ROAD ACCIDENT DATA BASE: THE CASE OF CACADU DISTRICT MUNICIPALITY

S O MOHAMMED and F J J LABUSCHAGNE

Transport Systems and Operations, Built Environment, CSIR, Pretoria 0001
SMohammed@csir.co.za; FLabuschagne@csir.co.za

ABSTRACT

The Cacadu District Municipality (CDM) in the Eastern Cape Province has been involved in collation of accident report forms from the South African Police Service (SAPS) and capturing the data in a database. The aim of the project was to identify hazardous locations and the conceptualisation of appropriate treatments/interventions for improving road safety on the road network of the Cacadu District Municipality.

The paper presents the data collection process and hazardous location identification methodology as well as the outcome of the project. It highlights the problems encountered, shortcomings of the accident reporting system and the way forward for a meaningful road accident database.

The study concluded that the road safety management process cannot be implemented until a number of challenges have been addressed such as incomplete accident reporting; data quality and accuracy which include aspects such as typographic error in data entry, imprecise entry as in the use of general terms to describe a location, incorrect entry of road names, level of accident severity, vehicle type, incorrect training and subjectivity – where data collection relies on opinions of individuals.

The crash data quality problem is therefore not unique to the Cacadu District Municipality but seems to be a national problem. Sinclair, for example, reviewed the national accident database and concluded that the quality of the data is questionable.

1   INTRODUCTION

The World Health Organization (WHO) ranks road traffic injuries as the eighth leading cause of death globally and the leading cause of death of young people aged 15-29. If the status quo prevails, it is anticipated that by 2030 road traffic deaths will become the fifth leading cause of death. In the low- and middle-income countries, the rates of road traffic injuries are double those of high-income countries. The main reason given for this is the increased rate of motorisation in many developing countries without the necessary investment in road safety strategies and land use planning. In some high-income countries, road traffic fatality rates are decreasing through coordinated, multi-sectoral responses to road traffic crashes such as the implementation of a number of proven measures that address the safety of road users, vehicle safety, the road environment and post-crash care (WHO, 2013). The United Nations (UN) launched a Decade of Action for Road Safety in 2011 with the goal to half road fatalities worldwide by 2020. To achieve the objectives of the Decade of Action indeed, and to improve road safety outcomes in general, reliable crash data is crucial. Furthermore, a reliable crash data base is essential in order to establish a baseline against which changes in annual road fatalities can be measured, as well as the year-on-year changes to road fatalities to measure progress over the next decade until 2020.

Crash data are essential for understanding, assessing and monitoring road safety issues and to design and implement effective countermeasures or policies. They are also the basis on which safety targets are set. The Road Traffic Management Corporation (RTMC) is responsible for gathering, capturing, analysing and reporting of road traffic crashes in South Africa. The RTMC collates crash data from the South African Police Service (SAPS), and provincial transport authorities, metropolitan municipalities, the Road Accident Fund and other private sector role-players are using the information contained in the Accident Report Forms (AR Forms). The data is aggregated by the RTMC at a national level, analysed and published annually to enable monitoring of road safety performance in the country. However, these aggregated data are of little use to road safety strategy implementing authorities who require detailed disaggregated accident records for analysis.

This paper addresses as a case study, the issues encountered by a district municipality in obtaining and maintaining a complete, accurate and continuous record of crashes within its jurisdiction. It highlights the need for coordination among the different authorities involved in recording, collating and analysing crash data. The finding of this case study is relevant for understanding what the critical information required is in order to implement effective road safety measures.

