COSTS OF CRASHES IN SOUTH AFRICA

Research and Development Report
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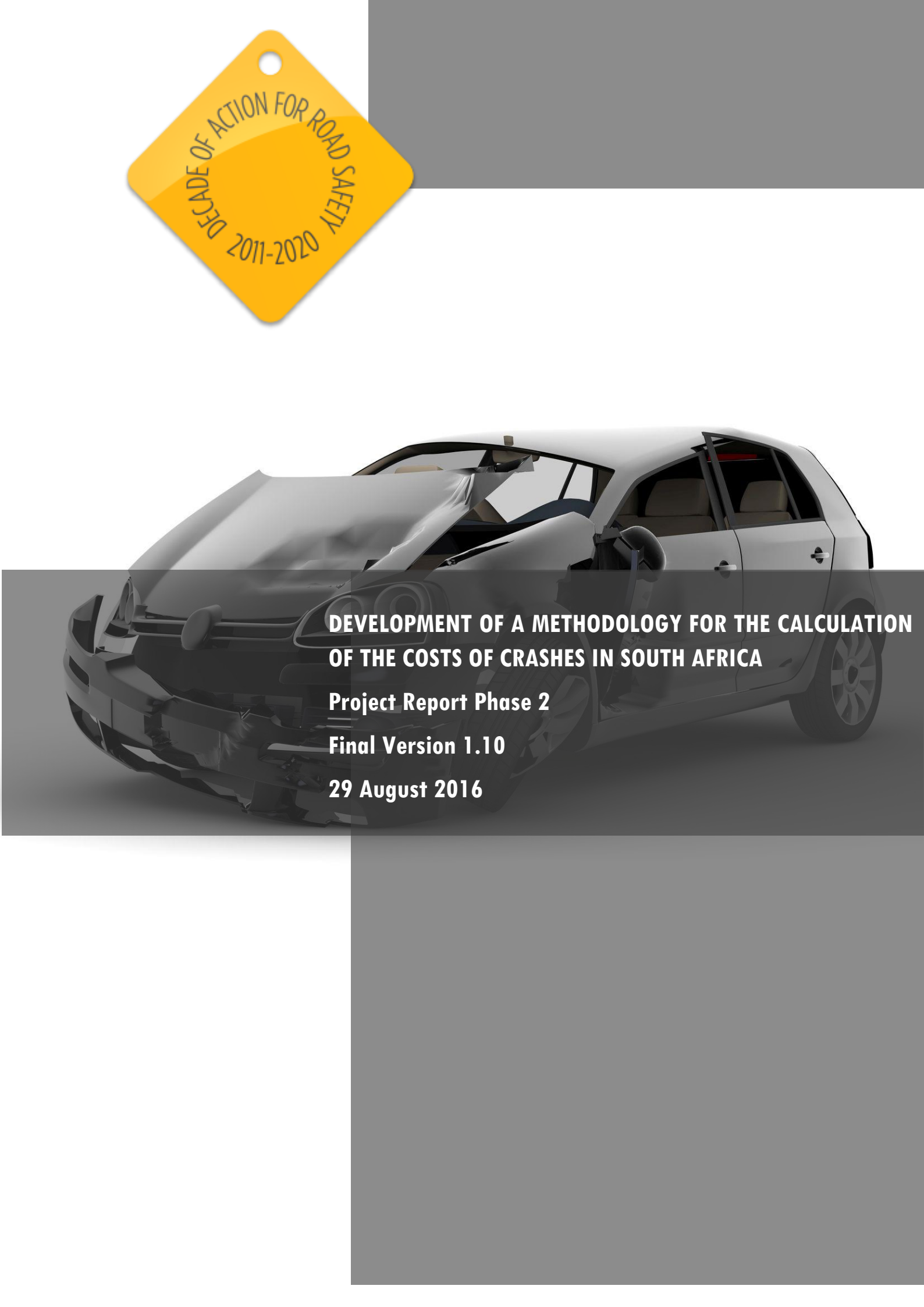

DEVELOPMENT OF A METHODOLOGY FOR THE CALCULATION OF THE COSTS OF CRASHES IN SOUTH AFRICA

Project Report Phase 2

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EXECUTIVE SUMMARY

The high number of Road Traffic Crashes (RTCs)[1] and their associated consequences have a significant impact on the South African society which continues to hamper socio-economic development and impact on the well-being of all South Africans. This impact is measured in terms of human lives lost, 'pain, grief and suffering', as well as an increasing cost to the economy.

The 'total cost of RTCs' metric is an important road safety indicator that serves as the departure point for understanding the extent and magnitude of the road safety problem in a country. On a national level, reported as a percentage of the Gross Domestic Product (GDP), the RTC cost estimation relates to the consequences RTCs have on the economy and social welfare of a country. It is part of country profile statistics, reported annually, providing a ranking scale of the comparative road safety performances of countries. Knowing the cost of RTCs on a national level serves to internalise the road safety scourge and to encourage role-players to take ownership of the problem that needs to be vigorously managed.

RTC cost estimation comprises three main cost categories, viz., human casualty costs, vehicle repair costs and incident costs. Understanding the cost elements of these cost categories facilitates informed decision-making for designing and implementing appropriate actions and interventions aimed at reducing RTCs and their impacts.

The main reference for estimating RTC costs in South Africa had been the report "The estimation of unit costs of road traffic accidents in South Africa", prepared by the Council for Scientific and Industrial Research Council (CSIR) and published by the Department of Transport in 2004 - hereinafter referred to as "Cost of Crashes 2004" (CoC 2004). The CoC 2004 methodology produced a variety of unit cost tables, useful for benefit/cost evaluation of road safety programmes and projects targeting of specific types of RTCs and victim groups, but did not adequately address the social and environmental cost elements and the methodology was generally viewed as cumbersome to apply. With the lapse of a decade, the Road Traffic Management Corporation (RTMC) commissioned the evaluation and review of CoC 2004. The overarching objective of the project was to develop a more user-friendly methodology that would more appropriately account for the local realities of the social and indirect cost of RTCs in the South African context. It also aimed to be in line with the 'Safe

[1] The term 'road traffic crash' with its acronym 'RTC' is intentionally aligned with the definition as in SANS/ISO 39001 and is used throughout this report. 'Road Traffic Crash' imparts the same meaning as "accident" noted in the National Road Traffic Act, Act 93 of 1996.

System' approach which is the basis for the five pillars of the United Nations Decade of Action for Road Safety 2011-2020 (DoA) as well as of the National Road Safety Strategy 2016-2020 (NRSS).

The first phase of the project updated the RTC unit cost tables of CoC 2004 using the RTMC's 2015 fatal RTC dataset and other appropriate cost elements relating to human casualty, vehicle repair and incident related costs. Where no new or updateable data were available, CoC 2004 data were updated using appropriate consumer price indices. The methodology was benchmarked against international practices to determine relevancy and completeness. Potential additional variables were identified to be included in the second phase which focused on the development of a 2016 methodology with 2015 as the base year (referred to as CoC 2016). International trends and best practices for calculating the social cost of RTCs were reviewed, and in some cases the results from credible studies were used as surrogate input values in the calculations model.

In 2015, a total of 12 944 fatalities in 10 613 fatal RTCs were recorded by the RTMC. Currently, only fatal RTCs and fatalities are recorded annually and therefore the other RTCs and RTIs were estimated from historical data. Under-reporting of RTCs is a worldwide problem that varies substantially among countries. A meta-analysis of 49 studies in 13 countries (European Road Safety Observatory, 2009) found that the mean reporting level according to the 30-day rule was 95 per cent for deaths.

The number of deaths and fatal RTCs were thus increased by 5 per cent to account for under-reporting. The figures used in this study are indicated below.

Number of RTCs and RTIs for 2015, adjusted for underreporting					
	Fatal	Major	Minor	Damage only	Total
Number of RTCs	11 144	40 117	132 609	648 560	832 431
	Death	Serious	Slight	No injury	Total
Number of persons	13 591	62 520	202 509	1 429 794	1 708 414

The total cost of RTCs on South Africa's road network for 2015 amounted to an estimated R142.95 billion - equating 3.4 per cent of GDP.

The breakdown of the total cost of RTCs by cost element and by severity is provided in the table below:

Cost Category	Total Cost of RTCs (R million)					
	Fatal	**Major**	**Minor**	**Damage only**	**Total**	**%**
Human Casualty Costs	58 332	24 794	14 546	1 358	99 030	69.3
Vehicle Repair Costs	218	809	2 902	17 395	21 326	14.9
Incident Costs	2 018	5 113	2 740	12 723	22 595	15.8
Total Cost	***60 569***	***30 716***	***20 189***	***31 477***	***142 951***	

Although it is difficult to directly benchmark South Africa's performance against other countries as costing methodologies differ from country to country, it is clear that South Africa is not performing favourably. The average cost of RTCs in comparable low- and middle-income countries is 2.2 per cent of their GDP while the average for high-income countries is 2.6 per cent of their GDP (varying between 1.0 and 4.6 per cent).

The following table summarises the unit cost per RTC and the unit cost per person by RTC and RTI severity respectively. These unit costs are commonly used in economic evaluation of road safety interventions.

Unit Cost per RTC (Rand)				
Fatal	**Major**	**Minor**	**Damage only**	**Any severity**
5 435 261	**765 664**	**152 244**	**48 533**	**171 727**
Unit Cost per RTI (Rand)				
Death	**Serious**	**Slight**	**No injury**	
3 916 187	**423 858**	**71 352**	**1 085**	

Further development of a RTC costing methodology would ideally be based on consistent and reliable RTC data on a national level. In the absence of this, strategies will have to be developed to simulate RTC statistics (as was the case to a large extent with CoC 2016) as part of a future strategy. The reporting and recording of RTCs need to be pursued with austerity as under-reporting continues to be a problematic element of RTC costing. Currently, it is uncertain what the level of under-reporting of RTCs in South Africa is.

The CoC 2016 calculations model contains metrics that need to be updated on a recurring annual basis as the availability and accessibility of RTC cost data more relevant to the South African context improve. Much of this will not necessarily be realised through top down demands on stakeholders for data, but through transformation to a road safety 'results focus'[2] paradigm with self-manifested shared responsibility across sectors. This paradigm shift is likely to be solely dependent on credible road safety governance and convincing leadership.

The total 2015 cost figure derived from the CoC 2016 study for South Africa (R 142.951 billion) should be the point of departure for the systematic change of the road traffic safety management system (RTSMS) to become 'results focus'. This includes informing policy and strategy development, facilitating improved coordination among stakeholders and allocating funds and other resources aimed at effectively curbing the road traffic safety problem. CoC 2016 provides evidence regarding the extent and magnitude of road traffic crashes that enable local and provincial authorities to mobilise road safety action plans that could potentially be included in Integrated Development or Transport Plans. By contextualising these costs, improved predictions can be made, targets set and monitored. In addition, the CoC 2016 results should be used to prioritise specific research and development programmes aimed at reducing specific crash costs. This will assist in ensuring that the implementation of the NRSS is efficient and effective.

The CoC 2016 results provide an improved picture of the road safety burden carried by each stakeholder and should be used to delineate road safety roles and responsibilities across sectors as stakeholders can now be held accountable for road safety actions within their domain. Stakeholders can measure progress towards reducing the impact that crashes have on specific sectors. Understanding this cost according to different sectors and domains assist in coordinating different stakeholders and to establish partnerships according to which resources can be allocated appropriately for maximum effectiveness. The acceptance of this monetisation of RTC costs as a measure of the real burden on the socio-economic development of the country should go hand-in-hand with accepting accountabilities and responsibilities for taking actions with an emphasis on the need to focus on the achievement of road safety results through effective implementation of the 'Safe System' underpinned by the RTSMS framework.

[2] To achieve road safety 'results focus' is the overarching institutional management function of the RTSMS framework (Bliss and Breen, 2009, SANS/ISO 39001).

ACRONYMS

AAA	Automobile Association of America
AASHTO	American Association of State Highway and Transportation Officials
B/C	Benefit/Cost
CBRTA	Cross Border Road Agency
CCDSTM	Crash Costing Data Source Traceability Matrix
CEO	Chief Executive Officer
CoC 2004	Report on “The estimation of unit costs of road traffic accidents in South Africa”, DoT 2004
CoC 2004/2015	CoC 2004 methodology applied to 2015 data
CoC 2016	Development of methodology for calculating the cost of crashes in South Africa 2016
CMF	Crash Modification Factors
CPI	Consumer Price Index
CODES	Crash Outcome Data Evaluation System (USA)
CSIR	Council for Scientific and Industrial Research
DALY	Disability-Adjusted Life Year
DoA	Decade of Action for Road Safety 2011-2020
DoH	Department of Health (SA)
DoHA	Department of Home Affairs (SA)
DoL	Department of Labour (SA)
DoT	Department of Transport (SA)
DFID	Department for International Development
ETSC	European Transport Council
ERS	Emergency Response Services
EU	European Union
FEVR	Federation of Road Traffic Victims (European)
FHWA	Federal Highway Safety Administration

GDP	Gross Domestic Product
GRSP	Global Road Safety Partnership
HC	Human Capital method
IMFs	Institutional Management Functions of the RTSMS
iRAP	International Road Assessment Programme
IRR	Internal Rate of Return
KOTI	South Korea Transport Institute
MRC	Medical Research Council (South Africa)
NHTSA	National Highway Traffic Safety Administration (USA)
NRSS	National Road Safety Strategy 2016-2020 (RSA)
NZ	New Zealand
OOP	Out-of-Pocket (expenses)
QALY	Quality Adjusted Life-year
RAF	Road Accident Fund (South Africa)
RCIS	Road Crash Information System (Australia)
RFA	Road Freight Association
ROI	Return on Investment
RTC	Road Traffic Crash
RTI	Road Traffic Injury
RTMC	Road Traffic Management Corporation (South Africa)
RTSMS	Road Traffic Safety Management System
SAIA	South African Insurance Association
SANRAL	South African National Roads Agency Limited
SAPS	South African Police Services
StatsSA	Statistics South Africa
SIP	Sickness Impact Profile
SWTRADA	Swedish Traffic Accident Data Acquisition
STRADA	Standardization of Traffic Data Transmission and Management
SWOV	Stichting Wetenschappelijk Onderzoek Verkeersveiligheid

	Institute for Road Safety Research (Netherlands)
TRB	Transportation Research Board
TRL	Transport Research Laboratory (UK)
UK	United Kingdom
UN	United Nations
URS	User Requirement Specification
US	United States
USA	United States of America
VISU	Victorian Injury Surveillance Unit (Australia)
VSL/VOSL	Value of a Statistical Life
WAN	Wide Area Network
WHO	World Health Organisation
WTP	Willingness-to-Pay method
YLD	Years Lost due to Disability

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1 INTRODUCTION

1.1 Background to the project

Road Traffic Crashes (RTCs)[1] have a significant impact on the South African society. This impact is measured in terms of human lives lost, 'pain, grief and suffering', as well as the increasing cost to the economy. The high number of RTCs continues to hamper socio-economic development and impact on the well-being of South Africans.

