# A Study on the Economic Burden of Road Crashes Along the Northern Corridor Road in Kenya

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*Violence – Prevention and control.*

## ABSTRACT

Road Traffic Accidents (TRAs) are a major cause of death and disability around the world. Road accidents are ninth ranked cause of death in the world and the ranking is projected to rise to third by 2020. An estimated 85% of the deaths occur in developing countries where 65% of the deaths are pedestrians, of which 35 % are children. In Kenya over 3,000 people die through road accidents every year, most between ages of 15 and 44 years. The kenya police service and NTSA classify areas of frequent and repeated RTI by sections stretching over 50 kilometers, the study identified and mapped 35 blackspots with GPS coordinates , using the LSEModeling the study found Road Traffic Incident fatalities have steadily increased from 2533 fatalities in 2005 rising in 3149 in 2008 and peaking in 2009 at 4032 fatalities in 2015 the fatalities were 2957, motor private and commercial claims paid by insurance industry were at 6,206,700,000 ksh in 2005 the figure rose to 13,687,327,000 in 2011 and peaked in 2015 at some 25,811,991,000 (ksh,billion) a increase of 400% in economic and fatal life losses from RTI in kenya, the country lost ksh 300 billion 5% of GDP in 2016.The study illuminates limitations that contribute to persistent rise in road crashes annually through economic impact of RTI to individuals and Kenyan economy it also highlight the gaps in the national psyche that relegates this economic impact away from the frontline of County Governments budgetary allocation for effective management of road safety.

## INTRODUCTION

Providing reliable transport infrastructure can stimulate economic development in several ways. For instance, foreign direct investment is attracted to regions that provide high-quality road infrastructure to facilitate efficient logistics. within a country, road infrastructure connects remote areas with centres of trade and connects centres of industry to global markets, spurring the growth of trade and reducing costs by improving access to goods and services (Kessides et al., 2010).some of these economic gains are however severely impacted by Road traffic incidents (RTIs) that contribute to a significant proportion of the burden of disease in Kenya. They also have a significant impact on the social and economic well-being of individuals, their families, and society. However, although studies have been carried done assess the Road traffic injuries from a epidemiological point of view by the WHO Burden of Disease 2015 with estimates quantifying the burden of RTIs in Kenya RTAs continue to rise and no econometric data do exists to support policy makers and implementers arrive at optimum investment in road safety.

The Kenya Roads Board (KRB) now National Transport Safety Authority NTSA is the main institution responsible for the national road infrastructure network in Kenya. Other institutions include, the Transport Licensing Board (TLB), Motor.

The failure of the police to enforce traffic rules is due to massive corruption, ill equipment and the impracticality of some of the rules such as Section 66 of the Traffic Act, which prohibits continuous driving of PSV vehicles for more than eight hours, yet the police, cannot detect how long one has been driving continuously (IPAR, 2004).

Lack of a clear policy guideline on whether the government favours private or public transportation. Although private vehicles are uneconomical in terms of road space usage per head, their number far outweighs the number of Matatus and buses registered. While the number of buses has been declining steadily, that of Matatus has been increasing a large number of RTAs are Neglect of pedestrians in road space design has resulted in the latter being not only the greatest casualties in road accidents, but also the second greatest cause of the same (IPAR, 2004; WHO 2015).
Since independence (1963) road transport in Kenya continue to be the predominant mode of transport carrying about 93% of all cargo and passenger traffic. Available data show that the government has greatly improved the

major road networks especially in the 1990s. As of 2012 the road network was estimated at 160,886 km of which 61,936 km is classified roads .On average, the increase in mileage is about 400%-600%, depending on which roads From a low 548 vehicles in 1963 there were 333,300 vehicles registered in the country in 1990, 17,600 of which were Matatus(Bhushan, 1993). By 2003, the numbers of Matatus were estimated at 40,000 (Asingo, 2004). In 2009 there were 1,221,083 vehicles registered in the country. The highest growth has been in personal cars and motorcycles.

According to the Economic Survey of 2010, the registration of new vehicles had increased from 45,000 units in 2005 to 161,000 units in 2009. Since 2005 the number of registered motorcycles in Kenya has increased almost 40 times, accounting for 70 percent of all newly registered vehicles in 2011(Xinhua, 2012) According to the Police Department a total of 582 cases of motorcycle crashes were recorded in 2011 representing more than seven percent of all road traffic crashes. The number of cases has continued to sour that several public hospitals have dedicated some wards to victims of boda-boda accidents. For instance recently Kenyatta National Hospital's wards 6A, C and D have been converted into emergency wards to receive the swelling numbers of motorcycle victims. In 2012 the Head of Division of Non Communicable Disease in the Ministry of Health reported that between seven to ten percent of all those in surgical wards of public hospitals are injured in boda-boda accidents (Xinhua, 2012).

Based on the Accident Cause Code Classification, Kenya Police reports reveal that 85.5% of crashes are caused by poor driver behavior, of which driver error represents 44.4%, pedestrians and passengers 33.9% and pedal cyclists 7.2% (Odero et al., 2013 Odero et al., (1997). Other proximal factors include vehicle defects 5.1%, road environment 2.9%, and other factors 6.4% (ibid) according to GBD 2010 However these statistics are not conclusive due to under-reporting by the various stakeholders and statutory bodies.

Principle in bad driving habits is the total disrespect for the traffic rules (laws and regulations). It is estimated that intentional, out of habit driver errors account for over 70% of all fatal smashes and serious injuries. Often the contributing factors include inexperience, speeding, intoxication (from drinking or drugs) or just plain recklessness. Other more subtle causes are fatigue from overworked drivers who doze at the wheel and lose control.

A traffic safety method developed by Dr. Haddon (Zein and Navin, 2003), breaks down the transport system into three components i.e. (road user, vehicle and road system) and three temporal sequences (before, during and after the crash) which are combined to form the 'Haddon matrix' containing nine cells. Each cell identifies the areas in which interventions can be initiated. For example, possible interventions aimed at the human factor are education (before the crush), restraints (during the crash) and trauma management (after the crash).

