AN ECONOMIC IMPACT ASSESSMENT OF TOLL ROADS, WITH SPECIFIC REFERENCE TO THE IMPACT ON ALTERNATIVE ROADS BETWEEN THE PUMULANI AND HAMMANSKRAAL TOLL GATES

BY

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DECLARATION

I hereby declare that:

AN ECONOMIC IMPACT ASSESSMENT OF TOLL ROADS, WITH SPECIFIC REFERENCE TO THE IMPACT ON ALTERNATIVE ROADS BETWEEN THE PUMULANI AND HAMMANSKRAAL TOLL GATES Is my own work, and that all the sources used and quoted have been indicated and acknowledged by means of complete references and that this dissertation was not submitted by me for a degree at another university.

_____ _____

Signature Date

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ABSTRACT

The erection of tollgates along the N1 freeway has triggered a great deal of interest. As a result of the toll fees, traffic has been diverted to alternative roads. This study investigates how traffic diverted from the toll road affect the welfare of users of the alternative road.

The literature review provides a theoretical framework of economic impact assessment and road pricing. Furthermore, the literature study reviews previous studies of a similar nature and compare them with the findings of this study.

There is no conclusive evidence that diversion of traffic from the N1 causes congestion on the R101 and has a negative impact on the economy of the region. On the contrary, evidence suggests that there was an initial diversion of traffic when the toll came into operation but that is slowly filtered back after six months.

In the application of the RED model, economic benefits are derived from user benefits, which is a function of savings in VOC's and time of normal and generated traffic on a road or saving due to an improvement in road safety, resulting from improved roads. A decrease in traffic has a measurable effect on vehicle travel speeds and travel time only when the roads are significantly congested.

In the case of scenario 1 (including diversion), frequent maintenance needs to be performed under increased traffic. Increased traffic due to "diverted traffic" causes congestion in accidents and travelling time, which is a cost to the economy. Under scenario 2 (excluding diversion), it is assumed that ADT will return to normal. Due to lower levels of congestion and travelling times would be faster, while maintenance costs and accident rates would decrease. Scenario 2 is selected as being economically the most feasible option.

It is clear that the R101 cannot cope with the current levels of traffic and congestion. One can speculate about the causes of the congestion but in order to derive at a solution to the problem more research needs to be done on the cause of the congestion in order to resolve the problem.

KEYWORDS

Road user charging

Road pricing

Toll road

Economic impact assessment

Cost benefit analysis

User pay principle

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ABBREVIATIONS

ATA	ANTI TOLLROAD ASSOCIATION
ADT	AVERAGE DAILY TRAFFIC
BCR	BENEFIT COST RATIO
BOT	BUILT OPERATE TRANSFER
BPCC	BAKWENA PLATINUM CORRIDOR CONSORTIUM
CBA	COST - BENEFIT ANALYSIS
CSIR	COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
EIA	ECONOMIC IMPACT ASSESSMENT
ERR	ECONOMIC RATE OF RETURN
HDM	HIGHWAY DESIGN AND MAINTENANCE STANDARD MODEL
MPB	MARGINAL PRIVATE BENEFIT
MPC	MARGINAL PRIVATE COST
MRS	MARGINAL RATE OF SUBSTITUTION
MRT	MARGINAL RATE OF TRANSFORMATION
MSB	MARGINAL SOCIAL BENEFITS
MSC	MARGINAL SOCIAL COSTS
NPV	NET PRESENT VALUE
NRA	NATIONAL ROAD AGENCY
RED	ROAD ECONOMIC DECISIONS
SADC	SOUTHERN AFRICAN DEVELOPING COUNTRIES
SDI	SPATIAL DEVELOPMENT INITIATIVE
SPSS	STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES
VOC	VEHICLE OPERATING COSTS

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CHAPTER 1

INTRODUCTION TO THE STUDY

1.1. INTRODUCTION

Transportation is an important and vital element of today's way of life. It has slowly and over time developed and now encompasses several different modes and means of moving people and goods over long and short distances. In today's world road transportation is the largest and is growing rapidly every year. The growth in road transport over the last decade has produced problems of epic proportions.

These problems include *inter alia*, maintenance of roads, accidents, congestion and pollution. These problems have reached a critical level and corrective actions are taken to alleviate the problems. The steps that have been taken to counter the expanding road mode are plentiful and range from charging vehicles and fuel with extra tax to charging for the actual use of the road. The method of charging for actual use of the road often causes diversion of traffic, which causes problems on alternative roads. Button and Verhoef (1998:15) and Cronau (1998:163) found that the imposition of a toll reduces traffic by diverting it to an untolled road. The untolled road, which is often inferior in quality, is ultimately congested. They further point out that profit maximising agencies charge tolls higher than optimal to the detriment of the untolled road; moreover, the gap between what the user pays and the marginal social cost, is not reduced.
This study investigates the impact of traffic diverted from the toll road to alternative roads, as it impact on alternative road users and stakeholders along the alternative road.

1.2. PROBLEM IDENTIFICATION

Roads can be classified as public goods because they satisfy the conditions of public goods, which are non-excludability and non - rival consumption. (Rosen, 1995:581). However,

roads also have characteristics of private goods and therefore it is possible to set a user charge for them.

The National Road Agency (NRA) is the institution appointed by the government to built, maintain and operate roads in South Africa. NRA obtains funds from the government to carry out its activities. The SA government has been experiencing a shortage of funds to maintain existing roads and build new roads. Money raised by the fiscal authorities is allocated for other important prioritised programmes. To alleviate the problem of shortages of funds, a user charge was set for some national roads, i.e. tollgates were introduced. Toll fees are user charges levied on the users of the roads, i.e. motorists. Tollgates were introduced for the purpose of among other, to raise enough revenues for the building, maintenance and operation of the tolled road. Further to that the problem of congestion on alternative roads is supposed to be alleviated.

The Highway News (2003:3), reports that the toll road will offer the following benefit to the users. Firstly, a high quality road network and improved road safety and secondly, saving on travellers' time and vehicle operating costs.

In the year 2002, tollgates were introduced along the N1 road from Warmbaths to Pretoria. After the introduction of tolls along this road, traffic diversion of about 30-40% was experienced. Road users were diverted to alternative roads such as the R101 road (CSIR, 2000:20). The diversion of traffic to these alternative roads causes serious problems to regular users of alternative roads. These problems include increased vehicle operating costs, congestion and environmental hazards. This problems triggered research interest in the field of road pricing.

Renewed interest in the field of research for road pricing has generated a number of studies directed at designing new methods and models and comparison of these with existing methods. Traffic diverted from toll roads cause problems that continue to challenge decision makers; in particular road policy makers. Political reality demands that policy makers respond to frustrated users of alternative roads who experience delays in their weekday commuting, environmental damage and costs associated with it. To ignore the problem

would be tantamount to political suicide. Yet, the magic cure for the problem seems to be as illusive as the care for a common cold. The most efficient remedy will most likely take the form of an integrated set of measures that provide synergy benefits. Benefits will be measured by the reduction in travel time and reduced vehicle operating costs and a reduction in accidents.

1.2.1. STATEMENT OF THE PROBLEM

1. Given the outline of the problem above, **the problem statement can therefore be described as the lack of research in to the economic impact of toll roads on the total welfare of users and other stakeholders along alternative roads.**

2. Evidence exist, which indicate that the impact assessment that was conducted prior to the commissioning of the existing road (N1) being tolled, did not consider all economic impacts on the alternative road. Evidence also suggests that proper procedure and in this case, proper procedure would include wider consultation with road users, was not followed in the approval of the tolling of the N1 national road under investigation.

3. Very little has been documented about the impact of traffic diversion on alternative roads and in order to participate in global discussions and contribute towards a wider body of knowledge it is evident that the impact (on alternative roads) of traffic diverted from toll roads needs to be determined. Furthermore, there is a responsibility to consider the economic impact of tolling on urban and rural classes of developing communities.

Cooper and Schiddler (1998:91) state that problems too broadly defined cannot be addressed adequately in one study. Thus, it was decided to specify and limit the statement of the problem to the diversion of traffic from tolls and its impact on alternative roads, as stated above.

Specific impacts on alternative roads measured in this study include the:

- Impact on the quality of life of users of the alternative road
- Impact on the quality of the alternative road
- Impact on vehicle operating costs

- Impact on congestion and travelling time
- Impact on pollution
- Impact on accidents
- Impact on property values
- Impact on prices of goods and services, business opportunities and employment
- Impact on the environment and the surroundings around the alternative road.

1.2.2. AIM OF THE STUDY

Although studies concerning diversion of traffic from toll roads have been conducted before, the present study will shed more light on the problem at hand. The study takes the form of an Economic Impact Assessment (EIA) and it will assess the welfare effects of traffic diversion on alternative roads. In other words, the study investigates whether there are welfare effects on alternative roads as a result of traffic diversion from the toll road. Further to this, it is important to realise that EIAs were done prior to the commissioning of the tolling of the N1. This is the first time that an EIA of the alternative R101 road is done after implementation. Many costs and benefits to society are now known compared to previous EIAs.

Also, ancillary to the main aims of the study, knowing that toll roads are now a reality, it is possible to make recommendations regarding a more optimal spread of costs and benefits between the N1 Toll road and the R101 alternative road.

The specific objectives of the study will be the following:

- Firstly, the study will investigate the benefits and costs of using the alternative roads by users and society.
- Secondly, the study will investigate the impact of diverted traffic on the following:
  - On the quality of life.
  - On the quality of the alternative road?
  - On vehicle operating costs.
  - On congestion and travelling time
  - On pollution

- On accidents
- On property value
- On prices of goods and services, business opportunities and employment.
- On the environment and the surroundings.

The above objectives will be realised through the use of various EIA techniques among others, this will include a comprehensive background to the problem or analysis of the current situation from existing documentation and the use of a cost - benefit analysis on the alternative road.

1.2.3. IMPORTANCE OF THE STUDY

South Africans affected by traffic diverted from toll roads face not only the increased cost in travel, but also of effects such as environmental damage and congestion. Discussions on traffic diverted from toll roads have been initiated. It is critical to participate in these discussions and to back them with empirical evidence. Very little has been documented in respect of the impact of diverted traffic on alternative roads. The study will provide empirical information of the problem under investigation. The findings of the study also present recommendations that attempt to mitigate the impact of traffic diverted from tolled roads. In addition, this study provides guidance to affected parties and researchers on how to address the phenomenon of the impact of diverted traffic and to measure the impact. The research provides a scientific background on the economic impact of traffic diverted from tolls in both the national and the international arenas. It aims to elucidate the unique manner in which diversion of traffic from tolls affect users in South Africa, since research based on EIA of traffic diversion to alternative roads is limited. The researcher selected the specific area for the study because:

- It lies on one of South Africa's important development corridors.
- All income groups and all classes of vehicles use it.
- Because of its relatively small size, it is relatively easy to measure and quantify.

At this juncture a call for investigations like this is apparent. Whether South Africa can indulge in the luxury of waiting for research to develop to address urgent challenges facing it is a question worth considering.

1.2.3.1. Background

Road pricing by means of tolls have a long history. In the 19th century many new roads were financed by tolls in the U.S. However, in other countries such as Germany and the U.K., there has been great opposition to toll roads, except for specific facilities such as bridges and tunnels. In recent times, it is widely accepted that tolling of roads would not be satisfactory and that the pricing of roads would have to await developments in electronic and other tolling mechanisms (Jenkinson, 2000:85). It is argued that the introduction of road tolls leads to distortions, which prevents the optimum use of resources.

The main concerns are

- Misallocation of resources,
- The costs due to traffic diversion, and
- The costs of collecting tolls.

In South Africa all did not warmly welcome the introduction of tollgates along the N1. Pressure groups were formed and the point of contention was that the N1 road is a national road and therefore it should not be used as an avenue for business. (Pretoria news, 2002:1), (Star, 2002:15). The Anti Toll road Association (ATA) also argues that the costs of tolls are excessively high. The above statements are consistent with the argument provided by Walters (1970:99), who provided a theoretical structure of road pricing, where he argues that tollgates are inefficient in the short run and they can only be efficient in the long run. In addition to that Rosen (1995:335) asserts that user charges (tolls) distort choices and thus lead to a reduction in welfare.

Users of the N1 road are road users from all over and they use all classes of vehicles. About 30-40% of traffic on the N1 national road was diverted to the alternative road after the toll road opened. This research aims to determine the nature of permanent shifts in road use patterns as a result of the toll road, as well as the costs and benefits that traffic diversion has on alternative roads.

The literature in this field is extensive and the vast majority of studies have been characterised by the use of CBA. CBA has been used extensively in the past for example; it

was popularly used in Norway and the USA where a number of projects were approved after the findings of the CBA.

Research of this nature is necessary to gain a better understanding of the EIA particularly where the tollgate was introduced on an existing road and therefore an in depth study is necessary to understand the welfare effects of traffic diversion and whether it undermines the welfare of society, as theory will have it.

EIA has been used extensively as a research tool in various studies. This study will provide an opportunity to apply this method of research. Usually, EIA conforms to the following criteria:

- It promotes efficient use of resources.
- It is able to test whether the scheme conforms with or advance objectives.
- It demonstrates to the public and decision makers that an important decision has technical basis.
- It is consistent in approach ensuring that common standards are applied.
- It acts as aid to the understanding of the incident of impacts.
- It establishes a control mechanism to which decentralised decision makers must conform.
- It is comprehensive in terms of the different kinds of impacts of the investment. Brathen (2001:4).

1.2.3.2. Literature review

The review of the literature is aimed at contributing towards a clearer understanding of the nature and meaning of the problem. It is a thoughtful and informed decision that provides a logical framework for the research that is set within a tradition of inquiry. The study looks at concept definitions, background information and other related topics. Practical experience of the impact of diverted traffic is also reviewed. To make sure that the theoretical framework encompasses all the elements of the research topic, the study uses the following literature sources.

- Articles and journals.
- Government documents and reports.
- Relevant textbooks.
- Other relevant references including research reports and media releases.

Road pricing is a popular research topic in economic theory. Since nearly all transport modes are associated with externalities like congestion and emission of pollutive gases, there has been a great deal of interest in various ways to price these externalities. The idea to overcome this type of market failure was already proposed in 1849 by Dupuit and later formalised by Piqou around 1920. Among the theories of road pricing is the Paretian welfare theory of marginal analysis. According to the principle of Pareto optimality, Pareto optimality can only be attained if the implementation of a program increases the well being of individuals without reducing the well being of other individuals. (Rosen, 1995:41) Pareto optimality can only be attained at the point where the marginal rate of substitution (MRS) is equal to marginal rate of transformation (MRT). In the case of a public project the external effects have to be taken in to account and as a result Pareto optimality will be attained where marginal social benefit (MSB) is equal to marginal social cost (MSC).

In recent years CBA has been used as the main method of analysing the desirability of projects. However, it suffers from several drawbacks. Nash *et al* (1997:627) identified the following drawbacks: Firstly, CBA often offers different results and the procedure for choosing the best one is based on normative judgement, for instance, the Hicks – Kaldor criterion may be preferred over the majority voting method.

Another drawback of CBA is that it is incompatible with other quantitative methods and CBA is often used to justify decisions that are already taken. Further improvements to this method of analysis are the Hicks – Kaldor criterion. It states that if the number of those who benefit from the project is greater than the number of those who loose, the winners will compensate the losers and the project should be carried out. These theories are all reviewed as part of the literature review.

The study discusses a comprehensive EIA. EIA is often preferred because it offers the following advantages. (Brathen, 2001:6)

- It realises that resources are scarce.
- It assists decision makers to use resources where benefits are the largest.
- It disciplines the decision making process by informing authorities about the costs and benefits of the project.

In Professional Engineering News (2003: 23) surveys were conducted, which showed that there is a high level of agreement that tollgates solve problems such as congestion. In another study conducted by Professional Engineering News (2003:22) it is revealed that tollgates lead to a change in travellers' behaviour, i.e. there will be use of alternative transport, a change in route or a reduction in the number of travellers. Studies conducted by Du preez (1995) reveal that tollgates raise enough revenues to finance road infrastructure. The study further reveals that the majority of road users become negative towards the introduction of a toll road but after it is introduced, the majority become positive. From the above discussion it can be concluded that tolls have been widely written about although the bulk of what is published tend not to be specific to the focus of the study. The literature review is confined to the issues that are considered important for this study and focus on important developments that help shape the current line of argument followed in this study. The research takes a comprehensive view of traffic diversion from tollgates in an international context and the recent developments. In a nutshell, it can be said that the research seeks to extend the view of EIA to alternative roads where there is a diversion of traffic from the toll road. Many studies established the relationship between tolls and travel behaviour; this study aims to focus on the relation between traffic diversion and welfare on alternative road users.

1.2.4. HYPOTHESIS

Although strictly speaking a hypothesis is not required for this type of study, the hypothesis to be tested may be stated as: Traffic diversion from toll roads has an impact on the welfare of users of alternative roads.

1.3. METHODOLOGY OF RESEARCH

As explained earlier, the study comprises both a literature review and an economic impact assessment. This section explores the survey that was used to compile useful information about the population, i.e. road users of the alternative route under investigation, the R101 route.

1.3.1. SAMPLING METHOD

The sampling method chosen for the study is a *proportionally stratified random sample* survey method. Although questionnaires will form an important part of the study, secondary information from relevant documents is equally important. NRA and CSIR will also supply information that will inform the CBA.

1.3.2. POPULATION

The term population refers to the total number of people, objects or events that are relevant to the research aspects being studied. The target population will be all users of the alternative road. This ensures that the population uniquely qualifies to provide the desired information.

1.3.3. SAMPLE FRAME

This will consist of two groups: Firstly, travellers who have diverted from tolls to alternative roads. Secondly, people who reside around the area of study and those who have been using the alternative road before the introduction of tolls.

1.3.4. SAMPLE SIZE

A sample big enough to be representative of all people affected by tolls is chosen. A proportionally stratified random sample of travellers along the R101 road large enough to achieve defined objectives is used.

1.3.5. SAMPLE DESIGN

It was decided to design a survey that would gather information on which an EIA could be based. A survey is a method whereby the researcher gathers information about a certain phenomenon and interprets it. The information is then used to determine the causality as well as factors influencing it. When conducting a survey the researcher measures various tests, hypothesise and makes inferences about past behaviour, experience and characteristics. A proportionally stratified random sample was used to obtain participants in the survey. Sample size was obtained from the total population of users using the following formula

$$n = \frac{Npq}{(N-1)D + pq}$$

N = 7100 Total population
p = q = 0.5 since there is no prior information available
B = 0.05 Bound on error
$D = B^2/4$
Therefore n = 379 sample size

To reduce errors the sample was further proportionally stratified, in two strata, *viz.* Travellers diverted from tolls to the alternative road and a Second strata were people residing around the area of study and travellers who have been using the alternative road before the introduction of tolls. The sample size for the two strata was obtained using the formula below.

$$n_1 = \frac{N_1}{N} * n = \frac{2100}{7100} * 379 = 113$$

$n_1 = 113$

$$n_2 = \frac{N_2}{N} * n = \frac{5000}{7100} * 379 = 266$$

$n_2 = 266$

Where N = total population

N1 = strata 1

N2 = strata 2

n = sample

The sample size for the survey was 379. This sample is considered big enough to be representative of the affected parties and large enough to achieve the desired objectives.

1.3.6. AREA OF STUDY

The area of study is the alternative road to the N1, the R101. The research was aimed only at a section of the road between Pumulani and Hammanskraal. The road connects Pretoria to Hammanskraal. All classes of vehicles use the road for various purposes.

1.3.7. RESPONDENT SELECTION

The study used a stratified random sampling in selecting respondents for the questionnaires. The study targeted all users as potential respondents.

1.3.8. QUESTIONNAIRES

A questionnaire is a list of carefully structured questions after considerable testing, with a view to eliciting reliable responses from a chosen sample. The aim is to find out what a selected group of participants do think or feel. A concerted effort was made throughout the design and layout of the questionnaire in an effort to achieve the common sense rule. It is

strongly suggested that one has to remember the following key points while designing a questionnaire.

- Use concise and simple language.
- Each question should ask about one thing only.
- Be straightforward and guard against double meaning.
- Get the question order right.
- Make layout easy to follow.
- Give clear instructions.
- Be polite (Riley *et al.* 2000: 96).

Designing a questionnaire is a complex procedure. It is influenced by project consideration, research design and the concerns that are inherent in any written or oral form of research. The following steps must be taken to design a questionnaire:

- Clarify the reason for the study.
- Determine the information required from respondents.
- List the research questions the researcher wants to answer with the questionnaire.

In this study most of the questions were developed from the literature study. A questionnaire should be short and relevant and not too long to complete. Questions can be open-ended or close-ended. Most of the items in the questionnaire were close-ended to elicit a standardised set of responses from all respondents. This makes it easier for comprehensive data analysis.

A paper-based questionnaire was issued to 379 participants. Participants were intercepted at various locations around the study area. A simple roadside paper-based interview was used. Two types of questionnaires were given to participants. The first questionnaire was aimed at users of the road who were diverted from the toll road. The second type was issued to old users of the alternative road and those residing around the area.

Questionnaires consisted of three major sections. The first section contained questions aimed at obtaining opinions about the costs and benefits of using the alternative road instead

of the toll road. The second section consisted of questions aimed at obtaining information from participants about the impact of tolls on the quality of life and third section consisted of demographic questions.

1.3.9. PRETESTING THE QUESTIONAIRE

Pretesting the questionnaire provides the opportunity to refine the questionnaire by revealing errors in the individual questions, sequence and design. The real test is to see how the questionnaire performs under actual conditions. The researcher relied mainly on the opinion of experts. Another aspect that was critical in the study was the fact that more than one language group was included in the study, which necessitated a pilot study.

A pilot study was constructed across a sample of 15 respondents. The respondents included two experts in the field of statistical survey. Final year tertiary students, the researcher's colleagues and users of the road under study were included in the pilot study. Some of the comments were the following:

- Use of different wording in some of the statements to increase the level of understanding.
- Time in completing the questionnaire is too long. Divide the questionnaire into two.

1.3.10. VALIDITY AND RELIABILITY

There are criteria that are used to evaluate a measurement tool. (Cooper and Schindler, 2001: 210). Validity is a characteristic of measurement. Validity refers to the establishment of evidence that the measurement is actually measuring the intended construct. The question that must be answered is, does the test measure what the researcher actually wishes to measure? Validity of construct relates to the degree to which a research instrument is able to measure or infer the presence of an abstract properly. There are several approaches for establishing construct validity. These include:

- Construct validity.

- Structural validity.
- External validity.

Reliability is a characteristic measurement. It is concerned with the accuracy, precision and consistency. It is a necessary but not sufficient condition for validity. Reliability refers to the consistency and stability of a measuring scale. There are several approaches for establishing reliability. Theses include:

- Reliability equivalence.
- Reliability internal consistency.
- Reliability stability.

Issues of validity and reliability were dealt with in the survey. The researcher ensured that the survey complies with the issues of reliability and validity. This was ensured through continuous discussion with the researcher's supervisor and comments and guidance from other researchers. The format of the questionnaire was modified to improve validity and reliability.

1.3.11. COLLECTION OF DATA

All participants included in the sample were contacted. However, due to time and financial constraints, the survey was conducted only for a period of one week. The issue of whether there is a relationship between travel and specific days of the week was not taken into account. The survey took place in the week of 28 June to 03 July 2004. During each day interviews were conducted in the morning and afternoon to interview peak period travellers and during midday to interview off peak period travellers. A cover letter explaining the purpose of the study and giving the assurance that all information would be used for research purposes only accompanied each questionnaire. Participation in the study was voluntary and questionnaires were handed back to the researcher on completion.

1.3.12. RESPONSE BIAS: QUESTIONAIRE PROBLEMS.

Few of the participants were reluctant to complete the section of open-ended questions of the questionnaire. Some respondents have difficulties in answering the section of the questionnaire where they were required to state the costs in monetary terms.