Up to 1999, the Department of Transport (DoT) was responsible for road safety in South Africa. The Road Traffic Management Corporation (RTMC) came into existence in 1999 through the Road Traffic Management Corporation Act, Act 20 of 1999 (RTMC Act) with the aim of fulfilling the road safety function in South Africa. Section 18 of the RTMC Act outlines the 10 functional areas for which the RTMC is responsible. One of these functional areas is road traffic information. The RTMC has since been responsible for the collection, analysis and dissemination of RTC information of which the costing of RTCs is considered a sub-component.

The Council for Scientific and Industrial Research (CSIR) has been estimating the unit cost of RTCs periodically since 1962 and the methodology has continuously been developing throughout this period. The most commonly used procedure for the human costs associated with RTCs was developed in 1991 and is based on the "Human Capital" (HC) or "Gross Output" approach that equates the value of a human life to the discounted market value of the output produced by an individual over an expected lifetime. In 1999, the United Kingdom (UK) Department for International Development (DFID) conducted a scoping study that concluded that the HC approach to account for direct costs, loss of output and cost of 'pain, grief and suffering' was at that stage deemed appropriate for use in developing countries. However, deficiencies were identified in the RTC costing methodologies used, especially in its application in developing countries. DFID concluded that more effort should go into improving the estimates of the cost components and into the inclusion of the cost of socio-economic impacts on the families of victims. One of the case studies was conducted in South Africa by a joint CSIR, Ross Silcock and Transport Research Laboratory (TRL) team in 2001.

In 2003 the DoT appointed the CSIR to review the methodology to allow for the inclusion of unit costs for RTC victims according to age groups and severity of Road

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Traffic Injuries (RTIs), and unit costs for the number of vehicles involved by vehicle type and by type of RTC (also considering rural and urban differentiation). The results of the 2001 study were incorporated into this study, which was completed in 2004 and documented under the title “The estimation of unit costs of road traffic accidents in South Africa” (De Beer and Van Niekerk, 2004) - hereinafter referenced as “Cost of Crashes 2004” (CoC 2004).

The outcome of the research contained in CoC 2004 was two sets of unit cost tables. The first reflected the human casualty costs and the second vehicle damage and incident costs. These tables were used to calculate RTC costs for the various types of RTCs, various types of vehicles involved and age groups of the victims for urban and rural areas.

1.2 Purpose of this project

In 2015, the RTMC identified the need to review and evaluate the CoC 2004 estimation of the unit cost of RTCs. CoC 2004 has been the main reference for RTC cost evaluations in South Africa and was due for review with the lapse of a decade since its publication. The RTMC commissioned the CSIR to conduct a study to address the need for review of the RTC cost estimation methodology.

The project, ‘Development of methodology for calculating the cost of crashes in South Africa 2016’, was structured in two phases.

Phase 1 entailed the updating of the RTC unit cost tables by applying the CoC 2004 methodology to available RTC and other 2015 data. This phase is hereinafter referenced as CoC 2004/2015. Phase 2 entailed the development of a “Cost of Crashes 2016” (CoC 2016) methodology for RTC cost estimation in South Africa. During Phase 2, methodological developments in international RTC costing approaches were considered. The review took cognisance of the context of these approaches and the transferability of international input values to allow for acceptable adaptation for local conditions. Shortcomings of the CoC 2004 RTC cost estimation formulation include the complexity of application of the method and deficiencies related to social or indirect costs of RTCs in South Africa. The second phase therefore needed to progress to address these shortcomings. Some of the objectives of the CoC 2016 methodology were to be more user-friendly in its application than CoC 2004, to be more suitable for South African conditions and to take into account relevant issues not previously incorporated. A case in point is the ‘Safe System’ concept that is the basis for the five pillars of the United Nations Decade of Action for Road Safety 2011-2020 (DoA) as well as the South African National Road Safety Strategy 2016-2020 (NRSS). CoC 2016 thus needs to support processes that facilitate the implementation of the ‘Safe System’ approach in its progressive development trajectory.

1.3 Research scope

The CoC 2004/2015 project report provides an overview of the RTC cost methodology used in South Africa since its inception. CoC 2004/2015 summarises the theoretical background of the CoC 2004 RTC cost formulation and provides a synopsis of the procedures followed in estimating and updating the unit cost of RTCs.

Phase 2 entails the development of CoC 2016 for costing RTCs in South Africa. This CoC 2016 report is organised in five chapters - each describing the contribution of a different aspect to the development of the CoC 2016. Chapter 2 provides a summary of findings and recommendations of CoC 2004/2015. This serves as a platform for the development of the CoC 2016 (the objective of Phase 2). Chapter 3 provides an overview of the research approach and methodology for the project. Chapter 4 describes the development of the CoC 2016 methodology and requirements, provides the results of the costing study and discusses the application thereof. Chapter 5 provides a way forward in terms of sustaining the CoC 2016 methodology as well as recommendations for improving the metrics of the methodology.

2 SUMMARY OF PHASE 1 FINDINGS: INFORMING THE DEVELOPMENT OF CoC 2016

2.1 Update of CoC 2004 tables

The CoC 2004 estimated:

- Human casualty unit costs based on the value of lost output or productivity, making use of the average life expectancy, employment rate and income of the population (according to age group and gender).
- Vehicle damage and incident unit costs according to type of vehicle and type of RTC.
- RTC and RTI costs relating to urban and rural areas.

A dataset on road traffic deaths and fatal RTCs for the 2015 calendar year were obtained from the RTMC. Currently, this is the only recent official RTC and RTI data available. Some indication of urban/rural split is inferable from the data. The numbers of serious and slight RTIs and damage only RTCs were estimated based on historic data.

Stakeholders that could potentially provide the same datasets used to calculate the various cost elements during the previous study were identified. Key stakeholders include the Road Accident Fund (RAF), the South African Insurance Association (SAIA), Department of Health (DoH), emergency response services (ERS), South African Police Services (SAPS), metropolitan police services, etc. Stakeholders received letters outlining the purpose of the research and the type and format of data

requested from them. Although every effort was made to regularly follow up with stakeholders, no useful data could be obtained in time for the preparation of the CoC 2004/2015 report. There are, however, understandable reasons for data not being available from stakeholders identified as data sources within the time of the project. These reasons include, among others, no formalised processes to extract data from both operational and financial business systems, uncertainties about the use and application of the data and the publication of the data or the inferred information, confidentiality, security, etc. In the absence of new data, appropriate consumer price indices (CPI) were used to update the different cost items[2].

One of the cost elements for which 2015 input values were available, was lost productivity. First, future and present productivity values per age group were recalculated from income and labour force statistics obtained from Statistics South Africa (StatsSA). Life expectancy data was obtained from South African life tables published by the World Health Organisation (WHO). Lost future and present productivity values were then calculated by taking the expected age distribution of RTIs into account.

In line with the CoC 2004 report, unit cost tables for human casualty costs according to age group (for urban and rural areas) were prepared. The RTC unit cost tables according to RTC type and vehicle type (for urban and rural areas) were also indicated – these include vehicle damage costs and incident costs. The total crash cost for 2015, using the CoC 2004 methodology, was calculated. This amounted to R 112.78 billion.

2.2 Phase 1 Conclusions

RTC data:

Comprehensive RTC statistics were available when the CoC 2004 study was first conducted. Updating the unit RTC cost tables in Phase 1 required the estimation of non-fatal RTC and RTI statistics. It may be some time before reasonable reporting on non-fatal RTCs can be anticipated and therefore, a methodology that relies on detail data is likely to encounter problems with respect to practicality.

RTC cost elements:

The cost elements included in CoC 2004 were in line with the Human Capital (HC) approach, while it also included some measure of ‘pain, grief and suffering’, and losses to the family of the victim. CoC 2004 was thus essentially a HC ‘hybrid’ method. However, social costs were considered largely under-estimated as they did not take into account, for instance, the loss of education opportunities in child-headed

[2] Refer to COC 2016 Phase 1 report for a detailed discussion of the cost elements

households after the death of a breadwinner, or the psychological trauma that accompanies permanent disability. Also, CoC 2004 did not focus sufficiently on damage to property, cost of traffic delays and the environmental impact of RTCs, such as the cost of additional carbon emissions caused by congestion.

Data availability and accessibility:

Data availability: Collecting, or making available, costing data is not generally a priority for any of the key data owners. Operational and cost data are not integrated, making it difficult to collect the data in required formats.

Multiple owners of data: Currently RTC cost data are sourced from different stakeholders. Multiple owners of data complicate the collection of data as stakeholders collect different types of data, for different purposes and currently there is no standardised approach to guide the collection or formatting of data.

Quality and reliability of data: Even if data is available there are no quality assurance systems in place for verifying data, no prescribed guidelines or procedures to validate the data or to ensure the quality of the data in terms of duplicate values, etc.

Data collection processes can be top-down or bottom-up, each producing different results. Collecting detailed empirical data is expensive and does not necessarily produce a more accurate end result, as RTC costing is generally based on projected average values.

Using robust values derived from international research or alternative reliable sources may produce a quicker, less expensive but just as accurate result. As an example, the International Road Assessment Programme (iRAP) values for Value of a Statistical Life (VSL) could be used as an alternative to the value for loss of future productivity and quality of life.

Complexity of the methodology:

CoC 2004 produced estimated RTC unit cost values for different age groups of RTC victims, RTC vehicle types and RTC types with an urban/rural split for each. These values apply to calculating total costs from a health or a transport perspective, but they are also applied to estimate RTC costs at a more localised or project level for purposes of, for example, benefit-cost analysis - which was in fact the main intent of the methodology. One of the main criticisms of the methodology has been its complexity, which is likely related to the difficulty of deriving RTC cost values by RTC severity as had been a typical output of the methods used prior to 2004.

Use of results:

The results of RTC cost estimation should be useable by a variety of users and add value to road safety-relevant decision-making processes. Results should not only be quoted to indicate the burden of road safety on a country's economy but should be used to motivate more effective spending on interventions, road safety operations and

on transport system management that can contribute to reducing risks of RTCs and RTIs.

The development of a user requirement specification (URS) should aid this process. As a forward looking concept, the URS is dependent on the progress made towards achieving the desired focus on road safety results among stakeholders.

Recommendations for Phase 2:

Phase 1 concluded with the following recommendations to inform the development of CoC 2016:

- 2016 methodology should measure the whole spectrum of economic, social and environmental costs.
- CoC 2016 methodology should ideally be based on a consistent, comprehensive and reliable set of national RTC data containing data elements that indicate severity of RTCs and RTIs; road user gender and age; date, time, type, location and road condition per RTC; and factors contributing to each RTC.
- In the absence of accurate and reliable RTC data, RTC statistics have to be estimated/simulated. Simulated RTC statistics should take into account some measure of under-reporting.
- CoC 2016 needs to take into account the availability, quality and reliability of data required to calculate the costs of the various elements. Since elaborate and potentially costly data collection exercises do not necessarily yield better results in the contexts for which RTC cost values are required, more cost-effective strategies to derive suitable information could be explored. As an example, better use could be made of annual statistics published through entities such as StatsSA or the results from international studies that provide sound values based on comprehensive research. Results from local micro-costing studies could also be considered.
- CoC 2016 should be easy to understand and apply (user-friendly), and produce timely and relevant results. A stakeholder analysis should be conducted to inform the development of a user requirement specification that will assist with simplified and more user-friendly application options. One of the applications of CoC 2016 should be to facilitate economic analysis of interventions.
- Statistical methods and international trends could be considered as options to fill in, or serve as surrogates for, information that may not be directly available. Although CoC 2016 would aim to be valid for a period of 10 years, it should be easily and inexpensively updateable on an annual basis. There should be a continuous process to assess opportunities to replace fill-in or surrogate information with values from local research when such become available.

- CoC 2016 should support implementation of the 'Safe System' approach and of a road traffic safety management system (RTSMS) (Bliss and Breen, 2009) with a focus on achieving the desired road safety results.

The Phase 1 report was submitted for peer review to key role-players. General feedback revolved around the need for the final report to be published for application by the roads planning and operations fraternity and other relevant users.

3 PHASE 2 RESEARCH APPROACH

3.1 Introduction

CoC 2004-unit cost tables were updated in Phase 1 to enable comparison of total crash costs using both CoC 2004 and CoC 2016 methodologies. At the same time, the opportunity presented itself to benchmark the ten-year old methodology against more recent international practices to determine relevancy and inclusiveness as well as identification of additional variables for determining cost of RTCs. Data collection and stakeholder interactions in pursuit of possible data to update CoC 2016 was continued throughout the project. Due to the data challenges that became more and more evident, a crash cost data source traceability matrix (CCDSTM), which was constructed in Phase 1 of the project. It serves as a dynamic data collection framework. The CCDSTM aims to guide and track the data sourcing effort among the various road safety-relevant data stakeholders. Throughout the process it became clear that obtaining the required data will not necessarily be realised through top down demands on stakeholders for data, but through transformation to a road safety 'results focus'[3] paradigm with self-manifested shared responsibility across sectors, which is likely solely dependent on sound road safety governance and convincing leadership.

3.2 Literature review

During Phase 2 an additional literature review was conducted to:

- re-affirm the importance and purpose of calculating the cost of RTCs at a national and local level;
- evaluate the advantages and disadvantages of alternative approaches used elsewhere in the world, with particular reference to relevance for South Africa conditions;
- assess practices for including cost elements that were previously excluded;

[3] To achieve road safety 'results focus' is the overarching institutional management function of the RTSMS framework (Bliss and Breen, 2009, SANS/ISO 39001).

- identify appropriate surrogate input values from reliable international sources and determine the transferability of those to the South African context, and
- determine how CoC 2016 could be developed and implemented in line with the 'Safe System'.

The literature review considers various approaches in use internationally to estimate RTC costs. It is, however, evident that there are as many variations of RTCs costing methods as there are countries applying the methods. A common thread in the literature, from different countries and universal to most approaches to RTC cost estimations, is the difficulty in sourcing appropriate and reliable data. For any RTC costing methodology to be sound and consistent, it may have to consider applying simulation approaches rather than relying on intensive and expensive sourcing exercises to obtain empirical data, which may have to be repeated periodically. The RTC costing model should be based on a set of robust, easily updateable values. Ultimately, as the 'Safe System' becomes more internalised, the potential for in-process generated road safety-relevant data becoming more accessible in format and content, is likely to significantly improve.