2   CACADU DISTRIC MUNICIPALITY

The Cacadu District Municipality (CDM) is located in the western section of the Eastern Cape Province, surrounding the Nelson Mandela Metropolitan Bay Area. It provides support and shares responsibility of providing basic services to nine local municipalities namely Kou-Kamma, Baviaans, Kouga, Ikwezi, Camdeboo, Blue Crane Route, Sundays River Valley, Ndlambe and Makana. Figure 1 shows the location of the respective local municipalities. Some of them are traversed by major national and provincial roads including the N2, N9, N10 and other major provincial roads such as R75, R400 and R62.
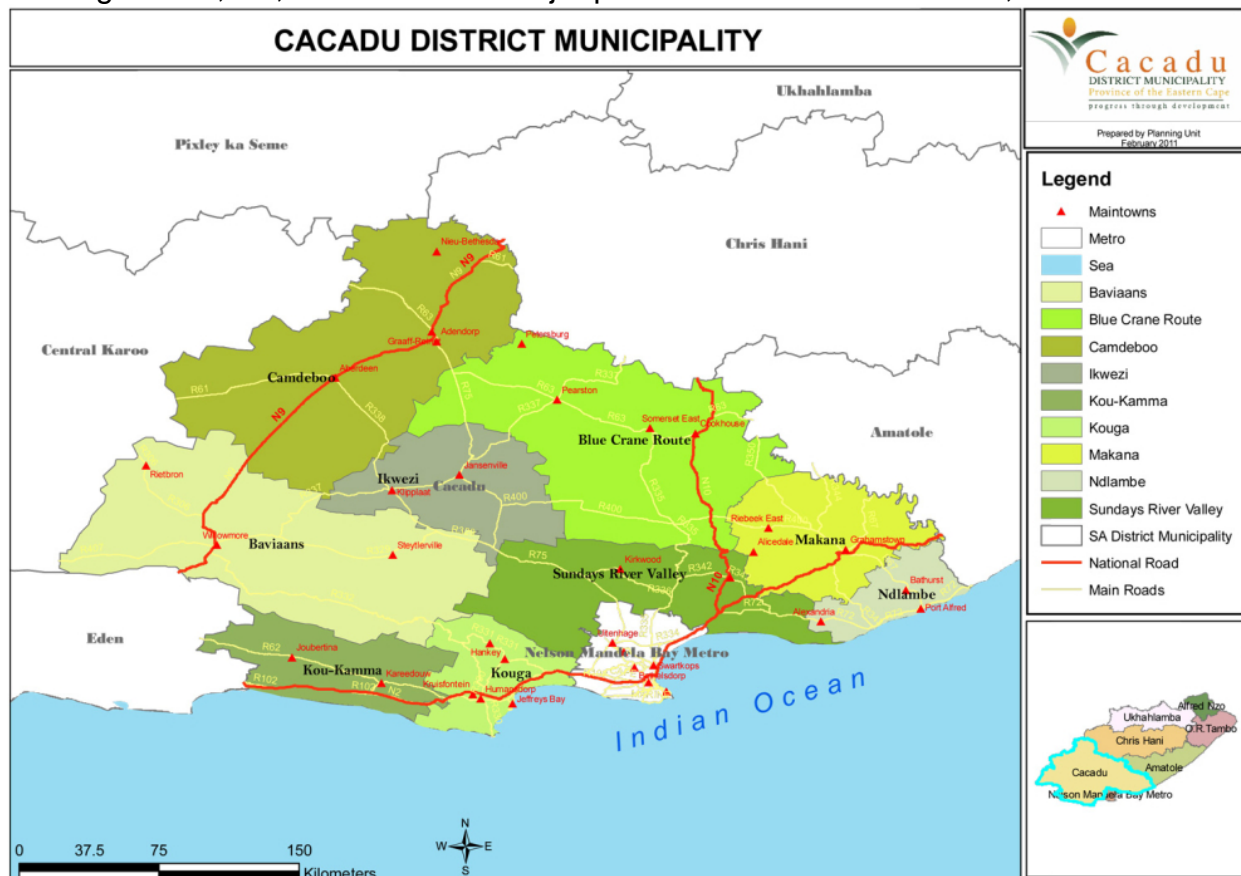
Proceedings of the 33rd Southern African Transport Conference (SATC 2014)
Proceedings ISBN Number: 978-1-920017-61-3
Produced by: CE Projects cc

576

7 – 10 July 2014
Pretoria, South Africa

Figure 1: Local municipalities within the Cacadu District Municipality

In 2011, the CDM set out to record and investigate road crashes within its area. With limited resources but a strong determination to make a difference in the lives of its residence in terms of road safety, the CDM embarked on the task of setting up its own road accident database.

The objectives of the road accident database were to:
(a) Conduct research regarding the concentration of certain types of accidents,
(b) Investigate measures for reducing particular kinds of accidents,
(c) Determine how to improve traffic safety, response time, one stop emergency centres…etc.; and
(d) Package the outcome of the database for greater impact on funders/planners.

