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Logistical cost model accounting for the impact of road quality and road works in South Africa

by

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ABSTRACT

Logistics in South Africa is experiencing an immense load of pressure due to globalization. As the global market becomes more competitive, companies have to ensure that their critical operations function as effectively as possible. This pressure increase has promoted the implementation of a higher performance standard to ensure the well-being of companies. However, companies are constrained by the current infrastructure, especially where logistics are concerned. As this trend continues, it forces the South African market to address the issues that can prevent South African companies to compete on a global scale.

The poor quality of roads, delays caused by road works, and the ramifications thereof are some of the burdens that South African logistics companies are facing. Knowing and understanding the cost impact of these factors is vital for the effective management of logistics and supply chains.

The aim of this project is to create a model to account for the broader cost spectrum associated with road conditions and to help quantify certain financial implications of the current logistical environment in South Africa. This is accomplished by developing a base model that takes into account the cost of logistical operations and incorporates the following:

- An estimation of the financial impact of road works on logistics.
- Quantification of the impact of different road surfaces on variable costs.
- An estimation of all internal costs of operating a truck in the current South African environment.

Figure 1: Example of poor road conditions in South Africa

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

CSIR - Council for Scientific and Industrial Research

IRI – International Roughness Index

USA – United States of America

SANRAL - South African National Roads Agency Limited

GLOSSARY

Stochastic – Refers to a non-deterministic model, system or process (Oxford dictionary, 2002)

Exogenous – External factors that cause of impact in the model or system (Oxford dictionary, 2002).

Amortization – It refers to the process of payments over a period of time (Oxford dictionary, 2002).

CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION AND BACKGROUND

The importance of logistics has become widely acknowledged in recent years, not just as a means of moving goods from one place to another, but to gain strategic advantage in a competitive marketplace. Globalization has made logistics even more important in a strategic sense as the world market is becoming increasingly more accessible. A report of the World Bank on Trade Logistics states the following: ”Better logistics performance is strongly associated with trade expansion, export diversification, ability to attract foreign direct investment and economic growth” (World Bank 2010). The pressure on South African logistics due to globalisation will continue to increase, forcing the country to address the issues that are preventing it from expanding and competing in global markets.

A firm’s understanding of operational cost provides an opportunity to increase profitability and decrease cost through efficiency gains (Casavant K, 1993). This understanding of cost is of vital importance to companies. However, due to external challenges in the South African infrastructure it is difficult for companies to quantify all costs associated with logistical operations on South African roads. One of these challenges is the impact of poor road conditions on the logistics of South Africa and the resulting cost increase.

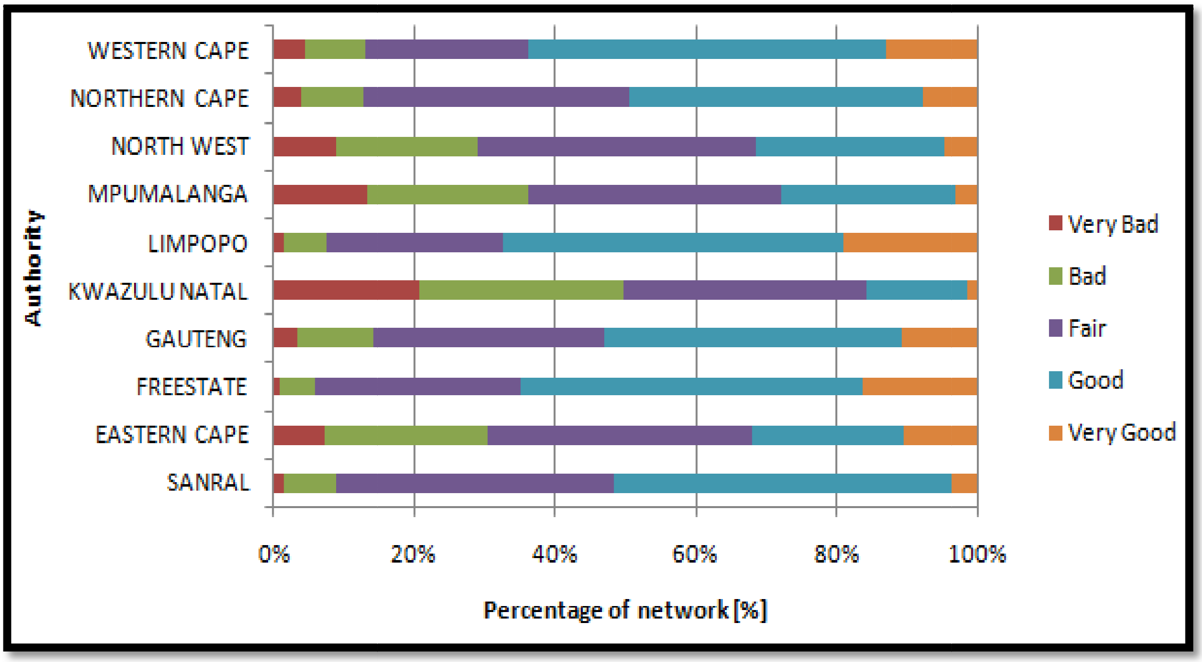


Figure 2: Roads conditions in all provinces in South Africa (Steyn & Bean, 2009)

Figure 2 paints a grim picture of the current condition of roads in South Africa. The figure shows the condition of roads for every province and then the condition of SANRAL owned roads. In this state, road conditions are adding considerable cost to logistics and supply chains in South Africa (Steyn W & Bean W, 2009).

There are two main external factors, associated with road conditions that are contributing to an increase in logistical costs. The first one is the fact that all the roads in the country are in a different state of repair. The cost breakdown in Figure 3 clearly shows how road conditions form a large part of a company's logistics cost both directly and indirectly (indicated in red are factors influenced by road quality).

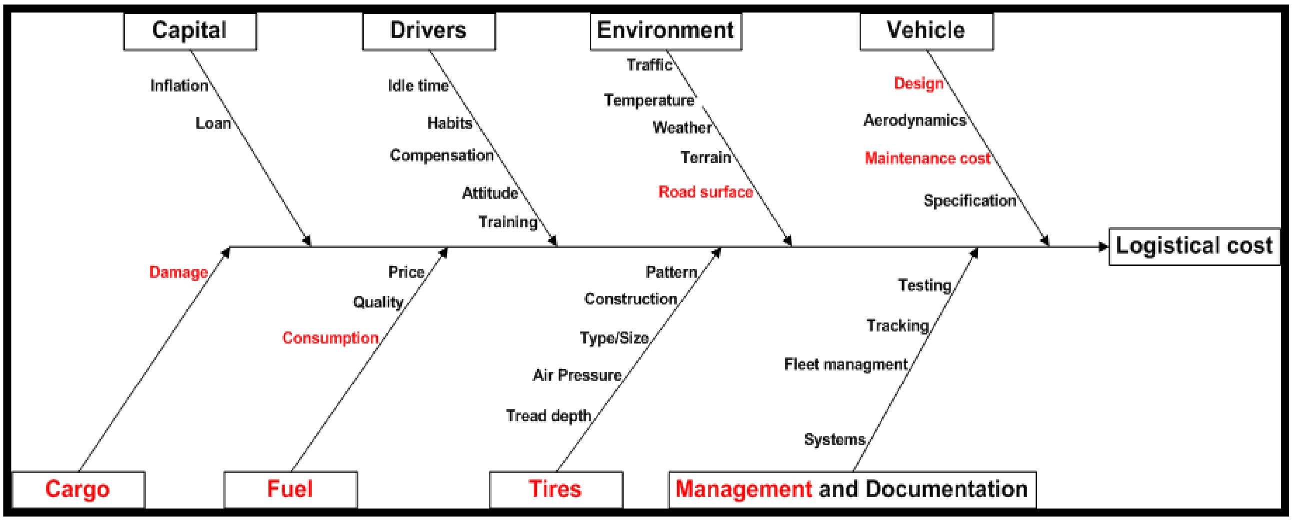


Figure 3: Some of the aspect that add cost to logistics

These cost impacts created by road conditions can be found manifested in different areas from tyre damage, increase in maintenance cost and repair cost, fuel consumption and cargo damage.

The second factor, which is often overlooked, is the delay caused by road works. Time spent waiting at stop points and decreased travelling speeds lead to a loss in productivity and increased lead time. This factor is not only affected by the quality of the road, but also by the efficiency of the road maintenance systems in place.

As stated before, an understanding and command (control) of cost is the basis of any business (Casavant K, 1993). Therefore this study focuses on building a logistics cost model that incorporates the basic costs of operations, as well as the variable costs caused by the quality of roads in use and the road maintenance system. The development of such a model is a step in the right direction towards helping South Africa to become competitive in global markets by managing the pressure on logistics.

1.2 PROJECT AIM

This project focuses on developing a logistical cost model by quantifying some of the financial impacts of operating a transport fleet (group of vehicles operating under one company) on South African roads. It takes into account the current road conditions and surrounding aspects such as road quality and road works and provides a custom logistical cost model for the South African environment. The model enables companies to trace costs to their origin in order to facilitate better logistics management. Costs are quantified into monetary values to achieve better clarity regarding the true impact of the problems focused on in the study. This provides companies with the means to make more informed decisions regarding technologies (tyres, suspension, trailer or truck design, and all similar aspects) and supply chain decisions for the future.

1.3 SCOPE OF WORK

A logistical cost framework model for South African conditions was created in Microsoft Excel. The model is used to estimate the cost incurred by logistical operations on South African roads, taking into account factors such as road quality and road works. The model enables the user to enter and analyse costs associated with three different types of trucks, operating on different roads and with different setups (type of truck, trailer, and tyres) as representative of a whole fleet.

The model can be logically broken down into two cost groups. The first is fixed costs that can be calculated by taking the factors as indicated in Figure 4 into account.

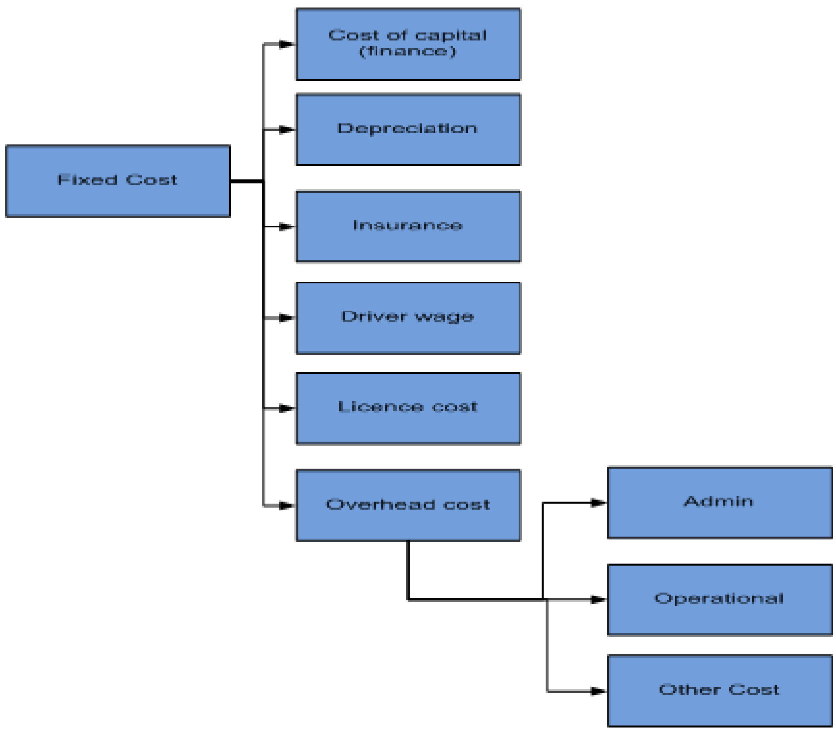


Figure 4 Fixed cost breakdown

The second cost group is variable costs as can be seen in Figure 5, and this is the cost group that is influenced dramatically by road quality and other external factors. For the purpose of this study external factors are factors that directly influence the cost of the logistics company's operations, such as road condition and road works. This part of the model is where factors of road quality and road works were incorporated to make a more accurate model for the current conditions in South Africa.