As important as the content of the methodology is, so is the purpose of, and context in which it is going to be applied. With this in mind, CoC 2016 for South Africa has been developed taking cognisance of South Africa within the context of the 'Safe System' that forms the basis of the DoA and on which the NRSS is founded.

3.2.1 Overview of the evolution of RTCs and RTC cost estimation

RTC crash cost estimations exist since the 19th century when 'accidents' between horses or horse drawn vehicles occurred where mostly these carts ran over pedestrians (ROSEBUD Thematic Network, 2006). Until recently, society as a whole, was too willing to accept the toll from these RTCs. RTCs being an apparent and inevitable consequence of the advances in / of mobility (AAA, 2007). The difference, now, is that the thinking has shifted and there is wider recognition that these costs are unacceptable and that system-wide measures to reduce RTCs and the associated costs needs to be introduced accordingly (ROSEBUD Thematic Network, 2006).

RTCs and their associated consequences have been discussed since the dawn of the automobile age with the first two traffic deaths registered in Great Britain in 1896 and one in the USA in 1899 (Borowy, 2013). Initially, motor vehicles (mainly due to speed and reckless driver behaviour) were regarded as a danger by other road users (whom were mostly pedestrians), with the driving population in the 1910s and 1920s finding it increasingly difficult to defend an increasingly negative image (Borowy, 2013). The mass production of motor vehicles during the Second World War changed perceptions and after the war owning and driving a motor vehicle was no longer seen as just a status symbol but a necessity (Borowy, 2013). With increases in motorisation levels, road traffic deaths escalated. In the 1950s mass motorisation changed injury and

death patterns as the majority of RTCs were no longer with pedestrians but increasingly between two or more motor vehicles (Borowy, 2013). Views regarding the causes of RTCs progressively focused on the human element with humans required to adjust their behaviour to ensure road and traffic safety. RTCs were considered a dysfunction of system, caused by individual traffic participants who were insufficiently adapted to the demands of modern life (Borowy, 2013).

The WHO started to recognise road traffic deaths as a burden of disease in 1958 and started to classify it as such. The first study, 'Accidents and Their Prevention' was commissioned by the WHO in 1961 (Borowy, 2013). This study cautioned that young people in particular, were the most vulnerable. For the first time in history recognition was given to the loss of young lives, 'as being 'a serious economic loss to the community' (Borowy, 2013: 116).

Despite the acknowledgement that road traffic deaths were impacting economies negatively, the importance of the automobile industry as a key facilitator for economic development became clear. For this reason, the 1960s marked an era where the *'cost of 20 lives lost for every 100 000 people seemed an acceptable price for the benefit of modernisation'*. A number of events led to a change or shift in thinking most notably the rising death tolls and that motor vehicle manufacturers were not prioritising safety and was thought to be held accountable for the many road deaths. Initially technical manufacturing solutions were considered the primary interventions. However, in the 1970s the WHO started focusing on addressing behaviour. By this time the economic, environmental and social costs associated with road traffic was clear as cities had to modify urban centres to alleviate congestion as well as RTCs (Borowy, 2013). According to the European Commission (2015), this period also marked the beginning of calculating the 'costs of road traffic'. Inclusions in this first analysis considered impact on travel time, vehicle operating costs and later RTCs. (European Commission, 2015). Initially the HC approach, which assigned a value to preventing a fatality or an injury proportional to the value of production lost, was used. However, the problem with this approach was that economically inactive people (children or the retired) did not have a monetary or market value (European Commission, 2015).

The Willingness-To-Pay (WTP) approach was first introduced by Schelling in 1968 followed by Mishan in 1971. This approach was used to estimate the value of lost quality of life and society's 'willingness-to-pay' for reduced risk and improved quality of life.

In an attempt to facilitate economic development in low and middle income countries, in the 1980s the World Bank initiated a focus on approaches that could potentially eradicate health issues, especially in low and middle income countries. The Global Burden of Disease Project introduced 'Disability Adjusted Life Years' (DALYs) as new measurement unit. DALYs combined mortality, morbidity and injury into a single

number. These metrics were intended to encourage impoverished countries to start considering RTCs as a serious health issue (Murray, 2003).

In line with the thinking of the time, rather than focusing on infrastructure provision to safeguard pedestrians and other non-motorised transport users, characteristic of Africa (Borowy, 2013) World Bank projects focused intensively on road infrastructure investment. This investment was aimed at economic development, as motorised traffic and improvements to the traffic system were at that stage the norm. World Bank projects continued to invest in infrastructure and development projects promoting safe driving. The irony, however, was that it was the people who could not afford vehicles, who have borne the brunt of the disease (Borowy, 2013).

In 1998 the International Federation of Red Cross and Red Crescent Societies warned of imminent disaster if RTCs are not addressed as a priority. In response the Global Road Safety Partnership (GRSP), consisting of large corporations where funds for road safety projects were established, funded and allocated to road safety projects (Borowy, 2013).

Late in the 1990s research into the use of the Kutznets curve, developed in 1955, revealed that economic growth was 'not only associated with growing numbers of motor vehicles in the population, but also seems to stimulate adaptation mechanisms, such as improvements in the traffic infrastructure and trauma care' (Borowy, 2013). The implication was that *economic growth itself can lead to a reduction of RTCs, making a rise in Gross Domestic Product (GDP) the best strategy to reduce the burden of road traffic deaths and injuries* (Borowy, 2013: pp. 125). Curiously, research by Bishai et al. in 1992 found that a 10 per cent increase in GDP in low income countries, increased RTCs by 4.7 per cent while increases in GDP in high income countries reduced RTCs. This again facilitated a shift in thinking and research. The University of Michigan suggested that lives could be saved by reducing either vehicles per capita or the fatalities by vehicle. Both would save lives but, unfortunately due to the dependence on the automotive industry, the thinking was that vehicles per capita are linked to economic growth and that the focus should be on reducing fatalities per vehicle (Borowy, 2013). In 1999 Sweden (Rumar) advocated a system-wide intervention where instead of accepting the need for motorised traffic as a given and focusing on ways to reduce its health price, strategies should focus on the underlying purpose of traffic (transportation and mobility) and the biological vulnerability of the human body to external shock, and combine benefits with least sacrifice.

This approach was adopted in the WHO five-year strategy for road safety which facilitated studies to inform the World Report on Road Traffic Injury Prevention, a WHO report, published in 2004. This was the first authoritative report on RTCs and injuries with specific recommendations as to what government, policy, legislation and enforcement, the public, vehicle manufacturers, donors, communities, civil society groups and individuals could do to improve road safety. For the first time RTC

prevention has been considered a shared responsibility (Borowy, 2013). The United Nations Road Safety Collaboration came into existence to implement the recommendations of the World Report. This led to the United Nations (UN) General Assembly in March 2010 to proclaim the period 2011–20 as the Decade of Action for Road Safety.

3.2.2 The 'Safe System' and RTC costs

The DoA strategy aims to stabilise the growing number of RTCs and to reduce the number of fatal RTCs by half over a ten-year period (WHO, 2013). The five pillars of the DoA aim to facilitate the design and implementation of interventions that will build capacity for road safety management, improve the safety of traffic-related infrastructure, improve the inherent safety of vehicles through better designs as well as enhancing the behaviour of road users and improving post-crash care (Buttler, 2014).

The DoA as a strategy, aims to assist countries to focus on the achievement of road safety results. Pillar 1 puts in place institutional management functions key to achieving road safety 'results focus'. Pillars 2 to 5 provide the recommended activities for the achievement of safer roads and mobility, safer vehicles, safer road users and improved post-crash response as a guide for the implementation of targeted programmes and interventions that will influence the results and ultimately contribute to achieving a vision of drastically reduced road traffic casualties.

The cost of RTCs to a country is the departure point for the development of a national road safety vision and long-term strategy to curb and minimise the magnitude and impact of RTCs on the country. Without a clear understanding of this RTC costs it is difficult to propagate, plan, design and implement activities and interventions that are focused on preventing RTCs, deaths and injuries. As a signatory to the DoA, South Africa needs to report on the progress made in terms of reducing RTCs and RTIs. Determining the cost of RTCs is also a tool or indicator to measure progress in terms of the reduction of RTCs, the number of fatalities and injuries, as well as the impact that specific interventions has on reaching targets.

The 'Safe System' approach forms the basis for the supporting actions of the DoA (Buttler, 2014) as described in the following quote from the Global Plan for the Decade of Action for Road Safety 2011-2020 (World Health Organisation, 2011, pp. 8): "*This approach aims to develop a road transport system that is better able to accommodate human error and take into consideration the vulnerability of the human body. It starts from the acceptance of human error and thus the realization that traffic crashes cannot be completely avoided. The goal of a safe system is to ensure that accidents do not result in serious human injury. The approach considers that human limitations - what the human body can stand in terms of kinetic energy - is an important basis upon which to design the road transport system, and that other aspects of the road system, such*

as the development of the road environment and the vehicle, must be harmonized on the basis of these limitations. Road users, vehicles and the road network/environment are addressed in an integrated manner, through a wide range of interventions, with greater attention to speed management and vehicle and road design than in traditional approaches to road safety.

This approach means shifting a major share of the responsibility from road users to those who design the road transport system. System designers include primarily road managers, the automotive industry, police, politicians and legislative bodies. However, there are many other players who also have responsibility for road safety, such as health services, the judicial system, schools, and nongovernment organizations. The individual road users have the responsibility to abide by laws and regulations" (World Health Organisation, 2011, pp. 8)

Figure 1 below, illustrates how the cost of RTCs fits into the 'Safe System'. South Africa needs to significantly reduce the number of fatal and serious RTCs - realising the result of halving the number of road fatalities by the target year depends on the level of success of the overarching institutional management function (IMF) to achieve road safety 'results focus' - denoted by (a). The baseline RTC and RTI statistics are reported as 'final outcomes' - denoted by (b). The 'social cost' of RTCs is derived from applying the CoC 2016 as the cost estimation of the burden of RTCs (of disease) on the South African society - denoted by (c). Benchmarking the country internationally as well as establishing the impact safety programs and interventions happens as part of the 'results' element of the RTSMS - denoted by (e). Ultimately, (e) is the measure of effectively achieving 'results focus' and of the level of coherency of all the IMFs against the targets that are set for the 'intermediate outcomes' as well as the long term vision of drastically reduced RTI of (a)

The IMFs ('results focus' included) - denoted by (g) (and a link to 'outputs'), inform and direct the 'outputs' as part of (e). The cost of RTCs is a key consideration of policy formation and strategy development as specific outputs. The other measured outputs associated with 'interventions' denoted by (d), are typically designed to progressively establish the 'Safe System' over the long term. RTC cost estimation is thus also intrinsically part of, e.g. the IMF 'monitoring and evaluation' - denoted by (f). This is especially important in understanding the level of impact that road safety interventions and programmes have in terms of reducing fatalities and injuries as well as the impact thereof on the economy. This understanding will lead to (g) (the IMFs), pertinently better 'coordination' and better 'allocation of resources' in order to curb the road safety problem and then to reduce the RTCs and RTIs. It will also provide a means to periodically monitor and evaluate the interventions in terms of their effectiveness in contributing to the achievement of the desired road safety results.

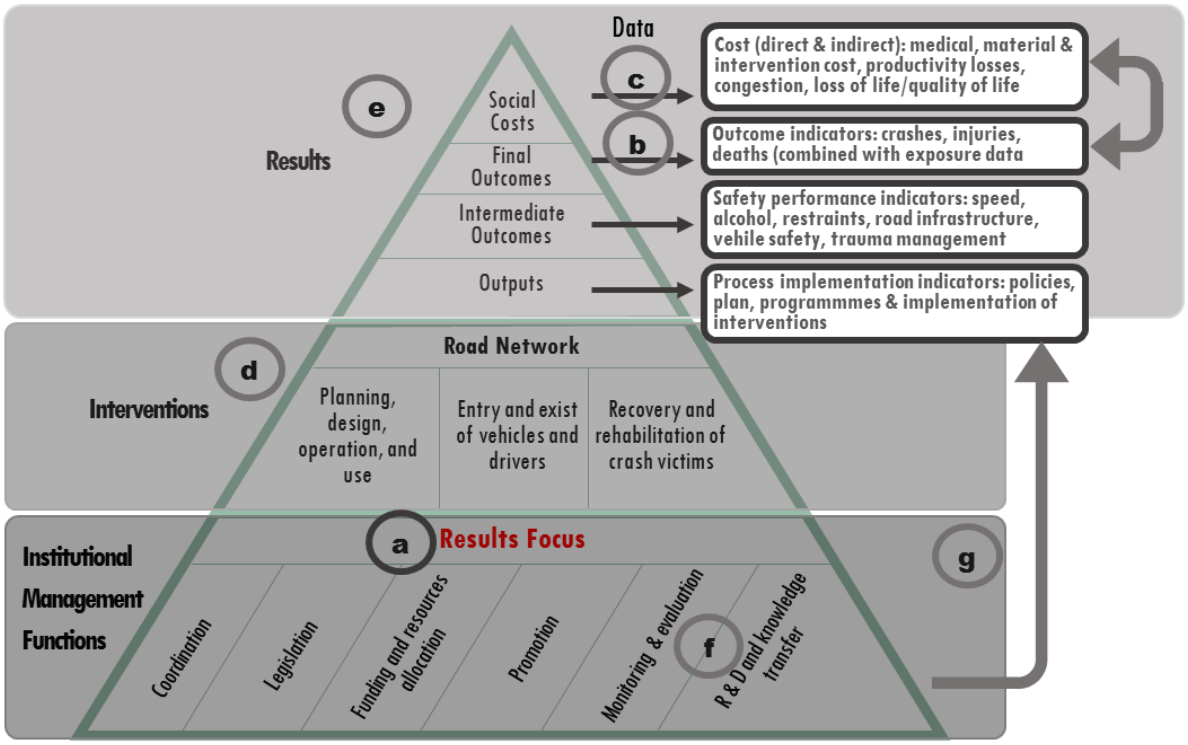

FIGURE 1: TOWARDS A 'SAFE SYSTEM': COST OF RTCS IN THE ROAD TRAFFIC SAFETY MANAGEMENT SYSTEM (ADAPTED FROM BLISS & BREEN, 2009)

The revision of the 2004 RTC cost estimation methodology provides the opportunity for the road safety fraternity to mobilise achieving 'results focus'. Implementing the 'Safe System' effectively, and achieving 'results focus', will result in the dramatic reduction of RTIs, severe injuries and fatalities in particular. It is the reduced RTI count that will ultimately be the measurement of a successful RTSMS. However, a RTSMS requires expending scarce resources in competition with other societal needs and monetisation is the means through which the balancing of diverse demands is settled. Consequently, warrants for road safety actions are to be articulated in monetary quanta. On a system level road safety monetary quanta will serve mainly two purposes:

1) For country-level benchmarking as an indicator of the relative burden of road safety on a country's economy or of the relative safety of a country's road network. Another nuance to this may be that it could indicate the level to which a country's economy is sustained by road safety failure and the level to which a country is deprived of development opportunity.