3   STUDY METHODOLOGY

Accident Record Forms (AR Forms) are used to report road crashes in SAPS centres. These AR Forms are then captured by provincial transport authorities. In the case of the CDM, the AR Forms are collected from all the SAPS centres within the district and captured on an accident database called AcciBase. The AcciBase has been used by other metropolitan municipalities in the Eastern Cape Province, notably the Nelson Mandela Bay Metropolitan Municipality and Buffalo City Metropolitan Municipality. They use the tool for crash analysis and motivation of accident black spot improvement programmes. Data capturers scan the AR Forms into the AcciBase which extracts the data and also save scanned copies of the AR Form. The tool has a base map on which the accident locations are plotted.

The crash records were to be supplemented with other sources of crash data such as emergency medical services (EMS) data where available. However, these were not readily available to be included in the study.

Based solely on the accident database collected by the CDM, a number of hazardous locations were to be selected for further detailed analysis based on a road safety assessment process. The outcome of the process would be a road safety assessment report with clearly identified countermeasures to reduce particular kinds of crashes.

Proceedings of the 33rd Southern African Transport Conference (SATC 2014)
Proceedings ISBN Number: 978-1-920017-61-3
Produced by: CE Projects cc

7 − 10 July 2014
Pretoria, South Africa

577

4   FINDINGS

Altogether 4157 accident records dated from 2000-2010 were received by the study team for analysis. The distribution of these data records are shown on Table 1 below.

Table 1 Number of accident records by year

Year	Total
2000	1
2002	1
2003	1
2004	1
2005	3
2006	3
2007	2
2008	2 949
2009	726
2010	470
Total	**4 157**

Accident records prior to January 2008 were not included in the study as they covered insignificant numbers of accident records in those years. Available accident records from January 2008 to June 2010 were included in the analysis. The accident records for 2009 (726 records) and 2010 (470 records) seem to be very low compared to those from 2008 (2949 records). This may indicate that not all crashes were captured in the database. The study, however, focused on those accident reports from January 2008 to June 2010 for the hazardous location identification. The ideal inputs required for such a study should be based on at least 3 years accident records.

The quality of the accident location entry on the CDM database was found to be unreliable due to the lack of precise location information on the actual SAPS AR Forms. The location data on these AR Forms were based on descriptions only; and the start and end points of the road segment were not defined.

Using the available data, a network screening exercise was attempted. This includes grouping road segments by:

- Functional classification (freeway, arterial, collector…etc),
- Area type (e.g. urban, rural, township)
- Roadway network elements (intersections, roadway segments, facilities, ramps, etc).

An attempt was also made to group the sites by reference population which is a grouping of sites with similar characteristics (e.g. four-legged signalised intersections, two-lane rural highways, etc.). With limited information on such fields on the CDM database, grouping was made based only on roadway network elements such as segments and intersections. Ultimately, prioritisation of individual sites was made within a reference population.

The next step was to select one or several performance measures to be used in evaluating the potential to reduce the number of crashes or crash severity at a site. Due to the lack of traffic volume data, limited performance measures could be conducted. These were: average crash frequency, equivalent accident number and relative severity index. The result of this analysis was a list of sites listed according to the selected performance measure. Those sites higher on the list are considered most likely to benefit from countermeasures intended to reduce crash frequency.

4.1   Selection of hazardous locations

4.1.1 Crashes on road segments (street)

The distribution of road crashes on road segments was found to be doubtful. Figure 2 below shows the distribution based on crash types.
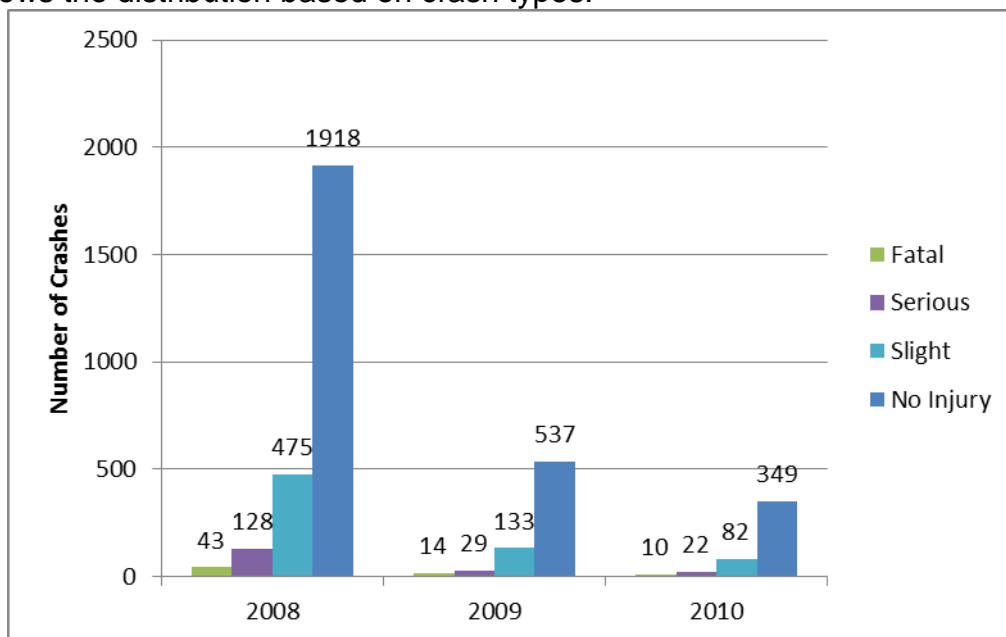