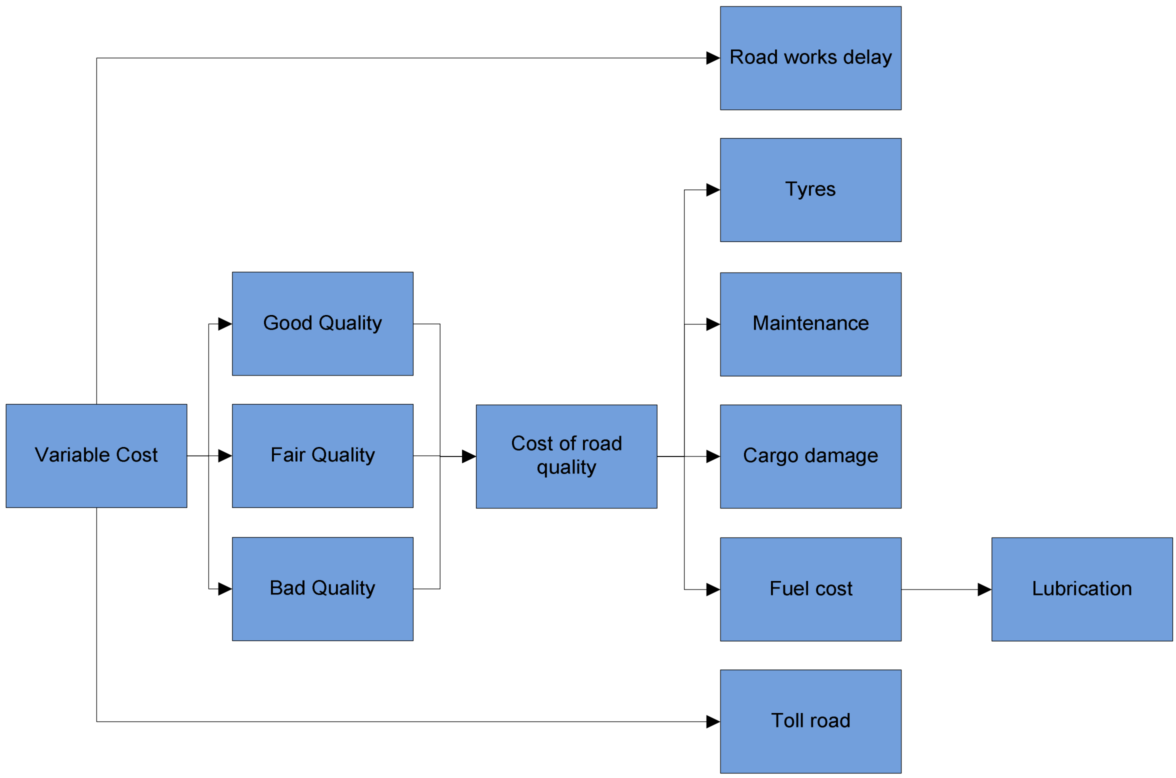


Figure 5: Variable cost breakdown

The model enables one to acquire user-friendly information regarding logistical expenditures and report on all cost aspects, including costs associated with road works and road quality.

The model is tested with a numerical example to verify its functionality. The model can serve as a valuable indication of the impact of these costs by showing logistical managers how operating in different road conditions can contribute to an increase in logistical costs, as well as the financial impact of road works on logistical operations.

CHAPTER 2: LITERATURE REVIEW

The literature review covers research that has been done in the field and addresses the following topics:

- Supply chain and logistical management
- External cost factors
    - Road quality
        - Maintenance and repair
        - Fuel
        - Cargo damage
        - Tyre damage
    - Congestion due to road works
- Trucking costing model
- Conclusion

2.1 SUPPLY CHAIN AND LOGISTICAL MANAGEMENT

Supply chain management has been defined in different ways over the years. One definition by Cooper et al. (1997) is: "... an integrative philosophy to manage the total flow of a distribution channel from supplier to the ultimate user". This definition refers to managing the whole supply chain depicted in Figure 6 as an interrelated and integrated entity.

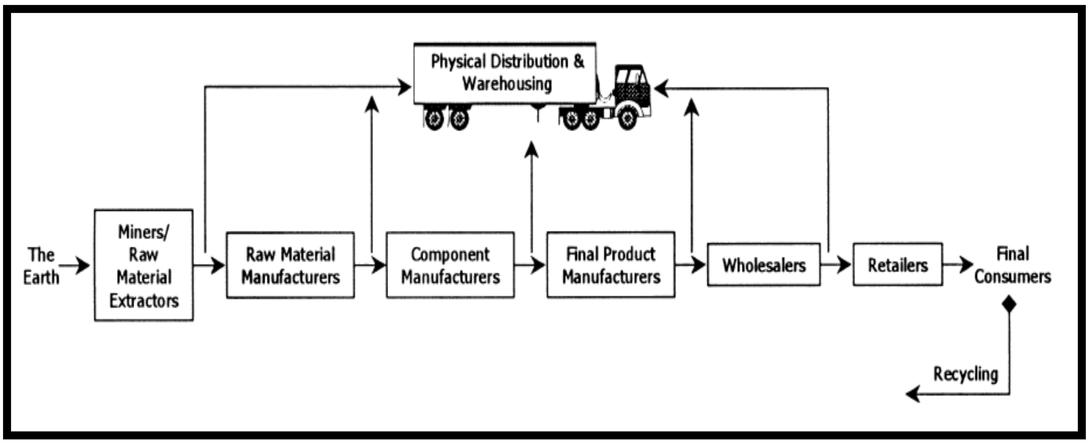


Figure 6 : Example of supply chain (Tan, 2000, p39-48)

Managing a supply chain as an integrated entity involves forming a close link between logistical functions and other key corporate functions. Incorporated systems enable a company to deliver products in a more timely and effective manner. In turn, this enables a company to exploit the competitive advantage associated with integrated processes (Keah Choon Tan, 2000). This competitive advantage has become a necessity for companies to compete in the global market (Barnes, 2007). As this necessity has become apparent to managers, they realize that the backbone of a supply chain is logistics and that it forms a crucial part of the chain. Therefore 'logistics management', as defined below, has become a recognized activity within many companies.

"Logistics is defined by the Council of Logistics Management as the process of planning, implementing and controlling the efficient and effective flow and storage of goods, services and related information from the point of origin to point of consumption for the purpose of conforming to customer requirements "(bin Illyas Tan & BT Ibrahim, 2010, p451-456).

Logistics managers therefore aim to fulfil the objective of effective and efficient process management that entails planning, implementation and control of logistical operations. Managers are constantly faced with many alternative courses of action, each one influencing logistics in a different way. Many factors, concerning these courses of action, play a part in the decisions a manager must make, of which some cannot be converted to monetary value (Carter, Mac Donald & Cheng, 1997). Because of this, the starting point is to have an in-depth understanding of the quantifiable aspects that different courses of action could have. This is especially important as finance; cost and the flow of money have become increasingly emphasized in recent years due to pressures created by globalisation in supply chain management.

As a result, supply chain managers begin the decision-making process with finance and capital budget decisions (Hofmann, 2005). The ability to make sound decisions is a crucial part of the managerial process, and business managers and professionals are often required to justify decisions on the basis of data (Arsham, 1994). It is therefore imperative to make decisions that are grounded on facts and not assumptions.

The numerous benefits of understanding the facts concerning the cost of operations have been indicated in various studies on the subject. Cost information plays a critical role in determining the selling prices of services or goods (Drury, 2000; Horngren et al, 2000; Langfield-Smith et al, 1998).

There are numerous benefits of understanding the monetary factors in business and being able to trace these factors to their origin. This study therefore focuses on building a logistical cost model in order to exploit these benefits. In section 2.2, external factors that affect internal costs are discussed, after which existing logistical trucking cost models will be reviewed to see what changes have been implemented in the field and how an improved model can be designed specifically for logistical operations within South Africa.

2.2 EXTERNAL COST FACTORS

2.2.1 ROAD QUALITY

The road surface determines the quality or condition of the road. A variety of different road surfaces exist, and their impact on operations varies (Steyn & Haw, 2005). The type of road surface varies according to a variety of factors, for example construction material (asphalt, concrete, composite surfaces, metalling and others) and road wear, to name but a few.

For the purpose of this study, road condition and quality refers to the same aspect of road conditions, and in the case of this study the International Roughness Index (IRI) will be used as an indication of the quality or condition of the road, except with tyre cost where micro texture is used as it is the biggest contributing factor to tyre wear (Lowne, 1969, p57-70). The speed at which the IRI measures the travelling roughness response is 80km/h. In other words, it is a reference average rectified slope, which expresses a ratio of the accumulated suspension motion of a vehicle, divided by the distance travelled during the test (Sayers, Gillespie & Paterson, 1986). This can be defined as the macro texture. Micro texture refers to how smooth the road surface is on a smaller scale. Both of these terms are illustrated in Figure 7.

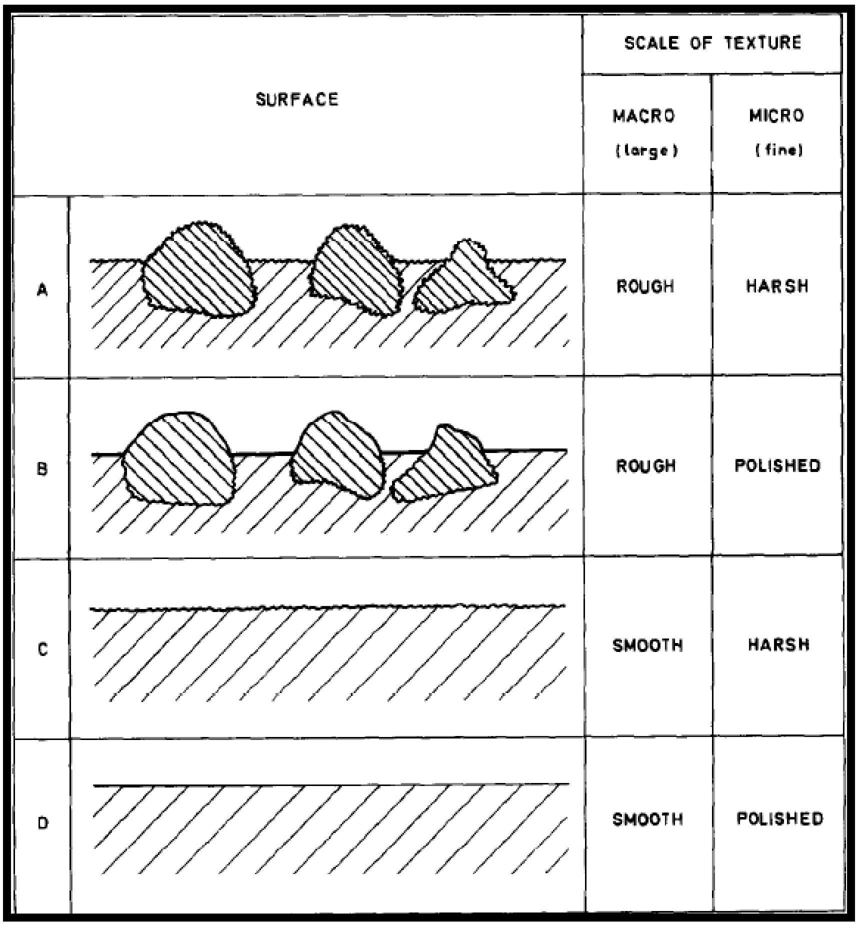


Figure 7 : Illustration of terms used to describe road quality (Lowne, 1969 p70).

The road surface determines the quality of the road and as its quality has a major impact on the cost, it will affect a variety of variable cost factors, such as maintenances and repair, fuel, cargo damage, tyre cost etc. Figure 8 is a visual representation of some of the impacts that road quality can have on logistical costs.

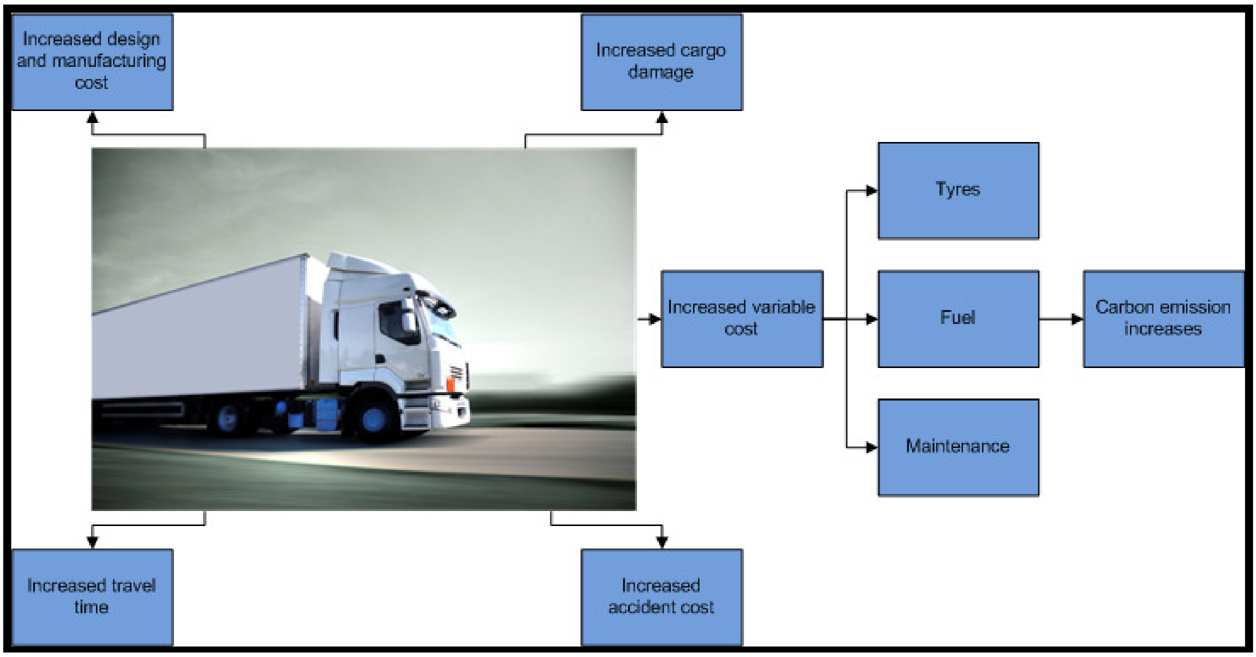


Figure 8 : Some of the logistics costs associated with road quality

These costs must be absorbed by the company operating on the road (road user), and it eventually culminates in a rise of costs for the end user (customer receiving end product/service).

As studies have shown, the variation in operational cost per kilometre can vary from R3.00 to about R7.00 per kilometre when operating trucks in South Africa (Steyn, Bean & Monismith, 2008). Studies done in the USA have also shown that the road user costs can increase with a deterioration of road quality (see Figure 9 on the next page).