2) For real introspection purposes so as to take account of the burden of road safety failures on an economy with the intent to take action. These two quanta will not necessarily account to the same monetary value.

Deriving a quantum for 1) requires a methodology to be followed that is sufficiently universal among countries to allow for reasonable country level comparison. It is typically reported as a percentage of a country's GDP (e.g., 2 per cent of GDP). The quantum for 2) can be quite different as it may deploy a methodology that is more specifically attuned to the local contexts. For example, the typical country level quantum may not take account of the level of employment. Countries with high unemployment will have lower valuations of the Value of Statistical Life (VSL) since the earning potential of the unemployed is by implication taken as zero. For introspection purposes a higher VSL may be considered to better account for the cost of deprived opportunity to contribute to, or participate in economic activity.

On the intervention level, the need for quantifying road safety failure is quite different. Higher granularity of cost quanta is needed to conduct benefit-cost analyses and to prioritise viable road safety interventions targeted at increasing safety or reducing risk. Estimations of unit costs of RTCs are thus required to calculate the benefit of increased safety or reduced risk against the cost of investment in road network level interventions.

3.2.3 Purpose of determining the cost of RTCs

Lindberg in 1999 highlighted RTC costs as some of the highest transport costs, presenting a significant challenge to countries struggling to eradicate poverty (Jacobs, 1995). Road safety remains a complex problem in need of multiple solutions (FHWA, 2011). These solutions vary in cost, effectiveness and involve different engineering, education and enforcement approaches in order to manage the problem. The purpose of quantifying the cost of RTCs is therefore multiple but the main reasoning is to inform objective decision-making, not influenced by subjective judgements or political considerations (FHWA, 2011). The cost of RTCs on a national level provide insight into the consequences that RTCs have on the economy as well as social welfare and estimates the return on investment in road safety (Wijnen, 2013). This insight assists governments with the formulation of policy and informed decision-making in terms of interventions aimed at reducing the impact of RTCs. Knowing the cost of RTCs on a national level serves to internalise the road safety scourge and to encourage role-players to take ownership of the problem that needs to be vigorously managed.

RTC cost estimation, at country level, benchmarks road safety performance in comparison with other countries. Different countries have different approaches to calculating the cost of RTCs particularly with regard to loss of unpaid production, property damage other than vehicle damage (particularly damage to infrastructure), human costs of slight injuries, congestion costs and costs of vehicle unavailability (Wijnen, 2013). The comparison of the cost of RTCs among countries assists with understanding the economic burden that each country carries in terms of RTCs (Miller, 2011).

In addition, RTC cost estimation can be used in the economic evaluation of interventions aimed at reducing RTC frequency for specific type of RTCs, which then serves as basis for the prioritisation of road safety improvements programmes and projects. If interventions are introduced, the introduction of RTC frequency and/or severity 'before and after' studies provide a measure of how successful, these measures were. By determining the internal rate of return (IRR) on road safety investments, the development of optimal solutions to road safety problems is further encouraged. RTC costing serves as a monitoring and evaluation tool and is especially important to understand the level of impact that road safety interventions and programmes have in terms of reducing fatalities and injuries as well as the impact thereof on the economy.

In Sweden, Wieser et al. (2009) conducted a benefit-cost analysis of RTC prevention measures implemented between 1975 and 2007 in an attempt to quantify the level of prevention (lives saved) compared to the monetary return on investment (ROI). By focusing investment on proven countermeasures, it is possible to demonstrate measurable results and show a meaningful return on these investments (AAA, 2011). As such, the benefit-cost analysis in Sweden shows the importance of public efforts in reducing road casualties between 1975 and 2007, as most of the measures responsible for this development are a result of public policy (Wieser et al., 2009). These costs are used to motivate for increases in funding for testing and evaluating safety interventions, programmes and should be based on sound scientific principles that allows for systematic evaluation after which resources can be applied more effectively (FHWA, 2011). Economic evaluation of cost of RTCs assists social decision-making to become more efficient (Sund, 2010). By calculating the cost of RTCs it becomes possible to objectively select cost-effective countermeasures for road safety and to justify the expenditures for countermeasures (Mohan, 2002) In addition it informs evidence-based policy making (Wijnen, 2013).

Assessment of costs and defined sources of funding make actions realistic as it assists with determining what interventions are needed as well as what the budget of these essential interventions should be (European Commission, 2013). In addition to increasing transparency and bettering the chances of successful implementation, a dedicated funding stream or budget for road safety also proofs that road safety is being taken seriously at a political level. In the European Union (EU) a common road safety management discrepancy was that funding allocation happens annually while many road safety projects are multi-annual. This creates financial insecurity and increase risks for the implementation of programmes (European Commission, 2013).

3.2.4 RTC cost estimation methodologies - right versus practicable

The various methodologies for calculating the cost of crashes (and their advantages and disadvantages) are described in detail in CoC 2004/2015. The main points are summarised in this section.

Literature highlights a number of ways to estimate RTC costs, but there seems to be little consensus regarding the 'best' method. Most of the methodologies are data-dependent and the use of specific methodologies is mainly attributable to the level to which useable data are available for some RTC cost components (Wijnen, 2013). RTC cost estimation is considered an inexact science (Commonwealth of Australia, 2000). RTC cost estimates depend on particular cost estimation approaches used, the number of RTC cost components that can be estimated, quality and quantity of available data and the value of key parameters, such as the discount rate, used. The calculation of direct and indirect costs of RTCs along with the methodologies used to do so has also been under scrutiny for many years as there is a debate regarding the difficulty in putting monetary values on death, 'pain, grief and suffering' (Mohan, 2002). Sund (2010) confirms that putting a monetary value on a life is a sensitive aspect in many cultures and religions around the world but that the allocation of scarce resources to save lives need to take precedence over the ethical concerns.

Although internationally the WTP approach is generally regarded as the correct method from a theoretical point of view, collecting reliable data has been proved to be very difficult and costly, especially in developing countries (Jacobs, 1995; Mohan, 2002; Donário et al., 2012). Donario and dos Santos (2012) believed that the HC method provides more trustworthy estimates of the social cost of RTCs than the WTP method because of the different format in which questions are posed to WTP respondents. They also believed that the HC method allows for the calculation of cost trends over a number of years based on historic data from several institutions, in comparison with the WTP method that assesses the cost only for the particular year in which the surveys are conducted.

3.2.5 Categories and elements of RTC costing

In order to value the cost of RTCs it is necessary to estimate the total number of RTCs and injuries, and then quantify the cost of specific RTC categories (Risbey et al., 2010). This estimation should include human costs (loss of life; treatment of injuries and ongoing care of persons with disabilities); vehicle damage costs; and general costs such as insurance administration and emergency service costs. These costs can also be described as internal (damage borne by the individual vehicle user), external (damage and risks borne by other road users), and insurance compensation (damage compensated by insurance). Insurance compensation costs are external at the individual level but internal to premium payers as a group (TRB Transportation Economics Board, 2004). This same comprehensive approach was

followed by Litman (Victoria Transport Policy Institute, 2016). Litman referred to RTC costs as market or non-market costs that could be categorized as internal, external or insurance compensation costs.

Hendrie and Miller (2012) investigated the long-term consequences of trauma due to RTCs and injuries in Australia. The consequences were classified according to three categories namely the direct costs of road trauma caused by RTCs (medical expenses, police and legal costs, insurance administration); secondly the indirect tangible costs of road trauma, including the losses in output attributable to premature death, permanent impairment or temporary absence from work caused by RTCs. However, the authors again highlight that no international consensus exist on the approach or methodologies to quantify these aspects. Hendrie and Miller state that conceptually the task of measuring the costs of road trauma is straightforward as it involves multiplying the number of cases of road trauma by the sum of the component costs of road trauma. However, in order to estimate the magnitude of road trauma there is a need for different methodologies in order to fill in information gaps. A key approach is to supplement traditional data with linked data from other sectors.

The European Transport Safety Council (ETSC, 2007) reviewed the socio-economic consequences of RTIs in Europe. Key considerations in this review included the completeness and accuracy of official road accident statistics, the long-term impacts of traffic injury and social disparities in road accident risk. The findings from the review indicated that official RTC statistics were incomplete and inaccurate in all European countries and that very little is known about the long-term impact of road trauma. In addition, the review recommends further research to understand the role that social disparities play road accident risk as the research found that people with low social status tended to have a higher RTC risk than people with higher social status.

More recently Blincoe et al. (2015) conducted an elaborate study to determine the cost of RTCs in the USA. This study considered the cost of fatal, injury and damage only RTCs in terms of lost quality of life, the cost of incidents, congestion costs and costs to the US government. This detailed study also considered the costs of RTCs where alcohol, speed and distracted driving played a role in the RTC and considered non-motorised transport user costs as well as the cost of a motorcycle RTC. In addition, the study calculated the cost of RTCs by roadway location and included special RTC scenarios and the costs associated with intersection RTCs, interstate highway RTCs, single vehicle RTCs and roadway departure RTCs.

3.2.5.1 Social and Intangible costs

In a study conducted by the European Federation of Road Traffic Victims (FEVR, 1997) family members of deceased road traffic RTC victims indicated that immediate and long-term psychological, practical and legal support was essential. This study highlighted that in general, victims that recovered, victims disabled as a result of the

RTC as well as remaining family members were satisfied with the medical and health care received but most felt that criminal proceedings, court proceedings and insurance issues were not handled appropriately by authorities (FEVR, 1997).

Psychological stressors of remaining carers included sleeping problems, headaches, nightmares and general health problems. Victims themselves as well as remaining family members reported increasing use of medicine such as tranquillisers, sleeping tablets as well as alcohol. This study did not try to place a monetary value on this issue but rather highlighted the additional burden that RTCs and RTIs place on victims and remaining family members in the long run (FEVR, 1997).

In addition to the clinical significance of RTIs, it is important to understand the consequences of the financial burden RTIs place on society (Kunmar et al., 2012). In India, public spending on health is low and 'out-of-pocket expenses' (OOP) for the household (often already poor) caring for injured is high. Kunmar et al. (2012) quantified these expenses making use of medical and non-medical information documented for road traffic injury cases that reported alive or dead to the emergency departments of two public hospitals and a large private hospital in India. Findings indicated that these expenses are significant especially in a mostly impoverished community. The average OOP medical expenditure for RTIs were 2.5 times more than average annual medical expenditure suggesting a relatively higher adverse impact of OOP expenditure due to road traffic injuries on a household as compared with other illnesses (Kunmar et al., 2012). In addition, the burden of non-medical expenditure (transport costs, food etc.) is similar to the average medical expenditure for hospitalisation due to any other illness. This implies that RTIs pose a double burden on households.

Hendrie et al. (2012) reviewed different methodologies to provide costs of road trauma and its longer term consequences. In addition to the available RTC statistics and medical information used, the authors indicated that there is a need for supplement data to other data sets, which can provide additional information regarding the long-term consequences of road trauma. By linking core population health datasets (hospital discharge records, mortality data and emergency department data with police casualty records and the claims records of the Insurance companies can potentially address the under-reporting problem in the police RTC data and assist in identification of misclassification of injury severity. It can also potentially provide a more complete understanding of the recovery pathway of casualties who sustain injuries with longer term adverse outcomes (Hendrie et al., 2012).

Examples of countries that have linked RTC and health sets include Australia, Sweden and the USA. The Victorian Admitted Episode Dataset (VAED) is a state-wide collection of data on all admissions to Victorian hospitals. It is collected by the Victoria Department of Health and records every admitted episode for all Victorian hospitals (public and private) while the Victorian Injury Surveillance Unit (VISU) is a repository

for de-identified injury data from Victoria, by the Department of Health (VicRoads, 2013). These datasets are linked with the Australian Road Crash Information System (RCIS).

The Swedish Traffic Accident Data Acquisition (SWTRADA information system contains information on RTIs and RTCs on the entire Swedish road system that combines hospital data and police-reported RTC data since 1996 (VicRoads, 2013). Crash Outcome Data Evaluation System (CODES) in the USA is a national ongoing effort to develop hospital-level RTC cost data. The intention is to create linkages between the RTCs, RTIs, and medical costs in order to inform highway safety and injury control decision making (DeLucia, 2010).

Traditionally, the focus in South Africa fell on reducing the number of fatalities but fatalities only tell a part of the story. Moeketsi (2000) highlights that for each fatality there are ten hospitalisations and more than a hundred emergency room visits. This burden and additional costs on the healthcare system are enormous (Parkinson et al., 2014).

3.2.5.2 Congestion costs

RTCs are not only an inconvenience to other road users but are the cause of significant delays due to lane closures, police, fire, or emergency services activity, detours, and general traffic slowdowns resulting from rubbernecking and chain reaction braking (Blincoe, 2015). The costs of these delays are more difficult to determine as each RTC that occurs is unique. The costs of these delays can be measured in terms of time lost, fuel wasted and increased air pollution. The type of RTC, severity, vehicle involvement, roadway type, time of day, traffic density, emergency services response time, weather, hazardous material spillage, lane configurations, driver behaviour and other variables influences the cost of these delays.

3.2.5.3 Lost workplace productivity (reoccupation cost)

A European review (ETSC, 2007) highlighted the difficulty to describe long-term effects of road trauma with multi-dimensional scales and recommended the use of scales such as the Sickness Impact Profile (SIP), Quality Adjusted Life-year (QALY) or Disability Adjusted life years (DALY) to express the gap between the situation where life and limb is loss due to RTCs and the ideal situation where the whole population lives into old age, disease and disability free. Similarly, in South Africa, Diedericks (2014), stated that research into the long-term effects of motor accidents on the work performance and careers of victims in South Africa is limited but highlighted the importance of research in order to provide guidance to for example employers who must assist the employees that return to work after a RTC. Road trauma can result in high-impact injuries, like whiplash injuries that do not necessarily require hospitalisation but can result in extensive work disability which in turn has economic effects. Good health is a requirement for employment but employment is also a

requirement for health (Diedericks, 2014). The South African study findings highlight the significance impact that RTCs and injuries have on the careers of especially younger employees (under the age of forty years). The findings also suggest that employees with higher degrees rather than just secondary schooling were affected more (Diedericks, 2014).