Figure 2 Number of crashes on road segments by injury type

The CDM database shows a dramatic decrease in all types of crash severity from 2008 to 2009, i.e. to less than 25%. The perception is, however, that road crashes are on the rise over these years. With no major events to support the abrupt decrease of crashes over the three years, it is safe to assume that the CDM database is incomplete; a number of crashes have not been captured especially from 2009 and 2010.

Proceedings of the 33rd Southern African Transport Conference (SATC 2014)
Proceedings ISBN Number: 978-1-920017-61-3
Produced by: CE Projects cc

7 – 10 July 2014
Pretoria, South Africa

579

With the data available, the three performance measures were used to identify the most hazardous road segments as mentioned earlier

A) Average Crash Frequency: The site with the greatest number of total crashes in a specific period of time is given the highest ranking. This method is the simplest of all but has a number of limitations. It will not identify low-volume collision sites where simple cost-effective countermeasures could be applied easily. It also does not account for regression-to-the-mean (RTM) bias. The RTM is the tendency or statistical probability that a comparatively low crash frequency period will be followed by a higher crash frequency period or vice versa due to randomness of crash occurrences.

B) Equivalent Accident Number (EAN): This method assigns weighting factors to crashes by severity (fatal, serious, slight, no injury) to develop a combination of frequency and severity score per site. The weighting factors are calculated relative to *No Injury* crash costs. The advantage of this method over the previous method is that it considers crash severity but it may overemphasise locations with a low frequency of severe crashes depending on the weighting factors used. The weighting factors used in the study are *Fatal* = 25.2, Serious = 5.8, *Slight* = 1.5 and *No Injury* = 1.

C) Severity Index: This is based on the average crash costs of a site and shows the average weighting factor at a site. The EAN is divided by the total crashes at the site. It may mistakenly prioritize low-volume, low-collision sites.

The outcome of the preliminary evaluation based on the above performances is given in the Table 2 below

Table 2 Performance measures outcome

Ranking	Element ID	Total crashes	Element ID	EAN	Element ID	Severity Index
1	32721	91	32721	190.6	17850	3.56
2	32060	51	17850	145.9	63843	2.89
3	211413	47	32060	98.1	32442	2.85
4	63856	47	32187	91.9	32187	2.30
5	215283	44	32442	79.9	11501	2.28
6	215518	42	11501	77.6	32082	2.22
7	17850	41	211413	74.5	207693	2.20
8	1464	41	215283	72.5	32721	2.09
9	32187	40	63843	69.4	32080	1.95
10	210289	40	32080	64.5	32060	1.92

Based on this information, two of the road segments Element IDs were selected for further investigation. These are Element IDs 32721 and 17850 (shown in red).