1.3.13. UNIT RESPONSE

Few of the participants were not able to speak or write English properly and this affected the response rate. Participants who had problems with language were found mainly at the area around Hammanskraal but in the area around Pumulani Plaza the response rate was very high.

A few of the participants turned the questionnaire down indicating that they are under the pressure from time. Overall, the cooperation rate of the survey was above average.

1.3.14. CODING AND EDITING OF DATA

Questionnaires were edited, errors were corrected and the data were coded. A process of assigning numbers or symbols to answers in an attempt to group a limited number of categories is referred to as coding. (Martins, *et al.* 1996: 299)

The coding of data was done as follows:

A data capture sheet was developed in order to assist the data capturer. All completed questionnaires were transformed into codes, which were recorded on the capture sheet. The codes were then entered on the computer. A print of datasets was made to verify each of these codes and was compared to the data capture sheet. All mistakes made during the coding and data input process were corrected.

1.3.15. USE OF DOCUMENTATION

Documents such as magazines, newspapers, media reports and information available from the Internet are collected and used to test against the data collected from the survey.

1.3.16. DATA ANALYSIS

All data received from the questionnaires were captured in a spreadsheet format using the computer-based programme SPSS (statistical package for the social sciences) and a computer program excel for analysis.

1.3.16.1. Statistical methods

Statistical methods are a set of mathematical techniques that allows the researcher to analyse data. In this manner, logical conclusions could be reached about the population.

1.3.16.2. Descriptive statistics

Descriptive statistics is a method of presenting data quantitatively and describing it in a manageable form. It is therefore transformation of data into a form that can be easily understood and interpreted. This is the method of analysis used for this study.

1.4. OUTLINE OF THE PROPOSED STUDY

CHAPTER ONE demarcates the research field. It is aimed at setting parameters within which the scope of the study falls. Relevance and importance of the study is stated. The goals and aims of the study are also stated and the research methodology outlined in some detail.

CHAPTER TWO provides an organised and structured theoretical framework, which will inform the study. Definition of key concepts is provided. The chapter provides a theoretical

overview of EIA and CBA and the RED model. Further more the chapter provided a discussion on road pricing and some results of previous studies.

CHAPTER THREE consists of two sections. Section 1 provides a background overview of tolls in SA particularly the tolls along the area of study.i.e.N1.
The chapter also discusses the findings of the previous studies conducted along the area of study. Section II focuses on the presentation of results of the survey. Data collected during the survey is analysed with tables and other visual aids. The chapter ends with the summary of the main findings of the study.

CHAPTER FOUR is an analysis chapter. It is set out to conduct a socio-economic impact analysis of the road. The purpose of the chapter is to determine the economic feasibility of the N1 north toll road and the R101. It also aims to determine the impact that diverted traffic from the N1 has on the alternative route R101. This will be achieved by applying the cost benefit analysis appraisal technique using the red model

CHAPTER FIVE provides the summary and conclusions to the study. It shows whether the results confirm or deviate from the expected results. It also indicates gaps and uncertainties requiring further study. The chapter concludes with some recommendations.

CHAPTER 2

THEORETICAL REVIEW OF ECONOMIC IMPACT ASSESSMENT & ROAD PRICING

2.1. INTRODUCTION

The last century was marked by an increase in the use of roads for travelling, relative to other means, which show a decline. It is expected that the use of roads for travelling is going to increase even more in the coming century. This leads to road networks becoming an increasingly costly and scarce resource.
For instance, in the UK the department of transport calculates that road costs averaged £7.07 billion per year for the period 1992/3-1994/5. Over the decade 1984-1994 the number of private cars increased by 28 percent. Traffic on major roads increased by 25 percent. Newbery (2000:127), and Pulley (2000:175) reveal that if the trend continues, car mileage driven would increase by 30 percent by the year 2020 and travel by other modes will decline.

South Africa is no exception to this worldwide experience because of the following. Firstly, people have a want to drive. Secondly, there are a growing number of women licence holders. Thirdly, there is a changing social and family structure leading to more dispersed living patterns. Lastly, there is greater separation between home, job and leisure. Above all, the population is growing at about 3 percent per annum.

Newbery (2000:127) states that roads are a valuable and scarce resource and thus it should be rationed by price. Johansson and Mattson (1995:239) define road pricing as charging for the direct use of the road. This includes a situation where a toll has to be paid for passing a certain segment of a road link. Such pricing may be carried electronically by means of a manual tollgate or by any form of direct user charging. Grieco and Jones (1994:517)

distinguish between a toll and road pricing. According to them, tolls are mainly used for infrastructure development and road pricing is used for congestion management.

This section of the study lays the theoretical foundation of the entire study. Some important concepts related to the study such as EIA, CBA, public goods and externalities are explained. It provides a brief background of CBA as a method of valuing impacts and discusses the provision of public goods by the private sector. In addition it discusses other methods of valuing impacts (Section I). Furthermore, it explores some of the requirements for a good road pricing system (Section II), its principles as well as the various kinds of charging for road use. This section is concluded with an analysis of lessons learned from toll roads worldwide.

SECTION I

2.2. OVERVIEW OF ECONOMIC IMPACT ASSESSMENT

In today's world where road transport continues to be an important player in the economy, transport policy makers are under pressure to develop self sustaining programs and activities.

EIA studies are becoming widely used by agencies interested at maximising the economic benefits of road activities. EIA can be seen as the negative or positive effects of the level of economic activity. (Link, 1996:3) defines EIA as the appraisal of those factors that affect the level of economic activity in a region either positively or negatively. It traces spending through an economy and it generates an estimate of the economic consequences of a particular project on the local economy. It is rather a process of investigation and reasoning designed to assist decision makers reach an informed rational choice. Its fundamentals is to provide decision makers with an estimate of economic costs and benefits over time of any projects relative to those that attach to the continuing use of existing ones. The main reason of EIA is to test economic efficiency.

Brathen (2001:3) defines EIA simply as the process of weighing up advantages and disadvantages to decide whether a project is desirable or not. In other words according to Brathen (2001:3) an EIA is a systematic practice where assumptions, methods and results are presented in such a way that they can be tested. Its purpose is to evaluate both qualitatively and quantitavely the benefits to the economy that are associated with the present and to compare those benefits in a systematic manner to the costs of conducting that project. EIA studies provide information on the amount and nature of spending generated by a facility or event computed for a variety of purposes. Not only can the figures generated through the analysis help gather support for proposed developments but they also help determine what specific actions or plans will provide the most benefits to the community. Additionally, EIA studies have the potential to help target specific projects to increase economic activity. There are reasons why an EIA study is necessary:

- To ensure accountability and document value.
- To ensure overall management effectiveness

However there are critisms to EIA. Goldman & Nakazawa (1997:48) identified the following:

- EIA is irrelevant because decisions are made on a potential basis.
- Unrealistic expectations that the analysis can be completely accurate and comprehensive.

There are various kinds of impact assessments. In choosing the best method the following steps have been identified. Seven steps of choosing a method of project assessment based on the incremental principle are:

- Determine the size of the budget.
- Eliminate all projects that exceed the budget limit and all projects, which do not satisfy minimum acceptance criteria.
- Determine which projects have the highest benefit cost ratio within each group of mutually exclusive alternatives
- Choose the one with the highest benefit costs ratio

- ❖ Review the choice of the best project in each group of mutually exclusive projects. (Conninggarth economists, 2001:29)

This study will only be limited to the following methods of assessment as identified in Brathen (2001):

2.2.1. COST – BENEFIT ANALYSIS

The theory and practise of EIA is an offspring of CBA with the costs and benefits of EIA flowing as costs and benefits from CBA.

(Ceas, 1989:106) defines CBA as an economic technique used in project appraisal, which seeks to encompass in its arithmetic, all costs and benefits associated with an envisaged act of investment. It has the potential therefore, to serve as a very useful guide in decision making on the channeling of public investment. An investment is considered a profitable use of resources for the individual or society as a whole when the expected benefits exceed the costs, thus in choosing between alternative investments that will achieve greatest possible benefit in relation to costs. The technique of CBA has been developed to make this evaluation as systematic, reliable and comprehensive as possible and to eliminate the need for guesswork. CBA is an aid to normative judgment, however not a substitute for it, since future costs and benefits can never be predicted with certainty. The likely benefits of a project can never be completely precise. Therefore normative judgment must be used in the economic appraisal of investment projects. The value of CBA is that it provides a framework for evaluating both the magnitude of the costs and benefits and their distribution over time. Such a framework allows the judgment that must be made in assessing the likely yield of an investment to be explicit rather than implicit and vague.

Prest and Turvey (1966:102) as cited in Nas (1996:63), define CBA as a process of investigation and reasoning designed to assist a decision maker to reach an informed and rational choice. A comprehensive survey of CBA point out that Du Puit's paper on public

utility works in France published in 1844 was the pioneering work in the field of CBA Knight (1924:582). Nas (1996:92) also asserts that Du Puit did pioneering work in CBA. Du Puit brought the concept of social welfare maximization to economic analysis. He introduced consumer surplus and marginal utility in the determination of winners and losers. CBA did not receive widespread application until the 20th century. In its initial stages this was almost entirely in the USA.

In the USA, CBA was introduced by the 1902 River and Harbour Act, which required accountability for costs and benefits to commerce, of the various river and harbour projects. Subsequent to this, the 1993 Flood Control Act consolidated the momentum built up in the application of the technique and from here it spread rapidly to other applications and countries.

In the field of education, CBA took longer to make an impact. Its widespread application appears only to have gained popularity with the tremendous surge of interest in the field of investment in human capital in the late 1950s. Transport was among the first fields in which CBA came into regular use as part of decision making, e.g. in Britain in the study of the M1 motorway and of the Victoria underground railway line in London (Beesley and Foster 1963:617).

Brathen (2001:51) identified the role of CBA in planning process as follows:

- It may be used to assist in selecting an alternative among competing alternatives of the same project.
- It may be used to assist in selecting a project among competing projects in the transport sector as a whole.
- It may be used to assist in selecting a project among competing projects in the same sector of transportation.
- It may be used in selecting a project across sectors of the economy.

Brathen (2001: 51) states the aim of conducting a CBA as obtaining information to help guide policy and investment decisions towards the achievements of objectives. Therefore, CBA should meet the following requirements:

- It should promote efficient use of resources.

- It should be able to test whether schemes conform with or advance decision makers' objectives.
- It should demonstrate to the public and decision makers that important decisions have an adequate technical basis.
- It should be consistent in approach, ensuring that common standards are applied.
- It should act as an aid to the understanding of the incidents of impacts.
- It should establish a control mechanism to which decentralised decision makers must conform.
- It should be comprehensive in terms of the different kinds of investments.
- The technique employed for economic valuation should be best suited to the particular circumstances of appraisal.

Due to the shortcomings of CBA as a method of analysis it lost its popularity and was then supplemented with other methods of impact assessment, e.g. the cost effective method and multiple balance sheet criteria. This was because CBA does not take some of the costs into account such as the externalities and environmental costs.

Ceas (1989:110) view the relation between CBA and EIA as the following: Whereas CBA is concerned exclusively with comparison of direct benefits and costs to society; EIA examines the direct benefits and costs to society. EIA examines the distribution of many secondary impacts that falls outside the scope of CBA. EIA does this by studying changes occurring across broadly defined sectors of the economy. EIA means that the project is re-evaluated at prices that reflect the relative scarcity of inputs and outputs.

EIA has widened over the years in scope from considering narrow economic to wider socioeconomic impacts. European countries and the USA has a long tradition of conducting EIA for road projects and lately it has also been used extensively in third world countries for development projects of all kinds.

In its application CBA uses the following methods of choosing the best alternative. Brathen (2001)

2.2.1.1. Decision criteria of CBA

Net Present Value (NPV)

NPV is the difference between the discounted benefits and the discounted costs. If NPV is positive then the project is said to be economically worthwhile with respect to the monetised impact. If NPV is negative then the project is not worthwhile. If NPV is equal to zero then one should be indifferent whether to undertake the project or not.

Benefit Cost Ratio (BCR)

BCR expresses the returns of an investment relative to its costs. It is defined as the ratio between NPV to total costs of investment. The interpretation of BCR is calculated as Net benefit/ cost ratio. A BCR of 0.5 implies a net gain.

Internal Rate of Return (IRR)

IRR is the interest rate at which streams of benefits and costs are balanced. For a project to be selected the IRR must be equal to or greater than the market rate of return.

2.2.1.2. Important costs considered in cost - benefit analysis.

These important costs arise out of road use. Brathen (2001:68) distinguishes these costs as monetary and non-monetary costs. Monetary costs are costs valued in monetary terms and they include the following: Travel time saving costs, accidents costs, maintenance costs, vehicle operating costs, residual value costs, and investment costs. The non-monetary costs are costs, which is not necessary to express in monetary terms. They include costs to the natural environment, cultural environment, cultural monument and archaeological sites, landscape and outdoors recreation, agriculture and fishing, geo water resources and ecology, land use and regional development.

The review of these costs will only be limited to the following important ones.

2.2.1.2.1 ROAD DAMAGE COSTS

Brathen (2001:69) categorise these costs as follows:

- Costs of operating roads such as lighting, traffic management, policing, incidents and management, etc.
- Costs of road maintenance including routine activities such as clearing drains, which are continuous and rehabilitation activities, which are periodic.
- Costs of road improvement, widening, safety enhancement, etc.
- Initial costs of construction, including land acquisition and interest on borrowed funds.

2.2.1.2.2 CONGESTION COSTS

These costs arise out of the tendency of vehicles sharing limited road space to slow each other. The sole use of a freeway is to travel safely on it at high speed but congested conditions can bring all traffic to a stop. Time losses are the largest contributor to congestion cost. Button and Verhoef (1998:281) and Hau (1995:10), suggest that to be efficient and effective, charges for the use of congestion should be applied selectively with the price reflecting congestion levels at different places and at different times of the day, as it is done with telephone charges. Collection at conventional tollbooths then becomes impractical because tollbooths will also impose unacceptable delays to traffic. Congestion costs include health problems, stress, discomfort, loss of work and leisure, increased fuel consumption etc. These costs pose a serious problem in most cities today. Further to that they slows the movement of goods and services adding to the prices of products and reducing the competitiveness of business. (Luk and Hepburn, 1995:42).

Nasser (1998:201) states that congestion pricing signals the value of additional capacity and hence creates correct incentives. In a study conducted by Nasser (1998:203) using the telecommunication model network he concludes that it efficiently rations access to the network and it sends correct signals about capacity expansions. However, opponents of congestion pricing argue that profit maximisation behaviour leads to an increase rather than a decrease in congestion of the network. If competition is weak and network provision is monopolistic, congestion pricing leads to sub-optimal expansion of networks. If competition is strong to provide additional networks, congestion pricing will lead to optimal network expansion.

2.2.1.2.3 ACCIDENT COSTS

Accident costs include costs related to death, injury, and damage to property (Transportation Research Record 1107, 1987). World health organisations estimate that about 600 000 people are killed on the world's roads every year and about three quarters of the deaths occur in developing countries. There are two principles related to accident costs: Those who cause risk to others should purchase sufficient insurance to enable them to compensate victims in the event of an accident and all concerned with road conditions should be under pressure of strong incentives to reduce accidents (Transportation Research Record 1107, 1987).

It can be concluded that road accidents pose serious problems especially in developing countries. However, commercial insurance affordable to most road users can mitigate the financial risk and also exert pressure to raise safety standards. Charging road users can cover risks not covered by personal policies, but only if part of the user–charge is transferred to a road accident fund.

2.2.1.2.4 POLLUTION COSTS

Pollution costs are divided into global pollution and local pollution. Pollution includes pollution to the environment, air and noise pollution. Pollution costs are not attracting serious attention like accident costs. Hau (1992:205) comments, "The risk of premature death in a car accident in California is twice as high as the risk of premature death from pollution."

Vogel (1996:3) provide evidence that France and other countries are to introduce a new toll policy on all trucks to overcome the problem of pollution by heavy vehicles, as heavy vehicles contribute more to the pollution of the environment than light motor vehicles.

2.2.2. COST EFFECTIVE ANALYSIS

This method deals with benefits not easily quantified or for which there are no easily defined monetary units. The principal of CEA is to obtain money based index that is helpful in comparing alternatives that are intended to reach the same general type of objective.

2.2.3. MULTIPLE CRITERIA ANALYSIS

This method uses both effects that have a monetary value and other effects considered to be of interest. Its advantage is that it describes and shows the multiple objectives that decision makers generally have. It enables diverse objectives to be integrated. It recognises that economic efficiency is not the sole objective of a policy.

2.2.4. RISK BENEFIT ANALYSIS

This is the application of decision rules to risky events.

2.2.5. ENVIRONMENTAL IMPACT ASSESSMENT

This method requires the identification and measurement of impacts on the environment. It identifies environmental consequences of policy actions.

2.3. ROADS ECONOMIC DECISION (RED) MODEL

The RED model is a special version of a CBA, which was developed by the World Bank for specific application to decisions regarding the building of roads. The RED model has build-in fixed parameters regarding the valuation of aspects such as time and the impact on vehicle maintenance due to varying road conditions. For this reason, the model parameters needed to be adapted for South African road conditions. This was done by Transpotek (a division of the Council for Scientific and Industrial Research (CSIR)), on assignment from the Development Bank of Southern Africa (DBSA). This special application of CBA is applied to data of the study area and is discussed in Chapter 4. (CSIR:2000)

2.4. METHODS OF VALUING IMPACTS

These methods are categorised as follows (Brathen, 2001:56):

2.4.1. IMPACTS FOR WHICH PRICES EXIST

In a perfectly competitive market economy all goods will be produced for which consumers are willing to pay the costs. In such a market the resource values will be reflected in prices. In a free competitive market, market prices are an appropriate measure of costs and benefits of transport projects. It is mainly used for maintenance and operating costs.

2.4.2. IMPACTS FOR WHICH PRICES CAN BE DERIVED FROM QUASI MARKET OBSERVATIONS

For impacts that do not have market prices, values can be derived from observed or stated human behaviour. There are various methods to determine the value of those impacts. Brathen, (2001:57) identified the following methods to derive prices for those goods that do not have prices attached to them. They are:

Revealed Preference Method

This method relies on funding a market in which people reveal the value they attach to an attribute in question in terms of willingness to pay for it or accept compensation for its loss by observing actual behaviour. It is used mainly in time saving.

Hedonic Pricing Method

This is a form of revealed preference analysis. Its main proposition is that the price of a good is related to its characteristics and thus consumers' preferences for attributes of a good can be derived from consumption decisions. It is mainly used from consumption decisions. It is mainly used for house price models to derive environmental benefits associated with a particular area.

Travel Cost Method

This method is used for valuing the benefits of traveling facilities. In transport it is used to provide estimates of the value of recreational sites that are severely damaged due to road construction.

Stated Preferences Method

This method uses surveys to ask people about their hypothetical decisions. It is mainly used for determining the value of human costs of accidents, value of time and value of the environment.

Contingent Valuation Method

It involves actually asking direct questions about an individual's willingness to pay or willingness to achieve or avoid a particular result, such as reducing the level of noise nuisance in a given area.

2.4.3. IMPACTS THAT CAN ONLY BE INDICATED BY USE OF WEIGHTS

This method seeks to derive values directly by assigning weights for each impact stating the impacts importance relative to all other impacts under consideration. The weights are derived in a number of ways generally termed multi criteria.

2.4.4. IMPACTS WHICH CAN ONLY BE INDICATED BY USE OF QUALITATIVE DESCRIPTIONS.

Impacts in this category can be divided into two. Those that cannot be valued because no adequate study of the effects exists and those that exist, but the valuation is wrong in principle because it is irreplaceable or its effect may be irreversible. The first group can be dealt with by expert opinion. The second group may be inappropriate to place monetary value of impacts on, especially environmental ones. These considerations should therefore be thoroughly described for political judgment.

SECTION II

2.5. THE METHOD OF PRICING ROADS.

Welfare theory analyses the case of road pricing using the theory of Pareto optimality. Brown and Jackson (1990:18), and Musgrave and Musgrave (1998:60) define Pareto optimality as a condition where no one can be made better off without making someone worse off. The theory of Pareto optimality is based on various assumptions. Firstly, it assumes a condition of perfect markets. Secondly, it is restricted to the short run and lastly, it is based on a partial equilibrium analysis (Luk and Hepburn, 1995:45). For the principle of Pareto optimality to be met some conditions have to be satisfied. The first is the condition of allocative efficiency. Brathen (2001:4) defines allocative efficiency as the condition where production efficiency and exchange efficiency are in equilibrium. Production efficiency is the state of economic affairs where it is no longer possible to increase output of a good without reducing output of some other goods, i.e. the rate at which good x is converted to good y, must be equal to the marginal rate of transformation (MRT_{xy}). The second condition is the

condition of exchange efficiency. It is a state of economic affairs whereby it is not possible to make one consumer better off without making another consumer worse off. This means that the marginal rate of substitution for good A must be equal to the marginal rate of substitution for good B ($MRS_A = MRS_B$). Ultimately allocative efficiency will be attained where the marginal rate of transformation is equal to the marginal rate of substitution (MRT =MRS). However, in the real world the state of Pareto optimality is seldom attained because of market failures.

Rosen (1995:61) and Musgrave and Musgrave (1989:71) define public goods as goods, which consist of the characteristics of non-rivalry and non-excludability. Non-rivalry means that once the good is produced, costs of an extra individual's consumption are zero, e.g. the case of a radio programme. Non-excludability means that individuals cannot be exempted from consumption once the good is on offer, e.g. the case of a streetlight or a national defence force (Brown and Jackson, 1990:62).

Naude (1996:82) argues that roads can be classified as public goods but they have the characteristics of private goods and thus they can be rationed by price. When the theory of Pareto optimality is applied to roads it suffers from two drawbacks. Firstly, there is the free-rider problem; secondly, people have the incentive of underreporting their willingness to pay.

Brathen (2001:16) and Rosen (1995:90) define an externality as the costs and the benefits imposed on third parties. There are negative externalities such as pollution, noise, etc., and positive externalities such as research and development. The dissertation will limit the discussion to the case of negative externalities.

In a private market Pareto optimality is attained at a point where MPC = MPB. However, in the presence of an externality this result is considered inefficient from a society's point of view. For Pareto optimality to be attained in the presence of an externality marginal social cost (MSC) must be equal to marginal social benefits (MSB), i.e. marginal private cost plus costs of an externality must be equal to marginal social benefit MSB.

The principle of Pareto optimality has been found to be impractical particularly in the case of roads. The Hicks–Kaldor criterion is popularly used instead. The Hicks–Kaldor criterion is a state of economic affairs, which advocate that those who gain must compensate those who loose.

There are some criticisms levelled against this criterion. Firstly, the assumption of linear demand curves. Secondly, there is the assumption of constant marginal utility. Little as cited in Newberry (1997:35) concludes that the demand curve is partial and it fails to take into account the effect of the investment in all goods. Button (1983:15) shows that the winners of the Hicks–Kaldor criterion can bribe losers and this will later revert back to the *status quo*. Although the compensation of losers seldom occur in reality, Brathen (2001:32) supports the Hicks–Kaldor criterion by asserting that very few projects have winners only and therefore the Hicks–Kaldor criterion widens the scope of viable projects.

2.5.1 MARGINAL COST PRICING

Newberry (1990:161) asserts that road space is a valuable resource that can be rationed by price. He strongly believes that marginal cost pricing is the best method to achieve this. Marginal cost pricing involves the setting of price equal to the cost of producing one extra unit of that item. Marginal cost is the primary opportunity to society of producing the item - in this case road infrastructure.

