximately 0.99 cents per ton kilometre in comparison to rail which costs approximately 0.47 cents per ton kilometre. This equates to a 0.52 savings cents per ton kilometre if rail is used over a given lead distance of 200 kilometres. Similarly, at 500kms the cost by road equates to approximately 0.76 cents per ton kilometre in comparison to rail, which costs 0.42 cents per ton kilometre. This equates to a savings of 0.34 cents per ton kilometre if rail is used over the longer distance. Figure 5.5 below illustrates the rand value savings of road and rail.

Figure 5.5 further indicates that the rand per ton charge also follows a similar trend as Figure 5.4. At 200 kilometres (km) the cost by road transport is approximately R197.60 per ton in comparison to rail which costs approximately R94.00 per ton. This equates to a R103.00 per ton difference in transport costs. Similarly, at 500kms, the cost by road transport is approximately R380.00 per ton in comparison to rail transport, which costs approximately R210.00 per ton. This equates to a R170.00 per ton difference in transport costs.





**Figure 5.5:** Rate per (ZAR/ton) over lead distance (km) for road and rail transport: 2015

**Source:** NCT (2015b)

The methodology used to calculate these costs was based on taking the **[(lead distance (km) X cent per ton kilometre (c/ton)) = Rand per ton]**. For example, a road tariff is calculated as follows:

$$[200 \text{ (km)} \times 0.988 \text{ (c/ton)}] = \text{R}197.60 \text{ per ton.}$$

The same methodology applies to rail:

$$[200 \text{ (km)} \times 0.47 \text{ (c/ton)}] = \text{R}94.00 \text{ per ton.}$$

The cent per ton kilometre was taken from the Steel and Engineering Industries Federation of Southern Africa (SEIFSA), Tables L2, which were used to extrapolate the cent per ton prices for NCT’s timber growers over a given distance and referred to as the NCT Brokered Operations Rates 2015b.

When this trend was examined in further detail, it became evident that, over the longer distance, rail is cheaper than road. The reasons for rail transport being considered a cheaper mode of transport, especially over long distance, was due to the cheaper rail tariffs offered to the timber growers of NCT in comparison to the road transport tariffs offered. This can be justified based on the theories of economies of scale presented by Pienaar (2010) as discussed in section 3.4.2 of the literature review. Although both road and rail transport have high variable costs, it is possible to manage the variable costs for rail transport, thus allowing for 'piggybacking', as well as the longer distance covered by rail tracks. This demonstrated that rail transport users benefit from the longer distance travelled which effectively reduce the fuel utilisation and, therefore, the ton/kilometre charge for rail transport. However, rail requires sufficient volume to be operational over the longer distance (Hill & Jones, 2013). According to the operations manager of NCT, "to run a train, a minimum of twenty rail trucks is required on certain rail branch lines which involves pooling of volumes" if the economic benefits of rail transport are to be capitalised on (NCT Operations Manager, 2015). This was also mentioned in the literature review when it was noted that rail is able to offer cost reductions if there is a sufficient volume transported as the fixed costs are spread over larger volumes (Hill & Jones, 2013; Department of Transport, 2015b). According to Handfield et al. (2009:200), companies should take note of cost change strategies in pricing structures and volume to decrease supply chain costs, for example (New Price - Prior Price) X Estimated Volume. Similarly, in this study the cost change strategy from road to rail transport was analysed in Figure 5.6 to graphically reflect the change in pricing for each mode for a given volume hauled over set distance intervals. Table 5.3 provides a more detailed breakdown, indicating the difference in road and rail transport pricing for set volumes hauled for NCT over set distance intervals.

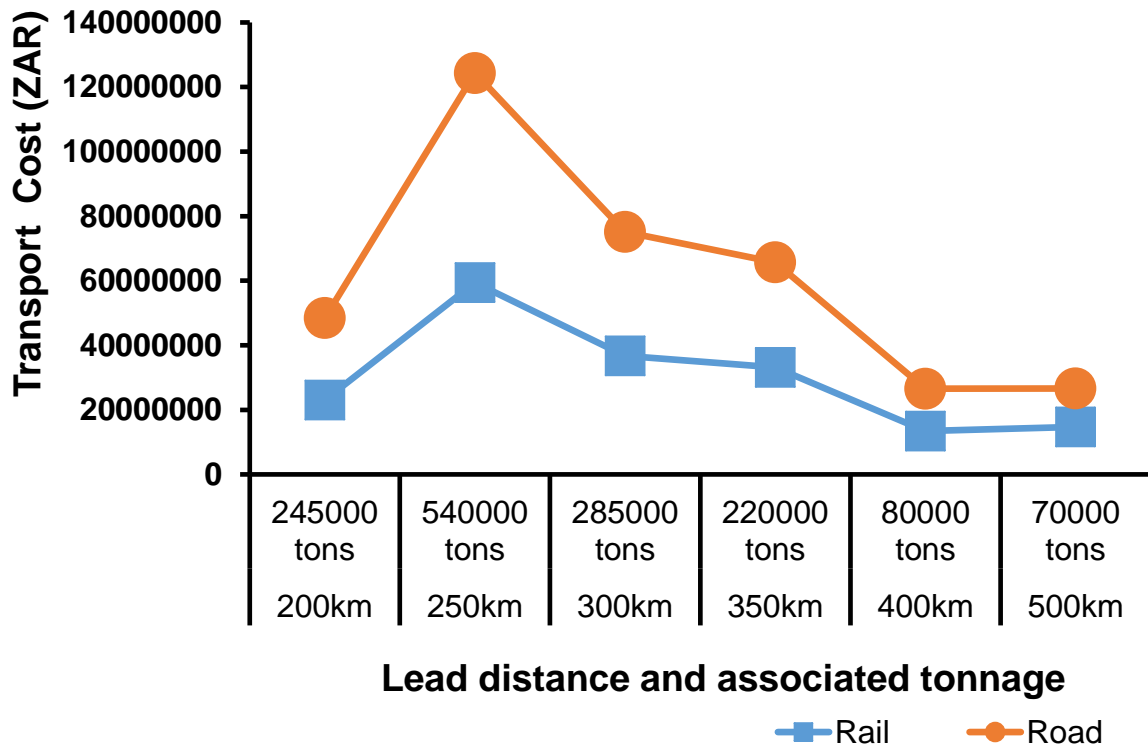


Figure 5.6: Transport cost comparison for road and rail based on volumes transported over lead distances: 2015

Source: NCT (2015a; b)

Table 5.3: Difference in road and rail transport pricing for set volumes hauled over set distance intervals: 2015

Kilometres	Current volumes hauled (Tons)	Rail cost (ZAR)	Road cost (ZAR)	Savings if everything went by rail (ZAR)
200 km	245 000	23 030 000	48 421 800	25 391 800
250 km	540 000	59 400 000	124 329 600	64 929 600
300 km	285 000	36 765 000	75 083 250	38 318 250
350 km	220 000	33 110 000	65 681 000	32 571 000
400 km	80 000	13 440 000	26 560 000	13 120 000
500 km	70 000	14 700 000	26 600 000	11 900 000
<b>Total</b>	<b>1 440 000</b>	<b>180 445 000</b>	<b>366 675 650</b>	<b>186 230 650</b>

Source: NCT (2015a; b)

Figure 5.6 presents the road and rail transport costs in relation to the average volumes hauled annually over lead distance for the timber growers of NCT. This analysis is

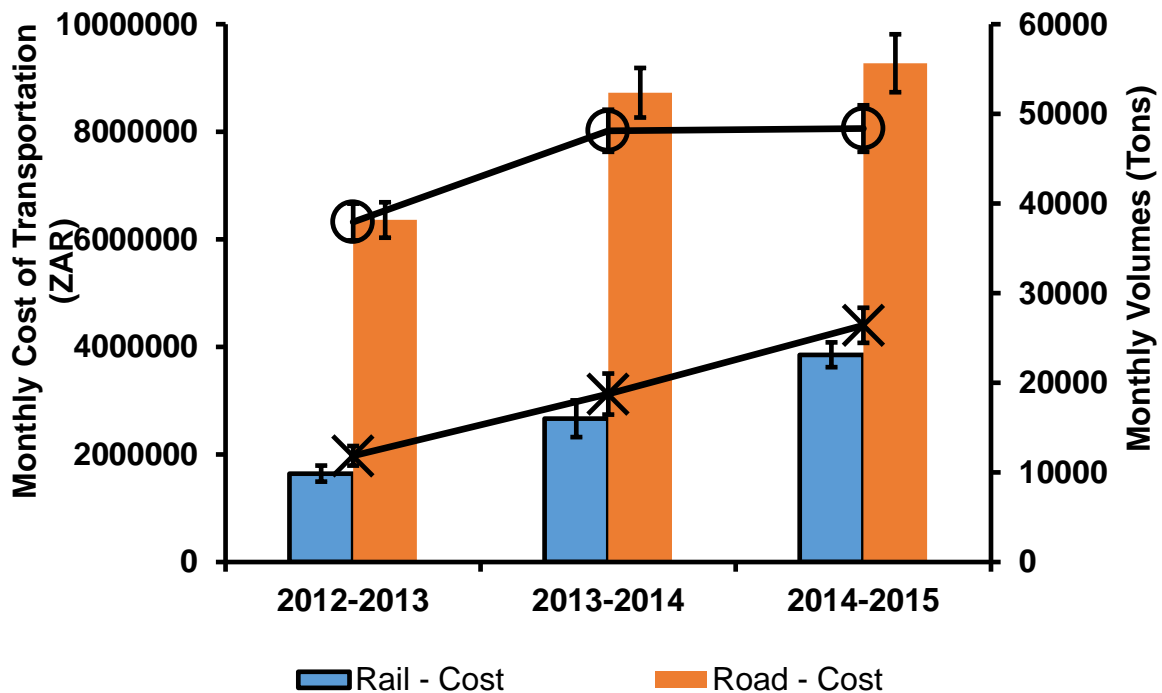
further quantified in Table 5.3, which depicts the total monetary savings for all tonnage of timber by rail. If the monetary cost of these current volumes, which equates to a total 1 440 000 tons between a lead distance of 200 to 500 km, were compared for road and rail transport, road would cost a total of R366 675 650 whereas rail would cost R180 445 000. This indicates a savings of R186 230 650 if this volume were to go by rail instead of road. This demonstrates that the use of substitute items at a lower cost, as suggested by Crimi and Kauffman (2002) and Russel et al. (2014), may assist in savings in areas such as transportation. However, at the time of the study there was excessive dependence on timber transport by road – the reasons for which were noted above. The impact of this on the logistics cost of road transport is examined next.