Proceedings of the 33rd Southern African Transport Conference (SATC 2014)
Proceedings ISBN Number: 978-1-920017-61-3
Produced by: CE Projects cc

580

7 – 10 July 2014
Pretoria, South Africa

A) Crashes on intersections (nodes)

In 2008, 384 crashes at intersections were recorded and during the subsequent year the figure decreased to only 13 according to the CDM database. The distribution of road crashes on intersections was also found to be doubtful as no major events occurred over those years to explain the radical decrease. Figure 3 below shows the distribution based on crash severity.
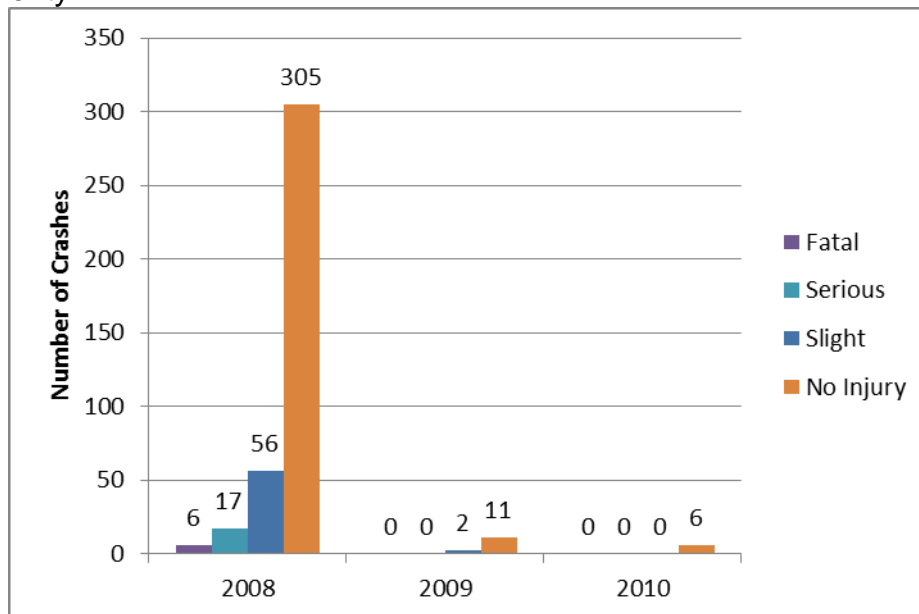

Figure 3 Number of crashes on intersections by injury types

Similar to crashes on road segments, Figure 3 shows that the database is incomplete and unreliable especially for the later years.

The result of performance measures on the nodes was found to be negligible compared to the performance measures on road segments. Thus the study focused on crashes that occurred on road elements labelled as road segments.

4.2   Diagnosis

GIS shape files from the CDM revealed that the road segments with Elements ID 32721 and 17850 are located on the National Road N2-13 66.4E to N2-13 79.2E close to Grahamstown and provincial road R102 Gopalall Hurban Road (Burns Dam to 4 km west) respectively. An in-depth study was undertaken to identify patterns in crash type, crash severity or roadway environmental conditions on these roads.

Proceedings of the 33rd Southern African Transport Conference (SATC 2014)
Proceedings ISBN Number: 978-1-920017-61-3
Produced by: CE Projects cc

7 – 10 July 2014
Pretoria, South Africa

581

4.2.1 N2 Grahamstown

The N2 section at Grahamstown was found to be the most hazardous road section based on the number of crashes and EAN. The section is between N2-13 66.4E and N2-13 79.2E just outside Grahamstown.

According to the database 91 crashes occurred on this section. Figure 4 below shows the number of crashes by type and severity on the road segment. Single vehicle overturn crashes type seemed to be prominent. All the 24 ARFs that pertained to those single vehicle overturn crashes in this section of the road were obtained for further investigation.
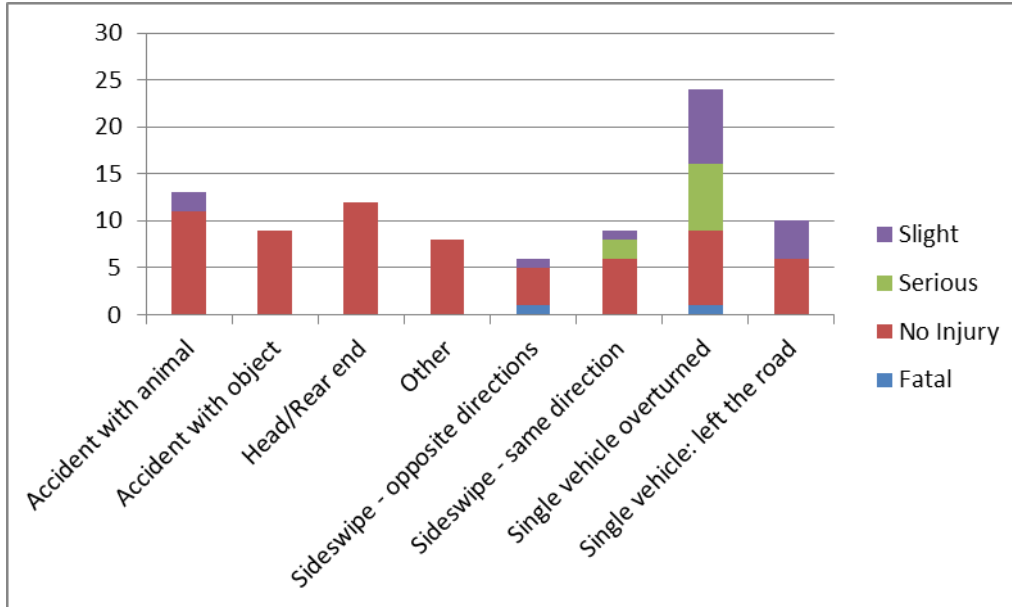