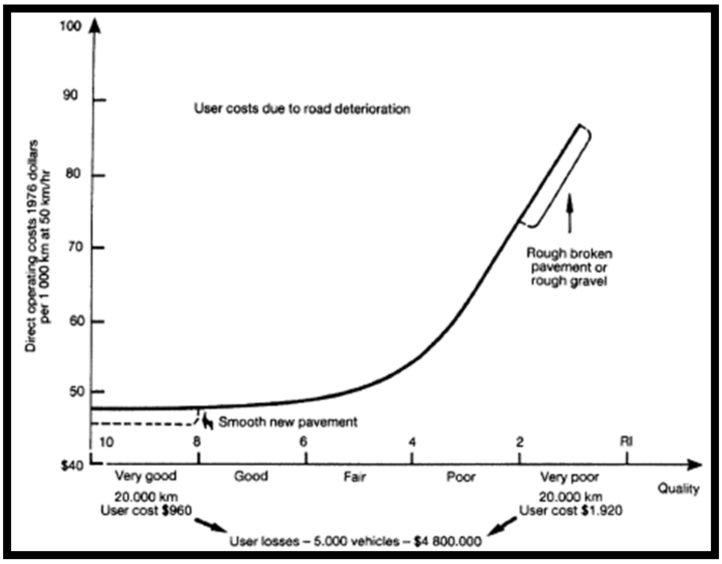


Figure 9 : Example of the relationship between road-user cost and pavement conditions (Pavement Management System, 1987)

The factors that drive the increase in operating costs are increased maintenance and repair cost, fuel usage, cargo damages, tyre cost and congestion.

2.2.2 MAINTENANCE AND REPAIR COST

Steyn & Bean (2009) studied the potential effects of deteriorating road conditions on vehicle maintenance and repair costs. The study considered the maintenance costs of different trucks from two companies on different routes. The routes were assigned IRI values as an indication of the road condition.

Road condition	Average maintenance and repair costs (R/km)	Average percentage increase in the truck maintenance and repair costs	Average percentage increase in company logistics costs
Good	R0,96	-	-
Fair	R1,24	30,24%	2,49%
Bad	R2,11	120,94%	9,97%

Table 1: Summary of vehicle maintenance and repair costs for routes with different IRIs (Steyn W &Bean W.L, 2009)

The study showed a big variation in costs. As can be seen in Table 1 , maintenance and repair cost on good road conditions cost around R1.00 per kilometre, whereas bad road conditions cost approximately R2.00 a kilometre.

2.2.3 FUEL

Fuel is almost always the largest single cost item, accounting for roughly 40% of the total cost of operations in companies that cover high annual kilometres (Braun M, 2008). There are a variety of factors that contribute to fuel consumption, as can be seen in Figure 10. Over the years different methods have been used to quantify fuel consumption and the cost thereof.

Hussein and Petering (2009) stated that fuel consumption is a function of the weight of the vehicle and the speed it is travelling at. Thus, it will vary with truck configuration and load change.

Knapton (1981) developed a formula that estimates the fuel consumption of a truck by taking the truck's weight and travel speed into account. The formula assumes that the truck is operating on level terrain and incorporates all fuel-efficiency measures, as expected in 1985. As the formula is only an aid to the final user, it does not account for different road conditions.

All the current methods contain some limitations and because a variety of factors (Figure 10) play a part in fuel consumption, it is recommended in most cases that companies obtain specific data through actual tests and benchmarking to have a better understanding on the monitoring and control of fuel consumption (Braun M, 2008).

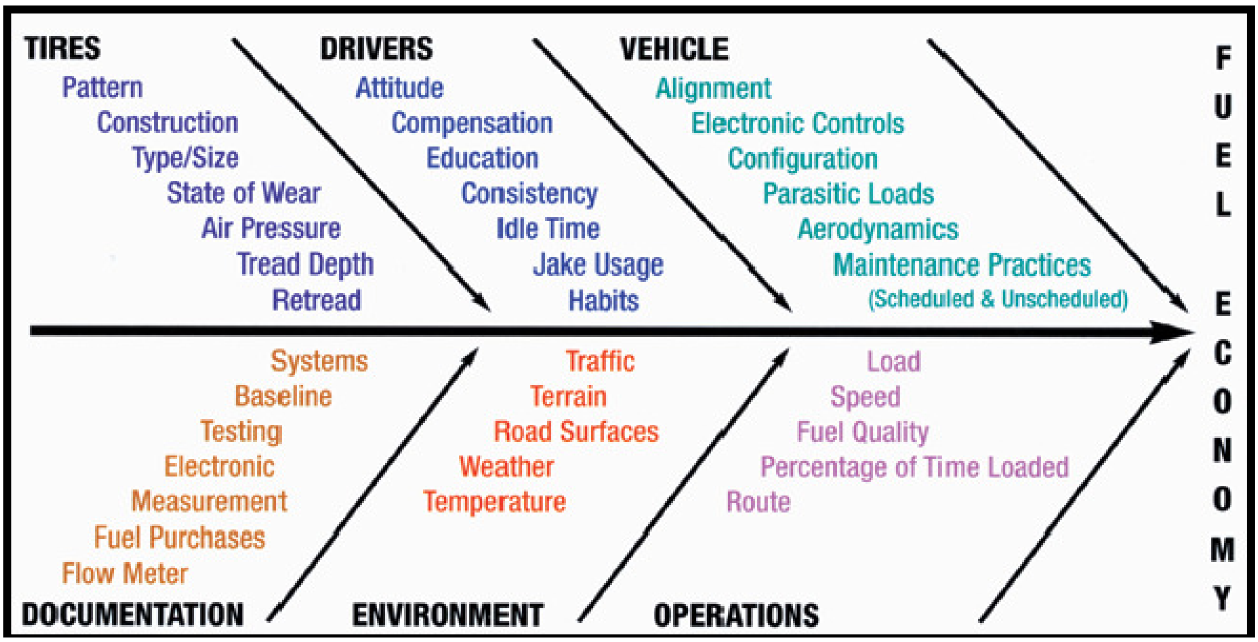


Figure 10 : Factors affecting fuel economy in the real word (Kenwoth, 2008)

2.2.4 CARGO DAMAGE

A road IRI is an indication of how uneven the road surface is. Road surface roughness causes vibrations and the vibrations in turn cause an impact on the truck as shown in Figure 11. This force is consequently transferred to the cargo (Figure 12). The magnitude of the force is dependent on factors such as the IRI of the road, truck setup factors like suspension, placement of the cargo, trailer design, truck dimensions, loaded weight as well as some other factors (Steyn & Bean, 2010, Nisonger & Ervin, 1979).

Although the root of the problem still needs to be examined, a proposed solution would be better suspension and packaging. (Steyn & Monismith, 2010)

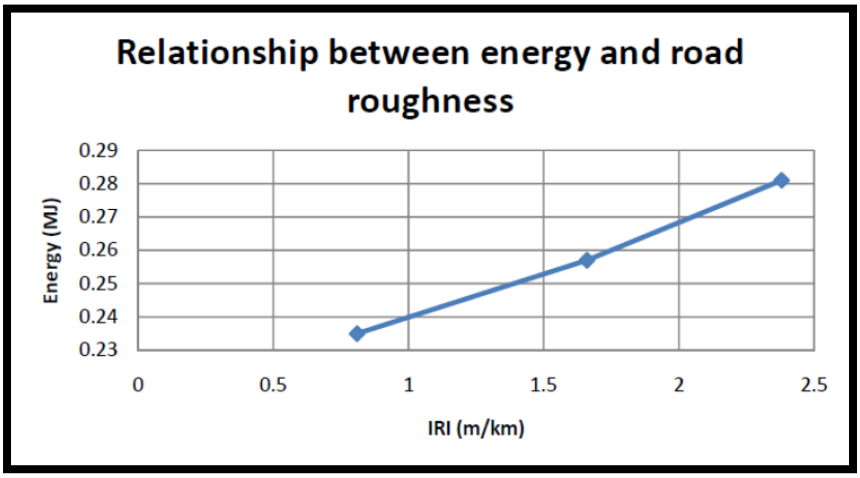


Figure 11 : Example of IRI vs. force (Van Der Merwe M, 2011)

Finally, in a questionnaire the impact of road conditions on cargo damage to fragile goods, was estimated between 1% and 2% of all volume moved (Van Der Merwe M, 2011).

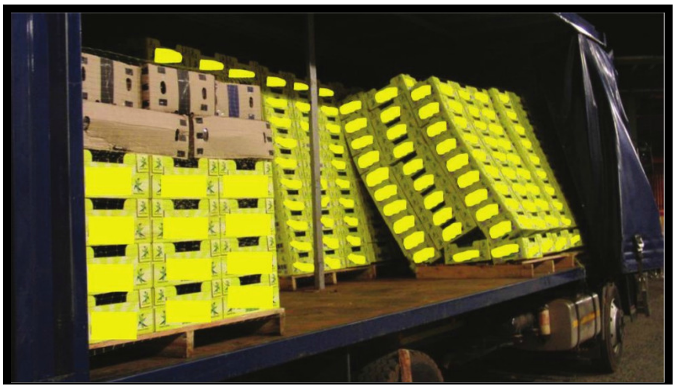


Figure 12 : Example of cargo damage due to road condition (Steyn W &Bean WL, 2009)

2.2.5 TYRE DAMAGE

Tyres constitute the only contact point between a truck and the road surface. Tyre companies sometimes do route surveys to aid in the decision-making process of their clients when selecting tyres (Steyn & Haw, 2005). Clients can therefore get optimal performance out of their tyres by making an informed decision.

Route surveys done by tyre companies show that tyre performance varies in accordance with the quality of the road. The typical average life of a truck tyre on the road is estimated at 100 000 miles (160934.4km), and for a trailer tyre it is estimated at 204 500 miles (329110.848km) (Heggeness, 1996). The average life span of a tyre is affected by the quality of the road.

Lowne (1969) describes the tests that were conducted to assess the effect of the road surface on the wear of a tyre. He used two techniques to indicate the wearing process of a tyre in a planned and controlled manner. He firstly used a method in which a vehicle is made to execute figure-of-eight manoeuvres, thus wearing a test tyre which is fitted to a front wheel. Secondly he used a fifth wheel method in which the wheel is forced to run at a fixed slip angle. The experiments indicated a big variation in tyre wear. Approximately three times more tyre wear occurred when moving from rough and polished surface to rough and harsh surfaces.

Figure 13 : Tyre damage due to impact on bad roads

2.2.6 CONGESTION DUE TO ROAD WORKS

A major external factor that impacts internal logistical cost is the congestion caused by road works. The time delay due to road works results in increased costs and traffic accidents (Jiang & Adeli, 2003).

Since road maintenance has major financial impacts on both private users and transport agencies, effort has been made to minimize this impact since it cannot be removed entirely (McCoy & Mennenga, 1998). It is therefore imperative that these impacts are incorporated into the cost model as accurately as possible.

Woensel & Cruz (2009) stated that when contemporary prices of transport are calculated, congestion costs are not taken into account. If road users are to make informed decisions concerning logistics they have to internalize this cost to have operational cost models that are as accurate as possible. Woensel and Cruz also discussed that, in a complex world, it is important to use models presented as a stochastic queuing model, in order to quantify congestion.

As congestion increases the time span of an operation, it implies additional costs. One of the methods of evaluating the value of time is to obtain the cash flow of a product or project, and by looking at its present value, annual value or future value, obtaining the cash flow over the project's lifespan (Blank L & Tarquin A, P 2008).

It is clear that accounting for the impact of the external factors of traffic congestion on internal cost of logistics is imperative in creating a trucking cost model that is as accurate as possible.

2.3 TRUCKING COST MODEL

Different truck costing models have been developed in the past, each one taking different factors into account.

Berwick and Dooley (1997) state that economic developers need estimations of truck transport cost to compare modes of transport and to benchmark performance and cost. They also investigated changes in supply chains and manufacturing environments, observing a trend in companies to continually decrease their inventory and thus move towards just-in-time management systems. This is something that necessitated an effective transportation system.

To help satisfy this need, Berwick and Dooley (1997) developed one of the first truck costing models. Their model was a spread sheet simulation model that estimated logistical costs for different truck configurations, trailer types, and trip movements. The model consisted of multiple sheets; the first sheet contains exogenous variables and decisions, the second sheet consists of performance measures and then multiple sheets containing logistical data and sensitivity analyses to observe the change in performance measures. The model firstly incorporated fixed costs as defined by Griffin, Rodriguez & Lantz (1992) as short-run costs that cannot be avoided and do not vary with output. These costs were specified to be equipment cost, returns on investment, licence fees, insurance, depreciation, sale tax, management and overheads. Secondly variable costs were identified according to Ferguson & Kreps (1965) as being the cost that changes as the firm's output changes. Berwick and Dooley's model consists of fuel, tyres, labour, maintenance and repair cost.

After the development of this truck costing model by Berwick and Dooley (1997), it was developed into a more functional model with the aid of Visual Basic by Berwick and Farooq (2003). They argued that the first model was useful, but lacking functionality.