This can be achieved by means of a price being set at marginal social cost of using the road network, which will ensure that users make use of the road when it is absolutely necessary. The theory of marginal cost pricing assumes that equilibrium occurs where price equal marginal cost (p = mc). This is the condition necessary for optimal allocation of resources. If the price of the good is the cost to the road user of purchasing it, it will be used only if the value of it is more than or as much as the price attached to it. If the price of the good is below marginal cost, consumers will purchase it even if the value they attach to it is less than that of the good that could be provided in its place. If the price exceeds marginal cost, consumers will refrain from purchasing it. It can be concluded that for efficient allocation of

resources to be attained marginal cost pricing (p = mc) is necessary. Marginal cost pricing can only offer best results in the absence of market failures. However, in the presence of market failures marginal cost pricing will need to be corrected.

Proponents of marginal cost pricing date back to Du Puit (1844) who demonstrated that the benefit to travellers of using a bridge was greater than the revenue collected from it. This was later followed by Piqou (1920) and Knight (1924) who developed a general and a special case of marginal pricing (Smeed, 1964:133).

Walters (1968:196) also supports marginal cost pricing. He advocates that the users of roads should be charged a levy to clear the market, according to the principle of economic efficiency. Walters (1968:196) leaves unanswered the question of whether such user charges will lower than the cost of investment. Nasser (1998:210) shows that marginal cost pricing could lead to economic efficiency, using the case of network expansions. He shows that if network expansion is competitive, congestion pricing leads to optimal investment and if network provision is monopolistic, under-investment will arise. Nasser (1998:210) proved this using the case of power networks and the Internet. He strongly believes that it can be extended to other networks such as roads. He suggests policy makers must therefore assess whether the network expansion is indeed competitive and they must design appropriate regulatory frameworks.

2.6. CHARGING FOR THE USE OF ROADS

This section explores the necessity of charging for the use of roads. Smith (1977:245) as cited in Lesort (1996) states "… the greater part of public works may easily be so managed, as to afford a particular revenue sufficient for defraying their own expenses, without bringing any burden upon the general revenue of society". Harrop (1993:65), and Lesort (1996:24) strongly argue that charging for road use is beneficial to all parties. They believe that charging for the use of a road will offer the following advantages. Firstly, investment decisions by the government can be facilitated and existing roads could become over utilised, if provided at no cost per user, resulting in an increased demand for space. Secondly charges,

which limit the use of the mode of roads, will prevent wastage resulting from congestion as well as serve to influence location decisions, which favour greater distance from resources and markets. Thirdly, user charges free up general tax revenues for other priorities. Fourthly, user charging targets those users who benefit directly from the services although the burden on low-income users will be a mitigating factor. Fifthly, user charges can assist in the optimal allocation of traffic between roads and other modes.

The advisory commission on intergovernmental relations (1987:27) as cited in Du preez (1975:73) asserts that "market prices in the context of private goods ration private goods or services among potential buyers while also playing a part in the determination of quantities of goods and services produced. User charges are held to have the potential to increase short run and long run efficiency related to benefits of a similar nature in the public context. It is also deemed a fair and equitable method by which the beneficiaries of public goods may pay for the enjoyment of the same"

Although user charges can play an important role in the rationing of road use, like any price it suffers from some drawbacks; it can be difficult to implement and it can undermine the principle of equity and the distribution of income. Charging for a road system has to be acceptable socially for it to be successful. The Smeed Report proposes that "road users should pay a sum equal to the cost imposed upon others" i.e. the direct cost arising from road use. The report identifies some operational requirements for a good road pricing system.

- Charges should be related to the amount of road use.
- It should be possible to vary prices for different roads at different times of day, week or year and for different classes of vehicles.
- Prices should be stable and readily ascertainable by road users in advance of their journey.
- Payment in advance should be possible.
- The system should be regarded as fair.
- The method should be simple for the road user to understand.
- Equipment used should be reliable.

- Payment should be difficult to evade.
- The method should be capable of handling millions of vehicles.
- Payment in small amounts should be possible.
- Drivers in high cost areas should be aware of their rates.
- Drivers should not be unduly distracted from their driving activities.
- The method should be able to accommodate users from other areas.
- Enforcement should lie within the capabilities of non-police staff.
- It should indicate to planners the strength of demand for road space.
- It should be amenable with gradual introduction starting in pilot areas.
- The payment process should not necessarily identify payers or vehicles. (HMSO,1964)

2.6.1 CHARGING FOR THE USE OF ROADS IN SOUTH AFRICA.

The research report (ARRB: 1995) indicates that toll roads in South Africa will bring along several benefits to society. According to the report toll roads are an instrument to stimulate economic growth, open up job opportunities, is an important ground for entrepreneurial training and it raises revenues. It is used as a traffic management tool and enhances efficiency (Civil Engineering Contractor, 2002:10). Although tolls in South Africa can offer the benefits mentioned above, they must first be viable. If they are not viable the benefits mentioned above will not be realised. The research report (ARRB: 1995) identified some factors, which need to be considered when determining the financial viability of a toll road. They are:

- How much traffic will be diverted or attracted.
- Perception of the value of money for the particular grouping.
- Benefits users will see from incident management along the road.
- Costs of accident management e.g. tow trucks, ambulances, construction costs and economic growth.

Johansson and Mattson (1995:239) provide the characteristics of a good pricing system from a society's point of view as follows:

- The system should bring about larger benefits than costs.

- The system should minimise intrusion of the natural urban environment.
- It should be possible to differentiate between types of vehicles.
- The system should be compatible with other related payment systems.
- Systems in different jurisdictions should be compatible.
- It should be possible to adjust the system to varied geographical conditions.
- The system should be appraised as fair.

Leiman (2003: 241) presents the objectives of tolling in South Africa as the following: Users are charged the full costs of the use of infrastructure and also users are charged full costs in order to support the infrastructure. In addition to these objectives Leiman (2003:241) identifies various weaknesses for tolling in South Africa. He asserts that tolling is inefficient unless it is imposed on all national roads, because as a result of tolls heavy vehicles avoid tolls and highways and use light roads, which lead to damage to these roads. The South African system also uses the number of axles for heavy vehicles as a proxy for pricing and it does not consider the actual loads of motor vehicles. Finally, there is a problem of cross-subsidisation. Further to that Leiman (2003:241) uses the example of the privatisation of Spoornet. After Spoornet was privatised there was a remarkable increase in heavy vehicles on South African roads. He believes that tolls will divert heavy vehicles to untolled alternatives and this will create further distortions on South African roads.

2.7. THE METHODS OF CHARGING FOR THE USE OF ROADS.

Roth (1966: 201) distinguishes between the direct and indirect methods of charging for road use. Direct charges are charges paid directly by a road user travelling along a specified road e.g. conventional tolls and electronic charging. Indirect charges are charges related to vehicle ownership e.g. license fees or charges related to vehicle usage e.g. shadow tolls, fuel and tyre taxes. The exposition will only be limited to tolls and electronic charging.

2.7.1 CONVENTIONAL TOLLS

Tolls involve the payment of a set fee by users of a facility at a location on the use of facility itself i.e. route-specific and traditionally levied for the use of sections of roads, bridges and tunnels (Mitchell, 1989:16) as cited in Du Preez (1975:86).

Tolls were in existence 2 500 years ago; they were paid for the use of the Susa –Babylon highway under the regime of Ashurbanipal who reigned in 17 century B.C.In 1653 John Evelyn reported "on April 11, I went to take air in Hyde Park. There every coach was made to pay a shilling and sixpence for every horse by the fellow who purchased it from the so-called state". Early forms of road toll charges, traditionally called turnpikes were applied to private and local rural roads and bridges as indicated in Johansson and Mattson (1995).

Tolls may be a fair proxy for a direct variable maintenance charge, if the toll varies per kilometre but it does not have practical application as a congestion charge. However, it conforms to the benefit received principle. Tolls conform to the principle of horizontal equity because they allow for the use of a differential pricing system enabling heavy vehicles to pay more for the use of roads (Markman, 1984: 31) as cited in Du Preez (1975:90). Markman further argues that tolls face a fairly inelastic demand and are simply passed on to the consumers. In developing countries, tolls have been found to have the opposite effect, e.g. toll charges in Latin America were substantial and lead to limited development because of the high diversion rate.

Tolls suffer from some drawbacks: Walters (1968: 219) argues that administrative costs are very high. Mitchell (1989: 58) argues that the land requirement for the erection of toll plazas is substantial. Thirdly, there are time delays for road users because they have to halt their journey and pay tolls. This results in time costs, particularly in developed countries. Some opponents of tolls argue that revenue theft is easy and increased congestion of the alternative untolled roads is likely to occur.

Garber and Black (1995: 253) identify the following negative externalities concerning toll roads. Firstly, tollbooths slow traffic flow and increase accident risk and add to noise and air pollution. Secondly, tollbooths cause heavy vehicles to divert from highways to secondary

roads to avoid tolls; therefore tolling raises externalities on alternative roads and reduces efficiency.

2.7.2. ELECTRONIC CHARGING SYSTEM S

Electronic charging involves the use of technology to record the frequency of use of a facility by a particular vehicle as well as facilitating automatic charging for the use of the facility. Technologies used, range from card-based systems by users against which use of the facility is recorded and payment is debited, to systems fitted onto the vehicle, which enables it to be identified each time the vehicle makes use of the facility. Electronic charging is usually introduced in the following areas:

- Where there is strong political leadership such as in Singapore;
- Where the scheme is presented primarily as a revenue raising devise linked to the hypothecated spending on new road construction such as in Bergen;
- Where some form of traffic restraint has been accepted because of severe congestion and environmental problems such as in Anthens or Florence (Du preez, 1975:103).

The other most advanced method of electronic charging or toll collection are smart cards and toll tags. Toll tags were first introduced in1989 in New Orleans to enable 13 000 uses of a road bridge to pay their toll without having to stop (Hau, 1995). Smart cards were first introduced in Singapore where they replaced the area licence schemes. Johansson and Mattson (1995:244) identified the following benefits obtained from the use of electronic charging methods:

- The reduction in waste of time because there is no stopping at tollbooths and it is a low cost system;
- They eliminate the need for land and administration costs are low;
- Electronic charging systems are efficient. However, it does not satisfy the requirements for equity because it favours high-income earners, i.e. those who value time most.

Hau (1995) identifies the following advantage and disadvantage with regard to the electronic charging system, respectively:

- The costs of implementing the system are fairly low;
- Enforcement is a weakness in the system because it requires fairly stringent monitoring and enforcement of fee evasion.

Another drawback of electronic charging that has been identified is that it creates an administrative burden upon local authorities.

2.8. PRIVATE PROVISIONING OF ROADS

In the past roads were provided by the government. However, with an increase in importance of roads in the economy the provisioning of roads by government suffer from various drawbacks. Roth (1966: 211) identifies the following weaknesses in the management of roads. Firstly, there is the weakness in ownership arrangement; secondly, there is the weakness of accountability to customers; thirdly, the absence of pricing responsive to costs and demand; fourthly, the absence of competition in the public sector; and lastly, the absence of financial independence.

Although the public sector plays the largest role in the provisioning of roads, the economic principle of efficiency is often undermined. From the picture painted above, it is clear that the private sector can play an important role in the provisioning of roads.

Meads and Wilkinson (1993: 75) assert that the provisioning of roads by the private sector offers some advantages. Meads and Wilkinson (1993: 75) identify the first advantage as follows "in particular, private ownership will be more likely to provide more effective monitoring and commercial incentives for the firms' management than public ownership. Private investors will be placing their own wealth at risk by investing in the firm and its management". Secondly, there will be less concern with politics and more concern with users' needs. Thirdly, there will be lower costs i.e. sensitive roadway design and high labour and equipment productivity. Fourthly, the private owners are informed quicker and better

about ways of improving the road system. The fifth advantage is that private providers have better access to sources of funds than the public sector. Lastly, the private providers can build and finance roads faster than the public sector and competition in the private sector can lead to less expensive services.

Proponents of private provisioning of roads assert that it is the best for road projects to be run by the private sector in a manner that the government becomes the rider and the private sector becomes the horse (Crawford, 1999: 66). Crawford further argues that private tolls will not influence travelling behaviour. Although he strongly supports the private sector providing roads, he is sceptical about the provisioning of roads by the private sector; he provides a popular example of the education sector where only a few segments are catered for by the private sector and where it is not possible to cater for all the people.

Crawford (1999: 72), and Hakim *et al* (1996:70) identify some difficulties in the private sector provisioning of roads. The first difficulty is that of getting the necessary right of way. Secondly, there is the difficulty of the road providers getting paid. Thirdly, the difficulty of competition from the public sector where there are free roads. Fourthly, there is the difficulty of interaction with the public sector roads authorities. Fifth, there is the fear of exploitation of users by private road monopolies and uncertainty about legal liability. Lastly, there is the difficulty of raising funds in the capital markets. Romero (1992:47) asserts that privatisation of roads can improve efficiency of roads and more revenues can be raised. However, he cautions that the danger of excessive toll charges or roads not being maintained to quality standards should not be overlooked.

Road pricing strategies are gaining popularity world wide as demand management tools. 'O Deck and Brathen (2002:253) and Pulley (2002:184), argue that although private provisioning of roads by the private sector has several advantages, there are possible disadvantages that need not to be overlooked, like an increase in costs.

2.8.1. PRIVATE PROVISIONING OF ROADS: A SOUTH AFRICAN CASE.

South African markets support privatisation, which they believe is efficient because of competition. The idea remains despite the theories of market failure and second best (Leiman, 2003:245). Even if the South African civil engineering market is small and dominated by few large firms, bidding to date has been free from corruption and inefficiency. The perception that a cartel of engineering firms handles the market may endanger political and social costs, which requires that the bid be competitive and be seen as such by the public. Although the market is small an unsolicited, proposals considered are subject to competition and counter proposals from other parties. In South Africa the project is awarded to the bidder who is low cost, effective and affordable.

The Civil Engineering Contractor (2000:18) outlines the responsibility of the winning bidder. The winning bidder is responsible for the design, construction and operation of the project for a period of thirty years. A consortium known as the Bakwena Platinum Consortium Concessionaires (BPCC) won the project for the erection and operation of the Pumulani and Carousel plazas. The consortium consists of: Grupo Dragados, Comcor Holdings, Murray and Roberts, WBHO Construction, The Royal Bafokeng Nation, Real Africa Holdings, Stewart Scott Investments, S.A. Infrastructure Funds, Public Investment Commissioners, Old Mutual Assurance, Keeve Steyn (Bakwena) and Compania Espanola de Finacialion Del Desarella.

The South African Road Agency (SANRA) is currently the one involved in the privatisation and tolling process of national roads. It has the powers to veto or counter any bid. In the bidding process a consortium will approach SANRA if it wants to, say construct a road on a built-operate-transfer (BOT) contract. If the bid is acceptable, other consortia are allowed to present counter bids within sixty days. The consortium that wins has to present its books for regular audits and its accounts have to be submitted annually. All toll fee changes have to be SANRA approved. An independent engineer is appointed the technical auditor of the process in contracts between SANRA and the private consortium.

2.9. IMPACT ASSESSMENT LESSONS FROM THE PAST.

Empirical studies have been conducted worldwide to ascertain whether the welfare of those affected by road pricing improves or not. The aim of this section is to uncover some of the results found by those studies.

Luk and Hepburn (1995:80) identify the groups, which benefit from the imposition of tollgates. They are those who value their time highly, mainly found in the upper income group and the users of public transport because in some cases it is subsidised. Further to that they identified the groups, which are losers from the imposition of tollgates. They are users of congested roads who are forced off them by higher prices or those who have to keep on using them, at an increased cost.

The empirical studies conducted about the welfare effects of road pricing yield mixed results. In Norway the introduction of toll roads has been an overwhelming success. Economic Affairs (1990:11) argues that road pricing has a favourable impact on industry. In addition the Institute for Public Policy Research argues that the effects of tolls on low-income groups are a favourable infrastructure improvement and better management of traffic. Proponents of road pricing argue that toll roads yield some benefits to road users in the form of savings in time and raised revenues to road administrators (Harrington, 2001:87). In an interview conducted among London residents, Scott and Jones (1993) find that road pricing is likely to be accepted if the system is simple, enforcement is guaranteed and revenues are used in a transparent manner. In another study, Luk and Hepburn (1995:80) report that congestion is socially acceptable if revenues raised are used for the expansion of road infrastructure. The paper further identifies high-income earners as beneficiaries of road pricing. Ison (2000:269) also conducted a study in London to understand the attitudes of car users towards road pricing. More than half view it as unacceptable but when revealed to what use these revenues was to be put, more than 62percent viewed it as acceptable. Although road pricing appears to be socially acceptable, Fielding (1994:20) identifies some pitfalls to road pricing. They argue that the technology of road pricing is not reliable and the system of road pricing is an invasion to privacy.

Road pricing harms the poor and problems of road pricing create boundary problems. Grieco and Jones (1994:520) further state that the system makes the working poor, low income the losers and high-income earners the winners. Opponents of road pricing argue that toll roads lead to an increase in the cost of production, which will ultimately be shifted to the consumers in the form of higher prices. Furthermore they argue that road pricing impact on consumers in the form of higher fares. This condition can only be socially acceptable if it leads to a cut in road taxes, (Vogel, 1996:16).

Hoom *et al.* (1999: 394) in a study of the Netherlands toll plazas found that the public rejected those toll plazas on the grounds that they require more land space and create traffic diversion. Metcalfe (1998: 2) uses the case of Latin America to present his view. There, tolls were established to maintain the Columbia mountain road system; one of the most congested and poorly maintained roads. He finds that the system failed because investors found it risky and demand was difficult to estimate. As a result, traffic fell short of projections. Button and Verhoef (1998:40), in their study find that the imposition of a toll reduces traffic by diverting it to an untolled road. The untolled road, which is often inferior in quality, is ultimately congested. They further point out that profit maximising agencies charge tolls higher than optimal to the detriment of untolled roads. Moreover, the gap between what the traveller pays and marginal social cost is not reduced. Fielding (1994: 24) finds that the imposition of tolls causes people to shift their mode of transport to commuting if public transport is subsidised. He finds that tolls are socially unacceptable because people are not prepared to pay for what was previously provided free of charge.

Johansson and Matsson (1995:254), Golob (2001:495) and Mclarty (1991:16) find the results of road pricing mixed. Johansson and Matsson (1995:254) find that in the first year of the imposition of tolls the results are negative but in the long run it becomes positive. Furthermore, they find that private car owners are the ones reacting quicker to tolls than business. In addition, they argue that for a toll to be socially acceptable it must address the following: Scheme objectives, fairness, privacy, reliability, simplicity and the correct use of raised revenues. Goodwin (1990: 7) adds by stating that tolls are sometimes not accepted as a

result of lobby groups with different objectives and therefore for tolls to be socially acceptable, the public must reach agreement on the objectives.

In South Africa, Leiman (2003:257) argues that if not all roads are tolled, tolling will create distortions. Further to that, it depends on whether the tolled road is a complement or a substitute; if it is a substitute it will create distortions. Leiman further argues that tolling will create distortions just like when rail is privatised.

In conclusion, it can be stated that distortions exist in all markets and the introduction of tolls will not clear the market, but it will create further distortions. However, tolls are here to stay because they are the best form of user charging in the road sector. There are some principles, which must be adhered to, in order for the public to support tolls. The objectives of the scheme must meet public concern and needs. It must demonstrate that there are no effective alternative solutions. Revenues received should be temporarily applied and alternatives provided to those that are not able to afford the toll charges. The scheme should be kept as simple as possible and technological issues should be carefully monitored. Lastly, issues of equity also need to be addressed.

2.10. SUMMARY.

The exposition so far indicates that winners from tolls are mainly those who value their time and it is mainly high-income earners. Low-income earners benefit from tolls under certain circumstances such as when public transport is subsidised.

The study further reveals that society benefit in the form of improvements in infrastructure. Those who lose from the implementation of tolls are mainly those who are moved from the tolled road because they have to pay tolls that they cannot afford and those who use alternative roads, which are congested as a result of the introduction of tolls. Empirical investigations conducted worldwide produce mixed results. Some were negative, some were neutral and some were positive. Further, the empirical studies reveal that those who are moved off the tolled road are mainly private car owners. Business travellers seem to mostly

remain on the toll roads. Empirical results further reveal that in the first few years after implementation of the toll road, society reacts negatively towards it but after some years the public's attitude becomes positive towards it. The reason for this is that the public finds it difficult to pay for something that was initially provided for free. Once they got used to the benefit of toll roads and used to paying for the use of these roads, attitude seems to improve and so the use increases too.

The chapter further explains some concepts and their relation to the study such as welfare analysis and marginal cost pricing, public private provisioning of public goods and the different kinds of user charges.

The study aims to conduct an EIA and as a result of this a brief explanation of EIA was made. It is revealed that the importance of EIA is that:

- It realises that resources are scarce.
- It assists decision makers to give priority to the most profitable project.
- It enables decisions to be ranked.
- It enables the decision makers to use resources optimally.
- It disciplines the decision making process by informing authorities about the costs and benefits of the project.

On the basis of the findings of studies reviewed, the impact of tolls on behaviour produce mixed results. In order to fully understand the impact of tolls it is necessary to also assess the impact of tolls on alternative roads. This is because tolls may appear to offer more benefits than costs but increased costs of travelling may cause diversion of traffic, which becomes a hazard to alternative roads and the users of these alternative roads. This study focuses on the costs and benefits to society along alternative routes after the introduction of tollgates on the N1 freeway. The next chapter provides an overview of toll roads along the N1 freeway.

CHAPTER 3
LITERATURE AND SURVEY RESULTS OF THE STUDY AREA

3.1. INTRODUCTION

The previous chapter provided a theoretical overview of road pricing. It discussed road pricing within the context of welfare and public sector economics.

This chapter presents the results of the survey used to assess the relationship between traffic diversion and changes in welfare on alternative roads. The results presented in this chapter are based on the responses from the questionnaire (Appendix C) issued to users of the R101 road. This chapter ends by presenting the main findings of the survey. First however, a brief overview is provided in Section I, of background information gathered during earlier studies conducted around the area of study. The purpose of including the findings of the impact assessment that was completed during the early stages of the toll road is that now provides for a comparative analysis.

Section II focuses more on the non-monetary or intangible benefits and costs of the introduction of the toll road on alternative road users. Chapter 4 deals with a special application of the RED model to complete a CBA of the study area and only deals with those costs and benefits that can be calculated, i.e. the so-called monetary or measurable costs and benefits.

SECTION I

3.2. OVERVIEW OF TOLLGATES ON THE N1 ROAD

The Spatial Development Initiative (SDI) is a programme in South Africa, which was brought to life by the National Department of Transport and Department of Trade and Industry to develop and improve trade between South Africa and its neighbouring countries.

Initially, the focus of the SDI programme was on an industrial development strategy and pursuance of the following main thrusts:

- A move from import substitution to export promotion and international competitiveness.
- A move from demand side incentives to supply side measures.
- A move from sanctions and regional antagonism to preferential trade and regional economic integration.
- A move from a small racial ownership base with large conglomerates to a greater spread of ownership representation and ownership, (Gauteng-NorthWest SDI, 1998: 7)

SDI is conceived as a catalyst for economic growth and social development. Moreover, it is believed that SDI would offer the following advantages:

- Providing greater access to maintain economic and urban facilities for the rapidly urbanising population.
- Improved transport access within the SADC region will contribute to increased trade within the region and landlocked countries would have access to the global market.
- Establishing a combination of private - public sector financing that would leverage capital.
- Creating an integrated infrastructure network.
- Stimulating economic growth and development.