Figure 4 Types of accidents on N2 Grahamstown road segment

A closer look at the individual ARFs(that were filled either by the SAPS at accident scenes or by the crash victims involved) revealed that of the 24 single vehicle overturn crashes, the location of four were coded incorrectly as they did not correspond to the N2 section. Another accident record had the exact location detail but was not within the N2 section under investigation. It was located on the Nanaga-Grahamstown section of the N2. Furthermore, only three of the remaining accidents can be plotted within the 12.8km long section of the N2 under investigation. The rest could have occurred anywhere on the N2 between Grahamstown and Peddie which covers a distance of 65 kilometres.

Proceedings of the 33rd Southern African Transport Conference (SATC 2014)
Proceedings ISBN Number: 978-1-920017-61-3
Produced by: CE Projects cc

7 – 10 July 2014
Pretoria, South Africa

582

4.2.2 R102 Gopalall Hurban Road

The 4km stretch on the R102 under investigation lies between Humansdorp and Jeffreys Bay. It is the second in ranking according to the EAN and Severity Index performance measures.

According to the database, 41 crashes occurred in this section. Figure 5 below shows the number of crashes by types and severity. Accidents with animals were selected for a closer look. All 10 ARFs that pertained to those crashes where animals were involved in that section of the road were obtained for further investigation.
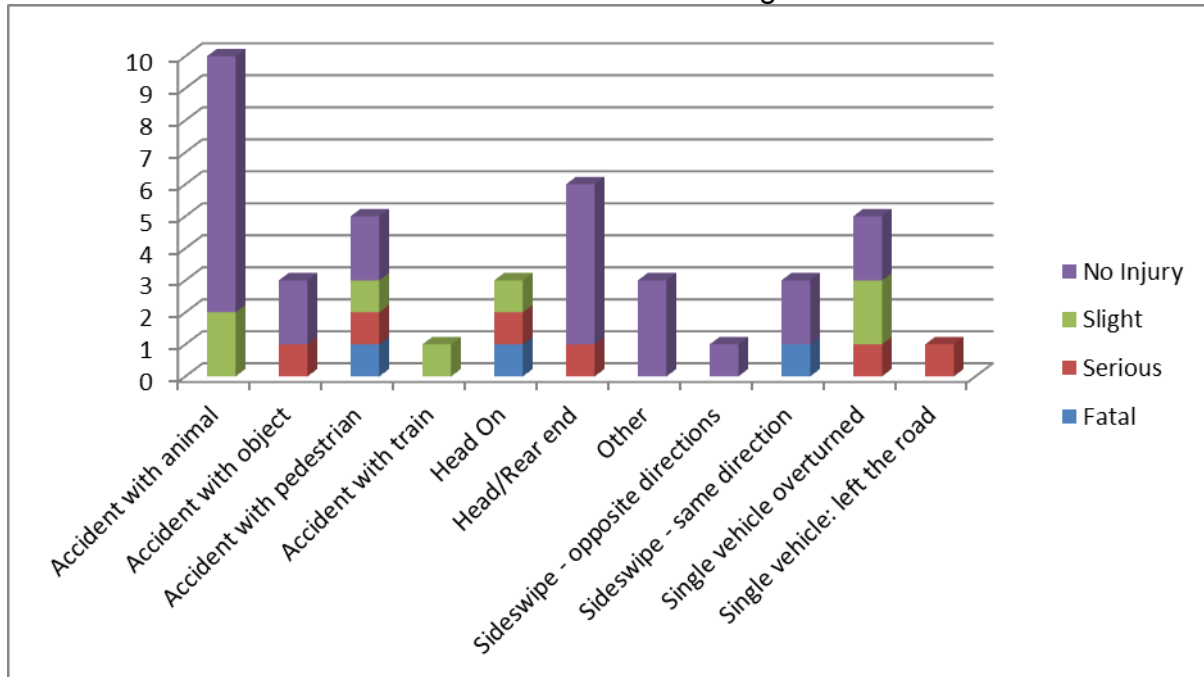