#### **5.6. WHAT ARE THE DIFFERENCES IN TRANSPORTATION COSTS FOR ROAD AND RAIL TRANSPORT FOR THE PERIOD 2012–2014?**

In the literature review it was noted that studies on the measurement of transport costs affirmed that traditional costing approaches are based on both economic and financial accounting measures (Wood, 1984). This study identified that output is a key economic function of transport activity (Wood, 1984; Meersan & Van de Voorde, 2013; Rodrigue, 2013). Accordingly, in this section, economic measures, such as moving averages and standard deviations, are used to reflect the spread and dispersion of the values associated with the transport costs which were incurred for the tonnage (output) transported by road and rail transport. Using this approach also provided for a technically correct method of measuring volume in relation to costs for NCT's transport operations. Figure 5.7 presents the histogram of transport costs for the 2012, 2013 and 2014 financial years. The 2014 financial year concluded in February 2015.

As revealed in the statistical analysis of the historical data (Figure 5.7), the standard error bars (SE) did not overlap at a 95% confidence interval (CI). As a result, the difference in transport costs for road and rail from 2012–2015 demonstrated a significantly higher ( $p < 0.05$ ) transportation cost associated with road transport as compared to rail, as well as significantly higher ( $P < 0.05$ ) volumes for road transportation. Thus, this provided evidence that the logistics cost of transport was excessively higher for road transport as compared to rail transport and as presented

in Table 5.4. This table presented the mean values and corresponding standard deviations of the costs and volumes for both modes of transport.



**Figure 5.7:** Monthly cost of road and rail transport for the period 2012–2015

**Source:** NCT Annual Operations Reports (2012–2014)

Table 5.4: Descriptive values of the costs of transportation using road and rail

Mode	Year	Mean (ZAR)	Mean (Tons)
Rail	2012–2013	1 644 216.54 ± 517 393.68	11 851 ± 3781
Rail	2013–2014	2 663 856.72 ± 1 181 978.75	18 739 ± 7934
Rail	2014–2015	3 853 570.32 ± 798 830.39	26 409 ± 6782
Road	2012–2013	6 359 840.06 ± 1 140 912.79	37 932 ± 7103
Road	2013–2014	8 725 753.00 ± 1 596 401.57	48 111 ± 8126
Road	2014–2015	9 273 564.32 ± 1 865 678.86	48 358 ± 8982

Table 5.4 reveals that road costs were significantly higher based on the observed differences in the mean monthly costs as compared to rail transport costs. Furthermore, for each reporting period the minimum road transport cost was still higher

than the maximum rail transport costs recorded. This may be a strong reason for using road transport instead of rail transport for the timber growers of NCT. According to the logistics and operations managers, the cause of the high transport costs on road included increases in the fuel price, thus providing evidence that road was an expensive mode of transport and that rail was still considered to be a far cheaper option. However, the key issue of poor service delivery by the railways has promoted road transport as the preferred mode of transportation (NCT Operations Manager, 2015). This section demonstrated that the logistics cost for road transport was substantially higher than for rail. As noted in Chapter 1, this is a significant cost that not only hampers the growth and sustainability of the timber growers of NCT, but also the forestry industry as a whole and this impacts on the economy as a whole.

#### **5.7. WHAT IS THE OPPORTUNITY COST OF TRANSPORT IF ALL VOLUME HAD GONE BY RAIL FOR THE PERIOD 2012–2014**

As noted in the literature study, supply chains offer the opportunity to save costs and are therefore considered to have a financial impact on an organisation. This in turn has an impact on the stakeholders (Coyle et al., 2013). Seeing that NCT endeavours to provide the best financial returns for their members, the switch from road to rail transport was considered as a potential cost saving opportunity. The opportunity cost of using road transport was calculated by using the future value formula to show the savings that may be achieved if all volume went by rail. An interest rate of 12% was applied. The rationale for using this interest rate of 12% to quantify the savings of investment was based on the interest rates charged by South African banks for 2015. These ranged between 10.05% and 13.73% for long-term investments, thus averaging 11.89%. Hence, for the purpose of this study, 11.89% was rounded off to 12% (Deposits.org, 2015).

In economic terms, opportunity cost is defined as the value of an activity forgone when an alternative activity is chosen (Dorman, 2014:61). It was therefore considered an important element in the decision-making regarding the switch from road to rail transport. The following results are based on the source data presented in Table 5.5. The source data in Table 5.5 consists of the outbound transport costs for road and rail

volumes. These volumes and costs were then used to calculate the opportunity cost of transport if all volume had gone by rail for the years 2012, 2013 and 2014.

**Table 5.5:** Outbound transport costs and volumes using road and rail: 2012–2014

Year	Rail and road combined volumes (Tons)	Rail and road combined cost (ZAR)
2012	597 404 11	96 048 680
2013	802 198 45	136 675 316
2014	897 209 81	157 525 616

**Source:** NCT Annual Operations Reports (2012–2014)

The outbound transport costs for all freight moved by rail, as indicated in Tables 5.6, 5.7 and 5.8 below, were calculated by using the rail and road combined volumes (tons) X (average rail rate). The most recent average rail rate was used for the purpose of this study in order to accurately calculate the opportunity cost if all volume had gone by rail for the timber growers of NCT. The average rail rate at the time of the study and according to NCT’s road and rail operations report equated to approximately R150.00 per ton (NCT Operations Report, 2014). For example, for the period 2012: 597 404 11 tons X R150.00 = R89 610 617. The same calculations were used for the periods 2013 and 2014.

### 5.7.1. Transport opportunity costs using road transport in 2012

For the 2012 financial year, the actual transport cost for road and rail equated to R96 048 680. If all the timber volume had been transported by rail this would have cost the timber grower R89 610 617 with a savings of approximately R6 438 063 (Table 5.6). If these savings had been invested over a three-year period (2013–2015) at a rate of 12%, the opportunity cost of using road transport would have amounted to R9 045 015.

**Table 5.6:** Transport cost differences in 2012

Transportation	Costs (ZAR)
Road and rail	96 048 680
All freight was moved by rail	89 610 617
Transport cost difference	6 438 063

$$FVn = PV0 \times (1+i/m)^{(n \times m)}$$

$$FVn = 6\,438\,063 \times \left(1 + \left(\frac{0.12}{1}\right)\right)^{1 \times 3}$$

$$FVn = 6\,438\,063 \times (1.1200)^3$$

$$FVn = 6\,438\,063 \times (1.404928)$$

$$FVn = 9\,045\,015$$

### 5.7.2. Transport opportunity costs using road transport in 2013

For the 2013 financial year, the actual transport cost for road and rail transport equated to R136 675 316. However, if all the timber volume had been transported by rail transport, this would have cost the timber grower R120 329 768 with a savings of approximately R16 345 549 (Table 5.7). If these savings had been invested over a two year period (2014 and 2015) at a rate of 12%, the opportunity cost for using road transport would have amounted to R20 503 857.

**Table 5.7:** Transport cost differences in 2013

Transportation	Costs (ZAR)
Road and rail	136 675 316
All freight was moved by rail	120 329 768
Transport cost difference	16 345 549

$$FVn = PV0 \times (1+i/m)^{(n \times m)}$$

$$FVn = 16\,345\,549 \times \left(1 + \left(\frac{0.12}{1}\right)\right)^{1 \times 2}$$

$$FVn = 16\,345\,549 \times (1.1200)^2$$



$$FVn = 16\,345\,549 \times (1.2544)$$

$$FVn = 20\,503\,857$$

### 5.7.3. Transport opportunity costs using road transport in 2014

For the 2014 financial year, the actual transport cost for road and rail transport equated to R157 525 616. However, if all the timber volume had been transported by rail it would have cost R134 581 471 with a savings of approximately R22 944 143 (Table 5.8). If these savings had been invested over a one year period (2015) at a rate of 12% the opportunity cost of using road transport would have amounted to R25 697 440.

**Table 5.8:** Transport cost differences in 2014

Transportation	Costs (ZAR)
Road and rail	157 525 616
All freight was moved by rail	134 581 471
Transport cost difference	22 944 143

$$FVn = PV0 \times (1+i/m)^{(n \times m)}$$

$$FVn = 22\,944\,143 \times \left(1 + \left(\frac{0.12}{1}\right)\right)^{1 \times 1}$$

$$FVn = 22\,944\,143 \times (1.1200)^1$$

$$FVn = 22\,944\,143 \times (1.1200)$$

$$FVn = 25\,697\,440$$

### 5.7.4. Summary of opportunity cost savings using road transport for the period 2012–2014

If NCT had used rail transport as the main mode for timber transport from 2012 to 2014, based on the results above, timber growers would have saved approximately R55 246 313 and this amount could have been invested in alternative timber farming operations. The opportunity costs over the three-year period are presented in Table 5.9.

**Table 5.9:** Transport opportunity cost summary from 2012–2014

<b>Year</b>	<b>Opportunity costs (ZAR)</b>
2012	9 045 015
2013	20 503 857
2014	25 697 440
<b>Total</b>	<b>55 246 313</b>

However, the results above represent an ideal scenario. In addition, several other criteria that are important in servicing the NCT supply chain would also have had to have been met by rail transport. For example, criteria such as reliability, flexibility, supply chain visibility, affordable rates and on-time delivery would need to have been met by rail transport in order to move the required volumes by road. These criteria are discussed in section 5.8. As highlighted in the literature review, financial benefits and customer service should be aligned with each other.

## **5.8. WHAT ARE THE OTHER CRITERIA TO CONSIDER IN DECIDING ON THE CHOICE OF TRANSPORTATION MODE?**

As noted in the literature review, transport brokers are also involved in selecting the most suitable transport mode with the aim of reducing supply chain costs as a value-added service by acting as intermediaries to various organisations and carriers (Hugo et al., 2009). Therefore, selecting the right mode plays an important role for a transport broker, such as NCT that is involved in brokering transport as a value-added service to the timber growers of NCT. A survey based questionnaire was conducted in the study as a means of addressing the dominant criteria used in evaluating a modal switch from road to rail and as suggested by the research discussed in section 3.4.4 in Chapter 3. This analysis may not address the total cost of ownership model due its complex nature but it does evaluate some of the dominant criteria used in intermodal studies on selecting the suitable choice of mode as noted in Chapter 3 of the study.

The survey (Appendix B) assessed road and rail transport based on the following five key criteria, namely, reliability, flexibility, supply chain visibility, and total transport

time. These survey questionnaires were issued to each of the six participants in the Greytown, Pietermaritzburg and Vryheid areas with two participants representing each sample geographical area surveyed. Each participant was requested to evaluate road and rail transport based on a scoring system designed to rank the performance of each mode. A total of 4 points on an ordinal scale rating, namely, 1 – poor, 2 – average, 3 – good and 4 – excellent, was used to rank the performance of road and rail transport in each of the geographical areas surveyed.

Table 5.10 and 5.11 evaluates the data collected from the six sample surveys. A total of 24 points was used to determine the consolidated scores of road and rail using the following scale: 1–11 (Poor), 12–14 (Average), 15–20 (Good), 21–24 (Excellent). Tables 5.10 and 5.11 below present an analysis of the key performance criteria for each transport modes for each geographical area, namely, Greytown, Pietermaritzburg and Vryheid. The data used to tabulate the figures in Tables 5.10 and 5.11 was obtained from the six geographical surveys (Appendices C to H) which provided each of the scores below.