According to the ETSC (2007) no European country has done extensive research on the psychological costs or the cost that injuries to the brain, spinal cord, etc. have on the quality of life of victims. If this results in job losses, the government of the country becomes responsible for the welfare of these individuals. Traffic injuries are associated with significant reductions of skilled manpower in the labour market, and especially men are affected negatively. This in turn has implications for the well-being of families that are dependent on the breadwinner or having to incur additional costs to care for an injured or disabled person. Donário and Dos Santos (2012) supported this notion and indicated that although a permanently disabled person is not excluded from future economic activity, their special conditions and needs necessitate that social resources are allocated to accommodate their needs and which is considered an opportunity cost. The percentage of permanent clinical impairment is a proxy measure for assessing the cost of the decrease in expected production that could have been obtained in the absence of disability. The World Bank cited the South Korea Transport Institute (KOTI) study focusing on the impact of RTCs on employment (Sung, 2015). The results indicated the secondary costs that RTCs have on diminished household income, unemployment, home ownership, divorce rate, and income gaps. The study found that 70.7 per cent of the disabled and 27.6 per cent of the non-disabled victims of RTCs experienced job losses after a traffic incident. In addition, 67.9 percent of the disabled and 24 per cent of the non-disabled who lost their jobs remain unemployed for long periods of time. Searching for employment after a hospital stay for victims on average take up to 38 months for disabled victims and 19.8 months for non-disabled victims compared to the 2.8 months for job seekers not involved in a RTC. The study concluded with the finding that economic losses tend to have a longer lasting impact on road traffic RTC victims especially in developing countries.

3.3 Input into a revised methodology

3.3.1 Data collection and stakeholder interactions

Phase 1, identified various stakeholders as typical sources of RTC costing-relevant dat. These stakeholders were approached through the RTMC.

The sourcing of data from these conventional RTC costing-relevant sources was deemed essential for the development of the new methodology. The literature review has indicated that worldwide the sourcing of reliable and quality data is problematic.

This is no different in South Africa and the Phase 1 report highlights the numerous challenges associated with RTC cost data in South Africa.

Although some data was collected, it was not as comprehensive as desired. However, the new methodology was developed based on the best available information and other methods of simulation to compensate for empirical data insufficiencies.

3.3.2 Crash Costing Data Source Traceability Matrix (CCDSTM)

The CCDSTM is a conceptual framework. This framework was under development throughout the project. It takes cognisance of the traditional and/or ideal sources and structure of data as well as potential surrogate sources for specific cost items. CoC 2004 provides the initial input into the CCDSTM. The CCDSTM was completed to a level of sufficiency for the purpose of finalising Phase 2 (given its working document status), but it continues to identify other potential sources of RTC cost relevant data or surrogates that can be used as alternative inputs to the costing items or categories, as well as the respective stakeholders. Each of the categories needs to be populated with information on different data elements. However, the required data might not always be readily available and therefore the CCDSTM was developed for this study to aid in the identification of potentially new sources of RTC cost data, or surrogates which can be used as alternative inputs into the different categories. The CCDSTM intends to define and describe each cost category, cost element and cost data item as well as acceptable surrogates. The CCDSTM remains a working document used to continuously inform input as data becomes available during future annual updates.

3.3.3 RTC data dictionary

A key requirement for collecting high quality data is consistent data elements with clear definitions of terms. The aim of a RTC data dictionary is to support road safety data collection from a variety of sources. Crash cost is but one element. Determinants of high quality data include the collection of timely, accurate, and complete data efficiently, coupled with the ease of linking the data to sources as well as accessing the data for reporting and analysis (DeLucia, 2010). The fundamental building blocks for a RTC costing system are the data recording systems. The severity, type, location, contributing factors, injuries sustained, time, date, gender, vehicle type and road conditions are some of the essential data items among a plethora others typical of good road RTC recording systems (Polinder, 2011). These data items are required in order to determine the cost of RTCs on a national basis (World Bank, 2007). The effectiveness of a road RTC cost system is dependent on a stable, accurate, broad and timely road RTC database (World Bank, 2007). Having a comprehensive road safety data system from which to calculate the impact of measures of road safety is vital to ensure the accuracy and consistency of interventions (Newstead, 2013).

Internationally, use is made of specific standards and guidelines for the collection of uniform RTC and injury data (EuroSafe, 2013; Governors Highway Safety Association and National Highway Traffic Safety Administration, 2015). The need for a minimum set of data items arise from the fact that different countries, departments and agencies collect data in different formats and may have different names and definitions for data items. This makes it difficult to compare or share RTC data among stakeholders (NHTSA, 2015). Phase1 highlighted the inconsistency of data collection approaches, formats and so forth as a key constraint in accessing usable RTC cost data for South Africa. In the US a minimum set of data is required, consisting of three types (NHTSA, 2015) namely data collected at the scene; data to be derived from other elements (mostly collected at the scene) and data obtained by linking data collected at the scene to other data sources. Greater standardization of RTC data enables better and cost-effective sharing of data, the comparison and exchange of RTC data. A similar approach is followed through the Standardization of Traffic Data Transmission and Management (STRADA) project in Europe in an attempt to harmonise the exchange of road traffic data which has previously been restricted because of the absence of standards (European Union, 1990). A structured data dictionary was developed in order to allow 'people and systems to speak the same language'. The dictionary includes raw data, such as traffic flows, speeds, as well as supplement information, such as incidents or weather. The rationale behind such a project is to facilitate and support the use of a public wide area network (WAN) architecture and exclusively open standards (European Union, 1990).

The RTC cost data dictionary for this project was compiled based on international practices and guided by the development of the CCDSTM. The RTC cost data dictionary currently contains descriptions of data elements some of which are not yet collected in South Africa. However, a concerted effort should be made to start collecting these elements for future use within the new methodology. There is also a need for a standardised approach to collect high quality data, based on standardised guidelines and minimum requirements for data elements to aid in future costing of not only fatal RTCs but serious RTCs as well. Similar to the CCDSTM, the RTC cost data dictionary also remains a working document which should be updated continuously as more relevant data for the population of the CoC 2016 methodology become available.

3.3.4 User requirement specification

One of the recommendations from Phase 1 is about conducting a user analysis informing the development of a user requirement specification that will assist in the configuration of CoC 2016. The RTSMS (see Figure 1) provides the framework for the strengthening of the focus on achieving high level coordination of road safety stakeholders. It may also be useful for achieving greater clarity of roles and responsibilities of stakeholders so as to impart the collective focus on achieving road safety results. On the road safety intervention level, the valuation of RTCs will continue

to evolve as 'Safe System' implementation gains momentum and road safety relevant decision-making gets better aligned with the RTSMS framework (see Figure 1). Making data-driven and evidence-based decisions require the integration of information from numerous data systems. Improving data is complex as stakeholders collect and use data systems for their specific purposes (e.g. business management and regulatory purposes), but then need to provide data to other stakeholders for road traffic safety analyses. The legislation further requires peer assessments of traffic records and strategic plans for improving traffic records (DeLucia et al., 2010).

As a shared responsibility, road safety data is needed by different stakeholders for different purposes. Stakeholders are classified into primary and secondary users.

Primary users include all stakeholders responsible for processing the data, analysing the data as well as report on the data. Primary users have the following functions (Miller, 1995):

- Processing data including the management of persons who enter and store the data.
- Summarising and describing data and data elements.
- Using the data for reporting requirements, analytical needs and data requests from the public or other branches of government
- Responsibly and ethically using and disseminating data and findings.

In South Africa these entities include the DoT and RTMC; law enforcement agencies (SAPS and traffic) and the RAF.

Secondary users include other agencies involved in RTC records assessment and use (Miller, 1995). They include other departments such as the South African National Roads Agency Limited (SANRAL), DoH, Department of Justice, Department of Home Affairs (DoHA) and private sector entities (Miller, 1995). These include the diversity of RTC data users and providers, the need for access to crash data, existing documentation of database capabilities, coordination among agencies, sources of duplication of effort, the methods used to collect data, and linkage opportunities. In light of this discussion, recommendations are made to improve RTC data utility, accessibility, and accuracy.

To add impetus to road safety decision-making at the levels of the three elements of the RTSMS (also as the management framework for 'Safe System' implementation), i.e., institutional management functions, interventions and results, a RTC costing User Requirement Specification (URS) was conceptualise as work in progress (for possible completion in a next update cycle) to add value through informing and guiding the use of the results of the cost of RTCs estimations by a variety of users. At country level, monetising the socio-economic burden of traffic system failures, expressed as a percentage of GDP, have the result of being an "invisible" quantum. The reason is that with such a large lump sum number it is not possible to differentiate responsibilities

and accountabilities for road safety actions to be taken. It has the effect of the road safety epidemic being the metaphorical “elephant in the living room”.

Further development of the URS (as forward looking concept) is dependent on the progress made towards achieving the desired focus on road safety results among stakeholders. Mindful of this, the CoC 2016 methodology is organised for initial preparedness to support ‘Safe System’ rollout and the achievement of road safety ‘results focus’ as the overarching road safety institutional management function. The URS imparts the need for RTC costing in CoC 2016 at three inter-related levels:

- To inform national resource planning to ensure that road safety is ranked equitably in terms of investment in its improvement.
- To internalise the impact of road system failure by an expression of tangibility that is achieved through appropriate monetisation of all elements of the societal burden of RTIs and RTC damages. Internalisation must be aimed at all public and private sectors and communities as well as individuals.

To ensure that the best use is made of any investment and that the most appropriate road safety improvements are introduced in terms of the benefits that they will generate in relation to the cost of their implementation.

3.3.5 Principles for the development of CoC 2016

The data challenges experienced during Phase 1 necessitated the development of a ‘guiding principles framework’ for the development of CoC 2016. These principles facilitated the research process and contributed to a better understanding of what the available RTC data in South Africa is, establishing the quality of the available RTC data, how this data is managed and applied in various sectors by different stakeholders.

Corner stones of the framework include understanding what is available (inventory of data), understanding what the value of the available data is (valuation), how data is managed and applied (lifecycle management of data) as well as assigning accountability to entities responsible for the collection, management and use of the data.

A key objective of CoC 2016 is that it must enable the user to consistently apply the RTC costing methodology. Results need to be of high integrity and quality.

Table 1 below provides an overview of the principles.

Table 1: Principles for the development of CoC 2016	
Principles	Description
Principle 1: Fit for purpose and valuable	The methodology is effective and efficient for purposefully informing/evaluating macro and micro indicators. It should facilitate cost-benefit analyses at all levels. The methodology should be easily applied.
Principle 2: Reliable, consistent and sustainable	The methodology consistently produces reliable results and are accepted and understood by end users. The methodology is scientific and can be repeated consistently. The RTC cost elements are continuously collected in a prescribed and standardised manner, which facilitates the ease with which the methodology can be applied.
Principle 3: Accessible and available	The manner in which the data is collected is clear and transparent. Data is available and accessible. Results are available and shared.
Principle 4: Cost effective and efficient	The methodology is robust, valid and will not require revision for a period of 10 years. Data collection is streamlined and not duplicated. Updating is easy and inexpensive. Surrogate data elements have been identified as alternative inputs.
Principle 5: Accountable	The methodology is considered influential and persuades end users to become more accountable for improving road safety.

4 2016-2026 METHODOLOGY

4.1 Introduction

The CoC 2016 is a ‘hybrid’ method to estimate the costs of RTCs, largely based on the HC approach. CoC 2016 is similar to the approach used in CoC 2004/2015, but cost elements relating to ‘pain, grief and suffering’ and lost quality of life; traffic delay and carbon emissions were added. A significant effort was made to obtain the relevant data to facilitate the calculation of the costs of the various cost categories and elements. In cases where no data was available surrogate input values were used, based on international good practices and referenced proportionalities. The intention

is to refine and improve the quality of the input values over time, as data more appropriate to the South African context becomes available, either through research or through relevant institutions making the data available.

This chapter deals with the various categories and elements of the CoC 2016 methodology, the method of collecting data and ideal sources of data for each cost element, use of proxy data and the method of calculating the costs for each element. The results of the cost calculations for 2015, a comparison with the results of the 2004 methodology, examples of application of the results and recommendations for future research are provided.

4.2 RTC cost categories and elements

Based on the work of Litman (Victoria Transport Policy Institute, 2016) the RTC cost categories and elements of CoC 2016 were organized into various market and non-market data items as indicated in Table 2.

Table 2: RTC cost data items – market and non-market		
	Market	Non-market
Internal	• Uncompensated lost productivity (victim) • Uncompensated medical treatment (victim) • Uncompensated vehicle and property damage • Insurance excess paid by victim • Uncompensated legal costs (victim)	• Uncompensated 'pain, grief and suffering' and lost quality of life (victim)
External	• Uncompensated lost productivity (others) • Uncompensated medical treatment (public sector) • Uncompensated property damage (others) • Uncompensated legal costs (others) • Workplace re-occupation (private and public sector) • Emergency response (private and public sector) • RTC attendance, investigation, etc. (public sector) • Infrastructure damage (public sector) • Delay, congestion and carbon emissions caused by RTCs	• Uncompensated 'pain, grief and suffering' and lost quality of life (others) • Uncompensated grief (victim's loved ones)
Insurance compensation	• Lost productivity compensation • Medical treatment compensation • Vehicle and property damage compensation • Legal cost compensation	• 'Pain, grief and suffering' and lost quality of life compensation

The following sections describe each of these RTC cost elements within the three RTC cost categories: human casualty costs, vehicle repair costs and incident costs.

4.2.1 Human casualty costs

The cost items for this category include loss of future and present productivity, funeral and medical expenses, workplace re-occupation and 'pain, grief, suffering and loss of quality of life'.

Lost future productivity: One aspect of human casualty costs is calculated based on the expected future earnings should a person not have died or become permanently disabled in a RTC.

The value of future productivity for the South African population at large is calculated for specific age groups, based on average income of the population by gender, average life expectancy by age group and gender, as well as labour force participation figures. The value of lost future productivity due to RTCs are then calculated using the expected age distribution of road users injured in RTCs. Lost future productivity owing to permanent disability is calculated in the same way, but the estimated proportion of serious injuries resulting in disability is used instead of the age distribution.