Figure 5 Type of accident on the R102 Gopalall Hurban road section

Similar to the road section investigated previously, the ARFs investigation revealed flaws in data gathering or capturing relating to crash location. None of the accidents with animals could be located with certainty along the R102. All the crashes could have happened anywhere along the R102 that stretches from Thornhill in the east to Leeubos in the west.

4.3.3 Other databases

As part of the study, the Eastern Cape Department of Roads and Transport and the RTMC were consulted for more data/information on the hazardous locations within the CDM. It was revealed that the information was of limited use to the study as it was highly aggregated at provincial and national levels.

5.   DISCUSSION AND CONCLUSION

Specific steps are involved in undertaking a hazardous location study as recommended by the Highway Safety Manual (HSM, 2010). These include:

- Network screening – review road network and ranking based on potential to reduce average crash frequency.
- Diagnosis – determine crash patterns using crash data, road network data and field conditions.
- Elect countermeasures – determine the factors that cause crashes at a site and select effective remedial measure to reduce the average crash frequency.
- Economic appraisal – evaluate cost: benefit ratio of selected countermeasures and choose one of those that are cost-effective and economical.
- Prioritise projects – evaluate projects across multiple sites and identify a set of projects that meet objectives such as costs, mobility or environmental impacts.
- Safety effectiveness evaluation – evaluate the effectiveness of countermeasures at one site or multiple sites in reducing crash frequency or severity.

Following the above procedure creates a quantitative and systematic process that results in a prioritized list of cost-effective countermeasures and an opportunity to leverage funding which was the objectives of the Cacadu hazardous location study. A major shortcoming of the process is the requirement for extensive quality accident data.

The CDM requested accident data from the RTMC to be able to tackle its road safety problems. However, due to problems relating to name changes to the district, the RTMC could not retrieve any crashes under the CDM. The district thereafter decided to embark on collating its own accident data directly from the ARFs. Little did the CDM know of the data quality problems that the national road crash data are riddled with as mentioned by Sinclair (2012). Moreover, the quality assurance measures during accident data entry by the district were inadequate as shown clearly in the two site examples above.

The road safety management process therefore cannot be implemented until the following challenges have been addressed:

- Incomplete accident reporting; and
- Data quality and accuracy which include:

  - Typographic errors in data entry
  - Imprecise entry as in the use of general terms to describe a location
  - Incorrect entry of road names, level of accident severity, vehicle type…etc
  - Incorrect training
  - Subjectivity – where data collection rely on opinions of individuals.

Proceedings of the 33rd Southern African Transport Conference (SATC 2014)
Proceedings ISBN Number: 978-1-920017-61-3
Produced by: CE Projects cc

7 – 10 July 2014
Pretoria, South Africa

584

The CDM case study shows that the challenge of obtaining quality road crash data to undertake much needed road safety studies is not expected to be solved by a single institution. The initial collection of data through the ARF and the processes of data capturing and managing the database involve a number of institutions such as the SAPS and each of the nine provinces' capturing authorities besides the RTMC. A coordinated response among all the entities is required to address this essential element of road safety and crash data.

The crash data quality problem is not unique to the CDM but seems to be a national problem. Sinclair (2012) reviewed the national accident database and concluded that the quality of the data is questionable.

6. REFERENCES

World Health Organization 2013, Global Status Report on Road Safety 2013: Supporting a Decade of Action.

Highway Safety Manual 2010, AASHTO, Volume 1, 2010.

Sinclair M. (2012), Road Injury Data in South Africa: An assessment of the national road collision database.

Proceedings of the 33rd Southern African Transport Conference (SATC 2014)
Proceedings ISBN Number: 978-1-920017-61-3
Produced by: CE Projects cc

7 – 10 July 2014
Pretoria, South Africa

585