**Table 5.10:** Service provider evaluation: Rail

Geographical area	Reliability	Flexibility	Supply chain visibility	Rates	Total transport time	Total
Greytown	3/4	2/4	2/4	3/4	3/4	13/20
Greytown	4/4	3/4	3/4	4/4	3/4	17/20
Pietermaritzburg	1/4	1/4	1/4	3/4	2/4	8/20
Pietermaritzburg	1/4	1/4	1/4	3/4	2/4	8/20
Vryheid	1/4	2/4	2/4	2/4	2/4	9/20
Vryheid	2/4	2/4	2/4	2/4	1/4	9/20
Totals	12/24	11/24	11/24	17/24	13/24	64/120
Performance ranking	Average	Poor	Poor	Good	Average	

**Source:** See appendices C–H

Table 5.10 presents the data analysis of how rail transport scored for each of the geographical areas of evaluation. Rail transport scored the highest for the rates criterion, followed by total transport time, reliability, flexibility and supply chain visibility.

Total transport time and reliability of rail transport, in particular for the Greytown area, increased the rail transport scoring due to the high levels of service in the area at the time of the study (Appendices C–D). On the other hand, supply chain visibility and flexibility impacted negatively on the scoring for rail transport, especially in the Pietermaritzburg area (Appendices E-F) and Vryheid area (Appendices G–H).

**Table 5.11:** Service provider evaluation: Road

Geographical area	Reliability	Flexibility	Supply chain visibility	Rates	Total transport time	Total
Greytown	3/4	3/4	3/4	3/4	4/4	15/20
Greytown	3/4	2/4	3/3	3/4	3/4	14/20
Pietermaritzburg	3/4	2/4	3/3	2/4	3/4	13/20
Pietermaritzburg	2/4	2/4	3/4	2/4	3/4	12/20
Vryheid	2/4	2/4	2/4	2/4	3/4	11/20
Vryheid	3/4	3/4	3/4	3/4	3/4	15/20
Totals	16/24	14/24	17/24	14/24	19/24	80/120
Performance ranking	Good	Average	Good	Average	Excellent	

**Source:** See Appendices C-H

Table 5.11 presents the data analysis of the road transport scores for each of the geographical areas of evaluation. Road transport scored the highest for total transport time, followed by supply chain visibility, reliability, flexibility and rates for all three of the geographical areas (Appendices C-H). On average, there were no distinct variances in the road transport scores between the three geographical areas. Road transport scored a total of 80/120 points in comparison to rail which scored 64/120. However, for the rates criterion, rail transport scored higher than road by 3 points, thus indicating that rail is a more affordable mode of transport than road in terms of price. On the other hand, the poor performance of rail in relation to the criteria of reliability, flexibility supply chain visibility and total transport time needs to improve further. Likewise, the average performance of road for the criteria of flexibility and rates could also improve further in respect of the NCT supply chain.

Table 5.12 provides a further analysis of the results further in an effort to determine whether the mean percentage scores differed significantly each of the modes. The descriptive values of the overall rail and road scores are presented in this table. These descriptive parameters of importance included the mean percentage, standard error of the mean, minimum and maximum values observed.

**Table 5.12:** Critical service provider report

Supplier	N	Mean	Std. Error of mean	Median	Minimum	Maximum
Rail	6	58	7	55	40	85
Road	6	68	4	73	55	75

Table 5.12 highlights that the mean percent score for road transport was higher than that for rail transport. However, based on the observed standard errors of the mean, the results showed that road transportation did not significantly differ from rail transport. It should, however, be noted that a larger sample size may have contributed to a greater confidence in the statistical significance of the observed results. Overall, the information presented in Table 5.12 shows that, in general, the timber growers preferred road transportation to rail transportation.

A general analysis of variance (ANOVA) was performed to determine whether the rail and road scores percentages obtained from the respondents demonstrated a statistically significant ( $p < 0.05$ ) difference between the two modes of transport. The results from the (ANOVA) are presented in Table 5.13. The (ANOVA) was run with the rail and road transport modes as separate groups. As alluded to in Table 4.3, Chapter 4, if the F-statistic is between the 1% and 5% then the differences between groups (road and rail) is not statistically significant ( $p > 0.05$ ) at the 95% confidence level. This emerged in Table 5.13 with F-statistics of 1.882. Furthermore, the corresponding p-value of 0.2 also indicated a lack of significance at the required confidence level. This is in line with the results presented in Table 5.12, which showed that overall the performance of rail transport was not significantly higher than that of road transport according to the survey respondents.

**Table 5.13:** Anova table

Overall score	Sum of squares	df	Mean square	F	Sig.	P value
Between groups (Combined)	352.083	1	352.083	1.882	0.200	0.2***
Within groups	1870.833	10	187.083			
Total	2222.917	11				

**Note:** \*\*\* ( $p > 0.05$ )

The survey respondents also made various comments in relation to the road and rail operations for each of the geographical areas. The specific details of these comments are provided in Appendices C to H. The details of the comments are summarised below.

### **Pietermaritzburg – Appendices E-F**

Road transport was noted to be associated with speed, flexibility and adaptability. It also appeared to meet the demand of the timber growers in the area, while rail transport was clearly considered to be unreliable with very few of the timber growers making use of rail in the area.

### **Greytown – Appendices C – D**

The rail service at the time of the study was noted to be good. However; it appeared that maintaining the future demand for rail until early 2016 was uncertain, thus forcing a switch back to road transport. Although rail was considered to be a cheaper option in the area as compared to road, rail truck shortages did occur, hampering service delivery. Thus, road transport was clearly a more expensive mode of transport as compared to rail but, on the other hand, it was also a more flexible mode of choice. In addition, despite the fact that road transport was subject to weather conditions it was a preferred choice for NCT's markets. Overall, the survey found that both modes were considered to be sound options for the timber growers in the area.

## Vryheid – Appendices G – H

Rail transport was noted to be a cheaper option of transport in the area. However, poor commitment on the part of Transnet and a lack of guarantees in respect of rail order requests hampered service delivery and led to rail truck shortages. Although road was a more expensive option, it was considered to be a more reliable option than rail. Both modes were considered to be sound options for timber growers in the area according to the survey results.

In summary, it is clear that both road and rail transport have an important role to play in servicing the timber growers of NCT. The survey results found that road transport was the dominant choice for NCT. This was in line with from the historical data presented in Table 5.1 of the study. The results from the survey also showed that, although the overall performance of rail transport was identified as lower that of road transport, the gap between the two was not large, thus implying that rail transport seen perceived as offering a fairly good performance overall. In particular, this could be attributed to the higher ratings of service overall for the Greytown area as compared to the other areas. However, the commitment to sustaining the service at that the time of the study until 2016 was considered uncertain, thus indicating the possibility that, that once the volumes of timber increased, the service levels would decline due to truck shortages. One of the main criteria in terms of which rail scored significantly higher with all district offices was that of the transport rates. This was also obvious in section 5.5 when the cent per ton kilometre for road and rail transport were compared. The triangulation of the data in section 5.5 confirmed the findings of the surveys to the effect that rail transport was definitely considered to be a cheaper option as compared to road transport. The results from the interviews conducted with the logistics and operations manager (§§ 5.3 and 5.4) also highlighted that road transport was more expensive than rail in terms of price but that, on the other hand, road transport provided a convenient and reliable service in comparison to rail. This further emphasised why, overall, rail transport had scored lower than road transport in the survey.

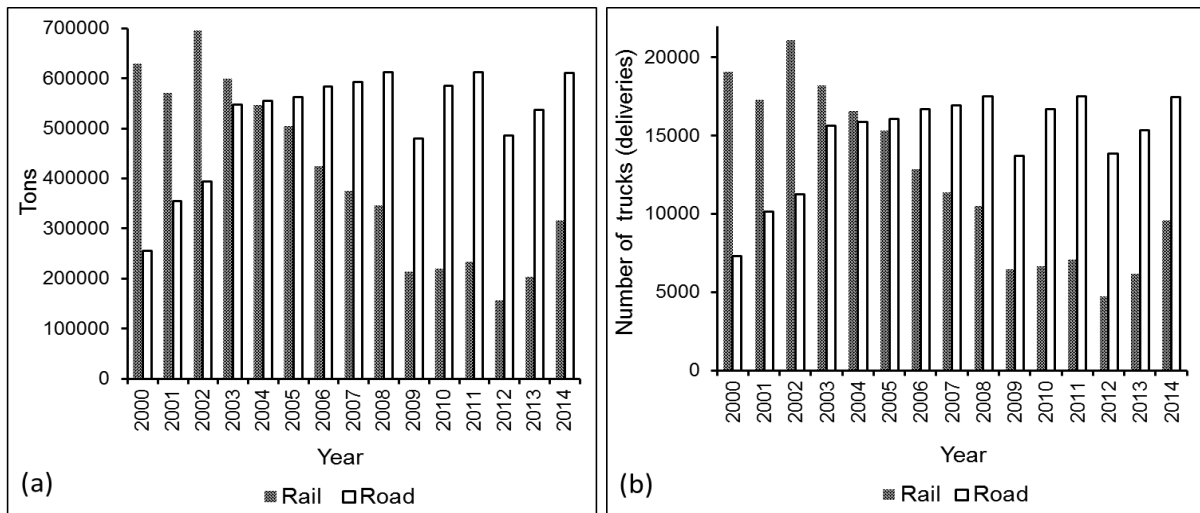
It had emerged from the literature study that trade-offs in supply chain often occur. It was evident in this case study that, although rail transport was able to offer the reduced costs, cost was traded off for service by using road transport, which was the more

expensive alternative. Transportation costs and service are two such elements that are frequently traded off in transport. However, it must be remembered that the goal is to minimise costs while continuing to maintain customer service and responsiveness (Chopra & Meindl, 2012). According to the results of the surveys, service and cost were not in alignment in either of the modal options. This was also highlighted in the interview with the logistics manager (§ 5.4) of NCT who commented that “price and service were equally important” to consider in road and rail transport (NCT Logistics Manager, 2015). This was also highlighted by the operations manager who indicated that “rail is cheaper, but on the negative side it is poor service” (NCT Operations Manager, 2015). The triangulation of the historical data, interview findings and surveys results showed that both service and cost were not in alignment in either road or rail transport. However, both are significant factors which should be considered when selecting a suitable choice of mode (Chopra & Meindl, 2012).

#### **5.9. WHAT ARE THE CARBON EMISSIONS OF ROAD AND RAIL TRANSPORT FOR NCT?**

Carbon emissions are related primarily to the capacity and volume of a vehicle (McKinnon et al., 2015), thus with road transport the smaller payload for vehicles may result in a compound effect because more trips are required, which further increases carbon emission levels (McKinnon et al., 2015). This is clear in Figures 5.8 and 5.9, which show that the tonnage moved by each mode was also attributable to the number of deliveries.