Berwick and Dooley's model laid the basis for logistic costing models to follow. An example of such a follow-up model is a policy-oriented cost model for shipping commodities by truck, as developed by Mazen, Hussein & Petering (2009). This model was built to estimate the cost of shipping different commodities between two locations. They argued that the cost of shipping is a crucially important component when selecting routes, locations and modes of transport. They furthermore stated that a good knowledge surrounding costs can aid in setting policies and operational strategies. It is essential for the survival of a trucking company to have a cost model, in order to be aware of all costs and to reconcile freight rates with trucking cost. This reconciliation ensures that the shipper remains competitive in the industry.

To gain some of the benefits mentioned above, such as improved cost understanding, to improve decision making and to quantify the impacts, some cost models do not only account for the direct impact of external cost factors in its scope but also the external cost factors that affect the whole industry. Forkenbrock (1999) estimates these external costs of road use of inter-city trucks by dividing the costs into four categories: accidents (property damage, fatalities and injuries), emissions (greenhouse gases and air pollution), noise and unrecovered costs associated with operation, provisions and maintenance of public facilities. He stated that these external costs should be internalized by road users so that the users could weigh the benefits of each specific transportation service against the true cost. Although these costs are important, it will have very little effect on the physical financial state of a company.

While aiming to control their finances, large carrier companies have developed various cost models to aid with internal management and strategic decision-making and have accepted the importance of costing models (Mazen, Hussein & Petering, 2009).

2.3 CONCLUSION

In conclusion, a review of available literature has indicated the importance of understanding and knowing how a company's finances are managed and influenced in terms of logistics, especially concerning expenditure. In aiming to run a world class supply chain, a cost model is an invaluable tool. A logistical cost model aids in the process of decision making, rate setting, benchmarking and implementation of technologies. The accuracy of the model is vital, and seeing as external factors play a big role in cost variations, it is important to incorporate them into the logistical cost model.

CHAPTER 3: MODEL DEVELOPMENT

3.1 GENERAL

The model can be defined as a simplified representation of an empirical situation (Bierman, Bonini & Hausman, 1991). The aim of this model is to represent all direct costs associated with companies that operate on South African roads, and takes into account external factors such as road quality and road work delays. As mentioned in section 1.3, this was calculated by dividing costs into two groups. The first is fixed cost, where external factors have almost no effect. The second is variable costs, where external factors have major impacts. All of these calculations where done in the following units of measure:

- Currency: South African rand (R)
- Distance: kilometres (km)
- Fuel: Litres (*l*)
- Weight: Kilograms (kg) or tons (T)

All inputs required in the model must be entered in these units; the input will be further discussed in the next chapter. From the input values, the model calculates the fixed and variable costs of the company.

The model is made as accurate as possible with the available data and time frame but hopefully inspired future studies will refine some of its aspects. Some of its limitations are firstly, a lack of data, making some estimation basic but it will still give the user a good indication of cost. Secondly, the model was aimed at internal operations and decision-making. Therefore it only considered external factors such as road quality and road works that directly affect internal costs, and not external costs as Forkenbrock (1999) (discussed in section 2.2) estimated in his model. The direct costs in the model were divided into fixed and variable costs. In the next section, aspects that fall into the above-mentioned categories are discussed as well as how they were calculated in the model.

3.2 FIXED COST

Griffin, Rodriguez and Lantz (1992) defined fixed cost as short-run cost that cannot be avoided and does not vary with output. In the model, fixed cost was regarded in this context. Berwick and Dooley (1997) also used it this way in their model. The model in this study incorporates the following as fixed cost: Overheads, depreciation, cost of capital, driver salaries and licence fees.

3.2.1 OVERHEADS

Casavant (1993) describes overhead costs as short-run fixed costs that are not directly attributable to a unit of output. The user of the model must identify the costs that fall within this definition and enter it into the model as annual overhead costs.

Overheads were subdivided into three categories namely administration costs, operational costs and other costs (see Figure 14). Firstly, administration cost includes salaries, wages, telephone and similar company expenses. Operational overheads include all claims, safety related costs, fines and related expenses. All overheads that do not fall into these two categories must be included in 'other costs'. The overhead amount that a truck must absorb is calculated as follows:

$$\boldsymbol{TO} = \frac{C_{admin} + C_{operat} + C_{other}}{FS}$$

Where

TO = Total Overheads

C_{admin} = Administration cost

C_{operat} = Operational cost

C_{other} = Other cost

FS = Fleet size, refers to the amount of vehicles operating within the certain operation; the model calculates this by automatically adding all truck types together to obtain the fleet size.

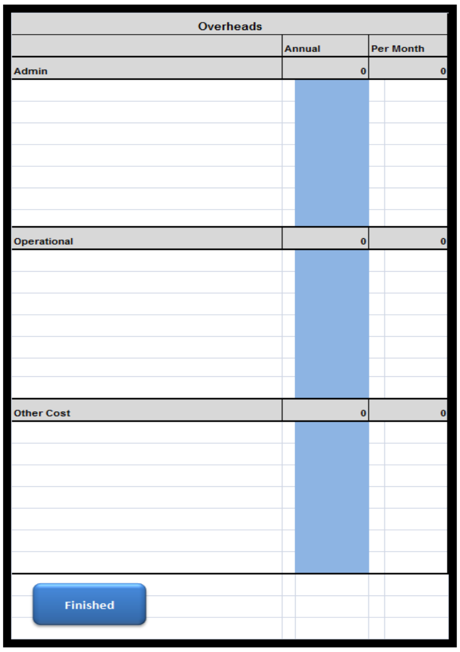


Figure 14 : Example of Overheads input screen

3.2.2 DEPRECIATION

Depreciation can be defined as the cost of using a capital asset (Fess & Warren, 1990). Another definition of deprecation is the amount of value an asset loses as it is being used with the passing of time (Berwick and Dooley, 1997).

This model aims to account for the loss in value on assets by using the straight-line method. The straight-line method assumes that the asset loses an equal amount of value each year (Hussein & Petering, 2009), and is calculated in the following manner:

$$\boldsymbol{D} = \frac{CS - SV}{L}$$

Where

D = Depreciation on market value per year (R)

$CS =$ Cost price (R)

SV = Salvage value(R)

L = Operating life (years)

3.2.3 COST OF CAPITAL

Capital is needed to obtain the equipment (truck and trailers) required by logistical operations. This capital is mostly obtained from loans which cost the company extra money in interest paid. The cost of capital in the model was treated according to Modigliani & Miller's approach (1958); they stated that the cost of capital for a loan is the interest paid on the loan. The following calculation was done to obtain the cost of capital and to help the user understand all payments surrounding cost of equipment. Firstly, the payment that will be made on a loan, its interest component, and cash component are calculated. Secondly, the cost of capital will be calculated and thirdly the amount payable. Hopefully this will assist the user in understanding the full extent of the capital investment surrounding equipment.

To calculate interest, a calculation is done in the same manner as Blank and Tarquin (2008). Firstly, the loan payment was calculated using the concept of an annual payment:

$$\boldsymbol{A} = P\frac{i(1+i)^n}{(1+i)^n - 1}$$

Where

A = Annual amount (R)

P = Value at time t = 0

i = Interest (R)

n = Number of periods (months, years)

In the model, the Excel formula 'PMT' is used to determine the annual payment. The yearly interest is converted to monthly interest, and the years that the loan has to be paid in, is converted to months. The present value of the truck is taken as the buying-value. Its future value is obtained by multiplying the buying-price with the residual percentage (percentage of the cost price that will remain after the equipment has been used) to get a residual value (future selling price). This is the amount that can be seen in the payment column in Figure 15.

Capital still to paid	Payments	Capital	Interest
1023561.54	13570.74	7949.58	5621.16
1002472.26	13570.74	8732.64	4838.11
981539.96	13570.74	8798.13	4772.61
960763.50	13570.74	8864.12	4706.63
940141.69	13570.74	8930.60	4640.14
919673.40	13570.74	8997.58	4573.17
899357.47	13570.74	9065.06	4505.68
879192.79	13570.74	9133.05	4437.70
859178.21	13570.74	9201.55	4369.20

Figure 15 : Example of how cost of capital can be presented

The interest is determined using the formula below (Blank & Tarquin, 2008) (with the symbols having the same meaning as defined for the previous equation):

$$\boldsymbol{P} = A\frac{(1+i)^n - 1}{i(1+i)^n}$$

The model uses Excel's formula 'PV' that uses the concept in the formula above to calculate the present value on a specified time period $n = n_t$-*x* (*x*= current period (month) and n_t=total periods (month)). This is then multiplied with the interest rate per month to get the interest component of every payment.

Acquiring the capital component of the payment is achieved by subtracting the loan payment and interest from one another. As can be seen in the example in Figure 15, the annual cost of capital is then determined using the formula:

$$\boldsymbol{CC} = \frac{i_{total}}{n_{loan}}$$

Where

CC = Cost of capital (R, annually)

i_{total} = Total interest paid (R)

n_{loan} = Loan repayment period (years)

Some extra information was included in the form of capital still to be paid. This calculation is done by taking the 'PV' formula as when calculating interest also in $n = n_t$-*x* (*x*= current period (month) and n_t=total periods (month)) time period and then using that value as the *F* value in the following formula:

$$\boldsymbol{P} = F \times \frac{1}{(1+i)^n}$$

Where

P = Value at time t = 0

F = Value at a specified time period in the future (R)

i = Interest (%)

n = Number of periods (months, years)

Adding the above calculations to the model gives the user a comprehensive understanding of cost of capital and aspects surrounding it.

3.2.5 DRIVER SALARIES

The drivers' salaries are entered in the model, and this cost accounts for the salary of a driver and driver's assistant. Users can stipulate the salaries and the amount of drivers and drivers' assistants that will be used to operate the truck. The model calculates the cost of operating staff in the following manner:

$$\boldsymbol{S_{total\ cost}} = (S_{driver} \times n_{drivers}) + (S_{assistant} \times n_{assistant})$$

Where

S = Salaries (R)

n = Number of persons (drivers or assistant) being used in operating truck over a year

3.2.6 LICENCE FEES

Considering that truck and trailer licence costs vary between provinces, the model uses Gauteng licence fees but can be changed as the user requires.

The licence fees were calculated from the tare weight (gross truck or trailer weight with no container or cargo) of the truck, so the user enters the weight of the truck and its trailer(s), and the model sources the licence fee associated with the weight and assigns it to the licence fee cost.

3.3 VARIABLE COSTS

Ferguson and Kreps (1965) defines variable costs as the costs that change as the firm's output changes. This part of the model was designed such that costs can be calculated by either a default value built into the model, or by taking as input all the costs associated with the following aspects: fuel, maintenance and tyre cost per kilometre. Default values for fuel, maintenance and tyre cost per kilometre were used in all variable cost calculations. If the company have these inputs available, the default value will not be used to calculate the variable cost. These values were provided seeing as few companies know the exact cost on different quality roads. The model takes all the truck and trailer data for fuel, maintenance, cargo damage and tyres and divides it by the amount of trucks entered into the model to get the average expenditure of the company when using different roads, and with different cargoes. The cost of fuel, maintenance, cargo damage and tyres vary between companies using company specific data. The default values were determined as accurately as possible, taking into account some limitation in the availability of data surrounding aspects of performance of trucks on roads in different states of repair.

3.3.1 FUEL COSTS

Berwick and Dooley (1997) stated that fuel prices fluctuate with supply and demand. These prices can easily be obtained from fuel stations along the truck routes. Due to the unpredictability and accessibility of data surrounding fuel price, no fixed fuel price was assigned and the model requires it as an input.

The fuel consumption for a truck is needed to calculate fuel cost; this consumption is influenced by a variety of factors. Fuel cost is a function of vehicle weight and speed (Berwick & Dooley, 1997). Therefore, the model's focus was on the impact of road conditions on fuel cost. Default values in terms of average fuel consumption of different trucks operating on roads of different quality were built into the model. The model did not account for vehicle speed or weight, and assumed that it is constant over the truck's lifespan. This enabled the quantification of the impact of road conditions on fuel consumption.

Default fuel costs were established by analysing fleet data of a logistics company obtained from the CSIR. Statistics of ten trucks from 2008 and 2009 that mostly travel on the N1 and N3 highway were selected. The overall quality of a road can be defined using IRI; N1 is rated as good by IRI standards, and the N3 is rated as fair (Steyn W & Bean W.L, 2009). The costs of fuel consumption when operating on these roads were extracted from the available data. Average fuel consumption was used as a representative of the fuel consumption of a truck operating on these roads (refer to Table 2).

N1 (Good)		N3 (Fair)	
Year	KM/L	Year	KM/L
2008	1.84	2008	1.73
2009	1.88	2009	1.72
Variance	0.03	Variance	-0.01
Average	1.86	Average	1.73

Table 2: Fuel consumption calculation results

Due to the limited data available for fuel consumption on bad road surfaces, the difference between good and fair roads was used as an approximation of the difference between fair to bad road surfaces. The value of the variation was 0.13 (km/l), and was used on the assumption that the cost will increase with the same amount between fair and bad as between good and fair. With this assumption, the fuel consumption on bad roads was calculated as 1.60 km/l. Default data can be used, or the fuel section of the variable cost sheet can be completed with company specific data (refer to Appendix C). The company can take km/l data of their fleet on different roads and the model will get the average value for the different road qualities and override the default values of the model to yield a more accurate set of results.