Lost future productivity was calculated according to Finkelstein's method (Lawrence, 2014) as indicated below:

$$\text{Earn}_{a,b} = \sum_{k=a}^{100} \{ P_{a,b}(k) * Y_{k,b} * \left(\frac{1+g}{1+d}\right)^{k-a} \}$$

a = age
b = gender
$P_{a,b}(k)$ = probability of gender b to survive from age a to age k
$Y_{k,b}$ = average annual earnings/production (including fringe benefits) of gender b at age k
g = productivity growth rate (eg 0.01 for earnings, 0.0 for unpaid work)
d = discount rate

A pure HC approach assumes that unemployed persons have a zero value and that their future productivity will remain zero. CoC 2016 used the narrow definition of unemployment as defined by StatsSA in the calculation of average earnings. This means that some measure of "unpaid work" was included to account for those studying or working in the home without receiving remuneration. Nominal productivity values were also assigned to children and the elderly. The previous methodology was based on a variation of the above formula (as used by the WHO, 2008, pp. 17) where it was assumed that productivity remained constant over time, i.e. there is a zero productivity growth rate.

Lost present productivity: Lost present productivity is based on the time a person is off work due to a RTC. This includes the length of stay in hospital and potential subsequent rehabilitation in the case of serious injuries. For slight injuries a person might be off work for a number of days to recuperate at home. In the case where no injuries have been sustained a person might be off work for a small period of time to deal with insurance claims, etc. External loss of present productivity also relates to time and effort spent by family and friends assisting the victim, visiting in hospital or at home, etc.

Medical and funeral cost: Medical expenses are expenses for hospitalisation in provincial or private hospital or health service facility. This includes average number of days that a casualty is hospitalised and average cost per day of hospital. It also comprises other medical expenses relating to long-term care and modifications made to houses and vehicles in the case of permanent disability. The costs for funeral or cremation are also included.

For the purposes of this study values were used based on the micro-costing study done in a South African regional hospital (Parkinson et al., 2014) and claims paid by the RAF. No current claims data have been received at the time of this report so the values from the 2004 study were inflated to 2015 values.

The ideal sources of this information are the DoH along with provincial healthcare facilities and private sector, the Department of Labour (DoL), RAF, Medical Research Council (MRC), mortuaries and funeral homes.

Different categories of the medical and funeral element and the associated cost items are illustrated in Table 3 below:

Table 3: Medical and funeral cost categories

Cost item	Description of cost
Funeral	Cost of funeral or cremation
Medical treatment	Cost of medical treatment on scene or in private or public hospital, either uncompensated or compensated by medical aid or the RAF
Rehabilitation	Cost of rehabilitation in case of disability

Lost quality of life: 'Pain, grief and suffering' related costs refer to pain endured by victims after being injured in a RTC or grief suffered by those left behind after losing the victim. These figures are usually obtained from the RAF, as was the case for the 2004 methodology. The revised methodology used the same figures, inflated to 2015 values, supplemented with an estimate of "lost quality of life". Lost quality of life refers to an intangible element relating to the lack of physical and/or psychological wellbeing, social and community belonging, spiritual growth, etc.

Proxy values were used to represent a cost for lost quality of life in the case of victims and their loved ones. According to the WebTAG Databook, 2016 (UK Department for Transport, 2016) the non-market values for lost quality of life are 66 per cent of the total unit human casualty cost for fatalities, 81 per cent for serious injuries and 77 per cent for slight injuries, respectively. To represent loss of quality of life for the victim's household 12.5 per cent of the victim's cost was used (Elvik, 1994).

Workplace re-occupation: Replacing an injured or killed worker has financial implications for employers. Wieser et al. (2009) estimated reoccupation costs at 50 per cent of the victim's annual income, based on studies originally done by Sommer.

Vehicle repair costs

Five cost elements are associated with vehicle repair costs and the main source of information is insurance companies or organisations such as the SAIA, towing companies and bodies such as the Road Freight Association (RFA) which might keep records regarding heavy vehicle maintenance and the cost of RTCs to the industry.

Table 4 provides an overview of repair costs and descriptions.

Table 4: Vehicle repair costs

Cost item	Description of cost
Vehicle repair	The cost of fixing a vehicle back to its state of original functionality and appearance or replacement with similar vehicle (considering combinations)
Damage to goods	Freight/cargo damaged, loss or recovery costs
Towing	Total cost of towing, relocation and storage of the vehicle.
Assessor	Cost of assessing the damage of the crashed vehicle.
Vehicle hire	Service provided by insurance company and or individual, the cost of which could be borne by the individual or insurance company.

For the purposes of this study, values were used based on data received from insurance companies, facilitated through SAIA. An estimate of the repair of uninsured vehicles was also included, based on surveys conducted in South Africa by a joint CSIR, Ross Silcock and TRL team in 2001.

4.2.2 Incident costs

Incident costs are costs that are related to the RTC incident and not to persons or vehicles - six cost items are included (Table 5). Potential sources of information include ERS, SAPS, traffic departments and private sector that attend the scenes, RTC clean-up service providers, insurance companies, freight vehicle operators, toll concessionaires and the DoHA as well as national agencies such as the RTMC, SANRAL, RAF, RFA, Cross Border Road Agency (CBRTA).

Legal costs are incurred by the RAF through their settlement processes and costs incurred by claimants. They include costs of attorneys, advocates, assessors, actuaries and other expenses such as accident reconstruction experts.

Infrastructure damage costs include the repair of roadside furniture, road damage and private property. Main sources of information are considered to be municipalities, provincial authorities, SANRAL and toll concessionaires that are liable to repair/replace the infrastructure.

Table 5: Incident costs

Cost element	Detail description
RTC scene attendance and clean-up	Cost incurred by authorised personnel to attend a RTC scene. These may include persons authorised to secure a RTC scene, public safety personnel, incident management services and emergency medical services. Cost of cleaning up a RTC scene - this involves the clean-up of hazardous goods spillages, human remains clean-up, etc.
RTC reporting, data capturing and analysis	Cost associated with the reporting of a RTC. This may involve the cost in the form of time and resources required to compile RTC report. Cost associated with capturing and analysing traffic RTC data.
RTC investigation and reconstruction	Resource and time cost required to investigate a RTC, especially high-profile RTCs. Cost of independent investigators from insurance companies, attorneys of parties involved in litigation, etc.
Time delay, excess fuel consumption and emissions due to congestion	Congestion and environmental costs associated with RTCs
Infrastructure damage costs	Costs of repairing or replacing roadside furniture, compensating for road damage and private property damage, etc.
Legal costs	Costs associated with litigation pertaining to RTCs

For the purposes of this study, values were based on data received from Ekurhuleni ERS, the crash investigations section of the RTMC and RAF. Vehicle delay hours per crash, fuel consumption and emission costs were based on work done by NHTSA (Blincoe et a., 2015), fuel prices (Department of Energy, 2016) and carbon tax data from the South African Consumer Goods Council (2013). RTC statistics

4.2.3 Severity of RTIs

For the purposes of calculating the total RTC costs at a national level the number of RTCs per severity is required. Only the number of fatal RTCs and fatalities are recorded annually in South Africa by the RTMC. According to the RTMC report, 12,944

people died in 10,613 fatal RTCs in 2015 (RTMC, 2016). From historical RTC data the ratio of serious injuries to fatalities has been estimated at 4.6:1. The ratio of slight injuries to fatalities is estimated at 14.9:1. Using these above-mentioned proportions of fatalities to serious and slight injuries, it was estimated that the number of serious injuries for 2015 was 59,542 and the number of slight injuries 192,866 - a total estimate of 265,352 casualties. It is estimated that a further 1,361,709 persons were involved in RTCs in South Africa without sustaining any injuries. From respective gender proportionality it is estimated that 71.2 per cent of road users injured in RTCs are male and 28.8 per cent female.

4.2.4 Severity of RTCs

The number of RTCs for 2015 was estimated using historical RTC trends, indicating a ratio of major RTCs to fatal RTCs of 3.6:1; minor to fatal of 11.9 and damage only to fatal of 58.2. Based on the official figure of 10,613 fatal RTCs, it was estimated that a total of 792,791 RTCs occurred in 2015.

4.2.5 Underreporting of RTCs

Underreporting of RTCs is a worldwide issue. There is, however, no recent studies indicating the extent of the problem in South Africa. According to a meta-analysis done in the EU the mean reporting level for fatal injuries according to the 30-day rule was 95 per cent (European Road Safety Observatory, 2007). Reporting levels for other severity levels were also provided, but it was decided to apply the five per cent underreporting level to fatal RTCs only. Table 6 shows the number of RTCs and RTIs by severity used in the analysis.

Table 6: Number of RTCs and casualties 2015, adjusted for underreporting

	Fatal	Major	Minor	Damage only	Total
Number of RTCs	11 144	40 117	132 609	648 560	832 431
	Death	Serious	Slight	No injury	Total
Number of persons	13 591	62 520	202 509	1 429 794	1 708 414

4.3 RTC cost results

CoC 2004/2015 provided unit RTC costs for different age groups, vehicle types, RTC types, RTC and RTI severity, per urban and rural areas. The complexity of the methodology made application of the results difficult. CoC 2016 calculated human casualty costs per person, for the different levels of RTI severity. These figures were then converted to cost per RTC, using adjustment factors derived from historic RTC data.

Vehicle repair costs were also converted to cost per RTC, using appropriate adjustment factors. This practice facilitated the calculation of unit RTC costs per RTC severity, incorporating human casualty, vehicle repair and incident cost elements.

The adjustment factors for persons per crash used in the analysis are shown in Table 7.

On average, one fatal crash comprises 1.26 deaths, 0.62 serious injuries, 0.51 slight injuries and 0.91 no injuries. A major crash comprises 1.38 serious injuries, 0.45 slight injuries and 0.92 no injuries. These factors differ in urban and rural areas. As expected, crashes are more severe in rural areas.

Table 7: Cost per Crash adjustment factors (persons per crash)

Anywhere					
Severity	Fatal	Major	Minor	Damage only	Any
Death	1.26				0.02
Serious	0.62	1.38			0.08
Slight	0.51	0.45	1.38		0.21
No injury	0.91	0.92	10.35	1.93	1.04
Urban					
Severity	Fatal	Major	Minor	Damage only	Any
Death	1.11				0.01
Serious	0.42	1.26			0.06
Slight	0.39	0.32	1.33		0.16
No injury	0.87	0.92	10.96	1.97	0.79
Rural					
Severity	Fatal	Major	Minor	Damage only	Any
Death	1.37				0.04
Serious	0.93	1.59			0.12
Slight	0.74	0.71	1.48		0.32
No injury	1.00	0.94	8.85	1.85	1.60

The adjustment factors for vehicles per crash are shown in Table 8. On average 1.72 vehicles are involved in a RTC. The factor for fatal crashes is higher in rural areas while for damage only crashes it is higher in urban areas.

Table 8: Cost per Crash adjustment factors (vehicles per crash)

Severity	Fatal	Major	Minor	Damage only	Any
Anywhere	1.34	1.38	1.50	1.84	1.72
Urban	1.23	1.36	1.55	1.88	1.79
Rural	1.42	1.40	1.40	1.71	1.57

4.3.1 Unit RTC costs

Unit costs per RTC, by cost category and element, are shown in Table 9. In 2015 the cost per fatal RTC was R 5 435 261; the cost for a major RTC was R 765 664; the cost for a minor RTC was R 152 244 and the cost for a RTC without any injuries (damage only) was R 48 533. The average cost per crash was R 171 727.

Table 9: Unit RTC costs by cost category and cost element					
Cost Element	**Unit Cost per RTC (Rand)**				
	Fatal	**Major**	**Minor**	**Damage only**	**Any severity**
Human Casualty					
Lost productivity	2 878 177	217 253	29 504	2 094	55 331
Pain, grief, suffering and lost quality of life	2 123 994	287 173	47 509		49 842
Medical treatment	147 143	110 656	32 681		12 509
Funeral	16 613				222
Work place re-occupation	68 638	2 949			1 061
Sub-total: Human Casualty Cost	5 234 565	618 031	109 694	2 094	118 965
Vehicle Repair					
Vehicle repair	19 604	20 171	21 887	26 822	25 618
Sub-total: Vehicle Repair Cost	19 604	20 171	21 887	26 822	25 618
Incident					
Emergency response	3 042	2 765			174
Legal	101 623	101 623			6 258
Vehicle related	3 107	3 197	3 469	4 251	4 060
RTC management	10 176	5 101	2 030	2 030	2 287
Infrastructure damage	1 596	1 637	2 023	2 508	2 376
Delay congestion and emissions	61 547	13 140	13 140	10 829	11 987
Sub-total: Incident Cost	181 092	127 462	20 662	19 618	27 143
Total Unit Cost	**5 435 261**	**765 664**	**152 244**	**48 533**	**171 727**

4.3.2 Total RTC costs for South Africa

The total RTC costs per category and severity for 2015 are shown in Table 10. The total national RTC costs for 2015 amounted to R142.95 billion, which translated to 3.4 per cent of South Africa's GDP.

Human casualty costs comprised 69.3 per cent of the total RTC cost, vehicle repair costs 14.9 per cent and incident costs 15.8. Fatal crashes constituted 43.4 per cent of the total cost, major crashes 21.5 per cent, minor crashes 14.1 per cent and damage only crashes 22.0 per cent.

Table 10: Total RTC costs by cost category and cost element

Cost Category	Total Cost per RTC (R million)					
	Fatal	Major	Minor	Damage only	Total	%
Human Casualty Cost	58 332	24 794	14 546	1 358	99 030	69.3
Vehicle Repair Cost	218	809	2 902	17 395	21 326	14.9
Incident Cost	2 018	5 113	2 740	12 723	22 595	15.8
Total Cost	**60 569**	**30 716**	**20 189**	**31 477**	**142 951**	**100.0**
Per cent	42.4	21.5	14.1	22.0	100.0	

4.3.3 RTC cost distribution

Table 11 shows the results according to the cost distribution (internal, external and insurance compensation), cost categories and cost elements (also refer to Table 2). The second column (Internal (uncompensated victim)) indicates the costs incurred by the RTC victims themselves – these comprised 57 per cent of the total RTC cost.

The third and fourth columns show costs that road users involved in RTCs impose on third parties. 'External (private) (uncompensated others)' refers to private third parties that may include a victim's household, family and friends in the case of the 'pain, grief and suffering and lost quality of life' cost element. It may also include other road users as in the case of the 'delay, congestion and emissions' cost element. 'External (public sector) (uncompensated others)' relates largely to the public sector or government. For example, the 'medical treatment' cost element refers to cost borne by public hospitals. RTC management and infrastructure damage costs are also borne by the public sector. External costs comprised 24 per cent of the total RTC cost.

The second last column (Insurance (private) (compensated victim and others)) indicates costs compensated by entities such as the RAF and vehicle insurance companies. It comprises 18 per cent of the total RTC costs.