**Figure 5.8:** Tons transported in relation to the number of trucks for road and rail transport for the period 2000–2014

**Source:** Adapted from: NCT Oracle software (2015)

It is evident in Figure 5.8 that the number of trips by road transport was significantly higher than the number for rail transport. This is further quantified in Table 5.14 below.

**Table 5.14:** Number of road and rail trucks used over a 14-year period

Year	Rail	Road
2000	19 074	7 290
2001	17 264	10 160
2002	21 072	11 258
2003	18 171	15 644
2004	16 548	15 589
2005	15 290	16 077
2006	12 853	16 696
2007	11 340	16 954
2008	10 480	17 501
2009	6 454	13 714
2010	6 633	16 708
2011	7 058	17 509
2012	4 715	13 874
2013	6 166	15 344
2014	9 583	17 464
Total	182 702	221 783

**Source:** Adapted from: NCT Oracle software (2015)

For example, from the period 2000–2014, approximately 221 783 road trucks utilised the road networks, whereas 182 702 wagons utilised the rail networks for the same period. Assuming that the 221783 road trucks were operational for 24 hours a day over a 365-day calendar year, on average, over a 14-year period, this translates into 15 841 trucks on the country’s roads every year and this further translates into 43 trucks per day and approximately two trucks every hour. This has a significant impact on the externality costs as noted in the literature review, namely, accidents, congestions, noise, overloading and carbon emissions.

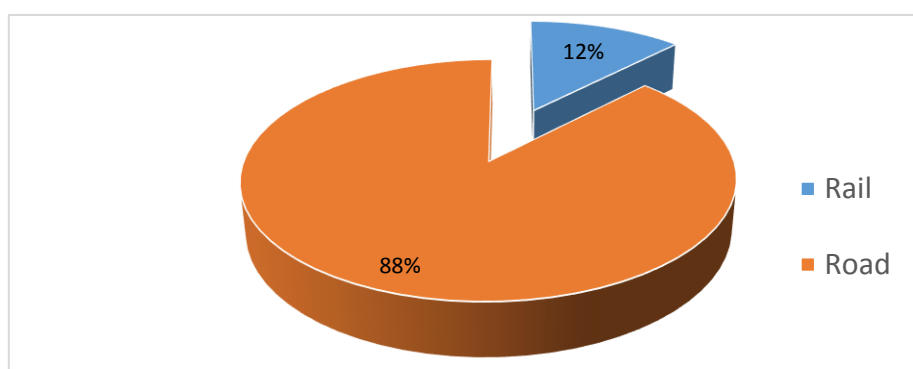
This raised questions regarding the intermodal solutions to curbing the environmental impact of road dominated transport in the market (Havenga et al., 2014). Of all the externality costs, carbon taxes have recently gained prominence and it has been proposed that such a tax will be implemented in the near future at a proposed R120 a metric ton CO2 equivalent (Engineering News, 2015). The activity-based approach was followed for calculating the carbon emissions for both road and rail transport and is shown in Tables 5.15 and 5.16.

**Table 5.15:** Carbon emissions for rail transport

Year	Rail tons	Average distance (km)	Carbon factor (kg)	Total emissions (kg)
2008	345 840	300	0.0316	3 278 563
2009	212 967	300	0.0316	2 018 927
2010	218 889	300	0.0316	2 075 068
2011	232 905	300	0.0316	2 207 939
2012	155 602	300	0.0316	1 475 107
2013	203 467	300	0.0316	1 928 867
2014	316 248	300	0.0316	2 998 031
<b>TOTAL</b>	<b>1 685 918</b>			<b>15 982 503</b>

**Table 5.16:** Carbon emissions for road transport

Year	Road tons	Average distance (km)	Carbon factor (kg)	Total emissions (kg)
2008	602 733	245	0. 1292	19 078 910
2009	479 998	245	0. 1292	15 193 857
2010	584 796	245	0. 1292	18 511 133
2011	612 801	245	0. 1292	19 397 606
2012	485 581	245	0. 1292	15 370 577
2013	537 054	245	0. 1292	16 999 894
2014	611 243	245	0. 1292	19 348 286
<b>TOTAL</b>	<b>3 914 206</b>			<b>123 900 262</b>



**Figure 5.9:** Carbon emission percentage for road and rail transport

Figure 5.9 shows the comparison between the carbon emissions for road and for rail transport with the largest percentage of carbon emission consumption being associated with road transport. In total the carbon emissions for rail transport were a conservative 12% in comparison to those for road transport, namely, an excessive 88%. However, if an intermodal switch from road to rail transport were to happen, road tons would be transferred to rail, indicating a combined tonnage for each year as shown in Table 5.17. Similarly, as shown in Table 5.15, the same factors would be used to calculate the carbon emissions for all volumes by rail in Table 5.17. Thus, in Table 5.17, an average of 300 kilometres and a carbon factor of 0.0316 was used to calculate the carbon emissions if all volume were to be moved by rail. The following result is given.

**Table 5.17:** Carbon emissions if all volumes went by rail transport

Year	Rail and road combined (Tons)	Average distance (km)	Carbon factor (kg)	Total emissions (kg)
2008	948 573	300	0.0316	8 992 472
2009	692 965	300	0.0316	6 569 308
2010	803 685	300	0.0316	7 618 934
2011	845 706	300	0.0316	8 017 294
2012	641 183	300	0.0316	6 078 414
2013	740 521	300	0.0316	7 020 135
2014	927 491	300	0.0316	8 792 615
<b>TOTAL</b>	<b>5 600 124</b>			<b>53 089 171</b>

**Note:** Calculation based on the factors for rail in Table 5.15

**Table 5.18:** Carbon savings if all volume were transported by rail

Carbon emission	Total emission (kg)
Road and rail transport emissions	139 882 765
Less carbon emissions if all volumes went by rail transport	53 089 171
More carbon emissions for road transport	86 793 594

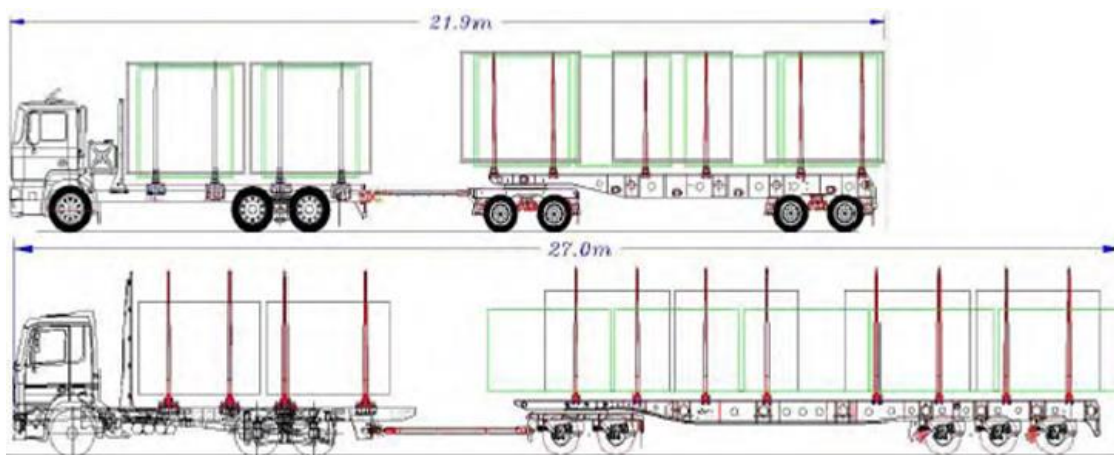
It is clear from the analyses presented in Tables 5.17 and 5.18 that rail transport has a far less impact on carbon emissions in comparison to road transport. If an intermodal switch from road to rail transport had been considered, from 2008 onwards, a substantial reduction of 86 793 594 kg of carbon emissions would have been achieved using rail transport.

If government were to impose CO<sub>2</sub> emission taxes on companies, the country's logistics costs would increase drastically. For NCT, this would mean a higher rand per ton charge for the movement of timber from farm to market. This would have an adverse effect on the profitability of the timber growers and this would then ultimately threaten the sustainability of timber farming due to the rising costs in forestry

operations (Jorgensen, 2013). Alternative recommendations for timber transport should therefore be investigated. PBS vehicles have gained prominence as an alternative transport option for the timber grower and are examined next.

### 5.10. WHAT ARE THE BENEFITS OF USING ALTERNATIVE TRANSPORT SOLUTIONS SUCH AS PBS VEHICLES FOR THE TIMBER GROWERS OF NCT?

Performance based standard (PBS) vehicles, also known as smart trucks, effectively allow for a reduction of vehicle utilisation on the road owing to the longer length axles which result in less congestion, overloading and carbon emissions and with substantial cost savings resulting from the extra loading capacity of the vehicle (RTMS Forestry, 2015). This was highlighted in the literature review by Button (2010) (see Table 3.3) on the benefits offered by longer length vehicles. According to Button (2010), a standard 35 tonne payload truck offers 5 to 7% savings, whereas a 45-ton payload truck offers almost double the savings due to the extended truck axles. Figure 5.10 illustrates the difference in the truck size configuration between a standard vehicle in comparison to a PBS vehicle. In terms of length a standard axle truck (21.9 m), with a payload of approximately 35 tons, is shorter than the PBS vehicle which has a longer length of (27.0 m) and a payload of approximately 45 tons.



**Figure 5.10:** Standard truck length in comparison to a PBS truck length

**Source:** NCT (2012b) PBS Vehicles

An investigation into the utilisation of PBS from June 2013 to December 2014 and, specifically for NCT, was conducted for a trial period. The data from the analysis was

retrieved from the Oracle software database which provided a detailed breakdown of all the loads carried out using a PBS trucks. The first set of findings considers the impact of moving volumes on a PBS truck versus a standard truck for Market 1. Table 5.19 shows that, for growers A – I, a total of 3376.95 tons was transported. If this volume had been transported using a standard truck it would have required 96.48 loads in comparison to the 75.04 loads when using a PBS truck. This indicates a reduction of approximately 21 (21.45) standard trucks in the number of standard trucks utilised on the road networks.