If company specific data is unavailable, the fuel cost per year is calculated by using the formula below:

$$\boldsymbol{C_{fuel}} = T \times \frac{FP}{kl}$$

Where

$\boldsymbol{C_{fuel}}$ = Fuel cost for road type (R)

T = % Travel on road type

FP = Fuel price (R)

kl = Km/l per road type

3.3.2 MAINTENANCE AND REPAIR COST

The predetermined value for maintenance costs in R/km was obtained directly out of the study by Steyn and Bean (2009), mentioned in section 2.2.2. The data is displayed in Table 3 in the first column.

	Total	Truck	Trailer
Bad	2.11	1.477	0.633
Fair	1.24	0.868	0.372
Good	0.96	0.672	0.288

Table 3 : Maintenance and repair cost on different road qualities

After studying a case study concerning company fleet data, it was observed that the contribution to maintenance costs by trucks is roughly 70% and 30% by trailers. This contribution margin was used in the model to assign costs per truck and trailer.

The maintenance cost was thus determined for all road qualities by using:

$$C_{Maintenance} = T \times MCK \times KT$$

Where

$C_{Maintenance}$ = Maintenance cost for road type (R)

T = % Travel on road type

MCK = Maintenance cost per kilometre (R)

KT = Kilometres travel a year

All of the road quality costs are added to obtain the cost of maintenance and repair for both trucks and trailers.

3.3.3 TYRE COSTS

Tyre costs on different road qualities have not yet been quantified definitively as there is a magnitude of factors that contribute to tyre wear, for instance tyre pressure, rubber composition, load and tread pattern.

The literature shows the estimated average life span of a truck tyre is 100000 miles (160934.4km), and a trailer tyre 204500 miles (329110.848km).

To calculate tyre cost, the life of the tyre is needed as well as the amount of retread (old tyres are made serviceable by removing worn out treads and replacing it with new treads) that can be done on it. Firstly, aiming to obtain a default value for tyre life to be used in the model, an interview with Bowren (2011) was conducted where he estimated the tyre life of a 315/80R22.5 tyre as they are the most widely used in industry. The estimation, as depicted in Table 4, shows the average life that he estimated to be close to that found in literature.

Tyre Life		min	average	max
Truck	Steering	80000	120000	220000
	Driving	130000	210000	380000
Trailer	Front/rear	100000	190000	300000
	Centre	210000	320000	500000

Table 4 : Tyre life estimation (in km's)

Table 4 is used to calculate the average life of a tyre on different roads by taking the average life of the trailer and truck tyres for minimum, average and maximum life and using that in order to calculate the life of the tyres on different road surfaces. Values for these calculations are given in Table 5.

	Bad	Fair	Good	Test
Truck	105000	165000	300000	2.857143
Trailer	155000	255000	400000	2.580645

Table 5 : Model default tyre life values

The variation in tyre life between bad and good road surfaces can create a variation of roughly three times the performance from bad to good surfaces (Lowne, 1969). The above estimation and calculation indicates a 2.85 and 2.58 variation from bad to good roads. This is close to the findings by Lowne (1969), and show that the estimation is acceptable.

Secondly, a company related case study was used to obtain re-tread capability in the real world environment. To obtain default retread values, two of the tyre brands they currently use in their fleet were selected as representative of the company. The average retread that tyres undergo per month was considered, and an average was obtained over a 10 month period for the two brands. An average between the two tyres brands are calculated as can be seen in Table 6. This value is used as the default value for re-tread in the model.

	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	Average recaps
BRIDGESTONE	2.5	1.5	1.54	1.88	1.4	1.7	1.33	1.35	1.5	1.44	1.614
MICHELIN	4	3	2.7	2.33	1.5	2.25	2.43	2.14	1.88	2.3	2.453
											2.0335

Table 6 : Recap amount per brand per month

The default value estimation is only an indication of tyre costs, and if a company wants to obtain more specific data they can complete the model with company specific data. Thus the default values will be replaced. Taking company specific data or default values, the tyre cost is then calculated as tyre cost per kilometre for every road quality.

It is calculated using this equation:

$$CT = \frac{(C_{new\ tyre} + (C_{re\text{-}tread} \times R))}{L} \times n_{tyres}$$

Where

CT = Tyre cost (p/km)

$C_{new\ tyre}$ = Cost of new tyre (R)

$C_{re\text{-}tread}$ = Cost of re-tread (R)

R = Number of re-treads possible

L = Tyre life (km)

n_{tyres} = Number of tyres

The cost per kilometre is then taken and the tyre cost per road surface is calculated:

$$CT_{road\ quality} = T * CT * KT$$

Where

$CT_{road\ quality}$ = Tyre cost for road quality (R)

T = % Travel on road type

CT = Tyre cost (p/km)

KT = Kilometres travelled per year

All the costs of the different road qualities are added to get total tyre cost.

3.3.4 CARGO DAMAGE COSTS

There is very limited information available surrounding this topic, and there is a magnitude of factors that contribute to the variation that road quality will have on cargo damage cost. In constructing the model, the cargo damage was calculated in two different ways. This can be refined in future studies. The first is a general manner that classifies cargo into three categories (delicate, moderate and robust) and then calculates damage costs. The second method is to use a default value from a case study done specifically on grain.

FIRST METHOD: GENERAL CARGO DAMAGE

A questionnaire by Van Der Merwe (2011), completed by the management of a fleet company estimated cargo damage on glass to be between 1% and 2% due to road condition.

In the model, glass will fall under fragile goods and with the assumption that delicate goods will undergo a 1% to 2% loss due to road quality the following was extrapolated.

Cargo type	Delicate			Moderate			Robust		
Road quality	Bad	Fair	Good	Bad	Fair	Good	Bad	Fair	Good
Lost cargo to damage %	2.00%	1.50%	0.50%	1.00%	0.50%	0.00%	0.00%	0.00%	0.00%

Table 7 : Cargo damage percentage losses in transport

Using Table 7 and the formula below the cargo damage for all road types are calculated:

$$CD = TT * T * L$$

Where

CD = Cargo damage (road and cargo specific)

TT = cargo type transported (%)

T = % Travel on road type

L = Lost in cargo (%)

Due to the above mentioned data shortage the model also enables the user to enter company specific cargo losses on road type and the model will replace the predetermined data in Table 7.

SECOND METHOD: GRAIN LOSSES

The second method to calculate cargo damage costs is only applicable to grain transport and was obtained from a case study done on a grain shipping company.

From the company shipping data, two types of transport contracts were selected, the first was farm loads. This is where grain is loaded at farms and shipped to silos. In this case the roads are mostly in a poor condition. The second contract is silo-to-mill, where the roads are mostly in a good condition.

Due to the fact that grain is fine-grained, some of the cargo is lost during transportation, especially on roads that are in a bad condition. Data that indicates the loading and unloading weight of the cargo was obtained from the contracts mentioned above, and the variation between these two weights were calculated by subtracting unloading weight from loading weight.

This is not the only variation that the data exhibited, however. There were other special variations. For example, if a truck was in an accident and lost its whole cargo, the unloading weight would be unusually small compared to the loading weight. Anomalies like this were eliminated from the data set.

After all special variations were eliminated, the data variation remaining was caused by two factors: road quality (as explained above), and a variation in the calibration of the scales at the loading and unloading bays at the beginning and end of the journey. The data was inspected again, and all the values that showed an increase in cargo weight was isolated. This increase can only be contributed to scale calibration errors. The amount of data points that showed this variation were added together to obtain the amount of scale underweight errors. Assuming that the same amount of scale errors for overweight and underweight values will occur, the probabilities that the variation is caused by scale error was calculated. As can be seen in Table 8, in the probability column, the sum of the scale variation (amount of trips that an increase in cargo weight occurred*2) was divided by the total amount of all variations, to obtain scale error probability. This was then subtracted from unity to obtain the probability that the road quality would cause a variation in the loading and unloading weight.

		Probability	Probability of underweight only
Good	Scale error	0.71	0.55
	Road quality	0.29	0.45
Bad	Scale error	0.64	0.47
	Road quality	0.36	0.53

Table 8 : Probability of cargo loss

After this was done, the same calculation was performed, while ignoring the data points that showed a weight increase. The values yielded by this calculation are shown in column two of the Table 8.

For the next calculation, the data points showing a weight increase (which was only caused by scale calibration errors) were eliminated and the remaining data was used to calculate the average tonnes lost.

$$TL = \frac{AV}{V} * PR$$

Where

TL = Average tonnes lost per trip due to road quality

AV = Sum of all variation in tonnage

V = Total amount of loads with variation

PR = Probability caused by road quality

The formula was used to obtain the tonnes lost for good and bad road conditions. The value for fair road conditions was extrapolated from the other two by assuming the data is linearly distributed and it will fall in the middle of the other two values. These default values can be changed to company specific data if required.

	Tons lost
Good	0.07243643
Fair	0.091708184
Bad	0.110979938

Table 9 : Tons lost per trip

The model calculates the cargo damage (losses) in monetary value with the following formula:

$$CD = L * T * C_{commodity} * AT$$

Where

CD = Cargo damage (R, road specific)

L = Loss from road quality (tonnes)

T = % Travel on road type

$C_{commodity}$ = Price of commodity per ton (R)

AT = Amount of trips done per year

This calculation was done for all road qualities. The cargo damage in monetary value that was obtained for every road quality was finally added together to obtain the total cargo damage.

3.4 ROAD WORKS IMPACT

Road work costs can be defined as the cost incurred due to time lost as a result of road works. In order to quantify this impact on cost, it was necessary to assign a monetary value to time inside the model. This value was calculated by determining the loss in revenue that the company experiences, and the loss in productive hours that the company has available to absorb its costs. The model firstly calculates the cost that the company has to absorb every hour that it operates with the following formula:

$$\boldsymbol{C_{per\ hour}} = \frac{C_{Total}}{D * CH}$$

Where

$C \quad = \text{Cost (R)}$

$D = \text{Operating days}$

$\text{CH} = \text{Chargeable hours per day}$

Road works waste a lot of effective hours that a truck can be productive, while the company must still cover all its expenses. Accounting for time lost due to road works, a new cost per hour was calculated as follows:

$$\boldsymbol{C_{with\ road\ works\ time\ losses}} = \frac{C_{Total}}{(D * CH) - RD}$$

Where

RD = Road work delay (hrs)

Having this information made it possible to extract a quantifiable loss in revenue per hour for a company.

The next part of the model deals with the loss in revenue due to road works. It calculates what the revenue will be if a specific rate of return is required as well as the loss that is incurred due to delays in road works. This is calculated as follows (next page):

$$\boldsymbol{LR} = C_{per\ hour} \times (1+IRR) - C_{per\ hour}$$

Where

LR = Loss in revenue (R, per hour)

IRR = Internal rate of return (%)

This monetary value is then taken to calculate the total loss in revenue by multiplying it with the hours lost due to road works.

3.5 SUMMARY CALCULATION

In conclusion, the model provides the user with all the costs that the company must cover during the operation of its fleet.

It also provides a cost per kilometre for all variable and fixed cost aspects, calculated in the model by taking the total cost and dividing it by the kilometres a truck travels.

The model also calculates a suggested chargeable rate for the user:

$$\boldsymbol{CR} = C_{Total} \times (1 + IRR)$$

Where

CR = Chargeable rate (R)

IRR = Internal rate of return (%)

All the calculations and feedback of the model can be overwhelming if not presented in an easy understandable manner. Therefore a user interface was required to make the model feasible. A preliminary implementation of the model into such an interface is discussed in the next section.

CHAPTER 4: MODEL IMPLEMENTATION

4.1 GENERAL

To make the model accessible to companies, a preliminary user interface was constructed. The interface was built in Microsoft Excel as it is a widely used and easily understood program. The interface was designed with the aim of being user friendly.

4.2 USER INFORMATION AND INPUTS

The first screen displayed in the Excel model is a user information screen as shown in Figure 16. This explains to the user the purpose and functionality of the model. If the users read and understand this screen, they can proceed to begin using the interface by pressing the start button. The user is then directed to the first input screen.

Figure 16 : Model general info and model discussion interface

All cells that are not light blue have been locked to make sure a user doesn't enter data where not needed. All light blue cells in the input sheet indicate cells that must be populated with information for the model to operate successfully.

The first input screen that is displayed is general user information. This involves the interest rate associated with the cost of capital and the internal rate of return the company wants to achieve as seen in Figure 17.

General input:						
			Truck		Trailer	
Capital						
Internal rate of return	%		50.00%			
Cost of Capital (interest):	%		9.00%		9.00%	
		Next				

Figure 17 : Example of general input screen

After completion of the screen, the user can navigate to the next input screen with the "Next" button. The next input part of the model requires all the costs associated with a specific type of truck (a screen shot of the full work page have been added in Appendix D). The model has three of these input screens, enabling the user to analyse three types of trucks with different setups (Type of truck/trailer) to represent the company's fleet. The users only have to complete inputs on the screen according to the amount of truck types that must be analysed (once again, with the maximum being three types).

The first part of the input screen to be completed is shown in Figure 18. This part is where the user must enter the number of a specific truck type operating in his fleet. Next the user must complete the capital section that includes information for both trucks and trailers. It includes the cost price, repayment period and residual value – the value that is left after a truck repayment period has been completed – as well as depreciation, insurance as a percentage of the cost of obtaining equipment, and the tare weight. By entering tare weight, the model will automatically calculate the licence fee associated with this weight. This is sourced from a different sheet. After the capital part is complete, the tyre information is included as shown in Figure 18.