It is clear from the table that not all costs are accounted for. Owing to a lack of data on RTC costs involving, for instance, government vehicles, no vehicle repair costs for the public sector could be calculated.

Another example relates to the ‘workplace re-occupation’ cost element. The amount of R 883 million has been attributed to the private sector but not enough information is available to properly distribute this figure between the private and public sector. This figure may also underestimate the impact that employee absences as a result of RTCs and RTIs have on employers. Research to properly estimate the financial impact of re-occupation is required.

Table 11: Total RTC costs by cost type, category and element (Rand)					
Cost Element	**Internal (uncompensated victim)**	**External (private) (uncompensated others)**	**External (public sector) (uncompensated public)**	**Insurance (private) (compensated victim & others)**	**Total**
Human Casualty					
Lost productivity	34 528 657 739	6 017 632 169		5 513 262 664	46 059 552 571
Pain, suffering and lost quality of life	35 121 533 212	4 390 191 652		1 978 009 509	41 489 734 373
Medical treatment			9 354 315 159	1 058 420 917	10 412 736 076
Funeral	157 329 394			27 796 615	185 126 008
Work place re-occupation		883 185 558			883 185 558
Sub-total: Human Casualty Cost	69 807 520 344	11 291 009 379	9 354 315 159	8 577 489 705	99 030 334 587
Vehicle Repair					
Vehicle repair	12 334 550 509			8 991 026 648	21 325 577 157
Sub-total: Vehicle Repair Cost	12 334 550 509			8 991 026 648	21 325 577 157

Table 11: Total RTC costs by cost type, category and element (Rand)					
Cost Element	**Internal (uncompensated victim)**	**External (private) (uncompensated others)**	**External (public sector) (uncompensated public)**	**Insurance (private) (compensated victim & others)**	**Total**
Incident					
Emergency response			24 403 256	120 434 791	144 838 047
Legal				5 209 274 099	5 209 274 099
Vehicle related				3 379 716 014	3 379 716 014
RTC management			1 903 953 544		1 903 953 544
Infrastructure damage			1 978 138 540		1 978 138 540
Delay congestion and emissions		9 978 752 945			9 978 752 945
Sub-total: Incident Cost		9 978 752 945	3 906 495 340	8 709 424 905	22 594 673 190
Total Cost	**82 142 070 853 (57% of total)**	**21 269 762 323 (15% of total)**	**13 260 810 499 (9% of total)**	**26 277 941 258 (18% of total)**	**142 950 584 934**

4.4 Application of results

The results of the RTC cost analysis can be used by a variety of users in a number of ways:

- to understand the impact of RTCs on the economy and society of South Africa as a whole and on individuals, business and the government as separate entities
- to benchmark South Africa's road traffic safety performance internationally
- to serve as input into policy and strategy development in order to improve coordination and allocation of funds and other resources aimed at curbing the road traffic safety problem
- to monitor and evaluate the cost-effectiveness of road traffic safety interventions at all levels
- to assist the road safety fraternity to achieve 'results focus' through effective implementation of the 'Safe System' (Figure 1, pp. 14).

4.4.1 Socio-economic impact of RTCs

By monetising the socio-economic burden of road safety failures the impact thereof can be better understood and managed. It is evident that RTCs have a huge economic and societal impact in South Africa. As indicated in Section 4.3.2 the cost of RTCs in 2015 amounted to almost R143 billion. More than 90 per cent of the total RTC cost is incurred by road users and their loved ones, either through direct expenditure or payment of insurance premiums or levies, or through impact on their physical or mental health and wellbeing. For many, being a victim of a RTC means becoming disabled, losing income or losing a job, or difficulty in finding employment. For many losing a breadwinner means living in poverty, losing a parent or losing a home. For some losing a child, spouse or other loved one could mean psychological trauma and disruption of a stable family life. Putting a monetary value on these tangible and intangible losses makes the need for urgent and far-reaching intervention that much more indisputable to policy and decision makers.

4.4.2 International benchmarking

It is difficult to benchmark South Africa's road traffic safety performance against those of other countries as the method of calculating RTC costs differs from country to country. Some countries adjust RTC figures for underreporting and some do not.

The figure of 3.4 per cent for South Africa does not compare favourably with countries using similar methodologies. According to the Institute for Road Safety Research in the Netherlands, SWOV (Wijnen, 2013) the cost of RTCs in low- and middle-income countries that correct for underreporting and use the HC method is 2.2 per cent of their GDP. The average for high-income countries varies between 1.0 and 4.6 per cent of

their GDP, with an average of 2.6 per cent. If only those high-income countries that use WTP methods (which result in higher estimates) are considered, the average is 3.7 per cent of GDP.

4.4.3 Policy and strategy development

The results of the RTC costing analysis should aid in making the economic and societal burden of RTCs tangible and relatable to policy and strategy formulation. It provides a clearer picture of the extent of investment needs and where the priorities should be placed.

According to TRL (Ghee et al., 1997) expenditure on road safety improvements should only be less than the cost itself, when it is evident that the implementation of measures has been cost-effective and a substantial reduction in RTCs has been achieved, like in the case of the UK. Granting that developing countries would not spend to the same level as the UK it is stated that 10 per cent of the total RTC cost would be a justifiable level of investment in the improvement of road safety. Whatever policy decision is being taken in this regard in South Africa, it is clear that resources and efforts should be put into the most cost-effective road safety improvement measures. More information on effective measures and Crash Modification Factors (CMFs) can be found in the next section.

Road safety investment should not only be the responsibility of the government, but that of all the road safety fraternity. All relevant stakeholders, including public and private sector employers, should take ownership and be held accountable to invest in road safety improvement. Investment should not only take the form of financial expenditure but all stakeholders can achieve substantial cost savings by being focused on achieving road safety results and by planning and executing activities in line with the ‘Safe System’.

4.4.4 Economic evaluation of transport projects

As stated before, real road safety improvement can only come from implementing measures that have been proven to be successful – evidence-based countermeasures. Implementing these measures comes at a cost and where there is competition for resources such as funding, it is of utmost importance to conduct an economic analysis before implementing any measures. An economic analysis would typically consist of cost and benefit metrics. A cost metric is a calculation of the investment costs of the project while a benefit metric is an estimate of the cost savings that can be derived from the same project over a number of years. Results from the CoC 2016 study can assist in calculating the value of cost savings that could be achieved in programs and projects aimed at preventing RTCs and RTIs.

4.4.4.1 Infrastructure improvement projects

When evaluating any road safety improvement measure, RTC prediction models are used to estimate the number of RTCs and RTIs that may potentially occur in the future, both before and after the implementation of the particular measure. The estimate is often expressed as a RTC or RTI rate in relation to traffic volume, length of road, population, etc. RTC rates, for instance the number of fatalities or RTCs per kilometre driven, are useful to determine which projects, sites or routes should receive priority attention. Lovegrove and Litman (2008) suggested that vehicle kilometres driven can be used as a proxy for predicting safety impacts as road safety is so closely related to exposure. To calculate kilometres driven for a site or section of road, traffic counts and the length of the section are required – the number of kilometres driven on that section in a year can then be determined. The RTC rate per kilometre driven is calculated by dividing the number of RTCs occurring on the particular section of road per year into the number of kilometres driven.

To assist in determining what RTC or RTI rates could typically be achieved after implementing a road safety improvement measure, a lot of work is being done internationally in developing CMFs for various measures. These CMFs indicate the "measure of the estimated effectiveness of a safety countermeasure" (American Association of State Highway and Transportation Officials, 2012) The Highway Safety Manual (AASHTO, 2016) describes a CMF as "a factor estimating the potential changes in RTC frequency or RTC severity due to installing a particular treatment". As an example, a CMF of 0.7 means a 30 per cent reduction in RTCs and a CMF of 1.2 means a 20 per cent increase in RTCs. CMF's can be found at the CMF Clearing House (Federal Highway Administration, 2016). New Zealand (NZ) has also developed CMFs which are shown in their Crash Estimation Compendium (NZ Transport Agency, 2016).

The difference between the RTC or RTI rate before and after implementation of a measure is the saving that can be achieved. Results of CoC 2016 study can then be used to determine the RTC cost savings to be achieved by implementing specific countermeasures. RTC costs per kilometre driven can be used to compare different road sections or road types for prioritisation purposes. Kilometres driven by particular modes of transport, for example buses or minibus taxis, and the costs associated with RTCs involving these modes, are useful to drive public transport policy decisions. These types of 'before and after' 'benefit cost' analyses are regularly done by road and traffic engineers before implementing infrastructure improvement programs at site and route level.

For the purpose of more localized economic evaluations, additional unit cost tables were prepared. These indicate costs per person by severity of RTI (Table 12), cost per incident (crash) by severity of crash (Table 13) and cost per vehicle type involved (Table 14). Costs for urban and rural areas are also provided.

Table 12: Unit cost per person by severity of RTI (Rand)				
Area	Death	Serious	Slight	No injury
Anywhere	3 916 187	423 858	71 352	1 085
Urban	4 004 117	438 651	72 241	1 351
Rural	2 400 452	404 070	69 629	605

Table 13: Unit cost per incident (crash) by severity of RTC (Rand)				
Area	Fatal	Major	Minor	Damage only
Anywhere	181 092	127 462	20 662	19 618
Urban	196 402	130 735	24 099	22 494
Rural	153 217	121 544	14 477	14 334

Table 14: Unit cost per vehicle type (Rand)			
Vehicle Type	Anywhere	Urban	Rural
Sedan	14 563	14 414	15 011
Minibus	14 658	14 506	15 112
Midi-bus & Bus	15 136	14 973	15 625
Light delivery vehicle	14 511	14 363	14 954
Goods vehicle	15 489	15 318	16 004
Heavy goods vehicle	21 825	21 499	22 803
Any vehicle	14 609	14 459	15 060

Example of a cost calculation using the unit cost tables:

Say, during 2015 a particular rural road section had the following crash statistics:

- 2 fatal crashes involving 3 deaths, 2 serious injuries and 1 slight injury
- 7 major crashes involving 11 serious injuries and 5 slight
- 24 minor crashes involving 35 slight injuries
- 116 damage only crashes involving 215 no injuries

The following vehicles were involved:

- 200 sedans
- 15 minibuses
- 38 light delivery vehicles
- 15 goods vehicles
- 3 heavy goods vehicles

The summary of crash statistics is:

- 149 RTCs
- 58 RTIs (3 deaths, 13 serious injuries, 41 slight injuries, 215 no injuries)
- 271 vehicles involved

For calculation of person costs in a rural area:

- Refer to Table 12 last row (Rural)
- Multiply 3 deaths by R 2 400 452 (column 'Death')

Making use of formulas in a spreadsheet will simplify calculations but for the sake of clarity all the calculations are shown below.

For calculation of person costs in a rural area:

1. Refer to Table 12 last row ('Rural')
2. Multiply 3 deaths by R 2 400 452 (value in column 'Death').
   Result = R 7 201 356
3. Multiply 13 serious injuries by 404 070 (value in column 'Serious').
   Result = R 5 252 910
4. Multiply 41 slight injuries by R 69 629 (value in column 'Slight').
   Result = R 2 854 789
5. Multiply 215 no injuries by R 605 (value in column 'No injury').
   Result = R 130 075
6. Add results from 2. to 5. Result = R 15 439 130 (Total person costs)

For calculation of incident costs for the same road section:

7. Refer to Table 13 last row ('Rural')
8. Multiply 2 fatal crashes by R 153 217 (value in column 'Fatal').
   Result = R 306 434
9. Multiply 7 major crashes by R 121 544 (value in column 'Major').

Result = R 850 808

10. Multiply 24 minor crashes by R 14 477 (value in column ‘Minor’). Result = R 347 448
11. Multiply 116 damage only crashes by R 14 334 (value in column ‘Damage only’). Result = R 1 662 744
12. Add results from 8. To 11. Result = R 3 167 434 (Total incident costs)

For calculation of vehicle costs for the same road section:

13. Refer to Table 14 last column (‘Rural’)
14. Multiply 200 sedans by R 15 011 (value in row ‘Sedan’). Result = R 3 002 200
15. Multiply 15 minibuses by R 15 112 (value in row ‘Minibus’). Result = R 226 680
16. Multiply 38 light delivery vehicles by R 14 954 (value in row ‘Light delivery vehicle’). Result = R 568 252
17. Multiply 15 goods vehicles by R 16 004 (value in row ’Goods vehicle’). Result = R 240 060
18. Multiply 3 heavy goods vehicles by R 22 803 (value in row ‘Heavy goods vehicle’). Result = R 68 409
19. Add results from 14. to 18. Result = R 4 105 601 (Total vehicle cost)

For calculation of the total cost for the rural road section:

20. Add results from 6., 12. and 19. **Result = R 22 712 165** (Total crash cost)

The total cost for 2015 for the rural road section in the above example is R 22.7 million.

4.4.4.2 Road user behaviour interventions

In addition to the above-mentioned CMFs, which are largely related to road safety engineering measures, the Rosebud Thematic Network (European Commission, 2006) provided examples of assessed road safety measures involving human behaviour interventions.

For example, drinking and driving campaigns in Germany, Sweden and Norway resulted in benefit cost ratios (B/C-ratio) ranging from 4.7 to 20 (a B/C ratio of greater than 3 is considered excellent). Compulsory first aid education in schools showed a B/C ratio of 90; randomly scheduled law enforcement a ratio of 55; random breath testing 36 to 55; reflective devices for pedestrians 5 to 7 and seatbelt reminder in cars 11. Speed enforcement is less effective: B/C ratio of 2.9 to 3.6.

As a practical example, should an amount of R 1.0 million be invested in effective speed enforcement, an improvement in road safety (measured in terms of crash cost savings) of between R 2.9 and R 3.6 million could be expected. Investing that same

million rand in an effective drinking and driving campaign could result in a cost (and life) saving of between R 4.7 and R 20 million.

More research is required to determine the proportion of South Africa's human casualty cost that can be attributed to any of these activities but the quoted B/C ratios indicate that RTC costs can be saved through implementing effective evidence-based road safety education, campaign and law enforcement interventions.

4.4.5 'Safe System' implementation

Road safety improvement demands full sharing of responsibility between stakeholders. This means that implementing road safety countermeasures is no longer the sole responsibility of government and specifically the road and traffic sectors of government. Other sectors of government, such as the health sector, should become active participants in the improvement of road safety – firstly by understanding the impact that transport system failures have on their financial wellbeing and secondly by participating in the planning and implementing of improvement measures, guided by the principles of the 'Safe System' approach.