**Table 5.19:** Number of standard trucks and PBS trucks used to move set volumes for each timber grower in Market 1

Grower	Tons	Standard truck	PBS truck	Difference
A	137.55	3.93	3.06	0.87
B	173.72	4.96	3.86	1.1
C	410.97	11.74	9.13	2.61
D	335.92	9.60	7.46	2.14
E	279.1	7.97	6.20	1.77
F	779.79	22.28	17.33	4.95
G	1041.29	29.75	23.14	6.61
H	91.69	2.62	2.04	0.58
I	126.92	3.63	2.82	0.81
<b>Total</b>	<b>3376.95</b>	<b>96.48</b>	<b>75.04</b>	<b>21.45</b>

**Note:** Payload of a standard truck is 35 tons and a PBS truck 45 tons

**Source:** Adapted from: NCT Oracle software (2015)

**Table 5.20:** Number of standard trucks and PBS trucks used to move set volumes for each timber grower in Market 2

Grower	Tons	Standard truck	PBS truck	Difference
A	84.45	2.41	1.88	0.54
B	92.7	2.65	2.06	0.59



<b>Grower</b>	<b>Tons</b>	<b>Standard truck</b>	<b>PBS truck</b>	<b>Difference</b>
C	226.4	6.47	5.03	1.44
D	225.75	6.45	5.02	1.43
E	1807.49	51.64	40.17	11.48
F	445.8	12.74	9.91	2.83
G	158.23	4.52	3.52	1.00
H	222.5	6.36	4.94	1.41
I	47.7	1.36	1.06	0.30
J	2065.94	59.03	45.91	13.12
K	83.4	2.38	1.85	0.53
L	93.6	2.67	2.08	0.59
M	83.45	2.38	1.85	0.53
N	378.95	10.83	8.42	2.41
O	488.55	13.96	10.86	3.10
<b>Total</b>	<b>6504.91</b>	<b>185.85</b>	<b>144.56</b>	<b>41.30</b>

**Note:** Payload of a standard truck is 35 tons and a PBS truck 45 tons

**Source:** Adapted from: NCT Oracle software (2015)

Similarly, for Market 2, Table 5.20 shows that, for growers A – O, a total of 6504.91 tons was transported. If this volume had been transported using a standard truck, this would have meant 185.85 loads in comparison to the 144.56 loads when using a PBS truck. This indicates a reduction of approximately 41 (41.30) in the number of standard trucks utilised on the road networks when PBS were trucks. In total, for both Markets 1 and 2, there was a reduction of approximately 63 (62.75) loads when PBS trucks were used over a 7-month period. This resulted in reduced road congestion and overloading on the road networks; in addition, the vehicles were more productive as the number of trips were effectively reduced (Thorogood, 2009) and this benefited the timber grower and the transport operator.

The second set of findings considered the monetary savings that arise from the use of a PBS vehicle. In Table 5.21 the rand per ton reduction for timber Growers A – I is tracked. The table shows the discounted rates offered by PBS vehicles for Market 1. Grower A saved approximately R15.00 per ton using a PBS vehicle instead of a standard vehicle. This equated to a savings of R2062.5 for a total of 137.5 tons delivered. In addition, it is important to bear in mind that, if the load factor savings were also accounted for, it would effectively mean that Grower A had saved on almost 1 (0.87) entire truckload of timber transport which would have cost approximately R4611.00 using a standard truck. If Grower A had used a standard truck he/she would not have benefited from the reduced rand per ton charge of timber transport and the less than one truck load of timber transport cost. The same applied to Growers B – I for Market 1. Thus, a total savings of R43 347.65 were saved when a PBS vehicle was used to deliver 3376.95 tons for Market 1.

**Table 5.21:** Monetary savings when using PBS vehicles for Market 1

<b>Grower</b>	<b>Tons</b>	<b>Rand per ton reduction</b>	<b>Total rand value savings</b>	<b>Load savings</b>
A	137.5	15	2062.5	0.87
B	173.72	19	3300.68	1.11
C	410.97	5	2054.85	2.61
D	335.92	11	3695.12	2.14
E	279.10	5	1395.50	1.77
F	779.79	16	12476.64	4.95
G	1041.29	15	15619.35	6.61
H	91.69	5	458.45	0.58
I	126.92	18	2284.56	0.81
<b>Total</b>	<b>3376.95</b>	<b>109</b>	<b>43347.65</b>	<b>21.45</b>

**Source:** Adapted from: NCT Oracle software (2015)



**Table 5.22:** Monetary savings when using PBS vehicles for Market 2

<b>Grower</b>	<b>Tons</b>	<b>Rand per ton reduction</b>	<b>Total rand value savings</b>	<b>Load savings</b>
A	84.45	13	1097.85	0.54
B	92.7	17	1575.9	0.59
C	226.4	14	3169.6	1.44
D	225.75	12	2709	1.43
E	1807.49	3	5422.47	11.48
F	445.8	14	6241.2	2.83
G	158.23	14	2215.22	1.00
H	222.5	9	2002.5	1.41
I	47.7	11	524.7	0.30
J	2065.94	24	49582.56	13.12
K	83.4	13	1084.2	0.53
L	93.6	16	1497.6	0.59
M	83.45	2	166.9	0.53
N	378.95	12	4547.4	2.41
O	488.55	14	6839.7	3.10
<b>Total</b>	<b>6504.91</b>	<b>188</b>	<b>88676.8</b>	<b>41.30</b>

**Source:** Adapted from: NCT Oracle software (2015)

Similarly, in Table 5.22 the rand per ton savings for timber growers A – O was tracked. The table shows the discounted rates offered by a PBS vehicle for Market 2. It is important to note that, for Grower J, approximately R24.00 per ton reduction in transport cost was evident, with a total of R49 582.56 saved by using a PBS truck. In addition, Grower J also saved on transport costs with approximately 13 (13.12) loads less when using a PBS truck. If a standard truck had been used, Grower J would then have had to bear the cost of an additional 13 (13.12) trucks to transport 2065.94 tons of timber. This equates to approximately R66 703 in transport costs. Thus, a total of R88 676.80 was saved when a PBS vehicle was used to deliver 6504.91 tons for Market 2.

It is evident that, for both Markets 1 and 2, there were two significant benefits to using a PBS. Firstly, there was a reduction in the number of vehicle trips when a PBS vehicle was used instead of a standard vehicle and, secondly, the rand per ton charge for timber transport was also significantly reduced for the majority of timber growers. The rand per ton charges varied between a R2.00 and R24 saving for Market 1 and Market 2. The reason for the low rand per ton saving was because, in some instances, these timber farms were managed by NCT and had already benefited from special brokered transport rates. The standard rate offered to these growers at the time of the study was not far off the PBS rates due to NCT managing and, in some cases, owning the farms. Therefore, on comparing the standard truck rates versus the PBS truck rates, the savings in cost was not as significant as compared to the other notable savings. However, in total, an average of R12.11 per ton was saved using PBS vehicles for Market 1 and an average of R12.53 per ton was saved for Market 2. Had the growers for Markets 1 and 2 used standard axle vehicles for timber transport they would have had to pay an extra rand per ton charge, averaging between R12.11 and R12.53 for the transport of timber from the farm to the processing plant. Nevertheless, there were still significant load factor savings to be achieved for these growers. Finally, if the carbon emission calculation had been done based on the activity-based formula, the following results would have been achieved – see below.

**Table 5.23:** Carbon emission savings when using PBS vehicles

Loads savings	Volume	Average distance	Carbon factor (kg)	Total emissions (kg)
62.75	2196.25	245	0.1292	69 520.10

From the period June 2013 to December 2014, approximately 63 (62.75) trips were saved by using PBS vehicles. Therefore, if these truck loads were converted into volume based on a 35 ton standard truck payload, this would equate to approximately 2196.25 tons of timber. Based on these figures, a carbon savings of 69 520.10 kg would be realised as a result of the reduction in vehicle trips from utilising PBS vehicles. The use of PBS trucks has resulted in a host of improvements and benefits. These trucks have successfully completed over 219 trips in a period of 7 months and transported over 9881.86 tons of timber since commencing operations. In comparison,

if the conventional 22-metre unit trucks had been used to move the same mass of timber, this would have resulted in an excess of approximately 63 (62.75) trips. Carbon emissions were also reduced as a result of the economic benefits offered by the reductions in the number of road trips. In the interview with the logistics manager he stated that “PBS is doing very well and is the new standard” (NCT Logistics Manager, 2015). This was also affirmed in the separate interview with the operations manager of NCT who commented that PBS vehicles were a good option, stating that “Firstly, it is cheaper and you are using less trucks to move the same amount of volume” (NCT Operations Manager, 2015).

PBS vehicles are, therefore, definitely a recommended alternative for timber growers due to the host of benefits offered. However, it was highlighted in the interview with the operations manager that “the only limiting problem with PBS vehicles is obviously terrain”. The weight of a PBS truck may be a restricting factor in the event of steep roads and hills (NCT Operations Manager, 2015). However, there are a host of other benefits offered by PBS vehicles including reduced fuel consumption, reduced vehicle wear and tear, improved driver safety and productivity and improved network utilisation and infrastructure (Nordengen, 2013b). The study did not measure all of these benefits due to the technical background and engineering associated with the configuration of PBS trucks. This may perhaps justify a further investigation into the benefits of PBS vehicles as a topic on its own, although the topic was covered as a value-added focus area for the purpose of this research study due to the developments in the field of transport at the time of the study and an option for the timber growers of NCT.

#### **5.11. WILL AN INTERMODAL SWITCH FROM ROAD TO RAIL TRANSPORT BE BENEFICIAL TO THE INDEPENDENT TIMBER GROWERS OF NCT?**

The secondary research questions were addressed in sections 5.2 to 5.10 of the study with the relevant findings. It was therefore possible at this stage in the study to conclude by addressing the primary research question (and objective) of the study, namely, Will an intermodal switch from road to rail be beneficial to the independent timber growers of NCT?

The aim of transport is to physically move supplies in a reliable and safe manner, on time, cost-effectively and efficiently to their destination. This means that both cost and service elements are equally important in the NCT supply chain. As alluded to in section 3.4.4, there are several criteria to consider when determining an intermodal switch from road to rail transport. These criteria are assessed and summarised in Table 5.24 below and are in line with the framework provided in section 3.8.

**Table 5.24:** Summary framework: Key criteria when considering an intermodal switch

<b>Criteria</b>	<b>Reference to case study</b>	<b>Road</b>	<b>Rail</b>
Reliability	Section 5.8	Good	Average
Flexibility		Average	Poor
Supply chain visibility		Good	Poor
Rates		Average	Good
Total transport time		Excellent	Average
Cent per ton/km	Section 5.5	High in comparison to rail	Low in comparison to road
Advantages	Sections 5.3, 5.4 and 5.8	Fast (quick turnaround times), flexible, reliable, convenient, accessible	Cheaper option
Disadvantages	Sections 5.3, 5.4 and 5.8	Expensive option	Poor service delivery on the branch lines/truck shortages Safety issues/timber theft. Short haul required in some cases to the rail sidings
<b>Other Criteria</b>			
Opportunity cost	Section 5.7	Future value savings – lower using road transport	Future value savings – higher with rail transport
Carbon emissions	Section 5.9	Carbon emissions – higher using road transport	Carbon emissions – lower using rail transport
Performance based vehicles	Section 5.10	Trip reductions achieved Lower rand per ton savings Economies of scale possible (longer axles) Reduced carbon footprint from fewer vehicle trips	
Transnet freight rail	Sections 5.3, 5.4 and 5.8		TFR’s commitment to service prior to 2003 was good. TFR’s commitment to service delivery was poor since 2004–2014. TFR’s commitment to service delivery uncertain at this stage

**Note:** See Table 3.27 for literature reference

In assessing the feasibility of an intermodal switch from road to rail transport for the independent timber growers of NCT, Table 5.24 presented the key criteria which were analysed and assessed in this chapter together with a summary of the research results. Some of the key criteria used in the modal analysis studies were examined in this chapter in order to address factors such as the efficiency and effectiveness of each mode for the timber growers of NCT. In this vein Table 5.24 indicated that road transport had scored well in terms of overall performance as compared to rail transport in relation to criteria such as reliability, flexibility, supply chain visibility and total transport time while rail transport scored the highest in relation to the criterion of rates, in this category. However, the benefits associated with the strong service elements of road transport are far more advantageous than those associated with rail transport. Accordingly, the trade-off for cost over service has been a common factor influencing the preference for road transport on the part of the timber growers of NCT. As suggested in the literature review, supply chains should not reduce performance in one area to accommodate better results elsewhere (Gibson et al., 2014:8). The results of the study showed that cost and service were not in alignment in either of the modes of transport.