These goals and advantages require a developed road network to provide a link for South Africa with its neighbouring countries. South Africa has developed one of the finest road network systems in Africa to carry out the above goals. The National Road Agency (NRA) is responsible for the supply, maintenance and development of road infrastructure in South Africa on behalf of the government. NRA uses taxes from the Fiscal Authorities such as fuel tax to finance road networks. Resources are scarce and as a result NRA finds it increasingly difficult to finance the upgrading, maintenance and construction of South African road infrastructure. Moreover, the government needs funds to finance other projects, which are

of greater priority. It became inevitable for NRA to adopt a user-pay principle for the construction, maintenance and upgrading of roads. The user-pay principle means that those who receive direct benefit from the road have to pay for the road. NRA appointed Bakwena Platinum Consortium Concessionaires (BPCC) to build, operate and maintain some of these road networks. BPCC was appointed through a tendering process to maintain, build and operate the N1 road from Warmbaths (Limpopo province) *via* Pretoria (Gauteng) to Skilpadhek (North-West province) on the South Africa-Botswana border on a built-operate-transfer (BOT) lease for a period of 30 years. After the period has elapsed, BPCC will hand the road back to NRA in an acceptable condition. As mentioned before, BPCC is a private sector consortium, which is composed of Concor Holdings, Grupo Dragados, Murray and Roberts, Wilson Bayly, Holmes - Ovcon, Tolcon (Pty) Ltd, Keeve Steyn, Steward Scott, Real Africa Holding and Royal Bafokeng (BPCC, 2000: 4).

BPCC is to operate the highway on a user-pay principle whereby users pay for the use of sections of the road. This is accomplished by means of tolling the road. Tolling is a strategy to safeguard the national road infrastructure and to provide a high standard road network. A high standard road network is said to offer the following advantages:

- Promotion of economic activity.
- Enhancement of local and national mobility for the transportation of goods and people.
- Improvement of trade and foreign earnings.
- Promotion and support of infrastructure development.
- Creation of employment opportunities.
- Improved road safety, and
- Reduced vehicle maintenance costs for road users (BPCC, 2000: 4).

BPCC, in their agreement with NRA, subscribes to the following broad socio-economic objectives:

- Creating sustainable employment.

- Facilitating the upgrading of the social and physical environment.
- Enabling and empowering people, communities and business through training, capacity building and opportunities arising from the project.
- Establishing a quality and productive workforce.
- Stimulating economic growth and reducing imbalances in access to opportunities.
- Alleviating poverty.
- Correcting historically distorted social and economic patterns.
- Promoting sustainable integrated development (BPCC, 2000:15-2).

This study focuses only on tollgates on a portion of the platinum highway i.e. a section of the road between the Carousel and Pumulani plazas. The study is an EIA and it appraises the impact of the diversion of traffic from these tolls to alternative roads. NRA states in Highway News (2003: 3) that the benefits of toll roads are to ensure a high quality road network, contribute to improved road safety, reduce travelling distance and thus bring about a substantial saving in vehicle operating costs.

3.3. REVIEW OF PREVIOUS STUDIES IN THE AREA

In a socio-economic impact assessment study conducted along the platinum highway, before the establishment of the tollgates, BPCC reports the following findings:

- ❖ It is expected that the platinum highway will contribute R 2.2 billion to gross geographical product (GGP).
- ❖ It is expected that about 14 000 job opportunities will be created.
- ❖ The platinum highway will contribute about R731 billion to the fiscus.
- ❖ It is expected that the project will provide a net present value of R7.6 billion, internal rate of return (IRR) of 34.2 percent and a benefit-cost ratio of 5.4.
- ❖ It is expected that 61percent of the growth in GGP would go to the regional economy.

The analysis will later compare these findings with the results of the survey.

3.3.1. TRAVEL AND TRAFFIC

All classes of vehicles use the N1 road between the Pumulani and Carousel plazas. Both private and public transport users mainly for the purpose of work, shopping, education and leisure, etc., use it. It is reported that on average more than 7 000 vehicles use the road daily. Assessment studies reveal that after the introduction of tolls along this road, there was no significant difference in behaviour by light vehicle users. Only about 30percent of traffic was diverted from the road. Heavy vehicles form the majority of users of the road and studies reveal that there was a marked change in behaviour from heavy vehicles with about 40-50percent of heavy vehicles having been diverted from the road. Mitigation measures propose that heavy vehicles be charged lower fares at the mainline plazas and higher fares at off ramps to keep them on the N1 road.

Toll fares' impact on public transport users are in the form of increased travelling fares. Public transports, which use the road, are mainly busses and taxis. It was expected that tolls would lead to a reduction in service or an increase in the cost of public transport. Studies reveal that there is a diversion of traffic because some of the taxis and busses use the alternative roads such as the R101 road and alternative streets in Pretoria. Mitigation measures propose that discounts be offered to those who qualify on the basis of ability to pay such as the disadvantaged, pensioners and those who shop at selected shopping complexes. It was expected that the tolls would impact negatively on the volume of traffic. However, earlier studies in Europe reveal that there can be a reduction in traffic volume in the short-term but traffic volume is expected to increase in the long term because of a need for improved services.

3.3.2. LOCAL BUSINESS

Businesses situated along the N1 road such as garages, are concerned that the toll road will affect their business negatively because of the diversion of traffic and toll fares that make the businesses less attractive to shoppers. There were some attitude formations because of the expected loss of sales. Mitigation measures propose that a discount be offered to shoppers at

those affected areas. This discount will be claimed back by shop owners from the consortium. Shop owners along the R101 road and some residents of Hammanskraal view the diversion of traffic as a business opportunity and they believe that it will impact positively on their business, as it will attract shoppers.

3.3.3. RESIDENTIAL PROPERTY

There are some residential properties situated near Hammanskraal and Pumulani toll plazas and in the streets where traffic has been diverted. It is believed that there is a decrease in the value of those residential properties because of factors such as noise, light, air pollution and intrusion of privacy. Properties located in close proximity to tolls such as the informal settlement in Hammanskraal will be affected negatively. Mitigation measures propose rezoning and rate reductions.

3.3.4. TOURISM

The N1 road passes near most of the tourist locations such as game reserves. The road provides safe and convenient access to those tourist sites. A possible negative impact of the increase in transport fares on tourism as a result of toll fees is expected. Mitigation measures propose the development of tourism information, marketing and branding of tourism attractions and products and the development of tourism related SMME opportunities, which is likely to counter the negative impact of increased transport costs.

3.3.5. POLLUTION

There is a concern that tolls will increase pollution in areas near toll plazas and along the streets where traffic is diverted.

3.3.5.1. Noise

There is an increased amount of noise at toll plazas and at residential areas around the plazas. However, there are no major impacts because along most of the road there are no residential properties.

3.3.5.2. Air

Increased emissions at toll plazas and at congested streets and roads on the alternative routes had been observed.

3.3.5.3. Light

There is no significant amount of light pollution except along the streets where traffic has been diverted.

3.3.6. SAVING IN TIME AND MONEY

No major congestion at the Hammanskraal and Pumulani Plazas and as a result of the diverted traffic, time saving on the N1 freeway may be assumed. Electronic tolling such as the e-tag is more convenient and leads to saving in time even though it comes at an additional cost.

3.3.7. ACCIDENT COSTS

Accident costs are divided in to fatality, injuries and material damage. There is no major difference because of low congestion at the tolls. The possible hazards are driving at high speed at off ramps and the possibility of fewer accidents on the toll road has to be weighted against more on alternative roads. The introduction of rumble strips and warning signs alleviate the problem. BPCC has undertaken to identify high accident spots and to introduce control measures to channel pedestrians to appropriate crossing points.

3.3.8. VEHICLE OPERATING COSTS

Taking into account the condition of the road before and after the imposition of the tolls, there is no major difference in vehicle operating costs. There is only savings in operating costs for heavy vehicles. The introduction of the e-tag will lead to a decrease in stoppage time and toll plazas and this may lead to a decrease in vehicle operating costs associated with stoppage at toll plazas.

3.3.9. CAPITAL INVESTMENT COSTS

Capital investment costs come to about ten million rand for the construction of the tollgate along the freeway. A quarter of that amount is allocated to the portion of the road between Pretoria and Hammanskraal.

3.3.10. ROAD MAINTENANCE COSTS

Road maintenance costs are estimated at around four million rand per annum on the N1 freeway. This is said to lead to a reduction in maintenance costs for motor vehicles travelling on the toll road and an increase in vehicle maintenance costs on alternative roads.

3.3.11. LOCAL AUTHORITIES

The diversion of traffic to alternative roads such as the R101 puts increasing pressure on local road networks, which have to be maintained by local authorities. Toll plazas require more land. However, there are prospects of job opportunities being created for local people. New business opportunities created could boost the regional economy.

3.3.12. INDIVIDUALS

Tolls have brought an increased financial burden and inconvenienced communities residing around Hammanskraal. This is in the form of increased public transport costs and in addition to that communities have to cross the road, which is often unsafe and also a hazard

to their animals. It is reported that tolls are an inconvenience to people because traffic diversion leads to congested local road networks. Further, traffic diversion leads to increased highjacking and accidents. Alleviation measures include the construction of fencing around the affected area to ensure that there are no animals crossing the road. Pedestrian crossings also are to be addressed by the erection of pedestrian bridges, underpasses, traffic controls and reduced speed limits and lighting.

One may probably wonder at this point whether the costs associated with the compensating measures taken to alleviate the problems experienced along the alternative roads do not exceed the gains from the privatisation of the road maintenance along the N1 freeway. The study intends to measure these effects on the alternative roads to see whether traffic diversion has a negative effect in terms of the factors mentioned above.

SECTION II

3.4. DESCRIPTIVE STATISTICS

This Section presents the analysis using descriptive statistics. Tables and figures are widely applied in the section to illustrate the responses from respondents in the survey.

3.4.1. TRAVELLING MOTIVE

The respondents were required to provide their motives of travelling in questions 1, 2 and 3. In question 1 the respondents were asked how often they use the road. The results are presented in Table 3.1 below.

Table 3.1 Frequency of road use

FREQUENCY OF ROAD USE	OLD USERS	DIVERTED USERS
	Percentage (%)	Percentage (%)
Every day	45	35
Three times a week	20	30
Once a week	15	20
Once a month	20	15
No response	0	0
Total	100	100

Source: Survey

As indicated in Table 3.1, 45 percent of old users and 35 percent of diverted users of the road use the road every day. 20 percent of old users and 30 percent of diverted users of the road use the road three times a week. 15 percent of old users and 20 percent of diverted users use the road once a week and 20 percent of old users and 15 percent of diverted users use the road once a month. It is clear from the table that the daily users of the road form the largest group of road users.

In question 2 the respondents were required to provide the reason for their travel along the alternative road. The results are presented in Table 3.2 below.

Table 3.2. The purpose of travelling along the road.

PURPOSE OF TRAVELLING	OLD USERS	DIVERTED USERS
	Percentage (%)	Percentage (%)
Business	20	23
Private	25	46
Work	55	31
No response	0	0
Total	100	100

Source: Survey

As reflected in Table 3.2, 20 percent of old users and 23 percent of diverted users use the road for business purposes while 25 percent of old users and 46 percent of diverted users use the road for private purposes. 55 percent of old users and 31 percent of diverted users use the road for work.

In question 2 the respondents were required to state the reason for using the alternative road instead of the toll road. The results are presented in Table 3.3 below.

Table 3.3 Reasons for using the road

REASONS FOR USING THE ROAD	OLD USERS	DIVERTED USERS
	Percentage (%)	Percentage (%)
Shortest to destination	50	24
Cannot afford toll fees	45	72
Others	5	4
No response	0	0
Total	100	100

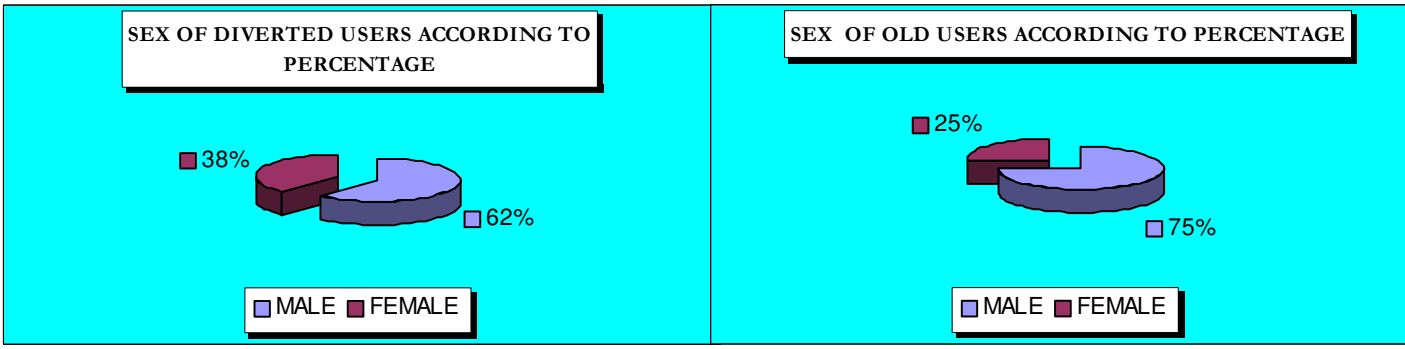
Source: Survey

50 percent of old users of the road and only 24 percent of diverted users of the road because it is the shortest route to their destination. 72 percent of diverted users and 45 percent of old users claim that they cannot afford the toll fees. Only five percent of old users and 4 percent of diverted users indicated other reasons, such as doing industrial work at Babelegi. It was clear from the survey that an overwhelming majority 72 percent of diverted users of the road would prefer to use the toll road but cannot afford fees. Although 50 percent of old users of the road use the road because it is a shortest route to their destination, a fairly large percentage (45 percent) would prefer to use the toll road but cannot afford toll fees.

3.4.2. DEMOGRAPHIC FACTORS

Demographic questions intended to obtain and compare the demographic features of diverted users of the road and old users of the road. Question 16 and 19 of the two questionnaires was intended to obtain the sex status of the respondents. The results are presented in Figure 3.1 below.

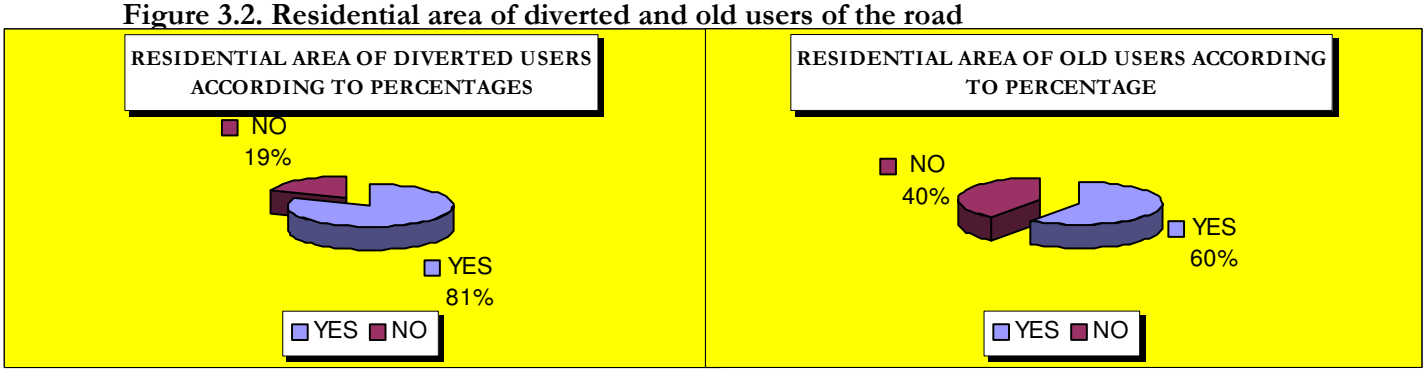
Figure 3.1. Sex status of diverted and old users of the alternative road.



As revealed in Figure 3.1, a very high percentage of the respondents were males with 62 percent of diverted users and 75 percent of old users being male. Only 38 percent of diverted users and 25 percent of old users were females. In both groups of users of the road there were more males than females. The difference is more obvious among old users of the road.

Question 17 and 20 of the questionnaires required respondents to answer YES or NO to the question "are you residing around the area Pretoria or Hammanskraal? The results are presented in Figure 3.2 below.

Figure 3.2. Residential area of diverted and old users of the road



Source: Survey

As indicated in Figure 4.2, 81 percent of diverted users and 60 percent of old users responded with YES, while only 19 percent of diverted users and 40 percent of old users responded with NO.

Questions 18 and 21 of the questionnaire were used to obtain vehicle class of the users of the road. Results are presented in Table 3.4 below.

Table 3.4. Vehicle class of old and diverted users of the road.

CLASS OF VEHICLE	OLD USERS	DIVERTED USERS
	Percentage (%)	Percentage (%)
Light	25	38
Medium	20	29
Heavy	20	14
Extra heavy	15	19
Non response	20	0
Total	100	100

Source: Survey

As far as classes of vehicles are concerned the survey revealed that 25 percent of old users and 38 percent of diverted users use light vehicles. 20 percent of old users and 29 percent of diverted users use medium size vehicles, while 20 percent of old users and 14 percent of diverted users use heavy vehicles and 15 percent of old users and 19 percent of diverted users use extra heavy vehicles. There was a non-response of 20 percent from old users of the road. It was expected that the greatest percentage of diverted users would be heavy and extra heavy vehicles. The results appear to be not in line with the expectation with only 33 percent of the users diverted to alternative roads.

Question 19 and 22 of the questionnaires required the respondents to state their income level. The results are presented in Table 3.5 below.

Table 3.5. Level of income of old users and diverted users of the road.

LEVEL OF INCOME	OLD USERS	DIVERTED USERS
	Percentage (%)	Percentage (%)
Less than 5 000	55	60
5 000 – 10 000	25	10
10 000 – 15 000	3	4
15 000 – 20 000	2	1
Greater than 20 000	0	0
Non response	15	20
Total	100	100

Source: Survey

As far as the level of income is concerned, there was a high non-response rate. It appears that the majority of those who did respond earns below R5 000 per month (55 percent old and 60 percent of diverted users). 25 percent of old and 10 percent of diverted users earn between R5 000 and R10 000 per month. Only 3 percent of old users and 4 percent of diverted users earn between R10 000 and R15 000 per month and two percent of old and one percent of diverted users earns between R15 000 and R20 000 per month.

Questions 20 and 23 of the questionnaires were intended to obtain the level of education of the respondents. The results are presented in Table 3.6.

Table 3.6. The level of education of the old and diverted users of the road.

LEVEL OF EDUCATION	OLD USERS	DIVERTED USERS
	Percentage (%)	Percentage (%)
No Education	0	0
Primary Education	20	24
Secondary Education	35	57
Tertiary Education	25	24
Non Response	25	0
Total	100	100

Source: Survey

As reflected in Table 3.6, most of the respondents had a fair level of education. An overwhelming majority of 77 percent of diverted and 60 percent of old users have completed some high school education, and there was no respondent without education. 20 percent of old and 24 percent of diverted users of the road have primary school education. There was a non-response rate of 25 percent.

3.4.3. IMPACT ON WELFARE

In question 4 respondents were required to rate the impact of tolls on their welfare on a 7 point scale ranging between Very negative impact and Very positive impact. Table 3.7 shows the comparison in response between the old users and diverted users.

Table 3.7: Impact on welfare

IMPACT ON WELFARE	OLD USERS	DIVERTED USERS
	Percentage (%)	Percentage (%)
Very Negative	20	25

Moderate Negative	0	5
Some Negative	28	25
Neutral	28	15
Some Positive	24	10
Moderate Positive	0	5
Very Positive	0	5
No response	0	10
Total	100	100

Source: Survey

As reflected in Table 3.7, a high percentage of approximately 55 percent of diverted and 48 percent of old users have a feeling that tolls impact negatively on welfare along the alternative roads. Of the respondents who indicated that tolls impact negatively on alternative roads, 20 percent of old and 25 percent of diverted users indicated that tolls impact very negatively on alternative roads. Only 24 percent of old and 30 percent of diverted users feel that tolls have some positive impact along the alternative road. 28 percent of old and 15 percent of diverted users were neutral. There was a non-response of 10 percent from diverted users of the road.

3.4.4. IMPACT ON SATISFACTION

Respondents were asked in question 5 "Overall how satisfied are you with the use of the R101 road before the introduction of toll gates on the N1 road" The results are presented in Table 3.8 below.

Table 3.8: Impact on satisfaction before and after the introduction of tolls.

Impact on satisfaction	Diverted Users %		Old Users %	
	Before	After	Before	After
Extremely Satisfied	12	0	10	10
Moderate Satisfied	16	8	20	10
Slightly Satisfied	24	14	30	10

Neutral	**32**	**31**	**15**	**25**
Slightly Dissatisfied	**10**	**27**	**15**	**15**
Moderate Dissatisfied	**6**	**12**	**15**	**15**
Extremely Dissatisfied	**6**	**8**	**5**	**10**
Non Response	**4**	**0**	**5**	**5**
Total	**100**	**100**	**100**	**100**

Source: Survey

As reflected in Table 3.8, the majority of respondents (52 percent of diverted and 60 percent of old users) indicated that they were satisfied with the alternative road before the introduction of tolls. Only 22 percent of diverted and 35 percent of old users were dissatisfied with the road before the introduction of tolls. 32 percent of the diverted and 15 percent of old users were neutral, and there was a non-response of four percent of diverted and five percent of old users of the road.

Respondents were again asked in question 6 "overall, how satisfied are you with the use of the road after the introduction of tollgates on the N1 road". The results are presented in Table3.8 above. As revealed in Table 3.8, 47 percent of diverted and 40 percent of old users are dissatisfied with the alternative road after the introduction of tolls on the N1 freeway. Only 22 percent of diverted and 30 percent of old users were satisfied with the alternative road after the introduction of tolls along the N1 freeway. 31 percent of diverted and 25 percent of old users were neutral, and there was a non-response of five percent from old users. The expectation was that there would be a high level of dissatisfaction about the prevailing conditions on the alternative road. However, the results seem to suggest a high level of tolerance to the prevailing conditions on the alternative road with only 10 percent of old and 8 percent of diverted users being extremely dissatisfied with the current situation on the alternative road.

3.4.5. BENEFITS AND COSTS OF USING THE ALTERNATIVE ROAD

Question 7 and 8 were open-ended questions intended to obtain the costs and benefits of using the alternative road. Question 7 required the respondents to state the costs of using the alternative road as compared to the toll road and the results are presented in Table 3.9.

Table 3.9. Costs of using the alternative road

Costs	Diverted Users %	Costs	Old Users %
High Congestion	48	Congestion and Pollution	33
Accidents	15	Busy and Time Consuming	25
Pot Holes & Speed limits	15	Hijacking	17
Vehicle Operating Costs	12	Accidents	10
Nothing to say	10	Nothing to say	5
Total	100	Total	100

Source: Survey

As reflected in Table 3.9, from the responses of diverted users of the road high congestion as a result of heavy vehicles moving slowly made top of the list with 48 percent of the respondents mentioning it. The fact that there are accidents occurring on the road also received wide support of 15 percent and the other 15 percent stated that there are potholes and speed limits along the road. 12 percent stated vehicle operating costs and 10 percent of the respondents have nothing to say.

As revealed in Table 3.9, from the responses of old users of the road congestion now coupled with pollution again made to the top of the list with 33 percent of the respondents mentioning it. The fact that the road is always busy and time consuming was mentioned by 25 percent of the respondents. Increased levels of hijacking were mentioned by 17 percent of the respondents. Increased levels of accidents especially during bad weather were again mentioned by 10 percent of the respondents. Five percent of the respondents have nothing to say. The results of the survey were in line with the expectations of the study because approximately 48 percent of the respondents indicated the level of congestion along the road as the main weak point. In addition to that the fact that there is an increased time spent

travelling along the road was also mentioned as the main cost by 25 percent of the respondents.

Respondents were required in question 8 to provide the benefits of using the alternative road instead of using the toll road. The results are presented in Table 3.10 below.