Business should start playing a more focused role in reducing RTCs and RTIs among their employees and establishing a road safety culture. This can be done through conducting economic analyses using RTC cost results and CMFs in the same way as the road safety fraternity would. The first step is to assess the number of kilometres driven by employees and the number of RTCs (by severity) that are recorded. RTC costs can then be calculated to determine the extent of the safety problem within the entity. Thereafter appropriate road safety policies and practices should be implemented and monitored to improve road safety behaviour of their employees.

It is possible, and necessary, to conduct economic analyses for a large variety of countermeasures. However, the required granularity of data is not always available to do comprehensive analyses. The collection of detailed data is required for good quality results. For instance, availability of RTC data and RTC costs per type of vehicle, RTC, road user and road type would facilitate a more detailed analysis that would lead to the development of improved countermeasures for a variety of users.

4.5 Comparison with CoC 2004/2015

In order to compare the results from the updated CoC 2004/2015 tables to the results of the 2016 study, the total cost of crashes for 2015 was calculated by applying CoC 2004 to 2015 crash statistics (adjusted for underreporting). For this purpose, the cost elements relevant to CoC 2004 were updated to 2015 values (refer to the Phase I Report CoC 2004/2015).

The COC 2016 differs from the CoC 2004 methodology mainly due to the following additions to CoC 2016:

- The estimated number of persons involved but not injured in RTCs
- A measure of underreporting of RTCs
- 'Lost quality of life' costs
- 'Workplace reoccupation' costs
- Estimates for repair of uninsured vehicles
- Increased fuel consumption and emission costs related to congestion after a RTC (thus the delay cost element was expanded).

Specific differences between the results of the two methodologies are indicated in Table 15.

Table 15: Comparison of results

Cost Category	2016 study	2004 study	Comments
Human casualty (R billion)	99.03	69.01	Elements of lost quality of life and workplace re-occupation costs added. Estimated number of persons not injured included in 2016 study.
Vehicle repair (R billion)	21.33	23.15	2004 study used repair costs from insurance companies only, resulting in a higher estimate, while 2016 study included estimates for repair of uninsured vehicles.
Incident (R billion)	22.60	20.62	Congestion-related costs were added.
Total cost (R billion)	**142.95**	**112.78**	
Average cost per RTC (Rand)	**171 727**	**135 483**	

5 WAY FORWARD

Road safety management:

The CoC 2016 study is one of the aspects of the evidence base for planning and execution of actions set out in the NRSS. It endeavours to provide the instrument for the consistent valuation of the total cost of RTCs to the country, universal RTC and RTI unit costs for economic valuation and analyses on interventions level and road user cost determinations for transport planning applications as well as other uses. These are typically the uses of RTC cost estimations as 'hard data' and are reconcilable with the activities of the 'interventions' and 'results' elements of the RTSMS (Figure 1). On the other hand, RTC costs are likely the most tangible in the RTSMS foundation element - the IMFs. Here the function of coordination may be regarded as the cornerstone of a government embracing a road safety management system that must achieve the desired focus on road safety results. Ensuring efficient and effective road safety management requires meaningful institutional collaboration among government departments and their agencies to set the platform for synergistic interventions with optimal impact on the diverse and intricate road safety problématique.

Good practice is indicated as having the ability to introduce special institutional arrangements to address accountability, coordination and funding issues. RTCs impart a financial burden on basically every entity of society - from the individual, to businesses, and ultimately specifically on those entities and government departments that are called on to deliver emergency response and related downstream services in reaction to RTCs. DoH, ERSs, SAPS, Metro Police, amongst other, arguably bear the brunt of having to respond to RTCs the most tangibly. For these entities attuning their operations and financial systems such that it will become possible to give comprehensive account of expenses and resource usage as a result of RTCs, can provide in-process generated information to the avail of the future periodic updating of CoC 2016. For the entities from which emergency responses are demanded there are two dimensions to warranting this. One, it will provide information that can be applied to improve the efficiencies of the operations and resources allocation in managing the uptake and downstream care of RTIs in the health sector and in managing RTC incidents and downstream operations, like clearing the RTC scene (including administration, e.g. filling out of, and following up on the accident reporting form). Two, being able to give account of the actual cost and resource consumption that are diverted away from core functions like disease and health management in the health sector or crime fighting in the policing sector, attention can be given to engaging and coordinating with road safety role-players to develop preventive action plans that will effectively reduce the RTC impacts on such entities.

Advocacy:

By understanding the impact of the cost of crashes the leading agency can encourage road safety commitment. The cost of crashes contributes to a clearer picture of what the current situation in the country is. By monetising this cost key measures for improving the road safety situation can be expressed through an action plan or framework such as the NRSS.

Organisation of stakeholders:

The CoC 2016 results provide a better picture of the road safety burden carried by each stakeholder. The results should therefore be used as the departure point for delineating road safety roles and responsibilities across sectors as stakeholders can now be held accountable for road safety actions within their sector/discipline/domain. The CoC 2016 results now form the baseline according to which stakeholders can measure progress towards reducing the impact that crashes have on specific sectors. Understanding this cost according to different sectors and domains assist in coordinating different stakeholders in a public/private sector/civil society in order to establish partnerships according to which resources can be allocated appropriately for maximum effectiveness.

Planning and prioritisation:

The RTC costing URS was conceptualised as work in progress to add value through informing and guiding the use of the results of the cost of RTCs estimations by a variety of users. The URS (as forward looking concept) should continuously be updated to reflect changing user requirements, depending on the progress made towards achieving the desired focus on road safety results among stakeholders.

CoC 2016 (as illustrated in the application example) can provide evidence regarding the extent and magnitude of road traffic crashes and enable local and provincial authorities to mobilise road safety action plans. This for example includes allocating funding for appropriate measures to address RTCs on a local and regional level. By contextualising these costs, better predictions can be made, targets set and monitored. This evidence could for example inform the development of action plans that could potentially be included in Integrated Development Plans (or Integrated Transport Plans).

In addition, the CoC 2016 results should be used to prioritise specific research and development programmes aimed at reducing specific crash costs. This will assist in ensuring that the implementation of the NRSS is efficient and effective.

Allocate road safety funding:

The results should be used at a national level to advocate for a dedicated road safety funding stream that mirrors the current cost of road traffic crashes in the country. Specific crash cost estimations by road authority or sector should be used to inform

decision-making regarding the allocation of funding and to prioritise funding allocation for programmes and actions highlighted in the NRSS.

The need for improved data:

CoC 2016 again emphasises the importance of quality RTC data. This data should include comprehensive RTI data. Currently a substantial coordination effort across different sectors is required to contribute and link data and databases to get a more complete picture of road safety in the country.

The set of principles is also embedded in the CCDSTM which was devised to, in the interim, support and supplement RTC data collection for input into CoC 2016. The CCDSTM remains a dynamic tool that should facilitate a shared understanding of sectoral road safety roles and responsibilities, which in turn creates greater accountability for road safety results. Increased accountability and the orientation towards achieving 'results focus' will underpin the need to identify relevant RTC data sources and to improve processes associated with the collection and management of the RTC data. This will provide credibility to the RTC data and ultimately, through its application in CoC 2016, ensure that the methodology is fit for purpose.

Responsible and ethical use of RTC data:

Responsible data use is defined as the duty to ensure people's rights to consent, privacy, security and ownership around the information processes of collection, analysis, storage, presentation and re-use (Granickas, 2015). Increased understanding of shared responsibility and accountability will facilitate the paradigm shift to become 'results focus' and entities need to take cognisance of issues underlying the responsible and ethical use of RTC data. Ethical considerations should therefore underlie all collection, analysis and reporting processes. High ethical standards, respect for privacy, and dignity along with organisational integrity is essential to RTC data management and data use.

Updating of CoC 2016 / Future research:

The CoC 2016 methodology uses a number of sound values and referenceable proportionalities for some of the essential RTC cost elements and data items. A calculations model was developed which is essentially the framework that should be used to update the RTC cost metrics (as presented in the respective tables of this CoC 2016 Report) on a recurring annual basis. For the future updating there must be a continuous quest to improve the availability and accessibility of RTC costing-relevant data. Without improvement in the collection, availability and accessibility of road safety-relevant data, the updating may simply involve CPI adjustments. This is not an uncommon practice, but given the level of simulation and derived parameter values that were used for the CoC 2016 RTC cost estimations, there should be a diligent effort to develop the respective parameters based on local studies. Though much effort may be devoted to the improvement of availability of, and access to road safety-

relevant data, this in itself will not contribute to the improvement of the RTC cost estimations or the model used to derive them. It is likely through a drive for local research and development on the various RTC cost estimation elements that the type of availability and access will be directed. In the process of compiling CoC 2016, a calculations model was developed. Recommendations for the improvement of input into the calculations model are shown in Table 16, below. Table 16 can be used as framework for a possible research agenda on RTC cost estimation as part of an overarching road safety research and development plan.

Table 16: Recommendation for improvement of inputs into the RTC costing calculations model				
Market / Non-market	**Internal / External / Insurance**	**Cost Element**	**2016 Inputs**	**Improvements recommended**
Human Casualty				
-	-	Human Casualty general	Proportion of casualties compensated by RAF (arbitrary 10%) used for lost productivity, Quality of Life (QoL), medical and funeral costs	More accurate proportion of casualties compensated by RAF
Market	Internal	Lost productivity (uncompensated victim)	Finkelstein formula: average earnings, life tables, employment figures, productivity growth rate, discount rate). Disability: Years Lost due to Disability (YLD), proportion disabled (Parkinson study). Casualties: age & gender distribution	Finkelstein formula: average annual earnings per gender and age group, value of children and the elderly. Disability: updated proportion of injured becoming disabled. Casualties: more accurate estimates of casualties by age and gender.

Market / Non-market	Internal / External / Insurance	Cost Element	2016 Inputs	Improvements recommended
	External	Lost productivity (uncompensated others)	2001 survey with TRL - Consumer Price Index (CPI) adjusted: losses incurred by family and friends of RTC victims. Disability: proportion disabled.	Household survey on time and other resources lost. Disability: updated proportion of injured becoming disabled.
	Insurance	Lost productivity (compensated victim and others)	2002 RAF claims - CPI adjusted	Latest claims data from RAF
Non-market	Internal	Pain, suffering and lost quality of life (uncompensated victim)	WebTAG Databook 2016 proportions - victims	Proportions more appropriate to South Africa

Market / Non-market	Internal / External / Insurance	Cost Element	2016 Inputs	Improvements recommended
Market	External	Pain, suffering and lost quality of life (uncompensated others)	Elvik proportions - household	Proportions more appropriate to South Africa
	Insurance	Pain, grief and suffering (compensated victim - RAF)	2002 RAF claims - CPI adjusted	Latest claims data from RAF
	Internal	Medical treatment (uncompensated victim)	No current source	Data on out-of-pocket medical expenses
	External	Medical treatment (uncompensated victim public hospital)	Parkinson micro-costing study	Similar studies from more hospitals indicating costs for fatal, serious and slight injuries, days in hospital
	Insurance	Medical treatment (compensated victim)	2002 RAF claims - CPI adjusted	Latest claims data from RAF
	Internal	Funeral costs (uncompensated victim)	From http://funeralplansguide.com/funeral-costs	Survey of costs from funeral homes. Household survey.

Market / Non-market	Internal / External / Insurance	Cost Element	2016 Inputs	Improvements recommended
	Insurance	Funeral costs (compensated victim)	2002 RAF claims - CPI adjusted	Latest claims data from RAF
	External	Work place re-occupation	Proportion from 2007 Switzerland study. Lost productivity adjusted for unemployment. Proportion disabled.	South African workplace surveys
Vehicle Repair				
-	-	Vehicle repair general	Proportion of vehicles insured - https://arrivealive.co.za/Car-Insurance-Vehicle-Coverage	Updated proportion of vehicles insured
Market	Internal	Vehicle and property damage (uncompensated victim)	2001 survey with TRL - CPI adjusted: vehicle repair cost from panel beaters and shade-tree mechanics	Household surveys on repair cost of uninsured vehicles.

Market / Non-market	Internal / External / Insurance	Cost Element	2016 Inputs	Improvements recommended
	Insurance	Vehicle and property damage (compensated victim)	Insurance companies through SAIA	Annual data from a large range of insurance companies, for all vehicle types. Fleet owner records.
Incident				
-	-	Incident general	Proportion public vs private ambulance use (arbitrary 50%). Proportion of incidents compensated by RAF (arbitrary 10%) used for legal and vehicle related (towing, etc.) costs.	More accurate proportion of incidents compensated by RAF
Market	External	Emergency response (public)	Emergency Response Services (ERS). Percentage response to RTC scenes from Association for the advancement of automotive medicine 2008	Annual data from a large number of ambulance services. Local data on response to RTC scenes.
	Insurance	Emergency response (private/insurance)	Claims allowed - Government Gazette 38718, April 2015	Annual data from a large number of ambulance services

Market / Non-market	Internal / External / Insurance	Cost Element	2016 Inputs	Improvements recommended
	Insurance	Legal fees (compensated victim and others)	2002 RAF claims - CPI adjusted	Latest claims data from RAF
	Insurance	Assessor	Insurance companies through SAIA	Annual data from a large range of insurance companies, for all vehicle types. Fleet owner records.
	Insurance	Vehicle hire	Insurance companies through SAIA	Annual data from a large range of insurance companies, for all vehicle types. Fleet owner records.
	Insurance	Towing	Insurance companies through SAIA	Annual data from a large range of insurance companies, for all vehicle types. Fleet owner records.
	External	RTC scene attendance (SAPS and Traffic), capturing, analysis	2002 data - CPI adjusted	Annual data from SAPS and traffic departments
	External	Investigation of high-profile RTCs	Costs from RTMC Provincial Cluster Head: RTC Investigations	More accurate estimate of the percentage of fatal plus serious RTCs investigated

Market / Non-market	Internal / External / Insurance	Cost Element	2016 Inputs	Improvements recommended
	External	Property damage (uncompensated others)	Estimated cost to replace/repair roadside furniture (arbitrary R30000). Percentage of RTCs involving objects.	Estimated cost to replace/repair roadside furniture from road authorities.
	External	Delay (others)	NHTSA 2010 occupant and vehicle delay hours per RTC. Average earnings per hour.	More accurate estimates of occupants per vehicle. More appropriate data for South African conditions.
	External	Excess fuel consumption	NHTSA 2010 fuel consumption per RTC. Fuel price.	More appropriate data for South African conditions.
	External	Emissions (others)	NHTSA 2010 vehicle delay hours per RTC. Carbon tax per ton from Consumer Goods Council, 2013.	More appropriate data for South African conditions.

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