As shown in Table 5.24 road and rail transport offer various advantages which were closely aligned with the comparisons made between road and rail transport from a theoretical perspective (Chapter 3). One of the disadvantages of road transport is that it is an expensive option for timber transport and this is a strong motivation for considering the switch back to rail transport. This was thus highlighted in the problem statement of the study. It was, therefore, important to consider the pricing performance on road and rail transport based on both volume and distance covered. It emerged from this analysis that rail transport was a cheaper option as well as a more economically beneficial option for the timber grower although poor service delivery was a concern that merited attention. This resonated with the principles of economies of scale addressed in the literature review, which indicated that rail was a more economically viable option as compared to road. Due to the excessively high transport costs for the financial period 2012–2014, the opportunity cost of using road transport was calculated to determine whether a volume switch from road to rail transport would be beneficial to the timber growers of NCT. There were substantial transport cost savings to be realised using rail transport as an alternative option. However, as noted

in the literature study, the criteria related to performance dimensions are equally important to cost savings in supply chains (Chopra & Meindl, 2012). Thus, rail transport still needs to be aligned with performance dimensions in the NCT supply chain.

One of the main externality costs measured in the study was carbon emissions and these were calculated for both road and rail transport. Externality costs have gained increased attention and pressure to move the transport of bulk goods back to rail is considered to be an important constituent of the economic freight strategy for South Africa. It was therefore considered an important requirement of the study to highlight the impact of externality costs and, specifically, carbon emissions. The study found that the carbon emissions for rail transport were considerably lower in comparison to those for road transport for the tonnage of timber transported from 2008–2014. PBS vehicles proved to be a beneficial alternative for the timber growers of NCT in terms of the cost savings, reduced vehicle trips and carbon emissions realised as a result of the use of these vehicles.

It is, therefore, essential to recognise at this point in the study that, although rail transport may be a beneficial cost savings opportunity for the timber growers of NCT, it was not possible for NCT switch to rail transport at the time of this study. In terms of NCT's road and rail transport a commitment from Transnet Freight Rail to service the branch lines and to provide adequate rail trucks is still a requirement in relation to the rail. It is for this reason that road transport will probably continue to dominate as a preferred mode although it was not providing the economic cost advantages of rail transport at the time of the study.

Based on the overall results provided in the framework above, should a timber grower need to evaluate a suitable transport option for his/her specific needs, the choice of mode which is the most appropriate and cost-effective for each timber grower's specific set of circumstances may be assessed based on the comparisons presented in Table 5.24.

## **5.12. CONCLUSION**

Based on the findings of the study it was recognised that it is imperative for NCT not only to consider the most suitable transport option for the timber grower, but also to ensure that both road and rail transport are preserved as choices of transport for the timber grower. The reasons for this were primarily due to the fact that although service delivery by rail is poor in comparison to road, the cheaper price offered by rail is still a strong motivator for using rail transport instead of road transport. Road transport continues to be the preferred choice for the timber growers of NCT due to its convenient, fast and reliable service offering. However, road transport is still deemed to be the more expensive option. Since NCT brokers transport on behalf of the timber growers as a value-added service, it was therefore important to compare and evaluate both choices of transport for the purpose of this study. Accordingly, the choice of mode that was the most appropriate from a cost and service perspective for the timber growers of NCT was assessed. This was the focus of Chapter 5, which presented a comparison between road and rail transport for the benefit of the timber growers of NCT.

## CHAPTER SIX

### GENERAL DISCUSSION AND CONCLUSION

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#### 6.1. INTRODUCTION

The 10th Annual State of The Logistics Survey (2013) together with the National Freight Strategy (2015) have strongly recommended a switch from road to rail transport in an attempt to reduce costs for the South African economy as well as for the primary industries which use road and rail transport as integral components of their supply chains. One of the main reasons for this recommendation was the increasing fuel costs for road freight transport which were impacting on the high logistics costs in the country. This was identified as the problem statement for the study (§ 1.2.1). The research problem, namely, the switch from road back to rail was motivated primarily by the high cost of transport that timber growers faced. In light of the problem statement, the following primary research objective was formulated, namely, to investigate and compare the brokered transport costs of road versus rail transport, and the savings that may be achieved specifically for the independent timber growers in KZN who are members of NCT.

For the purpose of the study, Chapter 1 provided a macro overview of the importance of logistics and transport in the South African economy. The impact of high transport costs was discussed as one of the main factors hampering economic growth and GDP in the South African economy. The forestry industry was shown to be a significant contributor to South Africa's GDP although a key constraint facing the forestry industry was the high cost of timber transported by road. Accordingly, an intermodal switch from road to rail transport was introduced as one of the main factors to consider in the effort to achieve logistical cost savings. Chapter 2 continued with a microanalysis of the NCT supply chain and the main participants involved in this supply chain. The aim of this chapter was to show the role of both road and rail transport in the NCT supply chain. The main issues of concern in the NCT supply chain was identified, namely, the high cost of timber transport brokered by NCT and that was impacting negatively on the profit margins of the independent timber grower.



Chapter 3 focused on providing a theoretical perspective on road and rail transport by providing an understanding of the cost savings that may be achieved by considering an intermodal switch from road to rail. Theoretical concepts interlinking supply chain management, logistics and transport were discussed with economic theories, such as economies of scale and opportunity cost, being addressed. The transport costs, advantages and disadvantages of each mode were discussed in order to ensure a greater understanding of the criteria and factors to consider when deciding on an intermodal switch from road to rail transport. An overview of externality costs was provided with specific focus on carbon emissions and the approaches used in carbon calculations. The role of PBS vehicles in transport was linked to the discussion on economies of scale in transport and the benefits of longer length vehicles for the timber industry. Chapter 4 presented the main research methods used in the study. A case study approach was used as the framework for constructing the study with historical data, interviews and surveys being used as the main data collection methods. In Chapter 5 an analysis of NCT's road and rail transport over a 14 year period was conducted and the findings assessed by comparing the road and rail transport operations in NCT forestry. Chapter 5 addressed each of the findings in relation to the secondary objectives of the study and concluded a discussion on the primary research question.

## **6.2. CONCLUDING REMARKS**

The primary objective of this research study was to investigate and compare the NCT brokered transport costs of road versus rail transport as well as the savings that may be achieved, specifically for the benefit of the independent timber growers in KZN who are members of NCT. Since NCT brokers transport on behalf of the timber growers as a value-added service, it was important to compare road and rail transport to determine the most suitable transport mode of choice for the timber grower. For the period 2000–2003, the historical data showed that the timber volume transport by rail was at its highest, ranging between 569 709 tons and 695 383 annually. The reason for this trend was strongly related to Transnet Freight Rail's (TFR) (previously known as Spoornet) commitment to service delivery in relation to the timber supply chain. In addition, the tariff structures offered made rail transport an economically viable option for the timber grower. Rail was therefore the preferred mode of transport during this

period as both service delivery and price were in alignment, thus ensuring that rail transport was an efficient and effective mode of transport at the time. Some of the findings from the study revealed robust collaboration between the timber industry and TFR and that operational problems were addressed at the regular interface meetings which were held between TFR and the key role players in the timber supply chain. It is evident from these reasons that, at the time, rail transport was the preferred mode of choice for the timber growers of NCT.

Nevertheless, although rail was the market leader as the preferred mode of choice for the timber growers of NCT the historical data showed that from 2000 to 2003, the volumes on road increased steadily year on year from a conservative 255 163 tons in 2000 to 547 532 tons in 2003. From 2004, road transport officially gained dominance over rail transport as the preferred mode of transport. The reasons for the tip over of volume to road transport from 2004 onwards included the exorbitant, annual inflationary increases imposed by TFR which increased by approximately 50% from 2002 to 2004. In addition to the tariff increases for rail transport, the poor service delivery by TFR, branch line closures and truck shortages caused the rail volumes to slowly decline, with the majority of the market share being lost to road transport. Road transport became the mode of choice as it provided a substitute transport option for the timber grower – one which was quick and reliable. This resulted in reduced turnaround times and thus quicker payments to the timber growers which rail transport was unable to offer.

At the time of the study, road and rail transport were both being used as transport options for the timber growers of NCT. In terms of the tonnage transported from 2013–2014, road transport delivered approximately R1 148 297 million tons of timber in comparison to rail transport which delivered 519 715 tons of timber. Based on the historical data analysis undertaken for the purposes of the study it appears probable that this trend will continue into the future with road transport maintaining the majority of the market share. The reason for the unequal freight structure of timber volumes may be attributed to the poor service delivery by rail transport. However, in the case study, the cost analysis showed that rail transport was a better choice with regard to cost efficient transport. With rail transport the cent per ton kilometre charge at a given lead distance of 250 kilometres is approximately 0.44 cents per ton kilometre while

500 kilometres would be even more cost efficient at 0.42 cents per ton kilometre. For road transport, 250 kilometres costs approximately 0.92 cents per ton kilometre and 500 kilometres costs 0.76 cents per ton kilometre. Economies of scale were, therefore, evident with rail transport offering the benefit of more ton-km per route-kilometre, thus allowing for a reduced unit transport cost in comparison to road transport.

The study also explored the opportunity cost concept. In economic terms opportunity cost is defined as the value of an activity forgone when an alternative activity is chosen as its purpose (Dorman, 2014). The total opportunity cost of using road transport for the period 2012 to 2014 amounted to R55 246 313, thus a significant amount of money would have been saved by the timber growers if rail transport had been used as the alternative option. The effectiveness of both road and rail transport was also assessed using key criteria such as reliability, flexibility, supply chain visibility, rates and total transport time in order to assess modal performance. Overall road transport scored higher than rail transport in respect of all these criteria and was noted to be an advantageous mode of transport for the timber grower. However, rail transport outperformed road transport in terms of transport rates, thus indicating that rail transport was still considered to be a cheaper option for the timber grower. In addition, the carbon calculation for rail transport was substantially lower than that for road transport, indicating that, if a volume switch from road to rail transport had occurred from 2008–2014, a substantial 86 793 594 kg of carbon emission savings would have been achieved.