Table 3.10 Benefits of using the alternative road

DIVERTED USERS		OLD USERS	
BENEFITS	**PERCENTAGE %**	**BENEFITS**	**PERCENTAGE %**
Short cut to destination	55	Short cut to destination	43
Less expensive	25	Less expensive	37
User Friendly	15	User Friendly	13
Nothing to say	5	Nothing to say	7
Total	100	Total	100

Source: Survey

As reflected in Table 3.10, the fact that the road is a shortest route to destination made top of the list with 55 percent of diverted users and 43 percent of old users of the road mentioning it. The fact that the road is less expensive also received a wide support as a strong point with 25 percent of diverted and 37 percent of old users mentioning it. The reason that the road is user friendly especially during off peak periods was also appreciated by 15 percent of diverted and 13 percent of old users of the road. Only five percent of diverted and seven percent of old users of the road had nothing to say. The expectation of the survey was that the respondents would mention the reason that the road is less expensive as a strong point. The results of the survey appear to be in line with the expectations because approximately 31 percent of the respondents supported the fact that the road is less expensive as a strong positive point.

3.4.6. IMPACT ON THE QUALITY OF LIFE

In question 9 of the questionnaire respondents were asked to rate the impact of tolls on certain factors mentioned below on a seven-point scale ranging from extremely good to extremely bad. The results are presented in Table 3.11.

Table 3.11: Impact on quality of life

DIVERTED USERS				OLD USERS			
	COMFORT & CONVENIENCE %	SAFETY %	FRUSTRATION %	COMFORT & CONVENIENCE %	SAFETY %	FRUSTRATION %	CONGESTION %
EXTREMELY GOOD	4	6	4	10	10	10	0
GOOD	12	4	4	15	10	20	4
SLIGHTLY GOOD	19	10	8	5	10	10	16
NEUTRAL	27	47	56	20	20	10	26
SLIGHTLY BAD	23	25	20	35	25	30	36
BAD	12	8	8	5	15	5	18
EXTREMELY BAD	4	0	0	5	5	10	0
NON RESPONSE	0	0	0	5	5	5	0
TOTAL	100	100	100	100	100	100	100

Source: Survey

Question 9.1 required respondents to rate the impact of diverted traffic on comfort and convenience travelling along the road. 35 percent of diverted and 30 percent of old users rated the impact as good. 39 percent of diverted and 45 percent of old users rated it as bad. 27 percent of diverted and 20 percent of old users were neutral with a non-response of five percent.

Question 9.2 required respondents to rate the impact of diverted traffic on the safety of the alternative road. As reflected in Table3.11, the fact that traffic diverted from tolls has a bad impact on safety of the road was supported by 33 percent of diverted and 45 percent of old users as a strong point. 20 percent of diverted and 30 percent of old users indicated that tolls have a good impact on the safety of the alternative road. 47 percent of diverted and 20 percent of old users were neutral and five percent did not respond to this question.

Question 9.3 required respondents to rate the impact of diverted traffic on frustration when travelling along the alternative road. 28 percent of diverted and 50 percent of old users rated the traffic diverted as having a bad impact on the alternative road. 16 percent of diverted and 40 percent of old users indicated that traffic diverted from tolls has a good impact. 56 percent of diverted and 10 percent of old users were neutral and five percent did not respond to this question. The fact that traffic diverted from tolls has a bad impact on congestion on alternative roads was supported by 54 percent. Only 20 percent indicated the impact as good. 26 percent of the respondents were neutral.

3.4.7. IMPACT ON TRAVELLING COSTS.

In question 10,12 and 14 of the questionnaire posed to diverted users of the road respondents were required to rate the cost of using the alternative road on a seven point scale ranging from much more increase to much more decrease. The results are presented in Table 3.12 below.

Table 3.12: Impact on travelling costs

IMPACT ON TRAVELLING COSTS	TIME SPENT TRAVELLING %	FUEL COSTS %	MAINTENANCE COSTS %
MUCH MORE INCREASE	14	5	5
MODERATE INCREASE	10	10	11
SLIGHT INCREASE	33	25	26
NO CHANGE	19	25	30
SLIGHT DECREASE	14	25	16
MODERATE DECREASE	5	0	0

MUCH MORE DECREASE	**5**	**0**	**0**
NON RESPONSE	**0**	**10**	**12**
TOTAL	**100**	**100**	**100**

Source: Survey

Question 10 required respondents to state whether there was an increase or decrease in time spent on the road after the diversion of traffic from the toll road. As revealed in Table 4.12, 57 percent of the respondents indicated that time spent travelling on this road has increased and 19 percent indicated that there is no change. Only 24 percent of the respondents stated that there is a decrease.

Question 12 required respondents to state whether there is an increase or decrease in fuel costs when using the alternative road. 40 percent of the respondents stated that there is an increase in fuel costs when using the road after the introduction of tolls. 25 percent of the respondents reported no change and only 25 percent reported that there is a decrease. There was a non-response rate of 10 percent. 42 percent of the respondents felt that traffic diverted from tolls caused an increase in the maintenance costs. 16 percent felt that there was a decrease and 30 percent of the respondents reported no change. There was a non-response of 12 percent. From the results stated above a conclusion can be drawn that traffic diverted from tolls have an impact on alternative roads. The reader is reminded that the responses could be biased as the responses are derived from a subjective judgement of costs and benefits of the sample.

3.4.8. MONETARY VALUE OF THE IMPACT ON TRAVELLING COSTS.

In question 11.13 and 15 of the questionnaire issued to diverted users of the road, respondents were required to state in monetary terms the costs of using the alternative road. In question 11 respondents were asked, "How much are you prepared to spend to save on travelling time". 58 percent of the respondents fall in the range of R0 – R50 per month and 21 percent of the respondents fall in the range of R50 – R150 per month. Although the average was R60 per month, the median is R35.00 per month.

In question 13, respondents were asked how much they are prepared to pay and save on fuel costs by using the toll road. Of those who responded to this question 50 percent falls in the range of R0 – R100 per month while 20 percent falls in the range of R100 –R200 per month. The average was R80 per month and the median is R30 per month.

Question 15 asked the respondents how much they are prepared to pay to use the toll road and save on maintenance costs. Of those who responded to this question 45 percent falls in the range of R0 – R100 per month. 20 percent falls in the range of R100 – R200 per month. The average was R145.50 per month and the median was R100 per month.

3.4.9. IMPACT ON POLLUTION

In questions 10, 11 and 12 respondents were required to rate the impact of diverted traffic on pollution along the road on a seven point scale ranging from much more increase to much more decrease. The results are presented in Table 3.13 below.

Table 3.13: Impact on pollution

IMPACT ON POLLUTION	NOISE %	AIR %	LIGHT %
MUCH MORE INCREASE	15	15	10
MODERATE INCREASE	15	20	5
SLIGHT INCREASE	25	25	10
NO CHANGE	20	25	35
SLIGHT DECREASE	10	0	10
MODERATE DECREASE	10	10	10
MUCH MORE DECREASE	0	0	5
NON RESPONSE	5	5	15
TOTAL	100	100	100

Source: Survey

As revealed in Table 3.13, question 10 required respondents to rate the impact of traffic diverted from toll roads on the level of noise pollution along the alternative road. A very high percentage of 55 percent supported the fact that traffic diverted from tolls caused an increase in pollution and the level of pollution along the alternative road. Only 20 percent reported that tolls caused a decrease in pollution. There was a non-response of five percent and 20 percent of the respondents reported no change.

Question 11 required respondents to rate the impact of traffic diverted from toll roads on air pollution along the alternative road. As reflected in Table 3.13, a high 60 percent felt that traffic diverted from tolls caused an increase in the amount of air pollution along the alternative road. 25 percent of the respondents indicated that there is no change while only 10 percent of the respondents indicated a decrease. There was a non-response of five percent.

Question 12 required respondents to rate the impact of traffic diverted from tolls on light pollution along the alternative roads. As revealed in Table 3.13, mixed results were obtained. 25 percent of the respondents stated that there is an increase in light pollution while another 25 percent stated that there is a decrease in the amount of light pollution along the road. A surprisingly high 35 percent indicated that there is no change in the level of light pollution along the road. 15 percent of the respondents did not respond to this question. The results of the survey were consistent with the expectations that tolls caused an increase in the level of pollution along the alternative road.

3.4.10. IMPACT ON THE LEVEL OF ACCIDENTS AND PROPERTY VALUES.

Question 13 of the questionnaire required respondents to state the impact of traffic diverted from toll roads on the level of accidents along the alternative road. Table 3.14 presents the results.

Table 3.14: Impact on level of accidents and property values

IMPACT ON ACCIDENTS & PROPERTY VALUES	ACCIDENTS	PROPERTY VALUES
MUCH MORE INCREASE	15	5
MODERATE INCREASE	10	5
SLIGHT INCREASE	20	0
NO CHANGE	20	20
SLIGHT DECREASE	15	35
MODERATE DECREASE	10	5
MUCH MORE DECREASE	0	20
NON RESPONSE	10	10
TOTAL	100	100

Source: Survey

As reflected in Table 3.14, the majority of respondents supported the fact that traffic diverted from tolls caused an increase in the level of accidents along the road with 45 percent reporting an increase. 20 percent of the respondents reported no change while 35 percent reported a decrease. There was a non-response of 10 percent.

Question 14 required respondents to rate the impact of traffic diverted from toll roads on property values on a seven point scale ranging from much more increase to much more decrease. As revealed in Table 3.14 a high percentage felt fact that traffic diverted from tolls caused a decrease. About 20 percent reported a "much more decrease" while overall a high percentage of 60 percent reported a decrease. 20 percent of the respondents felt that there is no change in property values and only 10 percent reported an increase in property values. 10 percent of the respondents did not respond to this question. It was expected that traffic diverted to tolls would cause an increase in the level of accidents and a decrease in the value of property along the area. It was clear that the results were in line with the expectations because they revealed an increased level of accidents and a decrease in the value of property.

3.4.11. GOVERNMENT SPENDING ON THE ALTERNATIVE ROAD.

In Question 16 of the questionnaire issued to old users of the road respondents were required to rate the level of government spending on the alternative road after the introduction of tolls on a seven point scale ranging from much more to much less. 35 percent of the respondents supported the fact that the government spend relatively less on the alternative road. 25 percent of the respondents were neutral about this question. 20 percent of the respondents indicated that the government spend more on the road and another 20 percent did not respond to this question.

3.4.12. IMPACT ON SOME ECONOMIC ADVANTAGES

Question 17 of the questionnaire required respondents to rate the impact of traffic diverted from toll roads on some economic advantages mentioned below on a seven-point scale ranging from extremely good to extremely bad. The results are presented in Table 3.15 below.

Table .3.15: Impact on economic advantages

IMPACT ON ECONOMIC ADVANTAGES	PRICES OF GOODS	BUSINESS OPPORTUNITIES	EMPLOYMENT	BETTER ROADS
EXTREMELY GOOD	5	20	20	10
GOOD	30	25	30	10
SLIGHTLY GOOD	30	25	10	5
NEUTRAL	10	10	20	20
SLIGHTLY BAD	10	5	5	35
BAD	5	5	5	20
EXTREMELY BAD	0	0	0	0
NON RESPONSE	10	10	10	10
TOTAL	100	100	100	100

Source: Survey

Concerning the impact of traffic diverted from tolls on the level of prices of goods and services along the road, a high 60 percent supported the fact that traffic diverted from tolls has a good impact on the level of prices of goods and services along the area. Only 15 percent indicated that traffic diverted from tolls have a bad impact on prices of goods and services along the road. 10 percent of the respondents were neutral and another 10 percent of respondents did not respond to this question.

The fact that traffic diverted from tolls has a good impact on business opportunities along the road received an overwhelming support with a very high 70 percent indicating it. Only 10 percent reported that the traffic diverted from tolls have a bad impact on business opportunities and another 10 percent were neutral. 10 percent of the respondents did not respond to this question.

A high 60 percent of the respondents supported the fact that traffic diverted from tolls has a good impact on the level of employment along the R101 road. A heartening 10 percent indicated that traffic diverted from tolls have a bad impact on the level of employment along the road. 20 percent of the respondents were neutral and another 10 percent of the respondents did not respond to this question.

Concerning the impact of traffic diverted from tolls on quality of roads along the area of study, 55 percent of the respondents felt that traffic diverted from tolls have a bad impact on the quality of roads along the area of study. 25 percent indicated that traffic diverted from tolls have a good impact on the quality of roads along the area of study. 20 percent of the respondents were neutral and another 10 percent of the respondents did not respond to this question.

The findings of the study were consistent with the expectations of the study that traffic diverted from tolls have a good impact along the area of study but a bad impact on the quality of roads.

3.4.13. IMPACT ON THE ENVIRONMENT AND SURROUNDINGS AROUND THE STUDY AREA

In question 18 respondents were asked "how they rate the impact of diverted traffic on some environmental factors mentioned below on a seven point scale ranging from extremely good to extremely bad. The results are presented in Table 3.16.

Table 3.16: Impact on environment around area of study

	BEAUTIFICATION OF AREA	TOURISM	ANIMALS	PEDESTRIANS
EXTREMELY GOOD	0	20	0	5
GOOD	0	30	0	5
SLIGHTLY GOOD	10	20	15	5
NEUTRAL	15	10	20	25
SLIGHTLY BAD	35	5	25	30
BAD	20	5	20	15
EXTREMELY BAD	10	0	5	5
NON RESPONSE	10	10	15	10
TOTAL	100	100	100	100

Source: Survey

Concerning the impact of traffic diverted from tolls on the beautification of the area along the road, as reflected in Table 3.16 the fact that traffic diverted from tolls has a good impact on the beautification of an area was supported by 60 percent of respondents. Only 10 percent indicated that traffic diverted from the toll road has a bad impact on the beautification of the area. 15 percent of the respondents were neutral and another 10 percent did not respond to this question.

The fact that traffic diverted from tolls has a good impact on tourism along the area was supported by a surprisingly high 70 percent of the respondents. Only 10 percent indicated

that it have a bad impact. 10 percent of the respondents were neutral and another 10 percent did not respond to this question.

Concerning the impact of traffic diverted from tolls on animals crossing the road, 50 percent felt that it had a bad impact and 15 percent indicated a good impact. 20 percent of the respondents were neutral and another 15 percent of the respondents did not respond to this question.

50 percent of the respondents felt that traffic diverted from tolls has a bad impact on pedestrians crossing the road. 25 percent of the respondents were neutral and 15 percent of the respondents indicated that it have a good impact. There was a non-response of 10 percent.

3.4.14. GENERAL COMMENTS

The last question in both questionnaires i.e. question 21 and 24 were open-ended questions that required respondents to comment on anything that they felt might be left out in the questionnaire. The results are presented in Table 3.17 below.

Table 3.17: General comments

DIVERTED USERS		OLD USERS	
COMMENTS	PERCENTAGE %	COMMENTS	PERCENTAGE %
Tolls must be closed	27	Tolls must be reduced	33
There are many tolls and their importance and purpose is not clear	25	Government must reduce tolls	27
Improve the road conditions on R101	23	High levels of unemployment tolls must be reduced	20
Time loss	15		
other	7	Other	5
Nothing to say	13	Nothing to say	15
Total	100	Total	100

Source: Survey

The fact that toll must be closed was supported by 27 percent of users of the road. The fact that there are many tolls and their importance and purpose is not clear was mentioned by 25 percent. 23 percent of the respondents indicated that the alternative road must be improved. 15 percent indicated that it is a waste of time. 7 percent have other less significant reasons and 13 percent have nothing to say.

Concerning old users of the road, Table 3.17 reveals that "tollgates must be reduced" made top of the list with 33 percent of the respondents selecting this option. The fact that government must reduce toll fees was selected by 27 percent of the respondents. 20 percent of the respondents felt that there is a high level of unemployment and toll fees must be reduced. Only five percent of the respondents had other reasons, which were unusable. 15 percent of the respondents have nothing to say.

Overall, the general comments point out dissatisfaction with traffic diverted from tolls to alternative roads.

3.5. SUMMARY OF THE FINDINGS

The study used descriptive statistics to analyse data and the following are the findings of the study

- The majority of the respondents use the road R101 daily.
- The majority of the respondents were males residing around the area of Pretoria and Hammanskraal.
- Traffic diverted from toll roads has a negative impact on welfare of users of the road R101.
- There is high congestion along the alternative road R101.
- Traffic diverted from the toll road has caused an increase in the level of pollution along the alternative road R101.
- Traffic diverted from the toll road decreased the road conditions along the alternative road.

- There is a significant decrease in the value of property along the alternative road as a result of traffic diversion.
- Traffic diverted from the toll road has a very positive impact on the level of employment and business opportunities along the alternative road.
- Users of the alternative road feel that toll fees should be reduced to bring back diverted traffic to the N1 freeway.
- Traffic diverted from toll roads have caused a slight decrease in the quality of life i.e. safety, comfort and convenience along the alternative road R101.
- There is an increase in the level of accidents along the alternative road R101.
- There is less government spending along the alternative road R101.
- The majority of respondents indicated high levels of pedestrian crossing along the alternative road.
- The majority of respondents indicated that there is an increase in vehicle operating costs along the alternative road R101.
- The majority of respondents indicated that traffic diverted from tolls have a high impact on the beautification of the area.
- The majority of respondents indicated that traffic diverted from tolls have a good impact on the prices of goods and services along the alternative road.

3.6. CONCLUSION

The chapter provided information and results of previous studies conducted along the area of study. The purpose of providing those studies was to provide a comparative analysis.

This chapter used descriptive statistics to analyse data. A computer program excel and SPSS were used to interpret the results. Percentage scores for both old and diverted users of the road indicated a reduction in welfare. The increase in vehicle operating cost and congestion (time) were affirmed, closely followed by the quality of life and environmental damage. The results clearly indicated a positive impact on some economic advantages such as employment and business opportunities. The percentage scores also indicated some dissatisfaction of users about the alternative road as hypothesised.

What is clear from the results of the survey is that users of the alternative road show a slight dissatisfaction with the road after the introduction of tolls. Respondents of the study conducted by the CSIR, (2000) are of a similar opinion. Furthermore the results of the survey indicated a reduction in quality of life and a reduction in road conditions along the alternative road.

The study also found that a decrease in property values and an increase in congestion coupled with an increase in vehicle operating costs and pollution as a result of traffic diverted from the toll road unfairly penalises the users who, having made their household and occupational decisions, have little choice but to continue driving along the alternative road.

CHAPTER 4

SOCIO-ECONOMIC IMPACT ANALYSIS

4.1 INTRODUCTION

The N1 Platinum Toll Route consists of some 100 km of the existing national road between Pretoria and Bela Bela (Warmbaths), running south north. This was one of number of Build Operate Transfer (BOT) Toll Road Concessions that the South African National Roads Agency (SANRAL) had put out to tender on a concession basis. The N1 North project is a good example of participation by the private sector and government. Private funding of R 650 million was used for the construction of the 122 kilometres of road. A state guarantee of stipulated monthly toll revenue to the value of approximately one billion Rand in net present value over 30 years was provided in this contract. The project involved the upgrading of the existing road, construction of toll plazas at various strategic locations, including provision of Electronic Toll Collection (ETC) gates at toll plazas. The Bakwena Platinum Corridor Consortium (BPCC) was appointed by SANRAL as scheme developer, the BPCC subsequently won the bid to implement the project. Bakwena has a contractual obligation to repair, maintain and rehabilitate the N1 toll for the duration of the 30-year concession.

The purpose of this paper is to determine the economic feasibility of N1 North toll road and the R101 and to determine the impact that diverted traffic from the N1 has on the alternative route, i.e. the R101. This analysis will be done by applying cost-benefit analysis (CBA) appraisal techniques and assumptions using the Roads Economic Decision (RED) Model. In the case of the N1 North Toll Road the economic appraisal is done without the effect of the tolling to determine whether the project without tolling is economically feasible. A financial appraisal was not considered as it aims to ascertain the profitability of the roads, which is not at stake here. In a financial feasibility one considers the cost of tolling the route as well as the toll income. Toll fees in general should not exceed 75 percent of the savings realised by the public in using the alternative road. In the economic appraisal the vehicle operating costs (VOC), time costs and accident costs of the users are considered. Road

maintenance cost is also considered. In the economic CBA the resource costs, or shadow prices is used to convert financial costs to economic costs.

4.2 MODEL DEVELOPMENT

The RED model was developed by the World Bank and adapted for South African conditions by the CSIR Transportek. The RED model computes benefits accruing to normal, generated and diverted traffic, as a function of a reduction in vehicle operating and time costs. It also computes safety benefits and model users can add other benefits (or costs) to the analysis, such as those related to non-motorised traffic, social service delivery and environmental impacts. The model is presented in a series of Excel 5.0 workbooks that collect all user inputs, present the results in a user-friendly manner and performs sensitivity, switching values and stochastic risk analysis.

RED adopts the consumer surplus approach, which measures the benefits to road users and consumers of reduced transport costs. This approach was preferred to the producer surplus approach which measures the 'value added' or generated benefits to productive users in the project zone of influence, e.g. agricultural producers, because the consumer surplus approach was judged to allow for a better judgment of the assumptions made and an improved assessment of the investment alternatives simulated. The Highway Design and Maintenance Standards (HDM) models also adopt the consumer surplus approach and can be used for the economic evaluation of low volume roads but are not customised for this purpose and are more demanding in terms of input requirements.

4.3 THEORETICAL CONSIDERATIONS

4.3.1. MODELLING CONSIDERATIONS AND CONCEPT

The basic task is to predict total life cycle costs, viz. construction, maintenance and road user costs as a function of road design, maintenance standards and other policy options. In certain circumstances an even broader definition of societal costs is necessary, e.g. where the costs of air pollution from road use suffered by non-road-users is significant. Such external costs, may if known, be entered into the model through the exogenous benefits and costs

facility. To have a generally applicable tool, one must know the effects of different environments (terrain, climate, traffic, traffic behaviour, economic conditions) on the different cost relationships. To search over many alternative strategies to determine the most economic, there must be a capability for the rapid calculation and comparison of alternative cost streams, which may extend over many years.

The broad concept of the RED model is similar to that used by the Highway Design and Maintenance Standards Model (HDM) and consists of three interacting sets of costs relationships which are added together over time in discounted present values, where costs are determined by first predicting physical quantities of resource consumption which are multiplied by the unit costs or prices:

Construction costs = f1 (terrain, soils, rainfall, geometric design, pavement design, unit costs)

Maintenance costs = f2 (road deterioration (pavement design, climate, time, traffic); maintenance standards; unit costs)

Road user costs = f3 (geometric design; road condition; vehicle speed; vehicle type; unit costs)

Vehicle speed, which is a major determinant of vehicle operating costs, itself is related through a complex set of probabilistic functions to road geometric design, surface condition, vehicle type and driver behaviour.

4.3.2. BENEFITS OF GENERATED TRAFFIC

The benefits of a new facility are estimated by means of a "with and without" comparison. Recurring cost is first projected for a continuation of the existing situation, also called the null alternative. In other words, the analyst assumes that no expenditure will be incurred on improvements other than those related to routine and periodic maintenance.