Number of type in fleet:			0			
		Truck			Trailer	
Cost price (excel VAT):	R		0		0	
Period of repayment:	yr		0		0	
Residual Value	%		0.00%		0.00%	
Other capital cost						
Depreciation	yr	(Straight line method)	0		0	
Insurance (% of Cost Price)	%		0.00%		0.00%	
Tare	kg		0	First Trailer	0	
	kg			Second Trailer	0	
Licence	R		0	First Trailer	0	
	R			Second Trailer	0	
Tyres						
Number of Axle(s)			0		0	
Number of Tyres (excl spare)			0		0	
Tyre Size						
Tyre Price	R	New Tyre (excl VAT)	0		0	
	R	Retread (excl VAT)	0		0	

Figure 18 : First part of input sheet

The next part is the shared data for both trucks and trailers as can be seen in Figure 19. This includes the driver and assistance salaries, as well as the number of employees that are required to operate the truck over its lifetime. The “Enter Company Overheads” button can then be used to navigate to the overhead sheet (refer to overhead in section 3.2.1 for more information regarding this section).

Vehicle Staff					
Drivers	R	Monthly salary	0	Amount people	0
Assistants	R	Monthly salary	0	Amount people	0
Overheads (annual)	R	Admin	0		
	R	Operational	0		
	R	Other Cost	0		
Variable Cost					
Lubricants (as % of fuel cost)	%	0.00%			
Fuel price	R	0			
Average cargo cost	R	0			
Cargo transport type (% Transported)		Delicate	Moderate	Robust	
	%	0.00%	0.00%	0.00%	
Grain only					
Commodity price (per Tone)	R				
Road Quality (% travelled on)		Bad	Fair	Good	
	%	0.00%	0.00%	0.00%	
Road works delay	Hours	0			
Toll road cost	R	0			
Utilization					
Annual Kilometres	km	0	0		
Payload Utilisation(km travel)	%	0.00%			
Average (trips annually)		0.00			
Annual working	days	0			
Chargeable Hours	h	0			

Verify road condition

Verify toll fees

Back

Next

Figure 19 : Second part of input sheet

The lubrication costs (this is the cost of oil and all lubrication in the operating of fleet) as a percentage of fuel cost, fuel price and average cargo cost must then be inserted into the model as well as the percentage of every type of cargo that will be transported over its lifespan. In the model, cargo is classified into three categories: Delicate, Moderate and Robust. This is an indication of how fragile the cargo is. If the cargo being transported is grain, then the classification of the cargo value does not have to be filled in. One must only enter the commodity price per ton.

Next, the amount of time a truck spends on the road as a percentage of its total lifespan, also stating the quality of the roads, is required. This can be verified by navigating to the map shown in Appendix A. This map shows the quality of all major roads in South Africa.

With the aid of the map, an estimation can be made regarding the road quality of the road on which the truck will be travelling.

The next input is the time delays caused by road works. This information can be obtained by satellite tracking or timing the travel time on each route.

Toll costs are required next, and can be obtained by navigating to the toll fee reference page included in the model. This toll verification sheet has all South Africa's toll fees and by clicking on the map icon, it provides the location. A screen shot of the toll fee page and toll gate location map have been added in Appendix B. If fees change they can also be modified accordingly in this sheet.

The next part is truck utilization, stating annual kilometres, payload utilization, kilometres travelled per day, annual working days and chargeable hours.

After these input screens have been completed, the model has all the necessary information to estimate the costs associated with operations. The "next" button can then be pressed, and the model will proceed to the full summary sheet.

4.3 SUMMARY AND INFORMATION SHEETS

The full summary sheet can be seen in Appendix E. This sheet contains the high-level accumulation of all the fixed and variable costs. The sheet also shows a fixed and variable cost breakdown, chargeable rate and includes buttons to navigate to all other sheets. As can be seen in Appendix E, the navigation buttons can navigate the user to specific cost breakdowns for the various truck types and their payment schedules, including a breakdown structure of the cost of capital. It also enables the user to navigate to the variable cost sheet where all variable costs are displayed and the sheet showing the cost of road works where the user can view the financial impact of road works. The full summary sheet contains the complete cost of logistics in a company and is displayed in an easily understandable manner.

FULL SUMMARY SHEET

The first part of the full summary sheet can be seen in Figure 20. The total cost of all cost aspects in a company is shown and this includes finance (cost of capital), deprecation, insurance, vehicle staff, overheads and licence, fuel and oil, maintenance, tyre and all other costs. This is depicted visually to the user in a high level cost breakdown pie-chart to assist the user in understanding the contributions of the various aspects to the total cost. A chargeable rate in monthly and hourly units is given to the user if the user would like to set a standard rate for all truck types. This rate has accounted for all truck costs and for the internal rate of return the company would like to obtain

Suggested chargeable rate		Finance	98019.775
Monthly	260153.5526	Depreciation	273102.4
Hourly	734.5512074	Insurance	97942.35
		Vehicle Staff	240600
		Overheads and Licence	106284
		Fuel and Oil	1006814.5
		Maintenance	201599.94
		Tyres	48766.667
		Other	8098.7701
		Total cost	2081228.4

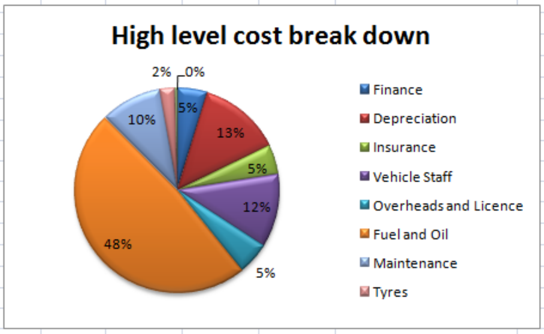
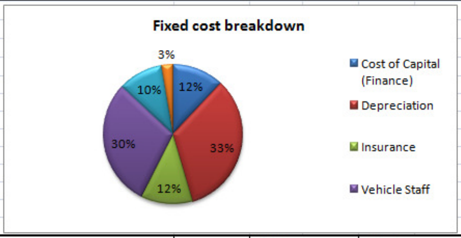
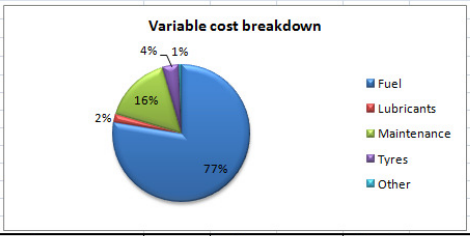


Figure 20 : Summary of annual costs with a suggested chargeable rate and pie chart illustrating the high level cost breakdown

The second part of the sheet gives the user a more in-depth breakdown of all fixed and variable costs as displayed in Figure 21. This part has fixed and variable costs with all the contributing factors as well as a pie chart that depicts the breakdowns of all the costs for trucks and trailers. A cost per kilometre (cpk) is also generated for the user.





Annual Fixed cost		Total R	Total cpk	Truck R	Truck cpk	Trailer R	Trailer cpk
Cost of Capital		98019.8	0.466761	46211.45	0.2200545	51808.328	0.2467063
Depreciation		273102	1.300488	171870.4	0.8184305	101232	0.4820571
Insurance		97942.4	0.466392	69822.35	0.3324874	28120	0.1339048
Vehicle Staff		240600	1.145714	240600	1.1457143		
Overheads	Total	84600	0.402857	84600	0.4028571		
	Admin	34800	0.165714	34800	0.1657143		
	Operational	40800	0.194286	40800	0.1942857		
	Other Cost	9000	0.042857	9000	0.0428571		
Licence		21684	0.103257	11352	0.0540571	10332	0.0492
Total fixed costs		815949	3.885469	578244.8	2.9736009	191492.33	0.9118682

Annual Variable Cost	Total R	Total cpk	Truck R	Truck cpk	Trailer R	Trailer cpk
Fuel	982258.06	4.6774194	982258.06	4.6774194		
Lubricants	24556.452	0.1169355	24556.452	0.1169355		
Maintenance	201599.94	0.9599997	139287.27	0.6632727	62312.67	0.296727
Tyres	48766.667	0.2322222	25666.667	0.1222222	23100	0.11
Other	8098.7701	0.0385656	1000	0.0047619	7098.7701	0.0338037
Total variable costs	1265279.9	6.0251424	1172768.5	5.5846117	92511.44	0.4405307

Total variable costs(annually)	2081228.4	9.9106115	1751013.2	8.558212634	284003.77	1.3523989
Total costs (Monthly)	173435.7	9.9106115	145917.77	8.558212634	23666.981	1.3523989
Total costs (Hour)	481.76584	9.9106115	405.32713	8.558212634	65.741613	1.3523989

Figure 21 : Variable and fixed cost breakdown example.

As mentioned above the sheet also has navigation buttons that enables the user to navigate to all three of the truck type breakdowns and their cost of capital sheets as well as variable cost break down and impact of road works sheets.

TRUCK TYPE SUMMARY SHEET

By using the buttons the user is navigated to the three truck type summary sheets. These sheets look the same as the full summary sheet with the same breakdown and chart but they contain all costs in accordance with the three truck types.

The sheets also show the suggested chargeable rate but it is now calculated for the specific truck types.

COST OF CAPITAL SHEET

The cost of capital sheet gives the user an in depth analysis of cost associated with acquiring equipment. The first part is shown for both truck and trailer and includes cost of the equipment (capital), interest, residual value, period, payment amount, and cost of capital (annually).

The next part is a breakdown of all capital per month still to be paid after residual cost and the payment that needs to be made every month. The payment is then split into its capital and interest components. The red blocks indicate the cost of capital for the specific year.

	Truck	Trailers
Capital (R)	749488	335000
Interest (%)	9%	9%
Residual Value (%)	20%	10%
Period (months)	60	60
Payment (R)	13,570.74	6,509.89
Cost of capital annually	32,242.83	15,430.11

Back

Amortization Schedule

Truck					Trailers				
Capital still to paid	Payments	Capital	Interest		Capital still to paid	Payments	Capital	Interest	
1023561.54	13570.74	7949.58	5621.16		491003.14	6509.89	3997.39	2512.5	
1002472.26	13570.74	8732.64	4838.11		480886.60	6509.89	4189.05	2320.84	
981539.96	13570.74	8798.13	4772.61		470845.37	6509.89	4220.47	2289.42	
960763.50	13570.74	8864.12	4706.63		460878.88	6509.89	4252.12	2257.77	
940141.69	13570.74	8930.60	4640.14		450986.59	6509.89	4284.01	2225.88	
919673.40	13570.74	8997.58	4573.17		441167.93	6509.89	4316.14	2193.75	
899357.47	13570.74	9065.06	4505.68		431422.37	6509.89	4348.51	2161.38	
879192.79	13570.74	9133.05	4437.70		421749.36	6509.89	4381.13	2128.77	
859178.21	13570.74	9201.55	4369.20		412148.35	6509.89	4413.99	2095.91	
839312.62	13570.74	9270.56	4300.19		402618.82	6509.89	4447.09	2062.80	
819594.92	13570.74	9340.09	4230.66		393160.22	6509.89	4480.45	2029.45	
800023.99	13570.74	9410.14	4160.61	162848.91	383772.04	6509.89	4514.05	1995.85	78118.73

Figure 22 : Example of a Cost of capital breakdown sheet

VARIABLE COST SHEET

The variable cost sheet's first part as seen in Figure 23 shows the cost per kilometre that will be used to calculate the variable cost for the whole company and specific truck types as well. If the user has not changed the variable cost by accessing the screen in Appendix C and filling in company specific data the model will display the default value discussed in the study and also use it to calculate the cost for fuel, maintenance and repair, tyres and cargo damage.

		Bad	Fair	Good	Bad	Fair	Good
Fuel cost	R/km	5.471698113	5.043478261	4.6774194			
Maintenance cost	R/km	1.457818	0.8567272	0.6632727	0.6521818	0.38327272	0.296727
Percentage (increase/decrease)	%	17.45%	0.00%	9.48%	70.16%	0.00%	22.58%
Tyre- steer tyre life	km	105000.00	165000.00	300000.00	155000.00	250000.00	400000.00
-drive tyre life	km	105000.00	165000.00	300000.00	155000.00	250000.00	400000.00
Number of Retreads		2.00	2.00	2.00	2.00	2.00	2.00
Tyre cost	R/km	0.349206349	0.222222222	0.1222222	0.283871	0.176	0.11

Back

Change variable costs

Road quality impact

Figure 23 : Example of part of variable cost sheet

This sheet contains a variable cost summary that shows the amount for all trucks as well as for every truck type. This summary is presented in the same manner for the total variable cost as well as for all truck types. It shows the percentage of time trucks travel on different road qualities and then shows the fuel cost contribution of the different road qualities and total fuel cost. The same is shown for maintenance and tyres but divided into truck and trailer distinctions.

The next part shows the average cargo value and the percentage of different types of goods transported in the operational life of the truck and trailer.