Lastly, a framework of the key criteria for both road and rail transport was presented based on some of the key findings noted above. This framework was assessed. The framework provided a contrasting perspective of conclusions based on modal performance, the advantages and disadvantages of each mode and other considerations. Based on the findings, it is clear that an intermodal switch from road to rail transport would be beneficial to the timber grower on a cost (rand) per ton basis as shown in section 5.5 in Chapter 5. However, rail as a mode of transport remains still discredited based on poor service delivery. Road transport, on the other hand, is in a position to offer the timber growers a fast reliable and accessible service which rail transport does not offer at this stage. The cheaper cost of rail is thus traded off for the improved customer service offered by road, which is the more expensive transport

option for the timber growers. Nevertheless, rail transport is still clearly considered as a mode of choice, as is evident by the more than half a million tons of timber delivered from 2013 to 2014. Whether it will be possible to sustain and improve these volumes will depend on TFR's commitment to rehabilitating the railways and servicing the timber industry in the way in which did prior to 2004. Should the railways improve, there is every likelihood that NCT will support the railways by committing to broker sustainable transport volumes by rail. However, at the time of the study the status quo was that road transport was the preferred mode of timber transport for the NCT supply chain. Based on the findings of the current study, the switch from road to rail will not be feasible at this stage.

### **6.3. FUTURE RECOMMENDATIONS**

In terms of modal shifts, smart trucks, also termed performance based standard vehicles (PBS), have gained significant interest as a recent innovation in road transport. Industry roll out projects in timber and coal have shown that there are a number of benefits to be realised from using these vehicles. These benefits include greater fuel efficiencies and a reduction in road wear and reduced congestion resulting from larger payloads, which mean fewer vehicle trips on the road networks. This study investigated an analysis of PBS truck deliveries that had been conducted over a trial period for some of the timber growers of NCT in order to determine whether any benefits could be achieved by using longer length vehicles. The outcome of this exercise indicated that PBS vehicles afforded the timber growers a reduced number of vehicle trips as well as a reduced transport cost. However, one of the disadvantages of PBS vehicles was that the longer length vehicles may not always be able to service timber farms where the terrain may be a challenge especially in remote, isolated farmlands where road infrastructure is not fully developed. There are, however, many other notable benefits from using PBS vehicles. However, this is a technical and value-added study on its own and thus would warrant further research in the field of logistics. A comprehensive impact of externality costs, such as accidents, congestions, emissions, noise and policing costs, on the timber supply chain was also not pursued in this study and may, therefore, be recommended as future areas of research on the research topic of this study.

#### **6.4. LIMITATIONS**

NCT fulfils the role of a transport broker as it acts as an intermediary, arranging transport on behalf of the timber grower and the carrier. Accordingly, transport costs such as the costs of delays, waiting times, lifecycle costs, and other hidden costs were not included in the calculations of the transport costs conducted in this study. The reason for this was that NCT does not own a vehicle fleet and it is, therefore, not in possession of the data on tracking vehicles movements associated with the costs of a typical transport operator. Road and rail transport costs were compared for the purpose of the study using the NCT Oracle software system and company reports. However, in view of the company disclosure policy, company data and reports on issues such as NCT's brokered operations rates could not be published for the purpose of the study and were used purely for the purpose of research.

#### **6.5. SUMMARY**

Based on the findings of the research, although road was the dominant mode of transport for NCT at the time of the study, the researcher is in favour of a balanced modal shift whereby both road and rail transport would be considered as options which compete fairly in the market and with no single mode monopolising the market share. This would afford the timber growers the benefit of both transportation modes and thus bring about improved efficiencies and effectiveness in timber transport. This would then also help to maximise the growers' income and profit margins over the long term. In addition, it may also result in reduced logistics costs for both the timber industry and for the South African economy overall.

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## **APPENDIX A: Interview schedule of questions**

- Please describe the current NCT supply chain?
- What are the main modes of transport available for the timber growers of NCT?
- In your opinion, what are some of the implications of using road and rail transport currently?
- What is an indicative volume of timber transported on road and rail during the period 2000-2004?
- What were the reasons for using rail as the primary mode of transport during this period?
- What were the reasons for rail transport losing market share to road transport after 2004?
- In terms of transport cost, during this period which mode would you have considered as a cheaper option for the timber grower?
- After 2004 onwards, which mode was considered a cheaper option for the timber growers?
- Are transport costs considered to be the most important factor in the supply chain or do you think the timber grower also considers other costs?
- Do you think externality costs are a concern for the timber industry?
- Do you consider Performance Based Standard (PBS) vehicles as a good alternate transport solution for the timber industry?
- Are there any benefits to be realised from this initiative?
- Considering NCT has been involved in brokering road and rail transport on behalf of the timber grower as a value-added service for the past 14 years, do you think an intermodal switch from road to rail transport will be beneficial to the timber growers of NCT? Please elaborate if yes or no.

## APPENDIX B: Survey based questionnaire

Dear participant,

Your informed consent and participation has been noted and you are, therefore, kindly requested to fill in the survey evaluating the performance of each mode of transport based on the timber grower preference in your area.

The objective of this survey is to determine whether an intermodal switch would be beneficial to the timber growers of NCT. The following performance scale has been used in a similar South African study on road versus rail transport. Performance scales are often used in modal analysis as a means of determining modal strengths, weaknesses and preference. The simple scoring system is indicated as follows: 1 – poor, 2 – average, 3 – good, 4 – excellent. Please indicate your desired score.

If you would like to leave a comment regarding the current road and rail operations in your area, please feel free to do so.

SUPPLIER	Score for					Total score (out of a max of 20)	Retain/remove/assistance programme	Signature of department respondent
	Reliability	Flexibility	Supply chain visibility	Rates	Total Transport Time			
RAIL	/4	/4	/4	/4	/4			
ROAD	/4	/4	/4	/4	/4			
Comment:								

# APPENDIX C: Survey of participant 1: Greytown



## CRITICAL LOGISTICS SERVICE PROVIDER EVALUATION

Dear participant, Your informed consent and participation has been noted and you are therefore kindly requested to fill in the survey evaluating the performance of each mode of transport based on the timber grower preference in your area.

The objective of this survey is to determine if an intermodal switch will be beneficial to the timber growers of NCT. The following performance scale has been used in a similar South African study on road versus rail transport. Performance scales are often used in modal analysis as a means to determine modal strengths, weaknesses and preference. The simple scoring system is indicated as follows: 1-poor, 2-average, 3-good, 4-excellent. Please indicate your desired score.

If you would like to leave a comment regarding the current road and rail operations in your area, please feel free to do so.

DATE... 7/12/15 .....

If a supplier scores below 10/20 (<50%), indicates poor performance mode of choice needs to be considered.

SUPPLIER	Reliability	Flexibility	Supply chain Visibility	Rates	Total Transport Time	Score (out of a max of 20)	Retain/Remove/Assistance Programme	Signature of Dept. Respondent
	Score							
RAIL	3/4	2/4	2/4	3/4	3/4	13/20		<i>Shaw</i>
ROAD	3/4	3/4	3/4	2/4	4/4	15/20		<i>Shaw</i>
Comment:	While rail rates are cheaper on occasion truck shortages hamper service delivery. Road is reliant on weather, with obt. availability and is more flexible in market choice. However rates are higher. Both modes of transport have their pros and cons.							

Thank you for your participation in this survey.

## APPENDIX D: Survey of participant 2: Greytown



### CRITICAL LOGISTICS SERVICE PROVIDER EVALUATION

Dear participant. Your informed consent and participation has been noted and you are therefore kindly requested to fill in the survey evaluating the performance of each mode of transport based on the timber grower preference in your area.

The objective of this survey is to determine if an intermodal switch will be beneficial to the timber growers of NCT. The following performance scale has been used in a similar South African study on road versus rail transport. Performance scales are often used in modal analysis as a means to determine modal strengths, weaknesses and preference. The simple scoring system is indicated as follows: 1-poor, 2-average, 3-good, 4-excellent. Please indicate your desired score.

If you would like to leave a comment regarding the current road and rail operations in your area, please feel free to do so.

DATE: 21/1/15

If a supplier scores below 10/20 (<50%), indicates poor performance mode of choice needs to be considered.

SUPPLIER	Reliability	Flexibility	Supply chain Visibility	Rates	Total Transport Time	Score (out of a max of 20)	Retain/Remove/Assistance Programme	Signature of Dept. Respondent
	Score							
RAIL	3/4	2/4	2/4	3/4	3/4	13/20		<i>Shaw</i>
ROAD	3/4	3/4	3/4	2/4	4/4	15/20		<i>Shaw</i>
Comment:	While rail rates are cheaper on occasion truck shortages hamper service delivery. Road is reliant on weather, with obtainability and is more flexible in market choice. However rates are higher. Both modes of transport have their pros and cons.							

Thank you for your participation in this survey.



## APPENDIX E: Survey of participant 3: Pietermaritzburg



### CRITICAL LOGISTICS SERVICE PROVIDER EVALUATION

Dear participant. Your informed consent and participation has been noted and you are therefore kindly requested to fill in the survey evaluating the performance of each mode of transport based on the timber grower preference in your area.

The objective of this survey is to determine if an intermodal switch will be beneficial to the timber growers of NCT. The following performance scale has been used in a similar South African study on road versus rail transport. Performance scales are often used in modal analysis as a means to determine modal strengths, weaknesses and preference. The simple scoring system is indicated as follows: 1-poor, 2-average, 3-good, 4-excellent. Please indicate your desired score.

If you would like to leave a comment regarding the current road and rail operations in your area, please feel free to do so.

DATE...30/11/2015.....

If a supplier scores below 10/20 (<50%), Indicates poor performance mode of choice needs to be considered.

SUPPLIER	Reliability	Flexibility	Supply chain Visibility	Rates	Total Transport Time	Score (out of a max of 20)	Retain/Remove/Assistance Programme	Signature of Dept. Respondent
	Score							
RAIL	1/4	1/4	1/4	3/4	2/4	8/20		
ROAD	3/4	2/4	3/4	2/4	3/4	13/20		
Comment:	<p><i>In our industry we have found that road with its speed, flexibility and adaptability meets the demands of our growers better than rail. Rail has become obsolete and very unreliable to our customers. The turn around time is much more efficient than rail.</i></p>							

Thank you for your participation in this survey.

# APPENDIX F: Survey of participant 4: Pietermaritzburg



## CRITICAL LOGISTICS SERVICE PROVIDER EVALUATION

Dear participant. Your informed consent and participation has been noted and you are therefore kindly requested to fill in the survey evaluating the performance of each mode of transport based on the timber grower preference in your area.