The potential savings in recurring costs, which may be affected by the introduction of a new facility, can be estimated in two ways:

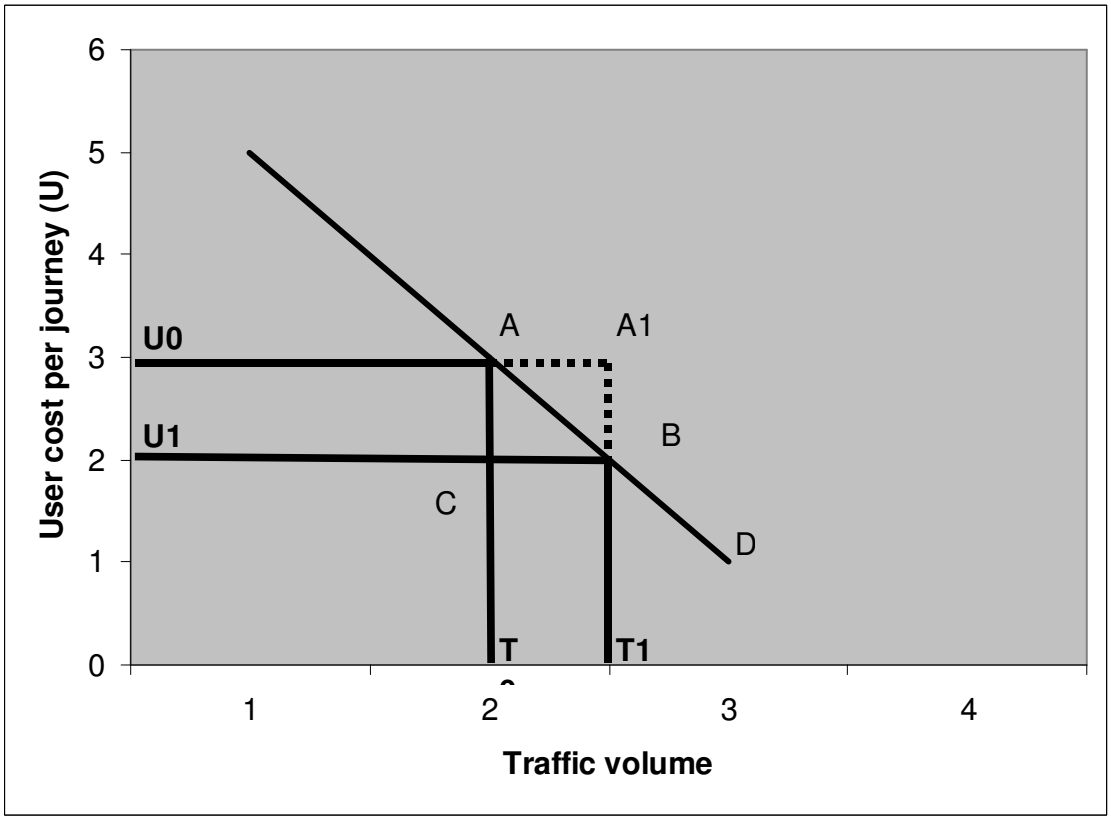
(1) If the proposed project will replace some existing facilities completely, a projection is made of recurring infrastructure and user costs, assuming (a) a continuation of the existing situation, and (b) the introduction of the new facility. Savings in recurring costs are estimated by projected recurring cost.

(2) If the addition of a new facility to an existing transport network is being investigated (in other words, existing routes and transport services are retained), savings in recurring infrastructure and user costs are determined by projecting these costs for a network "with" the additional facility and subtracting the result from the projected cost of the existing network "without" the additional facility. If the answer has a positive sign, a saving in cost is projected; and *vice versa.*

In (1) and (2) above the benefit accruing to generated traffic is not considered. On the assumption that demand for a transport facility is represented by a linear demand schedule, half of the benefit accruing to each existing journey is added to the project benefits for each generated trip. This is based on the additional or extended consumer surplus accruing to existing users (i.e. their saving) and the new consumer surplus created with respect to generate traffic.

The consumer surplus is the difference between the price a consumer or user actually pays for a product (i.e. good or service) and the amount that he would be willing to pay for the product, i.e. the value he attaches to the product. (A user's willingness to pay for the product is reflected by the satisfaction or utility she derives from the product, which is taken to be greater than the price actually paid, i.e. the utility sacrificed to obtain the product). In Figure 1 the willingness of users to make use of a transport facility at different prices is represented by demand curve D. At a generalised user cost per journey (the utility sacrificed plus disutility suffered) of Uo the traffic volume equals To with a resultant consumer surplus represented by area UAUo.

***F*igure 1: Potential user benefits of generated traffic**



Source: World Bank, 2004

The benefits achieved by each individual traffic component are calculated, thus:

- The savings accruing to existing traffic and normal growth in traffic, i.e. that traffic growth which would have taken place anyway (even if the facility was not improved) are imputed by subtracting each component's project user cost between origin and destination with the new facility from what it would have been without the new facility.

- The benefit of traffic diverted from other routes and transport modes are calculated by subtracting the cost of diverted journeys from the cost saving affected from those routes and by those transport modes from which traffic has been diverted.

- The benefit accruing to generated traffic is equal to the consumer surplus created with respect to this traffic component (see Figure 1).

4.3.3. PURPOSE AND NATURE OF COST BENEFIT ANALYSIS

The focus of cost benefit analysis is assessment of the net impact on welfare of society of the specific dynamics generated by a project. The impact of a project is assessed via the identification and quantification of the costs and benefits to society generated by the project and the calculation of the *net present value* (NPV) of project costs and benefits, the *economic rate of return* on the project *(ERR)* and an *economic benefit/cost ratio (B/C Ratio)*.

The output CBA i.e. the NPV, ERR and B/C Ratio is used to either:

- Identify and select projects, which meet *minimum standards of return* to society (i.e. of contribution to welfare), as indicated by a positive NPV, benchmark ERR and B/C Ratio, or to
- Select projects and design programmes, which *maximise return* to society as measured in terms of NPVs, ERRs and B/C Ratios.

The approach encourages a structured, disciplined way of thinking about projects and of investigating their relative merits. The use of CBA as a project selection tool can contribute towards efficient, and, or, optimal allocation of project funding and other scarce project resources from a society welfare point of view.

4.3.4. QUANTIFIED COST AND BENEFIT STREAMS

Cost and benefit streams should be quantified. This embraces valuation in terms appropriate to the criterion for the CBA, and expression in a common monetary denominator. Quantification takes place by:

- *Direct measurement* wherever possible,

- *Estimation* where direct measurement is not possible. Accepted tools and techniques should be used for estimation of project impacts.

Furthermore, where the impact factor is difficult to pin-down or measure and a credible *proxy* can be identified then the proxy for the impact should be measured or estimated.

Assessment of the IRR of a project in order to ensure project selection which optimises use of scarce resources, requires that cost and benefit streams be valued to reflect their true value to society. In CBA the *valuation* of some measurable cost and benefit streams might need to be *simulated or adjusted* using *shadow prices* when:

- Market prices are unavailable,
- Market prices are distorted in the sense that they do not reflect the true value of the impact of the factor.

4.3.5. NON-QUANTIFIED COST AND BENEFIT STREAMS

An inventory of the non-quantified costs and benefits related to the project should be compiled. These should be weighted or, at least ranked according to their relative significance *vis-à-vis* impact on welfare.

4.3.6. CALCULATIONS AND ANALYSIS

The data manipulations and calculations performed in CBA are: discounting of project cost and benefit streams; calculation of project NPV; calculation of the IRR of the project and calculation of discounted B/C ratio on the project. Sensitivity analysis is also conducted on significant potential sources of variance, which could impact on project attractiveness in economic terms.

4.3.7. DISCOUNTING OF COST AND BENEFIT STREAMS AND CALCULATION OF NET PRESENT VALUE

The cost and benefit streams associated with a project typically begin flowing at various times and accrue over different time spans. To enable summation and offsetting of sets of dissimilar cost and benefit streams they need to be first translated into present value terms using the technique of *discounting*. Once the streams have been discounted to present values using a standardised *discount rate*, the present value of the costs and benefit streams are summed and then offset against one another. The result is the *net present value* (NPV) of the costs and benefits of the project. The calculation is expressed in the formula:

$$NPV = \sum b_j / (1+i)^j - \sum c_j / (1+i)^j$$

Where, $b_0,b_1,...,b_n$ are the value of the distribution of the project benefits in years 0,1,2.....n, $c_0,c_1,...,c_n$ are the costs in years 0,1,2....n, respectively, and i the discount rate.

In *cost benefit analysis* the discount rate used is known as the *social discount rate*. This rate could be defined as a weighting factor, which represents the implicit value a community places on advancing accrual of benefits and deferring accrual of costs.

NPV is one of the criteria that can be used in project selection. If projects are to be selected which contribute to welfare, then the NPV must be positive. If projects are to be selected which maximise impact on welfare i.e. maximise net benefit to the community, then those with highest NPV would be chosen.

4.3.8. THE ECONOMIC RATE OF RETURN (ERR)

The net impact of the project as calculated in CBA is also expressed in terms of an internal rate of return (IRR). The IRR in an economic CBA is known as the *economic rate of return* (*ERR*).

The ERR is calculated as the IRR on project impacts (i.e. implied rate of return in terms of project economic benefits relative to project costs). The calculation is expressed in the formula:

$$\sum b_j / (1+r)^j - \sum c_j / (1+r)^j = 0$$

The calculated ERR is used as one of the criteria in project selection. The ERR can be compared to a benchmark ERR, to determine whether or not the project meets minimum acceptable standards of economic return to society. This benchmark rate can be termed the *threshold ERR*. The ERR can also be used as maximisation criterion to assist in selecting the most attractive projects or project alternatives from an impact on welfare point of view, from among options.

4.3.9. THE DISCOUNTED BENEFIT COST RATIO (BCR)

The discounted benefit-cost ratio (BCR) is the ratio of the present value of the benefits relative to the present value of the costs, i.e.:

$$BCR = \{ \sum b_j / (1+i)^j / \sum c_j / (1+i)^j \}$$

To calculate the B/C ratio in project appraisal the present value of benefits is divided by the present value of costs. The B/C Ratio is then used as criteria in project selection in similar fashion to the ERR i.e. relative to a benchmark and as an indicator for maximisation.

4.3.10. SENSITIVITY ANALYSIS – EXPOSING VARIABILITY AND POSSIBLE RISK TO PROJECT ECONOMIC VIABILITY

Sensitivity analysis is a method of analysing uncertainty and aspects of project risk by changing input variables and observing the response of the result to the change. Sensitivity analysis should be conducted in CBA to assist in the identification and assessment of *risks to the economic viability of a project*. The criterion on which the valuation is based (acceptable levels of ERR, NPV and B/C ratio) determines the economic viability of a project.

The method can be employed either on a *variable-by-variable* basis or by changing groups of variables simultaneously, in *multivariable* scenario analysis.

Variable-by-variable Analysis is a simple yet effective means to isolate the effect of a change in one variable on the NPV, IRR and B/C Ratio. There are four steps to employing the variable-by-variable approach in CBA:

- Identify important risk factors in the project setting, which could impact on project cost and benefit streams.
- For each risk factor define a range of possible impacts on individual streams of project costs or benefits. These should be based on realistic scenarios for the project setting.
- Apply impacts to one cost or benefit stream at a time holding all other factors at their expected or most likely values and calculate NPV's, ERR's or B/C Ratio's for each factor variation.
- Examine the pattern in variance in NPV, ERR or B/C Ratios to identify the relative scale of risk posed to project viability by the risk factors.

In *CBA* sensitivity analysis should be focused on potential sources of variance in project costs and economic benefits. Sensitivity analysis should be based on an identification of the major risk factors to project economic viability. Particular attention should be paid in the sensitivity analysis to project cost or benefit streams, which are exposed to risk factors in the project environment.

On the cost side these risk factors could include escalation in the *unit cost* of project inputs (capital, labour, materials and machinery and equipment) and increases in the quantity of inputs used, including, the "quantity" of credit resulting from delays in project completion and consequent commencement of benefit flows. On the benefit side risks to the flow of economic benefits from the project should be identified and simulated to assess their impact on project economic viability.

4.4. ASSUMPTIONS

4.4.1. TERRAIN TYPES

Table 1 provides the following definitions of terrain types, as given in the REDS Software guide.

Table 1: Definitions of terrain types

Terrain type	Gradient (vertical alignment)	Curvature (horizontal alignment)
Flat	0% gradient for 20% of distance 1% gradient for 40% of distance 2% gradient for 40% of distance	Curvature has no effect on vehicle running cost
Tangent and rolling	3,51% gradient for 75% of distance; remaining 75% consists of sag curves and crest curves	Curvature has no effect on vehicle running cost
Flat and winding	See "Flat"	Curve with 800 metre radius for 30% of distance and curve with radius >3 000 metres for remaining 70% of distance
Rolling	See "Tangent and rolling"	See "Flat and winding"
Mountainous	6,5% gradient for 75% of distance; remaining 25 % consists of sag curves and crest curves	Curve with 400 metre radius for 30% of distance and curve with radius >3 000 metres for remaining 70% of distance

Source: CSIR Transportek, 2003

4.4.2. RIDE QUALITY

Ride quality is one of the parameters of road conditions (the others being surface distress and surface texture). Ride quality is an indication of the roughness of the road and therefore it is an important parameter for indicating road condition and maintenance needs and for predicting vehicle operating costs. In the RED model, ride quality is expressed in terms of an IRI (International Roughness Index) and expressed in m/km. Tables 2, 3 and 4 provide guidelines on default values for different scenarios.

In interpreting these values, it is important to bear in mind that, in a South African context (excluding the deep rural areas), values will typically fall in the "Good" and "Fair" columns.

The likelihood that values will fall in the "Poor" and "Bad" columns respectively is "small" and "unlikely".

Table 2: Default values for ride quality: Bituminous roads

Road class	Ride quality (m/km IRI)			
	Good	Fair	Poor	Bad
Primary or Trunk	2	4	6	8
Secondary or Main	3	5	7	9
Tertiary or Local	4	6	8	10

Source: CSIR Transportek, 2003

Table 3: Default values for ride quality: Concrete roads

Road class	Ride quality (m/km IRI)			
	Good	Fair	Poor	Bad
Primary or Trunk	2	4	6	8
Secondary or Main	3	5	7	9
Tertiary or Local	4	6	8	10

Source: CSIR Transportek, 2003

Given the fact that ride quality constitutes a critical input variable in the model, it is strongly recommended that the user should refrain from selecting IRI values based on subjective judgment (even by so-called experts) and rather use values based on actual, scientific measurement of the road to be evaluated.

Table 4: Default values for ride quality: Unsealed roads

Road class	Ride quality (m/km IRI)			
	Good	Fair	Poor	Bad
Primary or Trunk	4	6	8	10
Secondary or Main	6	9	12	15
Tertiary or Local	8	12	16	20

Source: CSIR Transportek, 2003

The estimated cost of collisions are given in Table 6, for four collision severity types, as well as a weighted average value.

Table 5: Collision cost data (March 2003 Rand)

Collision severity	Drivers and passengers	Pedestrians	All
Fatal	817 036	267 781	554 538
Serious injury	175 413	71 625	127 492

Slight injury	45 901	9 185	33 254
Damage only	22 165	1 376	21 828
All	33 927	47 328	34 926

Source: CSIR Transportek, 2003

4.4.3. COST OF TRAVEL TIME

Estimates for the cost of travel time are presented in Table 6 below.

Table 6: Travel time cost data (March 2003 Rand)

Income group	Value of a Work hour	Value per recreational Hour for all persons	Value per recreational Hour for workers
Low income group	6.88	0.29	1.57
Middle income group	24.64	1.82	5.62
High income group	53.51	5.03	12.20
Total population	19.90	1.20	4.54

Source: CSIR Transportek, 2003

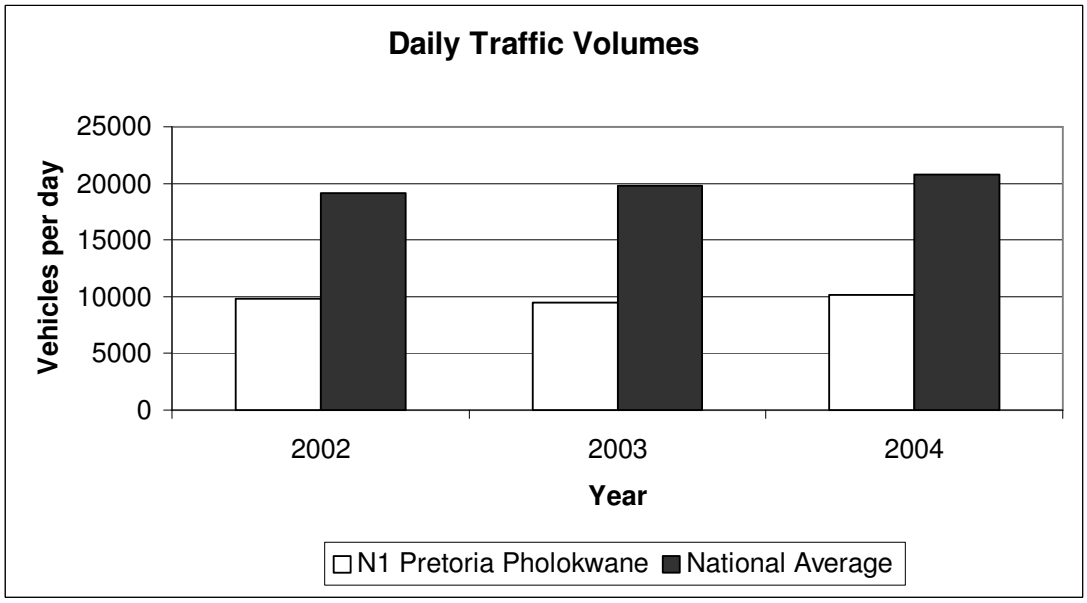
4.4.4. DAILY TRAFFIC AND TRAFFIC GROWTH

According to the Road Traffic and Fatal Crash Statistics held by the National Roads Agency the average daily traffic (ADT) on all national routes increased by 3,14 percent from 19 137 vehicles per day in 2002 to 19 775 per day in 2003. From 2003 to 2004 the increase was 5,15 percent to an average of 20 794 vehicles per day. The ADT on the Pretoria/Polokwane N1 route decreased by average rate of 3,5 percent from 9 839 in 2002 to 9 494 in 2003. From 2003 to 2004 the increase was 6,71 percent to an average of 10 313 vehicles per day. Trend analysis of time series data shows an exponential growth rate of 1,5 percent from 2002 to 2004.

Tables 7 and 8 present a comparison of ADT between the R101 and N1 from 2002 and projected to 2021 based on the assumed growth rates. The RED model assumes a price elasticity of demand for transport of 1.0 for all vehicles, meaning that a one percent decrease in transport costs yields a one percent increase in generated traffic due to reduction in

transport costs. This means that RED will compute internally the generated traffic as a function of the reduction in road user costs in relation to the 'without project' case road user cost.

Figure 2: Daily Traffic Volumes, 2002 - 2004



Source: National Roads Agency, 2004.

Traffic growth rates calculated are based on the exponential regression function that relates the dependant variable, i.e. vehicle numbers to time as an independent variable. Algebraically the function is as follows:

$$Y = a.\ Exp\ (bX)$$

where Y = vehicle numbers
X = time series as independent variable
a = intercept
b = slope of regression function

Regression coefficients are calculated for the period for which data is available. Perhaps the most attractive feature of this function is that the b coefficient can be directly interpreted as the annual growth rate in the independent variable Y.

The average daily toll road traffic as measured by BPCC is presented in Table 9. Vehicle traffic on the N1 between the Pumulani and Carousel Toll Plazas decreased at a rate of –0.71 between 2002 and 2004.

In contrast truck traffic grew at a rate of 3,5 percent over the corresponding period. The composition of traffic shows that trucks comprised on average about 13,2 percent of the total traffic. Trend analysis of vehicle traffic on the R101 shows a significant growth in light vehicle traffic (3,9 percent) compared to a very low growth in truck traffic (0,05 percent) between 2002 and 2005. The relative composition of truck traffic to total traffic has also decreased from 10,9 percent to 9,8 percent. It is assumed that the general increase in traffic on the R101 is caused a possible diversion of traffic from the N1 to the R101. Evidence, however, suggests that this increase could also be caused by an increase in local economic development and urbanisation in the surrounding northern suburbs.

4.4.5. TRAFFIC DIVERSION

It is believed that up to 30 percent of the traffic on the R101 is diverted traffic from the N1, which is caused by the avoidance of toll fees. Bakwena (2005) is of the opinion that there was an initial diversion of traffic when the toll came into operation but that it slowly filtered back after six months. New entrants are using the road and the traffic is growing normally as expected. Truck divers are instructed to stick to the toll road. This is confirmed by aforementioned statistics, which clearly indicated a decrease in ADTT on the R101. For purposes of this cost benefit analysis it therefore was assumed the traffic diversion would not comprise more than 10 percent of the ADT on the R101.

Table 4.7: R101 – Daily Traffic and Vehicle Composition

	Daily Traffic 2003 (veh/day)	Composition 2003 (%)	Daily Traffic 2022 (veh/day)	Composition 2022 ($)	Traffic Growth Rate (%)			
					2003 - 2007	2008 - 2012	2013 - 2017	2018 - 2022
Car	7 153	88.82%	12 389	91.93%	3.94	3.00	2.50	2.50
Utility	0	0.00%	0	0.00%	1.00	1.50	1.50	1.50
Light Bus	0	0.00%	0	0.00%	1.00	1.50	1.50	1.50
Medium Bus	0	0.00%	0	0.00%	1.00	1.50	1.50	1.50
Heavy Bus	0	0.00%	0	0.00%	1.00	1.50	1.50	1.50
Light Truck	400	4.97%	483	3.59%	1.00	1.00	1.00	1.00
Medium Truck	300	3.73%	362	2.69%	1.00	1.00	1.00	1.00
Heavy Truck	200	2.48%	242	1.79%	1.00	1.00	1.00	1.00
Artic. Truck	0	0.00%	0	0.00%	1.00	1.50	1.50	1.50
Total	8 053	100.00%	13 477	100.00%				
Weighted Average	7 153				3.61	2.78	2.33	2.33

Source:

Table 4.8: N1 Toll Road – Daily Traffic and Vehicle Composition

	Daily Traffic 2002 (veh/day)	Composition 2002 (%)	Daily Traffic 2021 (veh/day)	Composition 2021 ($)	Traffic Growth Rate (%)			
					2002 - 2006	2007 - 2011	2012 - 2016	2017 - 2021
Car	13 146	86.74%	15 882	82.97%	1.00	1.00	1.00	1.00
Utility	0	0.00%	0	0.00%	0.00	0.00	0.00	0.00
Light Bus	0	0.00%	0	0.00%	0.00	0.00	0.00	0.00
Medium Bus	0	0.00%	0	0.00%	0.00	0.00	0.00	0.00
Heavy Bus	0	0.00%	0	0.00%	0.00	0.00	0.00	0.00
Light Truck	565	3.73%	916	4.79%	3.50	3.00	2.00	2.00
Medium Truck	637	4.20%	1 033	5.40%	3.50	3.00	2.00	2.00
Heavy Truck	808	5.33%	1 310	6.85%	3.50	3.00	2.00	2.00
Artic. Truck	0	0.00%	0	0.00%	0.00	0.00	0.00	0.00
Total	15 156	100.00%	19 141	100.00%				
Weighted Average	13 146				1.33	1.27	1.13	1.13

In contrast truck traffic grew at a rate of 3,5 percent over the corresponding period. The composition of traffic shows that trucks comprised on average about 13,2 percent of the total traffic. Trend analysis of vehicle traffic on the R101 shows a significant growth in light vehicle traffic (3,9 percent) compared to a very low growth in truck traffic (0,05 percent) between 2002 and 2005. The relative composition of truck traffic to total traffic has also decreased from 10,9 percent to 9,8 percent. It is assumed that the general increase in traffic on the R101 is caused a possible diversion of traffic from the N1 to the R101. Evidence, however, suggests that this increase could also be caused by an increase in local economic development and urbanisation in the surrounding northern suburbs.