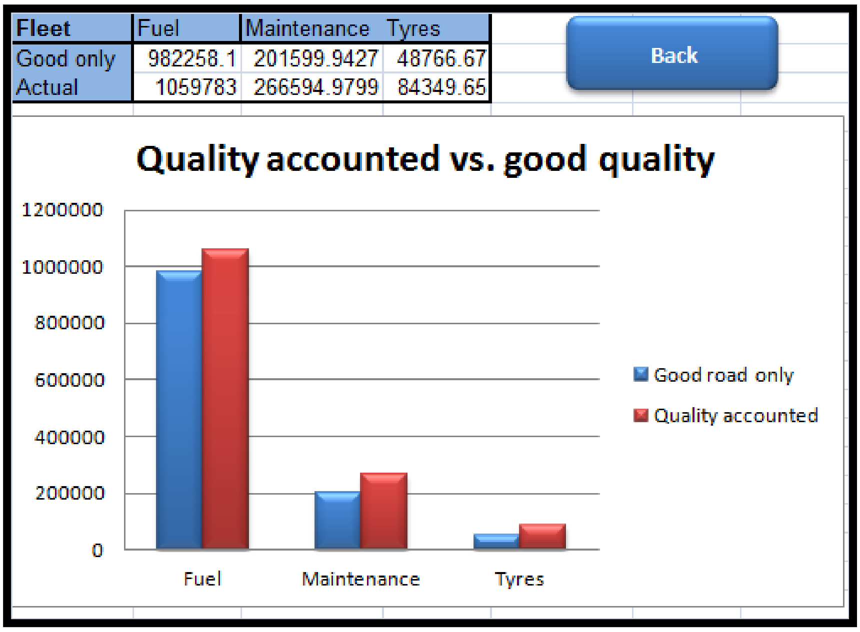
Road Quality (% travelled on)		Bad	Fair	Good									
	%	5.00%	90.00%	5.00%									
	Bad	Fair	Good										
Fuel cost	57452.83	953217.39	49112.90	**1059783.12**									
	Truck				**Trailer**								
	Bad	Fair	Good		Bad	Fair	Good		Total				
Maintenance cost	15307.09	161921.44	6964.36	**184192.89**	6847.91	72438.54	3115.63	**82402.09**	266594.98				
Tyres	3666.67	42000.00	1283.33	**46950**	2980.65	33264.00	1155.00	**37399.65**	84349.65				
Other													
Average cargo cost	R	750000.00										**Tons lost**	**Cost of loss**
Cargo type transported	%	Delicate	Moderate	Robust							Good	0.07243643	0.00
		5.00%	80.00%	15.00%							Fair	0.091708184	0.00
		Delicate			Moderate			Robust			Bad	0.110979938	0.00
Lost cargo to damage	%	Bad	Fair	Good	Bad	Fair	Good	Bad	Fair	Good	**Losses on a full load**	**Losses per tripe**	**Losses for a year**
		3.00%	1.50%	0.50%	2.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1171.88	820.31	57421.875
		56.25	506.25	9.375	600	0	0	0	0	0			

Figure 24 : Example of variable cost summary

As the variable cost sheet shows everything from cost per kilometre used, to the contribution of all aspect on a company and truck type level, the user can gain understanding of variable cost in an easy and efficient manner.

ROAD QUALITY IMPACT SHEET

This sheet can be accessed from the variable cost sheet though the “road quality impact” navigation button (Figure 23) this sheet contains comparison cost of all variable cost aspects for total fleet and all set-up types in fleet (an example of how it is presented in model can be seen in Figure 25). This sheet compares the cost of operating ones fleet on only good quality roads, versus the cost of operating on current road conditions. Thus this sheet indicates to the user the cost impact of the quality of the road and gives an indication of what contribution road quality makes to various costs.



Fleet	Fuel	Maintenance	Tyres
Good only	982258.1	201599.9427	48766.67
Actual	1059783	266594.9799	84349.65

Figure 25 : Road quality Impact comparison

ROAD WORK IMPACT SHEET

The impact of road works can be seen by accessing the sheet through the “road works” navigation button in the full summary sheet. An example of the sheet is shown in Figure 26. Shown is the cost per hour that needs to be absorbed and the hours that have been wasted through road works. It calculates the extra cost that has to be absorbed through this loss in utilization and then calculates the new cost per hour that has to be absorbed to account for road works. Then it shows the loss in revenue due to the delay caused by road works.

Average road works impact		
Extra cost that need to be absorb because of road works		
Cost	R/h	497.36
Delay	h	210.00
		104445.54
Increase cost	R/h	505.55
Lost in revenue		
Internal rate of return	%	0.50
Revenue	h	240.49
Losses due to roadwork's	R	50502.49
Back		

Figure 26 : Example of road work impact sheet

CONCLUSION

As discussed the model is built in a very user friendly manner and will easily guide the user through the process of using it.

The interface is easy to navigate and presents the results in an understandable manner, summarising key concepts that will aid any logistics manager to obtain a more comprehensive understanding of cost as well as the contributions of various costs in a way never done before.

CHAPTER 5: MODEL TESTING

5.1 NUMERICAL DATA TEST

Random numerical data was entered into the model as representative data for a fleet to test the functionality and accuracy of all aspects in the model. This test indicated that all cells are linked correctly, that all buttons are functional and that the output and calculations are executed as they were designed to do in the model.

5.2 CASE STUDY AND BENCHMARK TEST

The test in this section is conducted to validate the model's accuracy and to ensure functionality of the model in further applications.

5.2.1 BENCHMARK TEST

The first conducted test, using benchmark information (Appendix F), was done by Braun (2010) on South African logistics operational cost, including SANRAL data concerning road conditions in South Africa.

Firstly, data concerning the quality of all roads in South Africa was obtained from SANRAL (chart depiction of data Figure 2). Data obtained from SANRAL is used to quantify the average condition of roads in South Africa; these results can be seen in Table 10.

	Bad	Fair	Good
Road conditions	19%	34%	47%

Table 10 : Average road conditions in South Africa

The quantified road quality values in Table 10 are consequently used in conjunction with benchmark data in Appendix F to complete the model. In all aspects, except in variable cost, the model presented the same values as benchmark values in Table 11.

	Benchmark	Model	deviation
Fuel	638589.00	672885.69	5.37%
Lubricants	31429.00	33644.28	7.05%
Maintenance	211200.00	203995.76	3.41%
Tyres	65564.00	63251.56	3.53%
			4.84%

Table 11 : Variable cost comparison

The deviation in variable cost can be contributed to road condition estimation. The model will most likely obtain better results in a more controlled environment where company specific data can be obtained and used for all variable cost.

The tests still only showed a small deviation on variable cost factors and only a 2.21% deviation (Table 12) on total cost. This is an indication that the model's functionality is accurate.

	Total cost
Model	1708554
Benchmark	1671560
Diviation	2.17%

Table 12 : Total cost comparison

5.2.2 CASE STUDY

A company is selected to further test the model in a more dynamic and realistic environment. The company selected is a transport company that primarily transports grain and similar products within South-Africa.

Data as obtained from the company is entered into the model (appendix G). The variable cost sheet in the model could not be completed as company specific data is not available and the default values are used to calculate all variable costs.

Basic model inputs are completed and the model is executed. The generated output is depicted in Table 13 and this result is compared to the company's data concerning the operating costs of the trucks in similar situations as depicted in Table 13.

	Actual	Model	
Finance	93536	87382	
Depreciation	230511	188658	
Insurance	116292	116292	
Vehicle Staff	237402	237402	
Overheads and Licence	48030	48030	
Fuel and Oil	593626	618756	
Maintenance	169488	160182	
Tyres	57908	43373	
Other	15540	15540	
Total cost	1562333	1515615	3.08%

Table 13 : Case study comparison test results

The model shows overall 3.08% deviation on total cost when compared to that of the actual company data. This deviation can be contributed to a couple of factors. Firstly, the fluctuation in fuel price, as well as the impact of fuel purchases at different sources where price inland differs from the prices along the coast. The fuel cost has a great impact on the final cost and as the fuel price varies continuously, there will consequently be a final variation as only one fixed value is assumed in this model. The second factor is tyre cost. There is a magnitude of factors that contribute to the cost of tyres. Using default values to calculate cost will always cause deviation on the cost. In this case it shows that the company's tyre cost is higher than expected and they need to take a look at their tyre maintenance. Thirdly, there are other factors such as the way in which depreciation is calculated and fluctuation in cost of capital. All though there are deviations as can be seen in Figure 27 the cost contribution is very similar and the model gives the user a good indication of cost. The model can definitely aid the user in finding a good estimation of cost in the future as the model's final estimation varies with a mere 3.08% from the actual data.

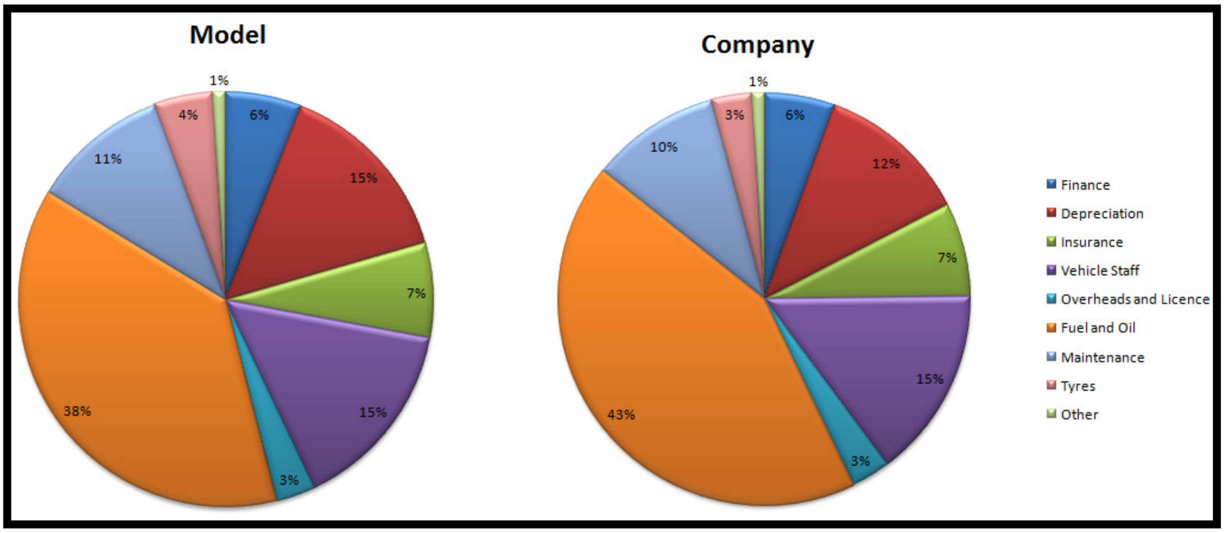


Figure 27 : Cost breakdown comparison

CHAPTER 7: RECOMMENDATIONS AND CONCLUSION

The model takes different factors into account in order to calculate the cost of operating a truck in South African conditions. The model was done in the most comprehensive manner possible under the time constraint but definitely needs some refining. This model will provide logistics management with a means of monitoring the complete logistics cost enabling better decision making based on sound estimation.

Hopefully the initial model will open a new line of thinking in South African logistics planning, paving the way towards future full-scale logistics-planning models that take the full cost of the road conditions into account. This would improve decision making in the South African logistics environment and also enable effective road maintenance planning.

A route selection model for South Africa could also be developed from a future model that takes road quality into account. A future model would be able to not just take optimal distance and time into account but also give companies cost effective route selection capabilities based on road quality, roadwork and all other cost associated.

This model and all future options and possibilities it might bring can definitely enable breakthrough ways of understanding operational cost. Continual improvement is a key factor for success in the logistics environment, and the improvement of this logistical cost model will create logistical savings resulting in greater customer satisfaction, which in turn will be critical to a logistics company in gaining a competitive advantage in the market.

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APPENDIX A: ROAD QUALITY MAP OF SOUTH AFRICA MAJOR ROADS

APPENDIX B: SOUTH AFRICA TOLL FEES AND LOCATION

PLAZA All amounts in Rands	Light Vehicles	2 Axle Heavy Vehicles	3 & 4 Axle Heavy Vehicles	5 & more Axle Heavy Vehicles	Map
N1					
Huguenot Mainline	26	72	112	181	Toll_Map_SA.pdf
Verkeerdevlei Mainline	37	75	112	157	
Vaal Mainline	43	81	98	131	
Grasmere Mainline	13	38	44	58	
Ramp (S)	6.5	19	22	29	
Ramp (N)	6.5	19	22	29	
Stormvoël Ramp	6	15	17.5	21	
Zambesi Ramp	7.2	18	21	25	
Pumulani Mainline	7.8	19.5	22.5	27	
Wallmansthal Ramp	3.6	9	11	12.5	
Murrayhill Ramp	7.2	18	21.5	25	
Hammanskraal Ramp	16.5	57	62	72	
Carousel Mainline	36	96	106	123	
Maubane Ramp	15.5	42	46	53	
Kranskop Mainline	29	74	98	122	
Ramp	8	22	26	39	
Nyl Mainline	38	71	86	115	
Ramp	12	22	26	33	
Sebetiela Ramp	12	22	28	37	
Capricorn Mainline	30	83	97	122	
Baobab Mainline	29	80	110	132	
N2					
Tsitsikamma Mainline	35	87	208	294	
Ramp	35	87	208	294	
Izotha Ramp	6	11	15	26	
Oribi Mainline	19	34	48	77	
Ramp (S)	9	16	22	35	
Ramp (N)	10	18	26	46	
Umtentweni Ramp	8.5	14	20	33	
King Shaka Airport Ramp	4	8	12	16	
Tongaat Mainline	7	15	20	29	
Ramp (S)	3.5	8	10	15	
Ramp (N)	3.5	8	10	15	
Mvoti Mainline	9	24	32	48	
Mandini Ramp	5	9	11	15	
Dokodweni Ramp	13	25	29	40	
Mtunzini Mainline	30	58	69	100	
Ramp (S)	25	47	57	79	
Ramp (N)	5.5	11	13	21	
N3					
Mariannhill Mainline	8	14	18	27	
Mooi Mainline	33	81	113	154	
Ramp (S)	23	57	79	108	
Ramp (N)	10	24	34	46	
Treverton Ramp	10	24	34	46	
Bergville Ramp	14	17	31	47	
Tugela Mainline	47	78	123	170	
Tugela East Ramp	29	49	72	100	
Wilge Mainline	44	76	102	144	
De Hoek Mainline	32	50	76	109	
N4					
Pelindaba Mainline	4	7	10	13	
Quagga Mainline	3	5.5	7.5	10	
Swartruggens Mainline	67	167	203	239	
Kroondal Ramp	9.5	23	26	31	
Marikana Mainline	14.5	34	39	46	
Buffelspoort Ramp	9.5	23	26	31	
Brits Mainline	9.5	33	37	43	
K99 Ramp	9.5	24	28	33	
Doornpoort Mainline	9.5	24	28	33	
Donkerhoek Ramp	8	12	17	32	
Cullinan Ramp	10	17	25	41	
Diamond Hill Mainline	24	34	63	105	
Valtaki Ramp	19	27	39	87	
Ekandustria Ramp	15	22	30	60	
Middelburg Mainline	40	87	132	173	
Machado Mainline	60	166	242	345	
Nkomazi Mainline	45	93	133	192	
N17					
Gosforth Mainline	8	22	24	33	
Ramp (W)	4	9	12	16	
Ramp (E)	3.5	14	15	20	
Dalpark Mainline	7.5	15	20	28	
Brakpan Ramp	6.5	13	17	22	
Leandra Mainline	25	63	94	125	
Ramp	15	38	56	75	
Trichardt Mainline	14	35	53	70	
Ermelo Mainline	25	63	94	125	