The objective of this survey is to determine if an intermodal switch will be beneficial to the timber growers of NCT. The following performance scale has been used in a similar South African study on road versus rail transport. Performance scales are often used in modal analysis as a means to determine modal strengths, weaknesses and preference. The simple scoring system is indicated as follows: 1-poor, 2-average, 3-good, 4-excellent. Please indicate your desired score.

If you would like to leave a comment regarding the current road and rail operations in your area, please feel free to do so.

DATE... 30/11/2015

If a supplier scores below 10/20 (<50%), Indicates poor performance mode of choice needs to be considered.

SUPPLIER	Reliability	Flexibility	Supply chain Visibility	Rates	Total Transport Time	Score (out of a max of 20)	Retain/Remove/Assistance Programme	Signature of Dept. Respondent
	Score							
RAIL	1/4	1/4	1/4	3/4	2/4	8/20		
ROAD	2/4	2/4	3/4	2/4	3/4	12/20		
Comment:	THE TIMBER GROWERS IN MY AREA WHO MADE USE OF RAIL TRANSPORT HAVE ALL SWITCHED OVER TO ROAD TRANSPORT							

Thank you for your participation in this survey.

~4/6 Total/N

Rel	4
Rod	2

## APPENDIX G: Survey of participant 5: Vryheid



### CRITICAL LOGISTICS SERVICE PROVIDER EVALUATION

Dear participant, Your informed consent and participation has been noted and you are therefore kindly requested to fill in the survey evaluating the performance of each mode of transport based on the timber grower preference in your area.

The objective of this survey is to determine if an intermodal switch will be beneficial to the timber growers of NCT. The following performance scale has been used in a similar South African study on road versus rail transport. Performance scales are often used in modal analysis as a means to determine modal strengths, weaknesses and preference. The simple scoring system is indicated as follows: 1-poor, 2-average, 3-good, 4-excellent. Please indicate your desired score.

If you would like to leave a comment regarding the current road and rail operations in your area, please feel free to do so.

DATE: 08-12-2015

If a supplier scores below 10/20 (<50%), indicates poor performance, mode of choice needs to be considered.

SUPPLIER	Reliability	Flexibility	Supply chain Visibility	Ratek	Total Transport Time	Score (out of a max of 20)	Retain/Remove/Assistance Programme	Signature of Dept. Respondent
	Score							
RAIL	1/4	2/4	2/4	2/4	2/4	9/20		<i>[Signature]</i>
ROAD	2/4	2/4	2/4	2/4	3/4	11/20		<i>[Signature]</i>
Comment:	Rail is cheaper than road but service delivery is poor. Road is more flexible and reliable. Rail and Road are both used in our area, the choice is the timber grower's decision.							

Thank you for your participation in this survey.

## APPENDIX H: Survey of participant 6: Vryheid



### CRITICAL LOGISTICS SERVICE PROVIDER EVALUATION

Dear participant, Your informed consent and participation has been noted and you are therefore kindly requested to fill in the survey evaluating the performance of each mode of transport based on the timber grower preference in your area.

The objective of this survey is to determine if an intermodal switch will be beneficial to the timber growers of NCT. The following performance scale has been used in a similar South African study on road versus rail transport. Performance scales are often used in modal analysis as a means to determine modal strengths, weaknesses and preference. The simple scoring system is indicated as follows: 1-poor, 2-average, 3-good, 4-excellent. Please indicate your desired score.

If you would like to leave a comment regarding the current road and rail operations in your area, please feel free to do so.

DATE: 14.12.15

If a supplier scores below 10/20 (<50%), indicates poor performance mode of choice needs to be considered.

SUPPLIER	Reliability	Flexibility	Supply chain Visibility	Rates	Total Transport Time	Score (out of a max of 20)	Retain/Remove/Assistance Programme	Signature of Dept. Respondant
	Score							
RAIL	2/4	2/4	2/4	2/4	1/4	9/20		<i>[Signature]</i>
ROAD	3/4	3/4	3/4	3/4	3/4	15/20		<i>[Signature]</i>
Comment:	<i>Rail = Cannot depend on rail requests, because nothing is guaranteed.                      Road = Much easier accessible and on time and guaranteed; although more expensive at least on time and reliable.</i>							

## **APPENDIX I: Participant information sheet**

### **Dear Prospective Participant**

I, Merisha Bepat am doing research with Doctor Beverly Waugh a Professor in Supply Chain Management, in the Department of Transport Economics, Logistics and Tourism at the University of South Africa. I would like your permission and consent to participate in this research.

### **WHAT IS THE PURPOSE OF THE STUDY?**

The aim of the study is to determine the logistics cost savings that can be achieved by considering an intermodal switch from road to rail for the independent timber grower in Kwa-Zulu Natal.

NCT has been selected because the supply chain focuses strongly on road and rail operations of the timber growers in Kwa-Zulu Natal.

The study will entail an analysis of road rail volumes from the period 2000-2014. The benefits of this study is to determine how feasible the intermodal switch is for the timber grower.

### **WHY AM I BEING INVITED TO PARTICIPATE?**

You have been chosen as a participant for this research based on your interactions with the timber growers in your area. You are also exposed to dealings with various road transporters and Transnet Freight Rail operators. The nature of your participation will therefore directly pertain to filling in a critical logistics service provider survey of road and rail transport. Here you will be required to rate road and rail transport services for your geographical area of timber growers. The duration of this survey is short and is based on a rating scale of 1 to 5. This survey will be sent through electronically via email and should be and can also be returned by email.

## **CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?**

Your participation is voluntary and there is no penalty or loss of benefit for non-participation.

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

## **WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?**

This study has the potential to provide critical information for improving the logistics services of NCT. Not only will this benefit the timber growers of NCT but also other role players in the timber supply chain.

## **WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?**

You have the right to insist that your name will not be recorded anywhere and that no one, apart from the researcher, will know about your involvement in this research. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods.

## **HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?**

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cabinet at Head office PMB for future research or academic purposes; electronic information will be stored on a password protected computer. Thereafter, hard copies will be shredded and electronic copies will be permanently deleted from the hard drive of the computer through the use of a relevant software program.

## **WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?**

This study has made no provisions for any incentives, nor will any costs be incurred for your participation

**HAS THE STUDY RECEIVED ETHICS APPROVAL?**

This study has received written approval from the Research Ethics Review Committee of the Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

**HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?**

If you would like to be informed of the final research findings, please email me, merisha@nctforest.com. The findings are accessible for a period of 5 years. Should you require any further information or have concerns regarding any aspects of this research, please contact Unisa, Department of Transport Economics, Logistics and Tourism on 12 433 4667.

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.

.....  
Merisha Bepat

## APPENDIX J: Consent form

### CONSENT TO PARTICIPATE IN THIS STUDY

I, \_\_\_\_\_ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the **survey based questionnaire / interview**

I have received a signed copy of the informed consent agreement.

Participant Name & Surname..... (please print)

Participant Signature.....Date.....

Researcher's Name & Surname: Mrs M Bepat (please print)

Researcher's signature.....Date.....



## APPENDIX K: Ethical clearance certificate



17 November 2015

**Ref #: 2015\_CEMS\_SES\_006**

**SCHOOL OF ECONOMIC SCIENCES  
RESEARCH ETHICS REVIEW COMMITTEE**

This is to certify that the application for ethics clearance submitted by  
Mrs Merisha Bepat (student #32921330, merisha@nctforest.com)

Road Versus Rail Transport for the Independent Timber Growers who are Members of NCT  
Forestry **received Ethics Approval**

The application for ethics clearance for the above mentioned research was reviewed by the School of Economic Sciences in November 2015 in compliance with the Unisa Policy on Research Ethics. Ethical Clearance for the project is granted.

You may proceed with the research project. The research ethics principles outlined by the Unisa Policy on Research Ethics must be adhered to throughout the project. Please be advised that the committee needs to be informed should any part of the research methodology as outlined in the Ethics application (Ref #2015\_CEMS\_SES\_006) change in any way or in case of adverse events. This certificate is valid for the duration of the project. The SES Research Ethics Review Committee wishes you all the best with this research undertaking.

Kind regards,

Ms C Loedolff  
Chairperson

Executive Dean: CEMS

**Amendment 20/02/2017**  
Permission granted for change of topic:  
**A Comparison of Road and Rail Transport for the Benefit of the Independent  
Timber Growers of NCT Forestry Co-Operative Limited**  
Mrs Carmen (Loedolff) Poole  
Chairperson



Open Rubric  
Open Rubric

University of South Africa  
Pretorius Street, Maitland Ridge, City of Johannesburg  
PO Box 392 UNISA 0003 South Africa  
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150  
www.unisa.ac.za

## APPENDIX L: Permission letter



### PERMISSION LETTER

**Request for permission to conduct research at NCT FORESTRY CO-OPERATIVE LIMITED.**

03-08-2015

Mr James van Zyl  
Commercial Services Department.  
033 8978525  
james@nctforest.com

Dear Mr J. T van Zyl,

I, Merisha Bepat am doing research with Doctor Beverly Waugh a Professor in Supply Chain Management, in the Department of Transport Economics, Logistics and Tourism at the University of South Africa. I would like your permission to conduct research on NCT FORESTRY CO-OPERATIVE LIMITED.

The aim of the study is to determine the logistics cost savings that can be achieved by considering an intermodal switch from road to rail for the independent timber grower in Kwa-Zulu Natal.

NCT has been selected because the supply chain focuses strongly on road and rail operations of the timber growers in Kwa-Zulu Natal.

The study will entail an analysis of road rail volumes from the period 2000-2014. The benefits of this study is to determine how feasible the intermodal switch is for the timber grower. Potential risks is that this research will be available for public reviewing. A Feedback procedure will entail the detail of the usage of this data.

Yours sincerely

Merisha Bepat  
Logistics Co-ordinator  
NCT Forestry Co-Operative Ltd

Mr J. T van Zyl  
Commercial Services Manager  
NCT Forestry Co-Operative Ltd



University of South Africa  
Pretier Street, Muckleneuk Ridge, City of Tshwane  
PO Box 392 UNISA, 0003 South Africa  
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150  
[www.unisa.ac.za](http://www.unisa.ac.za)

**APPENDIX M: Editors letter**

*Alexa Barnby*

*Language Specialist*

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Editing, copywriting, indexing, formatting, translation

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BA Hons Translation Studies; APEd (SATI) Accredited Professional Text Editor, SATI

Mobile: 071 872 1334

Tel: 012 361 6347

alexabarnby@gmail.com

10 May 2017

To whom it may concern

This is to certify that I, Alexa Kirsten Barnby, ID no. 5106090097080, a language practitioner accredited by the South African Translators' Institute, have edited the dissertation submitted in fulfilment of the requirements for the degree of Master of Commerce in Logistics, titled "A Comparison of Road and Rail Transport for the Benefit of the Independent Timber Growers of NCT Forestry Co-operative Limited", by Merisha Bepat.

The onus is, however, on the author to make the changes and address the comments.