According to Lammar (2006), seven risk domains have been identified. Road safety can also be decomposed into two main components, i.e. exposure and risk ( Farchi et al., 2006); pressure-state-response (PSR) model for modelling causal relationships between environmental pressures, the state of the environment and the policy response ( Van Reeth and Vanongeval, 2005)

The principal driving forces are factors that create the need to travel. The degree of mobility is affected by the economic status of a country (e.g. employment rate), the distribution of wealth (e.g. average income), the distribution of population (demographic factors such as the number of inhabitants, the age distribution, the family composition, etc.) and the physical geography of the country (Lammar, 2006).

Pressure factors result from the need to travel. The most important ones are cultural and social norms which create the interest in having a car and mainly travelling by personal transport. Cultural believes may explain the difference in road safety between countries to some extent. Countries within a certain area (e.g. Europe) are considered to have more or less the same pressure as their level of mobility is quite similar (Lammar, 2006).

The Risk factors that either increase or decrease the probability of an accident are sometimes referred to as primary risk factors. Secondary risk factors increase or reduce the injury in case an accident happened. Some factors affect both accident frequency and severity. Examples of accident risk factors are listed: drinking and driving, speeding, use of mobile phone, auditory or visual disturbance, active safety of vehicles, new driver, older road user, children without supervision, tiredness, medical disorder, infrastructural design and maintenance.

The following factors are considered to affect the level of injury: drinking and driving, speeding, usage of seat belts, helmets and other protective systems, passive safety of vehicles, young and older road users,

infrastructural aspects such as crash-protective roadsides and barriers, quality level of the rescue and pre-hospital emergency care and the health care system, etc.

From the registered accident information, the number of injury accidents, the number of fatalities and the number of injuries can be determined. Other interesting effect factors are the years of life lost, the degree of invalidity and the psychological effect.

Actions include a wide range of preventive interventions, policies, laws, structural changes, etc. These actions can be mainly related to engineering, education or enforcement. They are mostly aimed at reducing the health effects of accidents, reducing the prevalence of a risk factor or reducing the amount of exposure, but could also try to affect the driving forces, pressure and state. The effect of actions on the target can be monitored by means of indicators.

## ECONOMIC IMPACT OF ROAD TRAFFIC ACCIDENTS

An underlying principle of economic theory is that the worth of something is determined by the price that people are prepared to pay for it. In essence safety is a commodity like anything else in that achieving a reduction in risk requires expenditure i.e. a tradeoff between wealth and the desired level of safety. Demand for safety as for any other good will depend both price and affordability within an income restraint. Estimates of the value of statistical life are heavily influenced by income regardless of the method that is used. Both Willingness-to-pay and the Human Capital/Lost Output approach provide estimates that are income dependent (McMahon et al., 2015).

In general, there are basically three methods for estimating the costs of injury and death to society. Using Implicit Values, the accidents are priced according the average cost of the given medical treatment in trying to avoid a person dying divided by the probability of the treatment being successful. With the method of Human Capital, the major part of the cost of an injury is the discounted present value of the victim's future output or income lost due to the injury. The additional cost contributors are involving medical treatment, police, and property damage and administration costs.

Finally, the Willingness to Pay (WTP) method calculates the price of accidents from people's trade-off between road safety and other commodities, e.g. deciding between different modes of transportation with different safety levels. The advantage of this approach is that it reflects the public's concern for safety. Also because WTP values tend to be higher than implicit or human capital values, estimated benefits of remedial work are increased, which may increase the priority given to road safety. In practice, the actual cost of injury accident is dependent on the number of people involved in the accident. However, because this number is independent of the site of the accident, the average cost of an accident type is used.

Traditionally, road safety research has been based on accident data. However, simply counting accidents and casualties gives an incomplete indication of the level of road safety (Al Haji, 2003). Accidents and casualties are subject to random fluctuations and are corded number does not necessarily reflect the underlying 'expected' number, recording of accidents and casualties is incomplete and a count of accidents says nothing about the processes that result in accidents (European Transport Safety Council, 2001).

The global economic cost of MVCs was estimated at $518 billion per year in 2003, and $100 billion in developing countries. World Health Organization. 2004 The Centre estimated the U.S. cost in 2000 at $230 billion. In the United States, individuals involved in motor vehicle accidents can be held financially liable for the consequences of an accident, including property damage, injuries to passengers and drivers, and fatalities. In addition, some states allow recovery for the diminished value of the vehicle from the at-fault driver's insurance company. Because these costs can easily exceed the annual income of the average driver, most US states require drivers to carry liability to cover these potential costs. However, in the event of severe injuries or fatalities, victims may seek damages in civil court, often for well in excess of the value of insurance.
Advanced econometric methods (i.e. Unit root testing, the State-Space methods used by SWOV in the Netherlands, and DRAG models devised by Gaudry (2000) in Canada Use Methodological research that is oriented towards time series and cross section modelling. The empirical work involves estimating accidents risk function for death, fatal injuries, and conducing historical simulations (Gaudry (2000).

In this study, Autoregressive Integrated Moving Average (ARIMA) models and regression models with Autoregressive Moving Average (ARMA) errors, and logistic regression will be used for the explanation and prediction (historical simulation) of road safety in Northern Corridor road in Kenya during the period 1990-2015. Predictions made by these models and the quality of their predictions are compared (Leamer ,1987; 1983).

**OBJECTIVE**

This article aims to present the economic impact of road crash related disasters on the Northern Corridor Road of Kenya, using data from the police NTSA, insurance companies, emergency response support teams such as kenya Red cross/St John, Hospitals and individuals involved and affected by RTAs in Kenya, we present the current economic losses and econometrics of RTIs in the nation.it also sought to assess the status of 3 well-known risk factors for RTIs- poor driving culture: speeding alcohol and the use of helmets and reflective clothing, badly designed and neglected roads; lack of road signs misplaced speed bumps, and inadequate enforcement of existing traffic laws: overloading bribery roadworthy vehicles.