ZIMBABWE
MOZAMBIQUE
MOSAMBIEK
BOTSWANA
LIMPOPO
MPUMALANGA
SWAZILAND
NOORD-WES
NORTH-WEST
GAUTENG
VRYSTAAT
FREE STATE
KWAZULU-NATAL
LESOTHO
NOORD-KAAP
NORTHERN CAPE
EASTERN CAPE
OOS-KAAP
WESTERN CAPE
WES-KAAP
ATLANTIC OCEAN
ATLANTIESE OSEAAN
INDIAN OCEAN
INDIESE OSEAAN
PRETORIA
JOHANNESBURG
SOWETO
KIMBERLEY
BLOEMFONTEIN
DURBAN
PORT ELIZABETH
EAST LONDON
OOS-LONDEN
CAPE TOWN
KAAPSTAD
GABORONE
AA
Besorg oor Bewaring
Concerned for Conservation

APPENDIX C : VARIABLE COST INPUT SHEET

Variable cost input sheet

Back

			Truck			Trailer					
		Reg	Bad	Fair	Good	Bad	Fair	Good			
Truck nr	Fuel Consumption (R/km)										
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
		0	0	0	0						
	Maintenance										
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
		0	0	0	0	0	0	0			
1	Tyres- New tyre life										
	-Retread tyre life										
	Number of Retreads										
2	Tyres- New tyre life										
	-Retread tyre life										
	Number of Retreads										
3	Tyres- New tyre life										
	-Retread tyre life										
	Number of Retreads										
4	Tyres- New tyre life										
	-Retread tyre life										
	Number of Retreads										
5	Tyres- New tyre life										
	-Retread tyre life										
	Number of Retreads										
6	Tyres- New tyre life										
	-Retread tyre life										
	Number of Retreads										
7	Tyres- New tyre life										
	-Retread tyre life										
	Number of Retreads										
8	Tyres- New tyre life										
	-Retread tyre life										
	Number of Retreads										
9	Tyres- New tyre life										
	-Retread tyre life										
	Number of Retreads										
	Tyres- New tyre life	0	0	0	0	0	0	0			
	-Retread tyre life		0	0	0	0	0	0			
	Number of Retreads		0	0	0	0	0	0			
	Other Variable Running Costs										
1											
2											
3											
4											
5											
6											
		0	0	0	0	0	0	0			
			Delicate			Moderate			Robust		
	Cargo damage		Bad	Fair	Good	Bad	Fair	Good	Bad	Fair	Good
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
		0	0	0	0	0	0	0	0	0	0

APPENDIX D : INPUT SHEET

Truck Type 1:

Number of type in fleet: 0

		Truck			Trailer	
Cost price (excel VAT):	R		0		0	
Period of repayment:	yr		0		0	
Residual Value	%		0.00%		0.00%	
Other capital cost						
Depreciation	yr	(Straight line method)	0		0	
Insurance (% of Cost Price)	%		0.00%		0.00%	
Tare	kg		0	First Trailer	0	
	kg			Second Trailer	0	
Licence	R		0	First Trailer	0	
	R			Second Trailer	0	
Tyres						
Number of Axle(s)			0		0	
Number of Tyres (excl spare)			0		0	
Tyre Size						
Tyre Price	R	New Tyre (excl VAT)	0		0	
	R	Retread (excl VAT)	0		0	
Vehicle Staff						
Drivers	R	Monthly salary	0	Amount people	0	
Assistants	R	Monthly salary	0	Amount people	0	
Overheads (annual)	R	Admin	0			
	R	Operational	0			
	R	Other Cost	0			
Variable Cost						
Lubricants (as % of fuel cost)	%	0.00%				
Fuel price	R	0				
Average cargo cost	R	0				
Cargo transport type (% Transported)		Delicate	Moderate	Robust		
	%	0.00%	0.00%	0.00%		
Grain only						
Commodity price						
Road Quality (% travelled on)		Bad	Fair	Good		
	%	0.00%	0.00%	0.00%		
Road works delay	Hours	0				
Toll road cost	R	0				
Utilization		Day				
Annual Kilometres	km	0	0			
Payload Utilisation(km travel)	%	0.00%				
Average (trips annually)		0.00				
Annual working	days	0				
Chargeable Hours	h	0				

Verify road condition

Verify toll fees

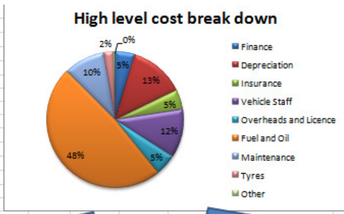
Back

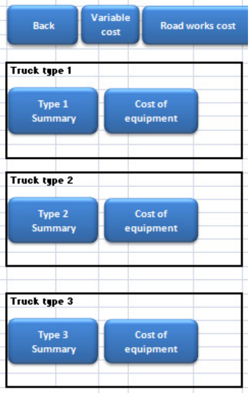
Next

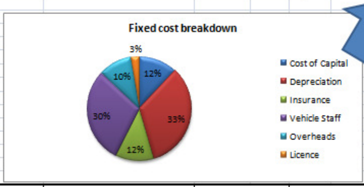
APPENDIX E: FULL SUMMARY SHEET

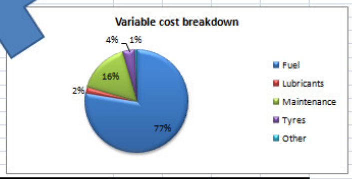
Suggested chargeable rate	
Monthly	260153.5526
Hourly	734.5512074

Finance	98019.7754
Depreciation	273102.4
Insurance	97942.35
Vehicle Staff	240600
Overheads and Licence	106284
Fuel and Oil	1006814.52
Maintenance	201599.943
Tyres	48766.6667
Other	8098.77014
Total cost	2081228.42









Annual		Total		Truck		Trailer	
Fixed cost							
		R	cpk	R	cpk	R	cpk
Cost of Capital		98019.7754	0.4668	46211.4	0.22005	51808.33	0.246706
Depreciation		273102.4	1.3005	171870	0.81843	101232	0.482057
Insurance		97942.35	0.4664	69822.4	0.33249	28120	0.133905
Vehicle Staff		240600	1.1457	240600	1.14571		
Overheads	Total	84600	0.4029	84600	0.40286		
	Admin	34800	0.1657	34800	0.16571		
	Operational	40800	0.1943	40800	0.19429		
	Other Cost	9000	0.0429	9000	0.04286		
Licence		21684	0.1033	11352	0.05406	10332	0.0492
Total fixed costs		815948.525	3.8855	578245	2.9736	191492.3	0.911868

Annual	Total		Truck			
Variable Cost						
	R	cpk	R	cpk	R	cpk
Fuel	982258.0645	4.677419	982258.1	4.677419		
Lubricants	24556.45161	0.116935	24556.45	0.116935		
Maintenan	201599.9427	0.96	139287.3	0.663273	62312.67	0.296727
Tyres	48766.66667	0.232222	25666.67	0.122222	23100	0.11
Other	8098.77014	0.038566	1000	0.004762	7098.77	0.033804
Total va	1265279.896	6.025142	1172768	5.584612	92511.44	0.440531

Total variable costs(annually)	2081228	9.910612	1751013	8.558213	284003.7679	1.352399
Total costs (Monthly)	173436	9.910612	145917.8	8.558213	23666.98066	1.352399
Total costs (Hour)	481.766	9.910612	405.3271	8.558213	65.74161295	1.352399

APPENDIX F: BENCHMARK DATA

OPERATION	14.7 tridem f/deck semi	1.2.3. artic
ASSUMPTIONS		
Vehicle Type	**6-axle Artic**	
Average Payload (tons)	30	
Deck Length (metres)	13,5	
Pallets	26	
Cubes		
Annual KM	**160000**	
Working Days	286	
Shift Hours (fridge)		
Useful Life (KM)	***800000***	
Useful Life (Years)	**5**	
CAPITAL COST		
Prime Mover	1184500	
Body		
Auxiliary Equipment		
1st Trailer	247200	
2nd Trailer		
Other		
Total Capital Cost	**1431700**	
STANDING COST		
Prime Mover Depreciation	177675	
Body Depreciation		
Auxiliary Depreciation		
Trailer Depreciation	11201	
Total Depreciation	188876	
Cost of Capital	89853	
Prime Mover Licence	12825	
Trailer Licence	10659	
Total Licence Fee	23484	
Total Insurance	100219	
Driver Wages	177958	
Assistant Wages	54387	
Total Wages	232344	
TOTAL STANDING COST	**634777**	
As a % of Total Cost	***37,98%***	
VARIABLE COST		
Prime Mover Fuel	628589	
Auxiliary Fuel		
Total Fuel	**628589**	
Top-up Oil	31429	
Prime Mover Repair & Maint	160000	
Auxiliary Repair & Maint		
Trailer Repair & Maintenance	51200	
Total Repair & Maintenance	**211200**	
Total Tyres	**65564**	
Unforeseen Expense	**100000**	
TOTAL VARIABLE	**1036783**	
As a % of Total Cost	***62,02%***	
TOTAL OPERATING COSTS	**1671560**	
SUMMARY		
Standing Cost Rands per/day	2220	
Standing Cost (Rands/Km)	3,97	
Variable Cost (Rands/Km)	6,48	
Total CPK (Rands/Km)	**10,45**	
Cost per ton (Rands)	195	
Cost per Pallet (Rands)	225	
Cost per Ton/Km	R 0,35	
Cost per Pallet/Km	R 0,40	
Cost per Cube/Km		
Cost per Deck Metre (Rands)	433	
RATIOS		
Useful Life Cost	8357801	
Capital Cost per Payload Ton	47723	
Capital Cost per Deck Metre	106052	
Capital Cost % Useful Life Cost	17,13%	
Oper Cost per Payload Ton	55719	
Oper Cost per Deck Metre	123819	
Capital Cost % Operating Cost	85,65%	
Maint Cost % Variable Costs	20,37%	
MaintCost % Operating Cost	12,63%	
Fuel Cost % Variable Cost	60,63%	
Fuel Cost % Operating Cost	37,60%	

APPENDIX G: TEST INPUT DATA

Number of type in fleet:		1				
		Truck			Trailer	
Cost price (excel VAT):	R		1074190		562400	
Period of repayment:	yr		5		5	
Residual Value	%		40.00%		15.00%	
Other capital cost						
Depreciation	yr	(Straight line method)	5		8	
Insurance (% of Cost Price)	%		6.50%		5.00%	
Tare	kg		9730	First Trailer	5495	
	kg			Second Trailer	6900	
Licence	R		11352	First Trailer	4164	
	R			Second Trailer	6168	
Tyres						
Number of Axle(s)			3		4	
Number of Tyres (excl spare)			10		16	
Tyre Size			315/80R22.5		315/80R22.5	
Tyre Price	R	New Tyre (excl VAT)	8200		8200	
	R	Retread (excl VAT)	1200		1200	
Vehicle Staff						
Drivers	R	Monthly salary	17985	Amount people	1.1	
Assistants	R	Monthly salary	8164	Amount people	0	
Overheads (annual)	R	Admin	16800	Enter company overheads		
	R	Operational	11906			
	R	Other Cost	12900			
Variable Cost						
Lubricants (as % of fuel cost)	%	2.50%				
Fuel price	R	8				
Average cargo cost	R					
Cargo transport type (% Transported)		Delicate	Moderate	Robust	Verify road condition	
	%					
Road Quality (% travelled on)		Bad	Fair	Good		
	%	5.00%	70.00%	25.00%		
Road works delay	Hours	70			Verify toll fees	
Toll road cost	R	0				
Utilization		Day				
Annual Kilometres	km	875	132000			
Payload Utilisation(km travel)	%	75.00%				
Average (trips)		70.00				
Annual working	days	265				
Chargeable Hours	h	16				

Back Next