Table 4.9: Average daily traffic, 2002 – 2004

	2002	2003	2004	% Change 2002-4
Toll Pumulani Plaza				
Total number of vehicles	1 754 372	6 176 326	6 391 313	
Average daily traffic (ADT)	18 027	16 923	17 477	-1.54%
Average daily truck traffic (ADTT)	2 173	2 153	2 255	1.87%
Percentage of trucks:	12.1	12.7	12.9	
Short	652	603	654	
Medium	761	754	744	
Long	761	797	857	
Toll Carousel				
Total number of vehicles	3 465 269	4 291 646	4 645 362	
Average daily traffic (ADT)	12 396	11 993	12 836	1.76%
Average daily truck traffic (ADTT)	1 581	1 640	1 767	5.72%
Percentage of trucks:	12.8	13.7	13.8	
Short	490	443	477	
Medium	458	508	530	
Long	632	689	760	
R101 (Bon Accord)				
Total number of vehicles	2 476 186	4 298 191	4 531 890	
Average daily traffic (ADT)	10 973	11 886	12 395	6.28%
Average daily truck traffic (ADTT)	1 199	1 186	1 219	0.83%
Percentage of trucks:	10.9	10	9.8	
Short	528	534	549	
Medium	444	427	439	
Long	228	225	232	

Source: Bakwena, 2005

4.4.6. ROUTE DESCRIPTION AND TOLL TARIFFS

For purposes of this analysis, the two routes compared, namely the N1 Toll route and the R101, was measured to cover distances of 41 km and 55 km respectively. The N1 Toll route is a dual carriageway of which the distance was measured from Zambesi Plaza to the Carousel Plaza. It has no stops and congestion except for the toll plazas. The alternative route, i.e. the R101 is a single carriageway which distance was measured from the Zambesi off-ramp to the Carousel Plaza located in short succession of each other. It has number of stops including traffic lights/robots. Table 10 presents the toll route tariffs effective from 1 March 2005.

Bakwena's profits are monitored on an ongoing basis by the Road Authorities. If profits exceed expectations it will be forced in accordance with an agreement to split a portion of its profit with the Road Authorities.

Table 10: The N1 Toll Route Tariffs – Effective 1 March 2005-10-09

Plaza		Class I Light	Class II Heavy	Class III Heavy	Class IV Heavy
Zambesi	Ramp	5.00	12.50	14.50	19.00
Pumulani		5.40	13.50	15.50	19.00
Wallmansthal	Ramp	2.50	6.20	7.40	8.50
Murrayhill	Ramp	5.00	12.50	15.00	17.00
Hammanskraal	Ramp	11.50	40.00	43.00	50.00
Carousel		25.00	67.00	74.00	85.00

Source: Bakwena Platinum Corridor Constortium (BPCC), 2005

4.4.7. VEHICLE OPERATING COSTS AND SPEEDS

The relationship between vehicle operation costs (VOC) and speeds to roughness for nine possible combinations of terrain and road types for nine possible vehicle types are modelled in the RED model. Here the relationship between roughness to the speed of the reference vehicle for nine possible combinations of terrain and road types are defined. All these relationships take the form of cubic polynomials. For example:

VOC (R/vehicle-km) as a function of roughness (IRI):

$VOC = a0 + a1*IRI + a2*IRI^2 + a3*IRI^3$

Where IRI = International Roughness Index

a1, a2, a3 = coefficients for the cubic polynomials derived from the hdm-3 or hdm-4 vehicle operation costs and speeds equations adapted for South Africa.

4.4.8. ROAD CONSTRUCTION COSTS

The road construction cost constitutes one of the basic elements of the cost-benefit analysis. The collection, checking and careful handling of the data in the process of evaluation is of utmost importance. Construction costs usually include cost items such as acquisition, design, supervision, and construction costs. The N1 was constructed in the mid 1970's as a double carriageway and no accurate figures are available on its construction and maintenance costs. Due to the fact that the toll road was put into operation much later in 2002, it was there decided to take 2002 as a starting year for the construction of the toll road in the CBA model. The construction costs used in the model would be based on similar road projects, which were constructed more recently. Some benchmark figures considered included the following:

Toll Road	Capital cost (Rand)	Length (km)	Cost/km (R/km)	Construction Year
Maputo Toll Road	1 400 000 000	532	2 631 579	1997
N3 Toll Road	2 200 000 000	424	5 188 679	2001
N17 Toll Road Project	769 300 000	164	4 690 854	2000

It was assumed that in the absence of realistic construction cost estimates, the construction cost of the N3 Toll Road would represent a realistic proxy of the expected construction cost the N1 North Toll Road. In the case of the R101, the construction cost is assumed to be between R 2 million and R 3 million per kilometre.

4.4.9. MAINTENANCE AND OPERATING COSTS

The road maintenance cost estimates should include both the routine and periodic maintenance cost (including reseals), for all project alternatives, appropriately spread over

time during the analysis period. For the maintenance and operating costs of the toll road the contracts of existing toll roads were considered.

Estimated maintenance cost per kilometre

Maintenance cost	N1 North (R per km/a)	R 101 (R per km/a)
Fixed maintenance	50 000	40 000
Variable maintenance	20 000	20 000
Total	70 000	60 000

4.4.10. DATA REQUIREMENTS OF THE MODEL

The RED model was originally designed for applications pertaining to rural roads. In this case use of the use of the HDM would have been more appropriate given the urban nature of the road. The HDM is however more data intensive and would have required a high level of technical and engineering expertise. This puts a time and financial constraint on the study.

The model is an abstraction of the reality. This means that one need to construct a model that simulates reality, which is based accurate assumptions. These assumptions need to reflect reality; therefore accuracy of the data is of paramount importance and need to be verified beyond any doubt. In this regard the assumptions pertaining to traffic diversion need to be confirmed.

4.5. ECONOMIC BENEFITS

Benefits can generally be classified as intra-sectoral or extra-sectoral benefits.

4.5.1. INTRA-SECTORAL BENEFITS

Intra-sectoral benefits occur within the transport system of the project region and can be categorised as follows:

- A reduction in either vehicle running cost or transport fares;
- Reduced risk of accidents;
- Savings in travel time; and
- Increased comfort and convenience.

Intra-sectoral benefits are easily quantifiable and the measurement of these benefits should proceed according to the group of transport users within the project region to whom these benefits accrue. For this purpose three categories of transport users are identified:

- Existing users of the facility;
- Diverted transport users, i.e. when traffic demand is transferred from other modes of the public transport network and from the road network; and
- Generated transport users, i.e. people who have not travelled before.

4.5.2. EXTRA-SECTORAL BENEFITS

Extra-sectoral benefits are the result of the effects that the proposed project will have on non-transport activities in the economy. Two broad categories of extra-sectoral benefits can be identified.

4.5.2.1. Effects on Local Economic Development

The construction of a project, such as a road project, could provide the stimulus through the income effects if the factors of production in the economy are underemployed. Should the factors of production in the economy be fully employed, it can, however, result in disadvantage because the project will have to compete with other sectors of the economy for the allocation of resources necessary for implementation.

Changes in transport conditions, manifesting though effects on capacity, quality and cost of public transport can also stimulate local economic development. These benefits accrue if a public transport project releasing latent economic advantages of a specific is involved, or when business is attracted to a region because of the availability of favourable transport conditions resulting from the implementation of such a project. These benefits are usually quantified via the changes that occur in land prices within the project region as a result of the implementation of public transport project.

A secondary impact on the economy can result from the implementation of a proposed project, i.e. investment in public road infrastructure can stimulate further investment in infrastructure. This could lead to lower prices of goods and services and the creation of more business opportunities in the study area.

4.5.2.2. Effects on Society as a Whole

The implementation of public road projects can have direct effects on non-users of roads. These effects are difficult or impossible to quantify because they are generally collective commodities for which no market exists. For this reason effects such as visual intrusion and disturbance to the landscape are often regarded as intangible. Other effects, such as air pollution and noise disturbance, can, however, be quantified via the cost implications of reducing their impact to levels that are acceptable to society through, for example, exhaust emissions legislation or the erection of noise barriers. These effects could not be quantified in monetary terms but because of their importance they have been included in the section of non-monetised items. The non-monetised items are as follows:

- Natural environment

  These are impacts on the physical surroundings; in the empirical study we included the impact on beautification of the area.

- Tourism

  These refer to the impact that traffic diverted from tolls has on tourism. Studies conducted along the study area reveal mixed results Bohlweki Environmental (2000). This section of the study will determine the effect of tolls on alternative roads.

- Animal crossing

  This refers to the impact that "diverted" traffic may have on animals crossing the alternative road. Along the area of study there are sections where animals cross the alternative road and increase the risk of accidents.

- Pedestrian crossing

Along the alternative road there are sections where pedestrians cross the road. The model considers the impact of various traffic scenarios and the occurrence of accidents.

In the RED model economic benefits are derived from user benefits, which is a function of savings in VOC's and time of normal and generated traffic on a road or saving due to an improvement in road safety, resulting from improved roads. A decrease in traffic has a measurable effect on vehicle travel speeds and travel time only when the roads are significantly congested (i.e. operating at less than free flow speed).

4.6. APPLICATION OF THE RED MODEL

In the case of the R101 alternative route, two scenarios were tested under aforementioned assumptions to simulate the impact of diverted traffic from the N1 North as follows:

- **Scenario 1** simulated the current situation (including diverted traffic), including ADT of 8 053 vehicles. It was assumed that traffic congestion on the road due to a 10 percent increase in ADT volumes would lead to lower speeds, which affects VOC and travel time. It would also result in more accidents, which is a cost to the economy.

- **Scenario 2** simulated normal ADT excluding diverted traffic, estimated at about 90 percent of the current ADT. The growth rate in traffic volumes is assumed to be the same as for Scenario 1. There would be less congestion, which affects VOC and travel time. This will result in the accident rate to decrease.

Results of the two scenarios modelled (see Appendix A) were as follows:

Scenarios	**IRR%**	**NPV (R million)**
R101		
Scenario 1	16.1	R 52
Scenario 2	38	R 367
N1 North Toll	27,8	R 349

Source: Results generated by the RED Model

The net present value (NPV) is used in the economic CBA to compare project alternatives (Scenario 1& 2), i.e. the without project with Option 1 (bring to fair). In the case of the R101, Scenario 2 has the highest NPV of R 367 million, thus indicating that it is economically the most feasible option between the two scenarios considered.

In the case of Scenario 1, frequent maintenance needs to be performed under increased traffic. Increased traffic due to "diverted traffic" causes congestion in accidents and travelling time, which is a cost to the economy. Under scenario 2, it is assumed that ADT will return to normal. Due lower levels on congestion, travelling times would be faster, while maintenance costs and accident rates would decrease.

Results show that in the case of the N1 the construction of the road (without tolling) is economically feasible with an internal rate of return of 27,8 percent and a NPV of R349 million.

In conclusion, it is clear that the R101 cannot cope with the current level of traffic and congestion. One can speculate about the causes of the congestion but in order to derive at a solution to the problem but more research need to be done on the causes of the congestion in order to derive at a proposal to resolve the problem.

4.6.1. SENSITIVITY ANALYSIS

The worksheets in Appendix B present the economic feasibility results for Option 1 (Bring to Fair), which demonstrates the effect of sensitivity analysis performed on the results. The worksheets present the net benefits and the economic indicators such as the NPV, IRR etc. It also performs a basic sensitivity analysis on the base case vs. road agency (capital investment cost) and user net benefit streams for the N1 North and R101 Alternative route. A sensitivity change of 25 percent is applied to the net benefit stream, i.e. 75 or 125 percent of the net benefit stream. The results are as follows:

Road		IRR%	NPV (Rm) *	Factor
R101 (Scenario 1)	Base case	16	52	1
	Agency..a	13	28	1.25

	User……b	12	15	0.75
	a & b	9	-7	
R101 (Scenario 2)	Base case	38	366	1
	Agency..a	33	343	1.25
	User……b	32	251	0.75
	a & b	27	228	
N1 North Toll	Base case	28	349	1
	Agency..a	23	305	1.25
	User……b	22	217	0.75
	a & b	18	173	

* discounted at 10%
Agency – investment cost
User – user net benefit stream
Factor – Sensitivity factor i.e. 0.75 = 75%

The results clearly show that in each case the base case, which has the highest NPV, is the most feasible option. It could be expected that a rise of 25 percent in the investment cost and a decrease in the user net benefit stream would result in a decrease in NPV and the IRR, respectively in each case.

4.8. DEVELOPMENT IMPACT

In the case of R101, the development impact of the road infrastructure, despite certain externalities, is in general positive. The growth in traffic, whether caused by diverted traffic or not, will stimulate local economic development along the R101. This was confirmed by the survey results of the empirical survey performed, which indicated an increased level of business opportunities and employment along the R101.

The N1 North tender stipulated that 12,5 percent of the contracts value – this is a minimum of R50 million – to be spent on the empowerment of SMME's, training and job creation. Small business and subcontractors were awarded the opportunity to borrow money at the same rate as large corporate companies. The development impact was as follows:

- More than 1900 people were trained and supported to become fully-fledged plant-hire operators, able to continue their business after completion of the project.

- The contractor directly employed approximately 800 people within the immediate vicinity of the project.
- Orders and subcontracts to the value R 64,4 million were awarded to 131 emerging enterprises.
- An accredited civil engineering training centre was established and 1982 training certificates were awarded.
- More that 108 community members and 408 sub contractors were given training ranging from basic literacy to on-site vocational training in general construction practices and foreman skills.
- Training in business practices and the support given SMMEs led to the creation of 59 SMMEs and about R54, 3 million being ploughed back into the provincial economy.

4.9. SUMMARY AND CONCLUSION

4.9.1. N1 TOLL ROAD

Without a national infrastructure there can be no trade, little economic development and marginal improvement in the quality of life of South Africa's citizens. For one industry to function, its production process requires, as inputs, the goods or services produced (output) by other industries. In addition wages circulate in the economy as part of household expenses. In this manner, each Rand of spending for transportation stimulates additional spending, affecting other industries in the economy; this is known as the multiplier effect. Therefore, expenditures to build and maintain infrastructure and operate transportation services, could influence a local or regional economy. The greatest problem in road infrastructure is the funding. In South Africa, the strategy of employing private sector funds and establishing the user-pay principle on toll roads was mainly implemented to alleviate the shortage of state funds for road construction This gave rise to toll roads such as the N1 North.

4.9.2. INTERNATIONAL EXPERIENCE

It is important the view toll roads within and international context. The international experience shows that most countries have no toll roads. Where there are toll roads the tolled network typically comprises less than 5 percent of the road network. In most

countries with toll roads the private sector has been heavily involved in development of the roads and often thereafter in their operation. Even where toll roads are operated in the private sector, Government support has been considerable, in almost all cases. The funds from toll revenues can be dedicated to the support of construction and maintenance for a particular road thereby ensuring that maintenance funds in particular do not compete with the requirements of other roads in the network.

Diversion of Traffic away from the New Road. Price elasticity of demand and the provision of free alternatives to the tolled road, will affect the level of traffic on the facility. In turn this may mean that some potential economic benefits of the new road are lost since the objective of new road provision is to move people and goods more reliably and quickly. However, when well designed the cost of tolling for revenue should be lower than those of any other system of revenue collection. Generally as a rule the toll fees should not exceed 75 percent of the savings realised by the public using the alternative road.

Social Impacts. Just as with any road, toll roads can have significant social impacts in the manner and location of their construction and in their operation. These can be both positive (providing improved access for some regions of a country) and negative (degrading the environment around the road, for example underneath an elevated urban expressway). However, there are additional consequences, which result from the tolls. For example, tolls

- Can discourage unnecessary trips and therefore provide environmental benefits,
- May be too high for the poor to benefit from the new facilities, or
- May be so high that traffic diverts off the new road onto parallel roads, which pass through residential neighbourhoods therefore reducing the environmental benefits that the new road could have provided.

The toll fees should therefore be monitored to comply with affordability criteria.

Cross subsidisation. The argument in favor of free parallel roads is one of social equity, to ensure that the poor can still have access to the road network.

Other concerns about cross subsidisation relates to the question of transferring resources from one group of consumers to another. Those who are paying tolls on the existing road are thereby paying for the construction of a new road, which would otherwise have been funded by taxpayers and will provide benefits for other future users. This may be part of a Government program of regional development but needs to be explicitly recognised.

4.9.3. DISCUSSION OF RESULTS

In this dissertation the economic impact of these toll roads are questioned on the basis that the diversion of traffic from these roads to avoid toll fees impact negatively of the flow of traffic on the R101. It causes congestion, accidents, and has a negative impact on the environment. One can argue that the diversion of traffic would mitigate or defer the need for highway expansion, measured in terms of the lane-kilometres that would otherwise be dedicated to carrying the diverted trips. The costs saved or deferred by not having to expand highways could not be included in total benefits, since they measure the same phenomenon as the highway congestion delay savings.

In this study the there is no conclusive evidence that diversion of traffic from the N1 causes congestion on the R101 and has a negative impact on the economy of the region. On the contrary evidence suggests that there was an initial diversion of traffic when the toll came into operation but that is slowly filtered back after six months. New entrants are using the road and the traffic is growing normally as expected. Truck divers are instructed by companies to stick to the toll road. This is confirmed by statistics, which clearly shows a decrease in the average daily truck traffic on the R101. ADT on the other hand has increased significantly and could be most probably be ascribed to demographic trends and the high level of urbanisation that is taking place.

With the exception of major former homeland cities the main urbanisation growth dynamic and rural urbanization is oriented towards towns in white South Africa with population concentration occurring along the former homeland (Bophuthatswana) perimeter. The majority of these migrating people are expected to urbanise in the four primary metropoles. A feature of the current pattern of urbanisation in South Africa, as in other developing countries, is the establishment of vast squatter communities due to a

shortage of formal housing. Apart from urbanization trends it could also be assumed that traffic is diverted from Pretoria North Municipal area onto the R101, which is a shorter route. A proper assessment of the traffic composition and diversion need to be performed in order to derive at a realistic situation analysis.

In the application of the RED model, economic benefits are derived from user benefits, which is a function of savings in VOC's and time of normal and generated traffic on a road or saving due to an improvement in road safety, resulting from improved roads. A decrease in traffic has a measurable effect on vehicle travel speeds and travel time only when the roads are significantly congested (i.e. operating at less than free flow speed). Other non-quantifiable costs and benefits were not considered in this modelling exercise.

In the case of scenario 1 (including diversion), frequent maintenance needs to be performed under increased traffic. Increased traffic due to "diverted traffic" causes congestion in accidents and travelling time, which is a cost to the economy. Under scenario 2 (excluding diversion), it is assumed that ADT will return to normal. Due lower levels on congestion, travelling times would be faster, while maintenance costs and accident rates would decrease. Scenario 2 is selected as being economically the most feasible option.

Conclusion

It is clear that the R101 cannot cope with the current levels of traffic and congestion. One can speculate about the causes of the congestion but in order to derive at a solution to the problem more research needs to be done on the cause of the congestion in order to resolve the problem.

CHAPTER 5

SUMMARY AND CONCLUSIONS

5.1. INTRODUCTION

South Africa has one of the finest road networks in Africa. These networks are also marked to pursue the goals and objectives of the SDI, which among others is considered to be a catalyst for growth and economic development in the Southern African region. This improvement in road networks brought with it the introduction of toll gates on national roads. Tolls led to the diversion of traffic to alternative roads. This study focus on the welfare effects of traffic diverted from toll roads on alternative roads in particular the R101.

This chapter is a summary chapter and thus it will not repeat the quotations that were made in the previous chapters, it will focus on providing the summary of the study and conclusions and recommendations.

5.2. SUMMARY

This dissertation consists of five chapters.
Chapter 1 is the introduction chapter. It was set out to achieve the following. It focused on the problem identification aims and objectives of the study. The importance of the research was also discussed. Further more the chapter discussed the methodology that was followed when conducting the survey.

Chapter 2 was a literature review chapter and it was set out to achieve the following. It provided a theoretical overview of EIA, CBA and the RED model. Further more the chapter provided a discussion on road pricing.

The chapter further provided a theory of welfare economics in particular the principle of Pareto optimality and marginal costs pricing. The requirements for a good system of road pricing and the issue of road pricing in SA were also discussed. In addition the chapter

provided a method of charging for the use of roads as well as the private provisioning of roads in SA. The chapter ended with lessons from previous studies about road pricing.

Chapter 3 was set out to achieve the following. Section 1 provided a background overview of tolls in SA particularly the tolls along the area of study.i.e.N1. The chapter also discussed the findings of the previous studies conducted along the area of study. Section II focused on the presentation of results of the survey. Data collected during the survey was analysed with visual aids and graphs. The chapter ended with the summary of the findings of the study.

Chapter 4 was an analysis chapter. It was set out to conduct a socio-economic impact analysis of the road. The purpose of the chapter was to determine the economic feasibility of the N1 north toll road and the R101. It also aimed to determine the impact that diverted traffic from the N1 has on the alternative route R101. This was achieved by applying the cost benefit analysis appraisal technique using the red model

5.3. CONCLUSION

5.3.1 CONCLUDING REMARKS

The evidence of the investigation conducted in this study appears to validate the premise that the introduction of tolls leads to a reduction in welfare on the alternative road. The deterioration in welfare is manifested in many ways e.g. congestion along the road and increased levels of traffic along the road.

Analysis of data shows an increase in vehicle operating costs and that the costs of using the road slightly exceed the benefit as a result of increased traffic. The less striking finding of the study was that there were no major differences between old and diverted users of the road. Similarly demographic features offered less striking results. The overall impression from the study is that the costs of using the R101 have slightly increased since the operation of tolls.

5.3.2. RECOMMENDATIONS

Recommendations

It is recommended that:

The nature and extent of diversion of traffic be investigated to ascertain its economic impact. If significant diversion is proven beyond any doubt (> 30%) then appropriate steps need to be taken to eliminate it or to reduce its impact.

It is proposed that the impact of diversion could be prevented or reduced by:

- providing toll concessions to residents along the route. This is already happening.

- Toll fees should be monitored on a regular basis to ensure that the toll fees charged is affordable

- The R101 should be upgraded to a level that could handle larger traffic volumes. The community at large is entitled to have better access to an improved roads infrastructure network, which would stimulate economic development and improve the welfare of the community.

In order to fully understand the welfare effects of diverted traffic on alternative roads, it is necessary to conduct a fully comprehensive study that will investigate the nature and extend of traffic diversion and ascertain its economic impact. Furthermore it is necessary to conduct a study that will uncover the causes of traffic diversion in detail.

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APPENDIXA.