## MATERIALS AND METHODS

### Methods

Data for this study were collected in 3 steps. The first step involved the collection of secondary data from the Kenya traffic police NTSA, insurance companies, emergency response support teams such as Kenya Red cross/St John, Hospitals to assess the current trends of RTIs in Kenya. Following this, observational studies and interviews were conducted along the NCR in ChimoiAthi river Mlolongo and salgaa in Kenya to assess the current status of fatalities and non-fatalities and arising economic losses to individual and corporates involved and affected by RTI, The investment in road safety was also assessed against economic losses and to determine the econometrics of RTI and opportunities to mitigate the economic losses.

### Methodology

A part of the methodological research is oriented towards time series and cross section modeling.That involved advanced econometric methods (i.e Unit root testing, the State-Space methods used by SWOV in the Netherlands, and DRAG models devised by Gaudry (2000) in Canada. Road Accidents Modeling provided a framework for discussing road accidents modeling, which are composed of four approaches:

- Descriptive Models
- Predictive Models for Aggregated Data
- Risk Models for Non-Aggregated Data
- Accident Consequence Models/ Accident Cost Approach and Framework.

The empirical work involved estimating accidents risk function for death, fatal injuries costs arising, and conducing historical simulations.

In this study, The Linear structural equation (These equations are applied when phenomena are assumed to be reciprocally causal) Wlezien, C. (1995).models using algorithm with associated path diagrams gave graphical causal models.the linear structural equation model LSEM allowed the researcher to collect information on micro (GNI per capita) and macro (GDP) Economic demographics of the respondents in order to describe them while correlational design aided in the critical understanding of the relationship between Economic factors.

## RESULTS AND DISCUSSION

### Economic Cost of number of killed and injured

Economic Cost of services related to RTI: include Insurance, emergency services, police and judicial costs, social care Costs. The Economic costs represent significant aspect of the consequences of motor vehicle crashes. People injured in these crashes often suffer physical pain and emotional anguish that is beyond any economic recompense. The permanent disability of spinal cord damage, loss of mobility, loss of eyesight, and serious brain injury can profoundly limit a person’s life, and can result in dependence on others for routine physical care. More common, but less serious injuries, can cause physical pain and limit a victim’s physical activities for years after the crash. Serious burns or lacerations can lead to long-term discomfort and the emotional trauma associated with permanent disfigurement. For an individual, these non-monetary outcomes can be the most devastating aspect of a motor vehicle crash.

Few guidelines exist at a national or international level for conducting analyses to assess economic burden Bowman B. (2002); Erasmus Medical Center and CSI Consumer Safety Institute EMC and CSI, (2004); Transport Research Laboratory TRL, (1995). Although the WHO is leading a global effort in this area for violence Alexander Butchart, WHO, 2006).

***Table 1: Distribution of Road Fatalities by Population***

| Year | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Population(Millions)[a]** | 35.1 | 36.1 | 37.2 | 38.3 | 39.3 | 40.3* | 41.4* | 42.5* | 43.7* | 44.9* | 47.8* |
| **Road Fatalities [b]** | 2,533 | 2,715 | 2,921 | 3,149 | 4,032 | 3,045 | 3,302 | 3,141 | 3,218 | 2,907 | 3,057 |
| **Fatalities per 100,000 population** | 7.42 | 8.21 | 7.93 | 8.31 | 9.54 | 8.25 | 7.97 | 6.82 | 7.22 | 6.34 | 6.4 |

It has been variously argued by researchers that economic burden of injuries can be ascribed to some loss of Gross Domestic Product GDP Road traffic injuries … cost governments approximately 3% of GDP." in studies that aim to understand health costs by estimating the value of a statistical life that is lost (or, when considering non-fatal disabilities, the value of a statistical life-year lost). GDP, which is the net monetary value of all goods and services produced by the society (WHO 2015).

**Type of Injuries**

A road traffic crash results from a combination of factors related to the components of the system comprising roads, the environment, vehicles and road users, and the way they interact. Some factors contribute to the occurrence of a collision and are therefore part of crash causation. Other factors aggravate the effects of the collision and thus contribute to trauma severity. The public health perspective includes delineating mortality, morbidity, and risk-taking behaviour. The Abbreviated Injury Scale (AIS) is an anatomically based, consensus-derived global severity scoring system that classifies each injury by body region according to its relative importance on a 6-point ordinal scale (1=minor and 6=maximal).

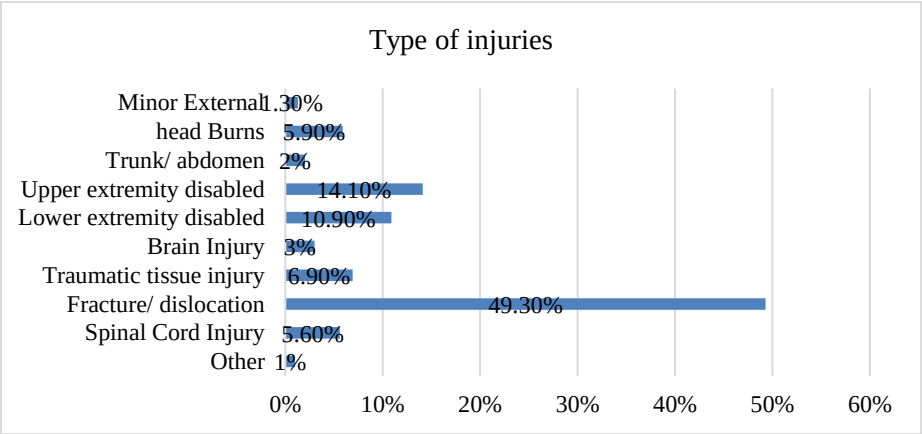


***Figure 1: RTI result in various types of injury***

Trauma severity is an indicator of injury and hence ability or inability , several types of injuries were reported to have been witnessed by respondents of the study 49.3% reported Fracture/ dislocation which is 4 maximal injury in the AIS scale 10.9% reported Lower extremity disabled as did 14.1% for Upper extremity disabled which is 6 maximal injury in the AIS scale also on the 6 maximal injury in the AIS scale some 5.6% reported Spinal Cord Injury, and 3% reported brain injury , 6.9% also reported Trunk/ abdomen which is 5 maximal injury in the AIS scale some 5.9% respondents reported head burns another 4 maximal injury in the AIS scale, whilst 6.9% reported Traumatic tissue injury and 1% reported Minor External injury which is 4 minimal injury in the AIS scale.

Men are three times more likely than women to die in a road crash. Higher deaths among men are partly due to more exposure.

One in eight people who died in a road collision in the first 10 months of 2015 were aged between 30 and 34. The second most vulnerable age-group is 25-29.

***Table 2: Fees Guidelines For Medical & Dental Practitioners***
***LEGAL NOTICE NO. 131***
***THE MEDICAL PRACTITONERS AND DENTISTS BOARD ACT***
***(Cap. 253)***
***SCHEDULE (r.3 (1), (4)) FORM***

| | | | |
|---|---|---|---|
| NEURO13 | Spinal fusions with implants | 120,000.00 | 240,000.00 |
| | Neurostimulation (Spinal Cord Stimulator) | | |
| | | | |
| NEURO22 | Excision of spinal tumours | 108,000.00 | 216,000.00 |
| ANAES101 | Chemodenervation of muscles innervated by facial, trigeminal, cervical spinal and accessory nerves, bilateral (chronic migraine): | 35,000.00 | 61,300.00 |
| NEURO26 | Elevation of depressed skull fracture | 60,000.00 | 120,000.00 |
| | | | |
| PRS65 | Rotational flap for compound fracture | 160,000.00 | 190,000.00 |
| | | | |
| | 4. COMPLEX FRACTURE FIXATION | | |
| ORTHOS14 | 4.1 Pelvis | 144,000.00 | 180,000.00 |
| ORTHOS15 | 4.2 Elbow | 96,000.00 | 144,000.00 |
| | B: MAJOR I | | |
| ORTHOS016 | 1.1 Diagnostic | 48,000.00 | 96,000.00 |
| ORTHOS017 | 1.2 Corrective/ Reconstruction | 90,000.00 | 180,000.00 |
| ORTHOS018 | 2.1. Long bones | 72,000.00 | 144,000.00 |
| ORTHOS019 | 2.2. Hand | 72,000.00 | 144,000.00 |
| ORTHOS020 | 2.3. Ankle and foot | 72,000.00 | 144,000.00 |
| ORTHOS050 | 1.0 Closed fracture/ joint reduction under GA & casting | 36,000.00 | 60,000.00 |
| | | | |
| END016 | Removal of separated/Fractured Instruments plus RCC | 30,000.00 | 50,000.00 |
| | | | |
| PROS019 | Repair of fractured procelain | 10,000.00 | 15,000.00 |
| OMFS019 | Reduction of alveolar fracture | 39,000.00 | 54,600.00 |
| NEURO03 | Cranitomy for brain tumour | 144,000.00 | 300,000.00 |
| NEURO19 | Brain abscess | 72,000.00 | 144,000.00 |
| ANAES100 | Chemodenervation of muscles of the trunk and/or extremity (cerebral palsy, dystonia, multiple sclerosis): | 28,000.00 | 49,000.00 |
| | | | |
| GEN.SURG47 | Repair of burst abdomen | 50,000.00 | 100,000.00 |
| DGRAD071 | Supine abdomen | 1,200.00 | 2,400.00 |
| DGRAD072 | Supine & erect abdomen | 1,800.00 | 3,000.00 |
| PRS58 | Major flap reconstruction of head and neck | 250,000.00 | 300,000.00 |
| | | | |
| DGRARD102 | Head / Skull | 14,400.00 | 26,400.00 |
| OMFS026 | Incision & Drainage head and neck abscess | 23,400.00 | 39,000.00 |
| | | | |
| ORTHOS037 | 3.2.1. With casting | 60,000.00 | 84,000.00 |
| ORTHOS038 | 3.2.2. With ORIF | 72,000.00 | 144,000.00 |
| ORTHOS039 | 3.2.3. With External fixation | 72,000.00 | 144,000.00 |
| | (Ilizarov) | | |
| ORTHOS041 | 5. BONE GRAFT (without additional procedure) | 48,000.00 | 96,000.00 |
| | | | |
| ORTHOS042 | 6. SOFT TISSUE RELEASE | 48,000.00 | 84,000.00 |
| ORTHOS043 | 7. Open Ligament repair | 60,000.00 | 84,000.00 |

| | | | |
|---|---|---|---|
| NEURO13 | Spinal fusions with implants | 120,000.00 | 240,000.00 |
| NEURO14 | Lumbar fusion / spondylosis / disc procedure | 120,000.00 | 240,000.00 |
| | | | |
| NEURO28 | Spina bifida surgery | 96,000.00 | 144,000.00 |

***Source: The Government Printer, Nairobi***

**Number of Vehicles Involved**

Type/Number of Vehicles Involved is a mixture of high-speed motorized traffic with vulnerable road users; insufficient attention to integration of road function with decisions about speed limits, road layout and design, alcohol, fatigue, illness, seating position, seat belt use; vehicle conditions, vehicle mass, vehicle size (Wets G et'al 2007).