APPENDIX A
Project-Options Main Features - N1 North

	Without Project Case Option 0	Project Alternatives Option 1
Option Description	Current Poor Condition	Bring to Fair Condition
Road Length (km)	41	41
Terrain Type (A/B/C)	A	A
A: Flat		
B: Rolling		
C: Mountainous		
Road Type (X/Y/Z)	X	X
X: Paved		
Y: Gravel		
Z: Earth		
Roughness (IRI)	6	4
Financial Investment Costs ('000R /km)	0	5000
Fixed Financial Maintenance Costs ('000R /km/year)	20	50
Variable Financial Maintenance Costs ('000R /km/year/ADT)	20	20
Accidents Rate (Accidents per 100 million vehicle-km)	100	50
And Optionally		
Percent With Fatality (%)	11	11
Percent With Injury (%)	17	17
Percent Damage Only (%)	72	72
Solution Summary		
Net Present Value (million R) at 10% Discount Rate		349
Internal Rate of Return (%)		27.8%

Source: Worksheet generated by the RED Model

APPENDIX A (CONT)

Project-Options Main Features - Alternative Route (Scenario 1)

	Without Project Case Option 0	Project Alternatives Option 1
Option Description	Current Poor Condition	Bring to Fair Condition
Road Length (km)	55	55
Terrain Type (A/B/C)	A	A
A: Flat		
B: Rolling		
C: Mountainous		
Road Type (X/Y/Z)	X	X
X: Paved		
Y: Gravel		
Z: Earth		
Roughness (IRI)	7	5
Financial Investment Costs ('000R /km)	0	2000
Fixed Financial Maintenance Costs ('000R /km/year)	20	30
Variable Financial Maintenance Costs ('000R /km/year/ADT)	20	20
Accidents Rate (Accidents per 100 million vehicle-km)	100	200
And Optionally		
Percent With Fatality (%)	11	20
Percent With Injury (%)	17	20
Percent Damage Only (%)	72	60
Solution Summary		
Net Present Value (million R) at 10% Discount Rate		52
Internal Rate of Return (%)		16.1%

Source: Worksheet generated by the RED Model

APPENDIX A (CONT)
Project-Options Main Features - Alternative Route (Scenario 2)

	Without Project Case Option 0	Project Alternatives Option 1
Option Description	Current Poor Condition	Bring to Fair Condition
Road Length (km)	55.0	55.0
Terrain Type (A/B/C)	A	A
A:		
B:		
C:		
Road Type (X/Y/Z)	X	X
X:		
Y:		
Z:		
Roughness (IRI)	7.0	5.0
Fixed Financial Maintenance Costs ('000R /km/year)	20.0	30.0
Variable Financial Maintenance Costs ('000R /km/year/ADT)	20.000	20.000
Accidents Rate (Accidents per 100 million vehicle-km)	100.0	50.0
And Optionally		
Percent With Fatality (%)	11	11
Percent With Injury (%)	17	17
Percent Damage Only (%)	72	72
Solution Summary		
Net Present Value (million R) at 10% Dicount Rate		367
Internal Rate of Return (%)		38%

Source: Worksheet generated by the RED Model

Appendix B
Feasibility report of the N1 North Toll Road

				Net Economic Benefits									Sensitivity Analysis		
	Normal Daily Traffic	Generated Daily Traffic	Induced Daily Traffic	Agency Benefits		User Benefits							A Agency *	B User *	A & B
				Investment Costs	Maintenance Costs	Normal Traffic		Generated Traffic		Road Safety	Other Benefits	Total	1.25	0.75	
Year	(veh/day)	(veh/day)	(veh/day)	(MR /year)	(MR /year)	VOC (MR /year)	Time (MR /year)	VOC (MR /year)	Time (MR /year)	(MR /year)	(MR /year)	(MR /year)	(MR /year)	(MR /year)	(MR /year)
2002	15156	0	0	-139.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-139.400	-174.250	-139.400	-174.250
2003	15358	0	0	-17.425	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-17.425	-21.781	-17.425	-21.781
2004	15563	0	0	-17.425	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-17.425	-21.781	-17.425	-21.781
2005	15773	789	0	0.000	-1.045	66.084	0.000	1.652	0.000	4.721	0.000	71.412	71.150	53.297	53.036
2006	15986	799	0	0.000	-1.046	67.244	0.000	1.681	0.000	4.785	0.000	72.664	72.403	54.237	53.976
2007	16192	810	0	0.000	-1.046	68.330	0.000	1.708	0.000	4.846	0.000	73.839	73.577	55.118	54.856
2008	16402	820	0	0.000	-1.045	69.438	0.000	1.736	0.000	4.909	0.000	75.038	74.776	56.017	55.756
2009	16615	831	0	0.000	-1.046	70.571	0.000	1.764	0.000	4.973	0.000	76.263	76.001	56.936	56.674
2010	16831	842	0	0.000	-1.046	71.728	0.000	1.793	0.000	5.038	0.000	77.513	77.252	57.874	57.612
2011	17051	853	0	0.000	-1.045	72.910	0.000	1.823	0.000	5.104	0.000	78.791	78.530	58.832	58.571
2012	17249	862	0	0.000	-1.046	73.879	0.000	1.847	0.000	5.163	0.000	79.843	79.582	59.621	59.359
2013	17448	872	0	0.000	-1.046	74.862	0.000	1.872	0.000	5.222	0.000	80.910	80.649	60.421	60.160
2014	17651	883	0	0.000	-1.045	75.860	0.000	1.896	0.000	5.283	0.000	81.994	81.732	61.234	60.972
2015	17856	893	0	0.000	-1.046	76.872	0.000	1.922	0.000	5.344	0.000	83.093	82.831	62.058	61.797
2016	18063	903	0	0.000	-1.046	77.900	0.000	1.948	0.000	5.406	0.000	84.209	83.947	62.895	62.634
2017	18273	914	0	0.000	-1.046	78.944	0.000	1.974	0.000	5.469	0.000	85.341	85.080	63.744	63.483
2018	18486	924	0	0.000	-1.045	80.003	0.000	2.000	0.000	5.533	0.000	86.490	86.229	64.606	64.345
2019	18702	935	0	0.000	-1.046	81.078	0.000	2.027	0.000	5.597	0.000	87.657	87.395	65.481	65.220
2020	18920	946	0	0.000	-1.046	82.169	0.000	2.054	0.000	5.663	0.000	88.841	88.579	66.369	66.108
2021	19141	957	0	0.000	-1.046	83.277	0.000	2.082	0.000	5.729	0.000	90.042	89.781	67.270	67.009

1.2% Growth	Net Present Value (million R) at 10% Discount Rate	349.364
	Internal Rate of Return (%)	28%
Evaluation Period (years)	Equivalent Annual Net Benefits (R /km) at 10% Discount Rate	909894
	Modified Rate of Return at 10% Reinvestment Rate (%)	17%
	Net Present Value per Financial Investment Costs (ratio)	1.70
20	First-Year Benefits per Economic Investment Cost (ratio)	0.42

	Net Present Value (million R) at 10% Discount Rate	305.221	217.880	173.737
	Internal Rate of Return (%)	23%	22%	18%
	Equivalent Annual Net Benefits (R /km) at 10% Discount Rate	794926	567453	452485
	Modified Rate of Return at 10% Reinvestment Rate (%)	15%	15%	14%
	Net Present Value per Financial Investment Costs (ratio)	1.49	1.06	0.85
	First-Year Benefits per Economic Investment Cost (ratio)	0.33	0.31	0.25

Source: Worksheet generated by the RED Model

Appendix B
Feasibility of Alternative Route (Scenario 1)

				Net Economic Benefits									Sensitivity Analysis		
				Agency Benefits		User Benefits							A	B	A & B
	Normal Daily Traffic	Generated Daily Traffic	Induced Daily Traffic	Investment Costs	Maintenance Costs	Normal Traffic		Generated Traffic		Road Safety	Other Benefits	Total	Agency * 1.25	User * 0.75	
Year	(veh/day)	(veh/day)	(veh/day)	(MR /year)	(MR /year)	VOC (MR /year)	Time (MR /year)	VOC (MR /year)	Time (MR /year)	(MR /year)	(MR /year)	(MR /year)	(MR /year)	(MR /year)	(MR /year)
2003	8053	0	0	-74.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-74.800	-93.500	-74.800	-93.500
2004	8344	0	0	-9.350	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-9.350	-11.688	-9.350	-11.688
2005	8646	0	0	-9.350	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-9.350	-11.688	-9.350	-11.688
2006	8960	448	0	0.000	-0.468	55.470	0.000	1.387	0.000	-37.515	0.000	18.874	18.757	14.039	13.922
2007	9285	464	0	0.000	-0.467	57.321	0.000	1.433	0.000	-38.879	0.000	19.408	19.291	14.439	14.322
2008	9545	477	0	0.000	-0.468	58.811	0.000	1.470	0.000	-39.967	0.000	19.847	19.730	14.768	14.651
2009	9813	491	0	0.000	-0.467	60.344	0.000	1.509	0.000	-41.087	0.000	20.298	20.181	15.106	14.990
2010	10088	504	0	0.000	-0.468	61.920	0.000	1.548	0.000	-42.240	0.000	20.761	20.644	15.454	15.337
2011	10371	519	0	0.000	-0.467	63.541	0.000	1.589	0.000	-43.426	0.000	21.236	21.119	15.810	15.693
2012	10663	533	0	0.000	-0.467	65.208	0.000	1.630	0.000	-44.647	0.000	21.724	21.607	16.176	16.059
2013	10915	546	0	0.000	-0.467	66.657	0.000	1.666	0.000	-45.702	0.000	22.155	22.038	16.499	16.382
2014	11173	559	0	0.000	-0.468	68.141	0.000	1.704	0.000	-46.782	0.000	22.595	22.478	16.830	16.713
2015	11437	572	0	0.000	-0.467	69.660	0.000	1.741	0.000	-47.888	0.000	23.046	22.929	17.167	17.050
2016	11707	585	0	0.000	-0.468	71.215	0.000	1.780	0.000	-49.022	0.000	23.506	23.389	17.513	17.396
2017	11985	599	0	0.000	-0.467	72.807	0.000	1.820	0.000	-50.183	0.000	23.977	23.860	17.866	17.749
2018	12269	613	0	0.000	-0.467	74.437	0.000	1.861	0.000	-51.373	0.000	24.458	24.341	18.226	18.110
2019	12560	628	0	0.000	-0.467	76.106	0.000	1.903	0.000	-52.591	0.000	24.950	24.833	18.595	18.478
2020	12858	643	0	0.000	-0.467	77.814	0.000	1.945	0.000	-53.840	0.000	25.452	25.335	18.972	18.856
2021	13164	658	0	0.000	-0.468	79.564	0.000	1.989	0.000	-55.119	0.000	25.966	25.850	19.358	19.241
2022	13477	674	0	0.000	-0.467	81.355	0.000	2.034	0.000	-56.429	0.000	26.492	26.375	19.752	19.635

Net Present Value (million R) at 10% Discount Rate	52.212	28.680	15.627	-7.905
Internal Rate of Return (%)	16%	13%	12%	9%
Equivalent Annual Net Benefits (R /km) at 10% Discount Rate	101368	55682	30340	-15347
Modified Rate of Return at 10% Reinvestment Rate (%)	13%	11%	11%	10%
Net Present Value per Financial Investment Costs (ratio)	0.47	0.26	0.14	-0.07
First-Year Benefits per Economic Investment Cost (ratio)	0.21	0.17	0.16	0.12

2.7% Growth

Evaluation Period (years)
20

Source: Worksheet generated by the RED Model

Appendix B
Feasibility of Alternative Route (Scenario 2)

				Net Economic Benefits									Sensitivity Analysis		
				Agency Benefits		User Benefits							A	B	A & B
	Normal Daily Traffic	Generated Daily Traffic	Induced Daily Traffic	Investment Costs	Maintenance Costs	Normal Traffic		Generated Traffic		Road Safety	Other Benefits	Total	Agency * 1.25	User * 0.75	
						VOC	Time	VOC	Time						
Year	(veh/day)	(veh/day)	(veh/day)	(MR /year)	(MR /year)	(MR /year)	(MR /year)	(MR /year)	(MR /year)	(MR /year)	(MR /year)	(MR /year)	(MR /year)	(MR /year)	(MR /year)
2003	7248	0	0	-74.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-74.800	-93.500	-74.800	-93.500
2004	7509	0	0	-9.350	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-9.350	-11.688	-9.350	-11.688
2005	7781	0	0	-9.350	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-9.350	-11.688	-9.350	-11.688
2006	8064	403	0	0.000	-0.468	49.923	0.000	1.248	0.000	8.279	0.000	58.983	58.866	44.121	44.004
2007	8357	418	0	0.000	-0.468	51.589	0.000	1.290	0.000	8.581	0.000	60.992	60.875	45.627	45.510
2008	8591	430	0	0.000	-0.468	52.930	0.000	1.323	0.000	8.821	0.000	62.607	62.490	46.838	46.721
2009	8831	442	0	0.000	-0.468	54.309	0.000	1.358	0.000	9.068	0.000	64.267	64.151	48.084	47.967
2010	9079	454	0	0.000	-0.468	55.728	0.000	1.393	0.000	9.322	0.000	65.976	65.859	49.365	49.248
2011	9334	467	0	0.000	-0.468	57.187	0.000	1.430	0.000	9.584	0.000	67.733	67.616	50.683	50.566
2012	9596	480	0	0.000	-0.468	58.687	0.000	1.467	0.000	9.853	0.000	69.541	69.424	52.039	51.922
2013	9823	491	0	0.000	-0.468	59.992	0.000	1.500	0.000	10.086	0.000	71.110	70.993	53.216	53.099
2014	10055	503	0	0.000	-0.468	61.327	0.000	1.533	0.000	10.325	0.000	72.717	72.600	54.421	54.304
2015	10293	515	0	0.000	-0.467	62.694	0.000	1.567	0.000	10.569	0.000	74.363	74.246	55.655	55.538
2016	10537	527	0	0.000	-0.467	64.093	0.000	1.602	0.000	10.819	0.000	76.047	75.930	56.919	56.802
2017	10786	539	0	0.000	-0.468	65.526	0.000	1.638	0.000	11.075	0.000	77.772	77.655	58.212	58.095
2018	11042	552	0	0.000	-0.468	66.993	0.000	1.675	0.000	11.338	0.000	79.538	79.421	59.537	59.420
2019	11304	565	0	0.000	-0.468	68.495	0.000	1.712	0.000	11.607	0.000	81.347	81.230	60.893	60.776
2020	11572	579	0	0.000	-0.467	70.033	0.000	1.751	0.000	11.882	0.000	83.198	83.082	62.282	62.165
2021	11847	592	0	0.000	-0.467	71.607	0.000	1.790	0.000	12.164	0.000	85.094	84.978	63.704	63.587
2022	12129	606	0	0.000	-0.467	73.219	0.000	1.830	0.000	12.454	0.000	87.036	86.919	65.160	65.043

Net Present Value (million R) at 10% Discount Rate	366.889	343.357	251.635	228.103
Internal Rate of Return (%)	38%	33%	32%	27%
Equivalent Annual Net Benefits (R /km) at 10% Discount Rate	712308	666622	488545	442859
Modified Rate of Return at 10% Reinvestment Rate (%)	20%	18%	18%	17%
Net Present Value per Financial Investment Costs (ratio)	3.34	3.12	2.29	2.07
First-Year Benefits per Economic Investment Cost (ratio)	0.64	0.51	0.48	0.38

2.7% Growth

Evaluation Period (years)
20

Source: Worksheet generate by the RED Model

APPENDIX C

QUESTIONARES

APPENDIX C.1.

STRATA 1 OLD USERS OF THE ROAD

TITLE: **AN ECONOMIC IMPACT ASSESSMENT OF THE DIVERSION OF TRAFFIC FROM TOLLROADS, TO THE ALTERNATIVE ROADS WITH SPECIAL REFERENCE TO THE HAMMANSKRAAL AND PUMULANI PLAZAS.**

1. How often do you travel along this road?

(Put an X under your answer)

Every day	At least 3 days a week	Once a week	Once a month

2.What is the purpose of travelling on this road?

(Put an X under your answer)

Business	Private	Work

3. Why do you use this road instead of the toll road?

(Put an X next to your answer)

1. Shortest distance to destination	
2. Cannot afford the toll fees	
3. Other	

If other please state_____

4. How do you rate the impact of the N1 tollgate on your society's welfare (standard of life)?

(Put an X under your answer)

Very Negative Impact	Moderate Negative Impact	Some Negative Impact	Neutral	Some positive Impact	Moderate Positive Impact	Very positive Impact

5. Overall how satisfied were you with the use of this road before the introduction of tollgates on the N1 road?

(Put an X under your answer)

Extremely satisfied	Satisfied	Slightly satisfied	Neutral	Slightly Dissatisfied	Dissatisfied	Extremely Dissatisfied

6. Overall how satisfied are you with the use of this road after the introduction of tollgates on the N1 road?

(Put an X under your answer)

Extremely Satisfied	Satisfied	Slightly Satisfied	Neutral	Slightly Dissatisfied	Dissatisfied	Extremely Dissatisfied

7. List your disadvantages (costs) pertaining to the use of this road after the introduction of tollgates.

_____

_____

_____

_____

_____

_____

8. List the benefits (advantages) pertaining to the use of this road after the introduction of tollgates on the N1 road?

_____

_____

_____

_____

_____

_____

9. With regard to the use of this road do you rate the following as bad or good after the introduction of tollgates on the N1?

(Put an X in the appropriate block)

	Extremely Good	Good	Slightly Good	Neutral	Slightly Bad	Bad	Extremely Bad
Comfort and Convenience							
Safety							
Frustration							

10. Do you think the level of Noise Pollution have Increased or Decreased on this road after the introduction of tollgates on the N1?

(Put an X in the appropriate block)

Much More Increase	Moderate Increase	Slight Increase	No change	Slight Decrease	Moderate Decrease	Much More Decrease

11. Do you think the level of Air Pollution have Increased or Decreased on this road after the introduction of tollgates on the N1?

(Put an X in the appropriate block)

Much More Increase	Moderate Increase	Slight Increase	No change	Slight Decrease	Moderate Decrease	Much More Decrease

12. Do you think the level of Light Pollution have Increased or Decreased on this road after the introduction of tollgates on the N1?

(Put an X in the appropriate block)

Much More Increase	Moderate Increase	Slight Increase	No change	Slight Decrease	Moderate Decrease	Much More Decrease

13. Do you think the level of accidents have increased or decreased on this road after the introduction of tollgates on the N1 road?

(Put an X in the appropriate block)

Much More Increase	Moderate Increase	Slight Increase	No change	Slight Decrease	Moderate Decrease	Much More Decrease

14. Do you think the value of property around this area have increased or decreased after the introduction of tollgates on the N1?

(Put an X in the appropriate block)

Much More Increase	Moderate Increase	Slight Increase	No change	Slight Decrease	Moderate Decrease	Much More Decrease

15. How much was the increase or decrease? State R_____

16. Do you think the government has spent more or less on this road after the introduction of tollgates?

(Put an X in the appropriate block)

Much More	More	Somewhat More	No change	Some what less	Less	Much Less

17. With regard to this area, do you rate the following economic advantages as good or bad after the introduction of tollgates on the N1 road?

(Put an X under your answer)

	Extremely Good	Good	Slightly Good	Neutral	Slightly Bad	Bad	Extremely Bad
1. Lower Prices							
2. More Business opened							
3. Employment							
4. Better Roads							

18. Pertaining to this road what is your opinion about the impact of tollgates on the following?

(Put an X under your answer)

	Very Good	Good	Slightly Good	Neutral	Slightly Bad	Bad	Very Bad
1.Beautification of area Plants and Trees							
2. Tourism							
3. Animals							
4.Pedestrians							

N.B. The following questions are for statistical purpose only.

19. Sex

(Put an X under your answer)

Female	Male

20. Are you residing between the area of Pretoria and Hammanskraal?

(Put an X under your answer)

YES	NO

21. Vehicle class

(Put an X under your answer)

Light Vehicle	Medium Vehicle	Heavy Vehicle	Extra heavy Vehicle

22. Income per month

(Put an X under your answer)

Less than R5000.00	R5000.00-R10000.00	R10000.00 - R15000.00	R15000.00 - R20000.00	Greater than R20000.00

23. Level of Education

(Put an X under your answer)

No Education	Primary School	High school	Tertiary Education

24. Provide comments on anything not included in this Questionnaire.

_____

_____

_____

_____

_____

_____

Thank you for being truthful in answering these questions.

We sincerely appreciate your time and effort in completing this questionnaire.

Have a nice day.

APENDIX C.2.

STRATA 2. DIVERTED USERS OF THE ROAD

TITLE: **AN ECONOMIC IMPACT ASSESSMENT OF THE DIVERSION OF TRAFFIC FROM TOLLROADS, TO THE ALTERNATIVE ROADS WITH SPECIAL REFERENCE TO THE HAMMANSKRAAL AND PUMULANI PLAZAS.**

1. How often do you travel along this road?

(Put an X under your answer)

Every day	At least 3 days a week	Once a week	Once a month

2. What is the purpose of travelling on this road?

(Put an X under your answer)

Business	Private	Work

3. Why do you use this road instead of the toll road?

(Put an X next to your answer)

1. Shortest distance to destination	
2. Cannot afford the toll fees	
3. Other	

If other please state_____

4. How do you rate the impact of the N1 tollgate on your society's welfare (standard of life)?

(Put an X under your answer)

Very Negative Impact	Moderate Negative Impact	Some Negative Impact	Neutral	Some positive Impact	Moderate Positive Impact	Very positive Impact

5. Overall how satisfied were you with the use of this road before the introduction of tollgates on the N1 road?

(Put an X under your answer)

Extremely satisfied	Satisfied	Slightly satisfied	Neutral	Slightly Dissatisfied	Dissatisfied	Extremely Dissatisfied

6. Overall how satisfied are you with the use of this road after the introduction of tollgates on the N1 road?

(Put an X under your answer)

Extremely Satisfied	Satisfied	Slightly Satisfied	Neutral	Slightly Dissatisfied	Dissatisfied	Extremely Dissatisfied

7. List your disadvantages (costs) pertaining to the use of this road after the introduction of tollgates.

_____

_____

_____

_____

_____

_____

8. List the benefits (advantages) pertaining to the use of this road after the introduction of tollgates on the N1 road?

_____

_____

_____

_____

_____

_____

9. With regard to the use of this road do you rate the following as bad or good after the introduction of tollgates on the N1?

(Put an X in the appropriate block)

	Extremely Good	Good	Slightly Good	Neutral	Slightly Bad	Bad	Extremely Bad
Comfort and Convenience							
Congestion							
Safety							
Frustration							

10. Do you think the amount of Time spent travelling on this road have increased or decreased after the introduction of tollgates on the N1 toll road?

(Put an X in the appropriate block)

Much More Increase	Moderate Increase	Slight Increase	No change	Slight Decrease	Moderate Decrease	Much More Decrease

11. How much are you prepared to pay to use the N1 toll road and save on travelling time? R_____

12. Do you think your Fuel costs have increased or decreased when travelling on this road after the introduction of tollgates on the N1 road?

(Put an X in the appropriate block)

Much More Increase	Moderate Increase	Slight Increase	No change	Slight Decrease	Moderate Decrease	Much More Decrease

13. How much of your fuel costs are you prepared to pay to use to the N1 toll road? R_____

14. Do you think your vehicle maintenance costs e.g. brakes, clutches e.t.c have increased or decreased when travelling on this road after the introduction of toll gates on the N1 toll road?

(Put an X in the appropriate block)

Much More Increase	Moderate Increase	Slight Increase	No change	Slight Decrease	Moderate Decrease	Much More Decrease

15. How much are you prepared to pay to use the N1 toll road and save on your maintenance costs? R_____

N.B. The following questions are for statistical purpose only.

16. Sex

(Put an X under your answer)

Female	Male

17. Are you residing between the area of Pretoria and Hammanskraal?

(Put an X under your answer)

YES	NO

18. Vehicle class

(Put an X under your answer)

Light Vehicle	Medium Vehicle	Heavy Vehicle	Extra heavy Vehicle

19. Income per month

(Put an X under your answer)

Less than R5000.00	R5000.00-R10000.00	R10000.00 - R15000.00	R15000.00 - R20000.00	Greater than R20000.00

20. Level of Education

(Put an X under your answer)

No Education	Primary School	High school	Tertiary Education

21. Provide comments on anything not included in this Questionnaire.

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Thank you for being truthful in answering these questions.

We sincerely appreciate your time and effort in completing this questionnaire.

Have a nice day.

APPENDIX D.

COVERING LETTER

Hello, I am Robert Kekana from the University of Pretoria. I am conducting a survey on an economic impact assessment of the diversion of traffic from toll roads, to the alternative roads with special reference to the Hammanskraal and Pumulani plazas.

The objectives of the survey is

- To assess the impact of tolls on travellers who have been diverted from the tolled road to alternative roads particularly the R101.
- In addition to that the survey intends to assess the impact of tolls on people who were using the alternative road before the introduction of tollgates on the N1 road, and those residing around the area of study.

Please complete this questionnaire, and hand it back to the person who gave it to you.

The study is important for all users of the road. Your participation in the survey is voluntary but is important for the study to be representative. Your cooperation will contribute significantly towards understanding the welfare effects of traffic diversion from toll roads on alternative roads. Your answers will be kept strictly confidential.