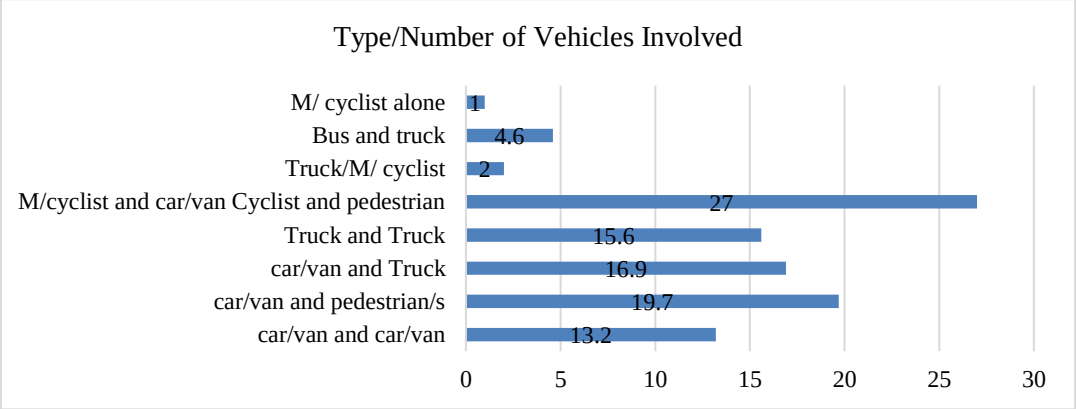


***Figure 2:Type/Number of Vehicles Involved***

Motor/cyclist and car/van Cyclist and pedestrian account for 27% of reported vehicles involved in RTI whilst car/van and pedestrian/s were at 19.7%, along with car/van and Truck account for16.9% RTI, Truck and Truck account for 15.6% of reported by respondents car/van and car/van follow at 13.2%, Bus and truck follow at 4.6%, Truck/Motorcyclist was reported by respondents by 2% whilst some 3% reported Motor cyclist/passenger alone. The foregoing shows Motorcycles are the most hazardous form of motor vehicle transportation. The lack of external protection provided by vehicle structure, the lack of internal protection provided by seat belts and air bags, their speed capability, the propensity for riders to become airborne through ejection, and the relative instability inherent with riding a two-wheeled vehicle all contribute to making the motorcycle the riskiest passenger vehicle.

**Characteristics of Road Accidents**

***Table 3: Fatal Accidents Serious Injuries. Accidents Slight Injuries. Accidents***

| **Annual Summaries Accidents** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fatal Accidents | 2154 | 2203 | 2283 | 2527 | 3237 | 2648 | 2772 | 2648 | 2584 | 2503 | 2559 |
| Serious Inj. Accidents | 4234 | 4280 | 4168 | 4218 | 4527 | 4482 | 4045 | 3469 | 2923 | 2572 | 2260 |
| Slight Inj. Accidents | 6011 | 5718 | 6019 | 4464 | 4605 | 2641 | 1376 | 800 | 698 | 590 | 491 |
| Total No. of Accidents | **12399** | **12201** | **12470** | **11209** | **12369** | **9771** | **8193** | **6917** | **6205** | **5665** | |

Traffic safety is a serious problem in Kenya, with over 13,000 traffic accidents annually (involving approximately 26,000 vehicles) causing 2600 fatalities and over 11,000 serious injury cases. This translates to over 36 accidents and 8 fatalities daily. The number of casualties per crash has also gone up from 1.3 in 1965, 1.8 in 1990 to 2.0 in 2002, while fatalities per 10,000 population during 1985 to 2002 has risen from 7.8 to 10 respectively. "Economic Recovery Strategy for Wealth and Employment Creation 2003-2007" (ERS), the Government of Kenya (GoK)The kenya Traffic Report (2005-2015) revealed that road accidents and the resulting causalities have noticeably decreased in the kenya over the last ten years. As can be seen from table (1.1), total of accidents increased from 12399 in 2005 to 9771 in 2010, reaching 5310 in 2015. This represents a decrease of 40% in ten years.

*Table 4: Persons Killed, Seriously Injured, Slightly Injured*

| Victims: | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Persons Killed | 2531 | 2714 | 2893 | 3158 | 4072 | 3055 | 3302 | 3141 | 3191 | 2907 | 3057 |
| Seriously Injured | 7899 | 8722 | 9013 | 9206 | 10644 | 9327 | 8647 | 7434 | 6299 | 5140 | 4731 |
| Slightly Injured | 12341 | 11828 | 13682 | 12162 | 9740 | 9739 | 7144 | 5037 | 4834 | 3971 | 4350 |

Death tolls however increased between 2005-2015, from 2531 to 3057 cases. Serious injuries increased from 7899 in 2005 to 9327 in 2010 they further decreased to 4731 in 2015. Likewise, light injuries and damages have exhibited a reverse trend, from 12341 in 2005 to 9739 in 2010 and 4350 in 2015.

*Table 5: Persons Up To 16 Years*

| Persons Up To 16 Years | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Killed | 333 | 356 | 414 | 375 | 424 | 381 | 397 | 418 | 376 | 364 | 389 |
| Seriously Injured | 704 | 795 | 761 | 638 | 826 | 917 | 864 | 910 | 823 | 791 | 810 |
| Slightly Injured | 984 | 891 | 1186 | 826 | 896 | 875 | 830 | 874 | 821 | 836 | 939 |

**Medical costs**

The cost of medical care is borne by the individual in the form of payments for insurance, deductibles, uncovered costs, and uninsured expenses. It is borne by society through higher insurance premiums and through the diversion of medical resources away from other medical needs, such as medical research, disease prevention and control, and basic public health needs.

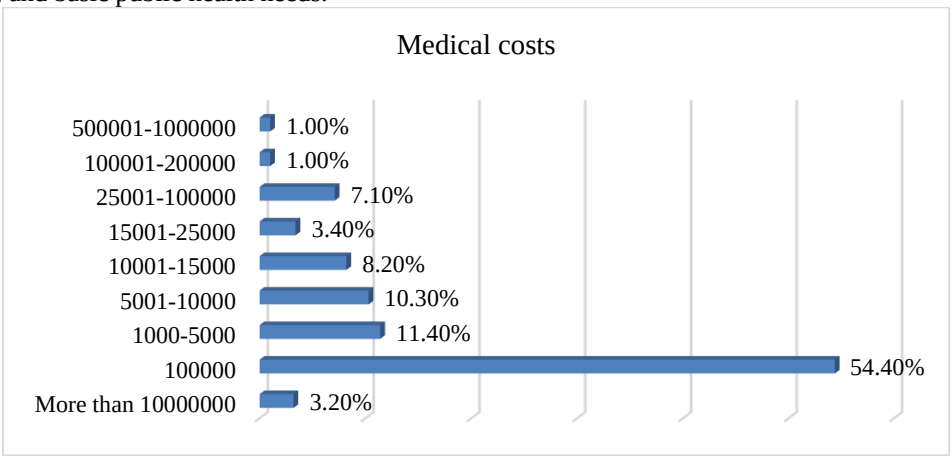


*Figure 3: Medical costs*

A question on Medical costs arising from RTI s was put to the respondents they were asked to estimate in monetary terms how much money might have been spent on medical costs in incidents they witnessed findings were as follows 54.4% reported costs related to medical at 100000,whilst 11.4% reported losses at 1000-5000 some 10.3% estimated cost to be between 5001-10000 ,8.3% reported costs to be 10001-15000 ksh another 7.1% respondents reported loss estimates at 25001-100000 , only 3.2% reported costs to be more than 1000000 ksh whilst 1% reported loss estimates between 100001-200000 ,1% reported loss estimates between 100001-1000000 these losses indicate high losses are incurred in medical costs after RTI.

**Emergency service costs**

Emergency Services consists of separate police, fire, and incident management components.

Despite the existence of emergency medical services personnel and institutions that train them, they are still not recognised as medical professionals in Kenya. Therefore, there are no national standards or regulations on their training by the government.

Emergency Medicine has just recently been recognised as a medical speciality by the Kenya Medical Practitioners and Dentists Board as well as the Clinical Officers Council. This will hopefully lead to the development of the speciality in the country. Currently, most public emergency centres are staffed by clinical and medical officers who lack specific training in emergency care.

The second big issue is resources. The majority of counties in Kenya lack ambulance services, others have contracted private companies. In most cases though, patients are transferred to hospitals by private means. For instance, by car, truck or taxi. Few people make it by ambulance given their cost, scarcity and the lack of a well-connected, reliable central dispatch system.

This is a big problem as over the last couple of years Kenya has seen an increased number of major incidents and disasters. The rise in global terrorism and lack of enforcement in traffic and building regulations have contributed to this. Without a coordinated response to these incidents, there is the potential of an unnecessary increase in morbidity and mortality.

The third problem is that Kenya doesn't have an organised national emergency or trauma care system.

The draft National Policy on Disaster Management in Kenya (2009) highlights the need for emergency care systems. However there has been little progress in actually implementing these interventions despite the formation of a National Disaster Operation Centre and National Disaster Management Unit. This is largely due to the delayed recognition of the need to develop emergency care systems in Kenya as a priority.

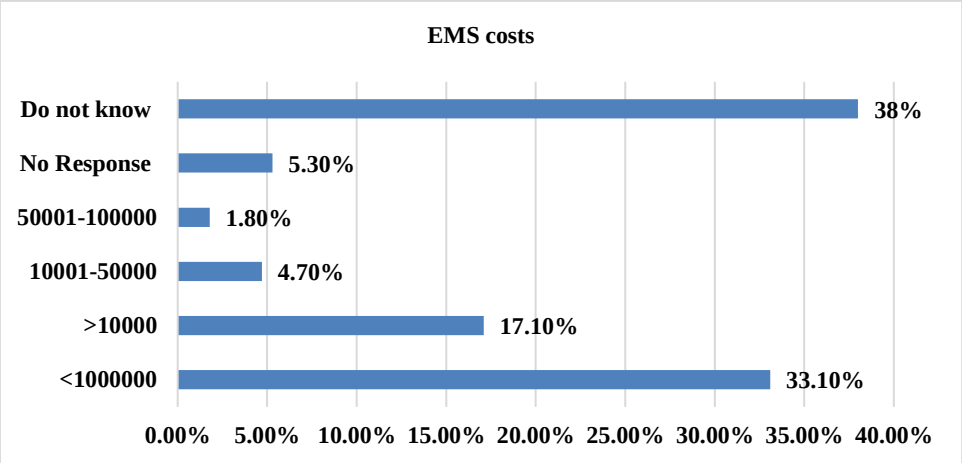


***Figure 4:EMS costs***

A question on EMS costs arising from RTI s was put to the respondents they were asked to estimate in monetary terms how much money might have been spent on EMS costs in incidents they witnessed findings were as follows 38% reported no costs or were unable to quantify costs related to EMS 33.1% reported costs to be less than 1000000, 17.1% reported costs to be less than 10000 some 5.3% gave no response whilst 4.7% estimated EMS cost to be between 50001-100000 ,1.8% reported EMS costs to be between 10001 50000 .

**Market Productivity**

There are also significant costs associated with the lost productivity experienced by an individual and others when the victim dies prematurely or experiences a short or long-term disability. The victim's dependents suffer immediate economic hardship in the loss of the victim's income and other contributions, while society is burdened by the necessity to support the victim or their dependents and through foregone contributions to the Nation's productivity. Aside from these economic consequences, victims suffer from physical pain, disability, and emotional impacts that can greatly reduce the quality of their lives. For lost productivity, these high costs are a function of the level of disability that has been documented for crashes involving injury and death.

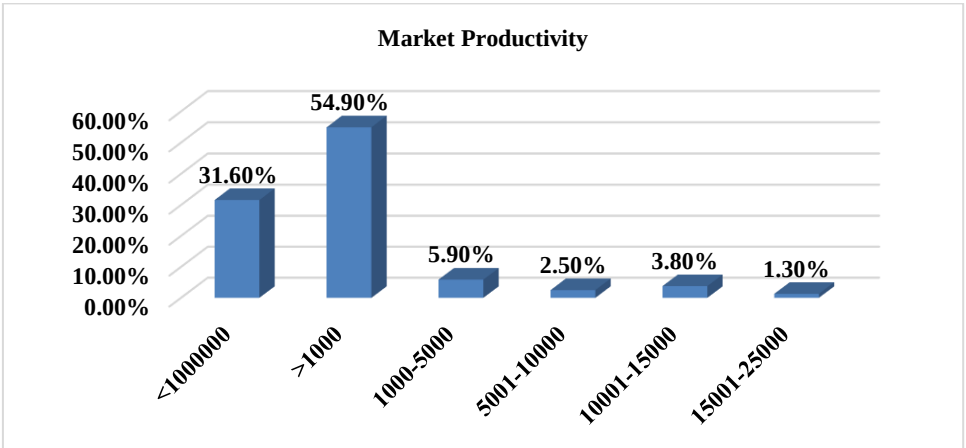


***Figure 5: Market Productivity losses***

Market productivity costs arising from RTI s shows 38% reported no costs or were unable to quantify costs related to loss in market productivity 7% reported losses at 1000-5000 some 3% estimated cost to be between 5001-10000, 3% reported costs to be less than 1000 ksh another 5% respondents reported loss estimates at 10001-15000, 15% reported costs to be more than 1000000 ksh whilst 2% reported loss estimates between 15001-25000, incurred losses in market productivity costs after RTI.

**Household Productivity losses**

The family and friends of the victim feel the psychological repercussions of the victim's injury acutely as well. Caring for an injured family member can be very demanding for others in the family, resulting in economic loss and emotional burdens for all parties concerned. It can change the very nature of their family life; the emotional difficulties of the victim can affect other family members and the cohesiveness of the family unit. When a crash leads to death, the emotional damage is even more intense, affecting family and friends for years afterward and sometimes leading to the breakup of previously stable family units.

***Table 6: Household Productivity losses***

| Losses | Percent |
|---|---|
| <1000000 | 6.8 |
| >1000 | 16.9 |
| 1000-5000 | 6.8 |
| 5001-10000 | 6.8 |
| 10001-15000 | 8.5 |
| 15001-25000 | 6.8 |
| 25001-100000 | 3.4 |
| Total | 55.9 |
| Do not know | 44.1 |
| Total | 100.0 |

A question on household productivity costs arising from RTI s was put to the respondents they were asked to estimate in monetary terms how much money might have been lost on household productivity costs in incidents they witnessed findings were as follows 44% reported no losses or were unable to quantify costs related to loss of household productivity 7% reported losses at 1000-5000 another 7% estimated loss to be between 5001-10000 ,17% reported losses to be less than 1000 ksh another 3% respondents reported loss estimates at 25001-100000 , some 6% reported loss to be more than 1000000 ksh whilst 7% reported loss estimates between 15001-25000 ,3% reported loss estimates between 25001-100000 these losses indicate high losses in household productivity after RTI. At societal level, poor population health is associated with lower savings rates, lower rates of return on capital, and lower levels of domestic and foreign investment; all of these factors can and do contribute to reductions in economic growth (Ruger et al., 2006).

**Congestion time during RTI**

Motor vehicle crashes result in significant time delays to other motorists who are inconvenienced by lane closures, police, fire, or emergency services activity, detours, and general traffic slowdowns resulting from rubbernecking and chain reaction braking. This results in a significant time penalty for those affected, which can be valued based on wage rates and the value people place on their free time. It also results in wasted fuel, increased greenhouse gas production, and increased pollution as engines idle while drivers are caught in traffic jams and slowdowns. These impacts affect drivers' transportation costs and negatively impact the health and economic welfare of the Nation Motor vehicle crashes also result in added societal costs due to congestion and workplace disruption. Congestion costs, which include travel delay, excess fuel consumption, and added greenhouse gases the time spent by police at the crash site. However, crashes begin to influence congestion from the time of their occurrence.

***Table 7: Congestion time during RTI***

| | Percent |
|---|---|
| <1000000 | 8.5 |
| >1000 | 18.6 |
| 1000-5000 | 11.9 |
| 5001-10000 | 1.7 |
| 10001-15000 | 1.7 |
| 15001-25000 | 1.7 |
| 25001-100000 | 1.7 |
| No response | 54.2 |
| Total | 100.0 |

A question on Congestion time taken at RTI scene was put to the respondents they were asked to estimate in monetary terms how much money might have been lost in incidents they witnessed findings were as follows 54% reported no costs or were unable to quantify costs related to congestion time 19% estimated cost to be less than 1000 ksh another 12% reported losses at 1000-5000 some 9% respondents reported loss estimates at more than 1000000 ksh whilst 8% reported loss estimates between 5000 -1000000 these losses indicate significant losses are lost in congestion time during RTI.

**Structural Equation Modeling (SEM)**

Graphical model consists of a graph with vertices that are random variables, and an associated set of joint probability distributions over the random variables, all of which share a set of conditional independence relations. The graph is often given a causal interpretation as well, in which case it is a graphical causal model. Linear structural equation models with associated path diagrams are examples of graphical causal models. By exploiting the relationship between graphs and conditional independence relations on the one hand, and graphs and causal relations on the other hand, many properties of path diagrams can be generalized to a wide variety of families of distributions, and assumptions about linearity can be relaxed Although graphical causal modeling has historical ties to causal modelling in econometrics and other social sciences, there have been recent developments by statisticians, computer scientists, and philosophers that have been relatively isolated from the econometric tradition(Muthén&Muthén, 1998-2007).

***Table 8: RTI Fatalities and motor insurance clams 2005 to 2015***

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Motor Claims | 6,206,700 | 6,920,793 | 234,643 | 211,576 | 162,307 | -155,797 | 13,687,327 | 16,436,321 | 18,056,112 | 21,704,297 | 25,811,991 |
| Road Fatalities | 2,533 | 2,715 | 2,921 | 3,149 | 4,032 | 3,045 | 3,302 | 3,141 | 3,218 | 2,907 | 3,057 |

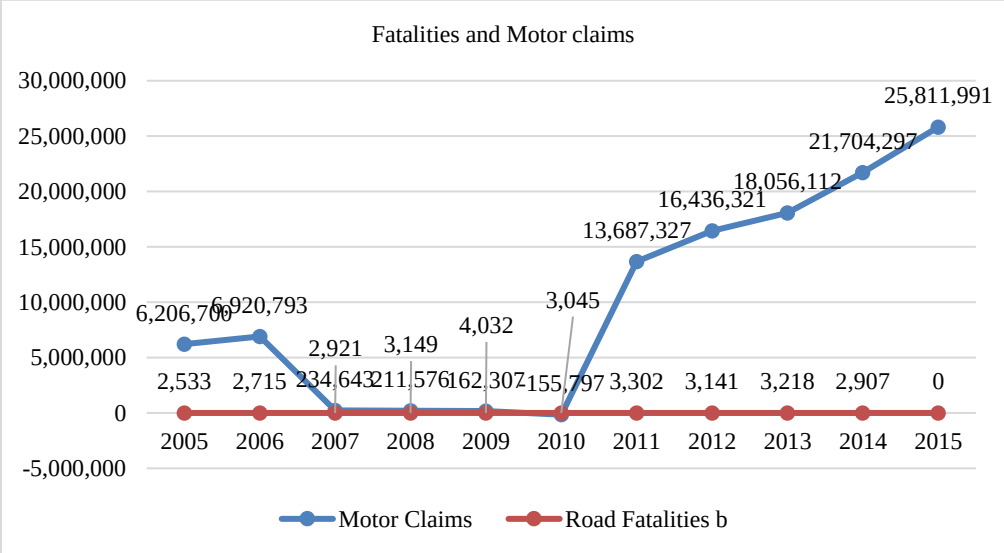


***Figure 57 LSEM of RTI Fatalities and motor claims***

**Temporal and Spatial Correlation**

To avoid the information lost in time-varying explanatory variables,the study used data in small time intervals: years' worth of crash data and divided these data into 12 monthly observations and considered the number of crashes per month and per year. Though the same roadway entity (roadway segment, intersection) generated multiple observations, and these observations were correlated over time because many of the unobserved effects associated with a specific roadway entity remained the same over time. From a statistical perspective, this set up a correlation in the disturbances used for model estimation, which were known to adversely affect the precision of parameter estimates. In a similar vein, there were correlation over space, because roadway entities that are in close proximity may share unobserved effects John Loehlin(2004).

The study found the he data on Road Traffic Incident fatalities have steadily increased from 2533 fatalities in 2005 rising in 3149 in 2008 and peaking in 2009 at 4032 fatalities in 2015 the fatalities stood at 2957, on the macroeconomic front motor private and commercial claims lodged and paid by the in insurance industry were at 6,206,700,000 ksh in 2005 the figure dramatically rose to 13,687,327,000 in 2011 and peaked in 2015 at some 25,811,991,000 ksh (figures are in billions of kenyashillings.the correlation in linear Structural Equation Modeling LSEM indicates a economic impact of disastrous proportions indicating a growing burden on individual economic status and a growing national health and economic burden that stands at ksh 300 billion 5% of GDP (NTSA 2016)

## CONCLUSION

This study highlights the significant burden of RTIs in Kenya (ksh 300 billion in 2015). A renewed focus on addressing this burden is necessary. Focusing on increasing helmet and reflective clothing use and enforcement of speed limits has the potential to prevent a large number of road traffic crashes, injuries, and fatalities. However, it is difficult to demonstrate the magnitude of the injury problem to policymakers with minimal or inaccurate data, and this study illustrates the need for national continuous, systematic, and sustainable data collection efforts, echoing similar calls for action throughout the injury literature.

The injury problem is large and heterogeneous regarding external causes, type of injury, severity, age patterns and opportunities for prevention. Injuries range from frequent minor injuries such as superficial injuries) to rare major injuries (such as polytrauma). As a consequence, injuries result in a wide array of individual patterns of use of health services and functional outcome. Choices must be made in setting priorities for injury prevention and allocating scarce resources between alternative uses. For example, should more resources be allocated to programmes for preventing falls among older people, programmes for promoting water safety among children or programmes for preventing violence among adolescents. Within preventing falls, should more resources be allocated to reducing the current rate of falls by screening the older people who have fallen and visit the emergency department (high-risk population) or to providing an information campaign for everyone older than, for example, 55 years (low-risk population). Methods are therefore needed for making the most optimal choices in injury prevention policies.

An injury prevention measure can lead not only to avoiding injury, disability, death and associated health care costs but also to reducing property damage, loss of productivity and the pain and suffering resulting from injuries Decision-makers want to know whether injury prevention interventions are worth implementing and whether the benefits from already implemented interventions have been worth their costs Highway traffic incidents on the Northern Corridor are a common occurrence and pose a real threat to the lives of many people and economic losses. There are many causes of the incidents including lack of preparedness and poor response from the emergency services, which lack the capacity to deal with the incidents compounding already dire situations. The reality is that these traffic incidents can either be avoided or impacts mitigated.

## RECOMMENDATIONS

If not addressed effectively, the Northern Corridor will continue to have the frequent road blockages and incidents common with it. Kenya needs to come up with a comprehensive Traffic incident management manual that will improve the preparedness and response especially by the police and other emergency services.

The police department especially must be well equipped to handle such incidents, radio calls, cranes, vehicles hydrants for the fire fighters must always be available and at easy reach whenever need arises.

The public should be sensitised on the gains of safety on roads both to them and to other road users. This can only be achieved in instilling of value of road discipline and concern for other users.

Regulations such as reduction of number of road blocks and weighbridges although passed, their enforcement must be strictly followed up to ensure the police do not set up illegal check points along the Northern Corridor.

**ACKNOWLEDGEMENTS**
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