



AfCAP
Africa Community Access Partnership



Identification of hazardous sites and the recommendation of remedial measures on selected rural roads

Inception Report



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Cover Photo: A typical unpaved low volume road in Ghana

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ABSTRACT

The overall aim for Research for Community Access Partnership (ReCAP) is to promote safe and sustainable rural access in Africa and Asia through research and knowledge sharing between participating countries and the wider international community. Safer roads are critical for the socio-economic development of countries, and Ghana is no exception. The National Road Safety Commission (NRSC), has intimated that, on average, 2,000 people die each year through road traffic crashes in Ghana and this is estimated to cause the nation some 1.6 percent of the Gross Domestic Product (GDP). Most of the road traffic deaths are vulnerable road users who mostly do not own automobiles and are usually from the poorer rural communities in society. The need to prevent road traffic crashes on the road networks and to reduce casualties has therefore become paramount.

The **overall objective of this project** is to develop an Accident Blackspot Management System (ABMS) for a coordinated approach to road safety on the rural road infrastructure under the control of the Department of Feeder Roads (DFR), through the reduction of road traffic crashes.

This inception report provides the overall framework for the study. In this report, the background, strategy and methodology of the study with comments on the ToR are provided. In addition, minutes of the kick-start meeting are also provided. A critical review of available literature on international blackspot management systems has established a proposed framework for an effective blackspot management at the DFR, Ghana. A detail implementation plan for the successful execution of the project has been provided in this report to guide the project team on how to effectively execute the project to meet the needs of the Client.

Key words: hazardous road sections; road traffic crashes; blackspot management; strip maps; GPS; stick diagram; iMAAP; remedial measures.

AFRICA COMMUNITY ACCESS PARTNERSHIP (AfCAP)

Safe and sustainable transport for rural communities

AfCAP is a research programme, funded by UK Aid, with the aim of promoting safe and sustainable rural access for all people in Africa. The AfCAP partnership supports knowledge sharing between participating countries in order to enhance the uptake of low cost, proven solutions for rural access that maximise the use of local resources. The AfCAP programme is managed by Cardno Emerging Markets (UK) Ltd, under the overarching Research for Community Access Partnership (ReCAP).

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ABBREVIATIONS AND ACRONYMS

ABMS	Accident Blackspot Management System
AfCAP	Africa Community Access Partnership
ARF	Accident Reporting Form
BRRl	Building and Road Research Institute
DFR	Department of Feeder Roads
DUR	Department of Urban Roads
DVLA	Driver and Vehicle Licensing Authority
FYRR	First Year Rate of Return
GDP	Gross Domestic Product
GHA	Ghana Highway Authority
GIS	Geographical Information System
GoG	Government of Ghana
GPS	Global Positioning System
HICs	High Income Countries
iMAAP	Internet-based Microcomputer Accident Analysis Package
LMICs	Low and Middle Income Countries
MAAP	Microcomputer Accident Analysis Package
MoT	Ministry of Transport
MRH	Ministry of Roads and Highways
MTTD	Motor Traffic and Transport Department
NRSC	National Road Safety Commission
NRSS	National Road Safety Strategy
ReCAP	Research for Community Access Partnership
RSU	Road Safety Unit
TRL	Transport Research Laboratory
UK	United Kingdom
WHO	World Health Organisation

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EXECUTIVE SUMMARY

The overall aim for Research for Community Access Partnership (ReCAP) is to promote safe and sustainable rural access in Africa and Asia through research and knowledge sharing between participating countries and the wider international community. Safer roads are critical for the socio-economic development of countries, and Ghana is no exception. Road safety has become a key issue of concern worldwide, as globally nearly 1.3 million people die each year as a result of road traffic crashes; 90 percent of deaths being in developing countries (WHO, 2011).

In Ghana, on average, 2,000 people die each year through road traffic crashes (NRSC, 2015) and this is estimated to cause the nation some 1.6 percent of the Gross Domestic Product (GDP) (NRSC, 2011). Most of the road traffic deaths are vulnerable road users who mostly do not own automobiles and are usually from the poorer rural communities in society (Nantulya, 2003; Nantulya, et al., 2003). The need to prevent road accidents on the road networks and to reduce casualties has therefore become paramount.

The **overall objective of the project** is to develop an Accident Blackspot Management System (ABMS) for a coordinated approach to road safety on the rural road infrastructure under the control of the Department of Feeder Roads (DFR), through the reduction of road traffic crashes.

This inception report provides the overall framework for the study. In this report, the background, strategy and methodology of the study with comments on the ToR are provided. In addition, minutes of the kick-start meeting are also provided. A critical review of available literature on international blackspot management systems has established a proposed framework for an effective blackspot management at the DFR, Ghana. A detail implementation plan for the successful execution of the project has been provided in this report to guide the project team on how to effectively execute the project to meet the needs of the Client.

1.0 INTRODUCTION

1.1 Overview

The Research for Community Access Partnership (ReCAP) is a programme of applied research and knowledge dissemination funded by a grant from the UK Government through the Department for International Development (DFID). The overall aim is to promote safe and sustainable rural access in Africa and Asia through research and knowledge sharing between participating countries and the wider international community.

Cardno Emerging Markets (UK) Ltd has been contracted by DFID to manage ReCAP. There are two components under ReCAP: the Africa Community Access Partnership (AfCAP) and the Asia Community Access Partnership (AsCAP). AfCAP has been working in more than ten African Countries and Ghana is now an active participant.

Safer roads are critical for the socio-economic development of countries, and this is equally true for Ghana. Road safety has become a key issue of concern worldwide in view of the high socio-economic costs associated with road traffic crashes and casualties (Peden, et al., 2004). The World Health Organization (WHO, 2011) reported that nearly 1.3 million people in the world die each year as a result of road traffic crashes, 90 percent of the road deaths occur in low-income and middle-income countries (LICs and MICs). Motor vehicle injuries are the third most important cause of deaths in developing countries (Soderlund and Zwi, 1995). In comparison, in most high income countries (HICs) road traffic deaths and injuries are on the decline due to systematic management of road safety. In HICs measures are actively applied to prevent road traffic crashes, with safety conscious road design and good policies based on evidential research; the same cannot be said about most low and middle income countries and this also includes Ghana.

The global, regional road traffic injury fatality rate is highest in Africa (24.1 per 100,000 population) compared with 10.3 per 100,000 in Europe (WHO, 2013; Peden and Krug, 2002). Baguley (2001) reported that some countries in Africa have high accident rates up to a hundred times greater than, for example, the UK, Sweden or Japan. In Ghana, on average 2,000 lives are lost every year through road traffic crashes (NRSC, 2015) and cost the nation some 1.6% of the Gross Domestic Product (GDP) (NRSC, 2011). Most of the road traffic deaths are vulnerable road users such as pedestrians, users of two-wheelers and passengers of cars and buses (NRSC, 2015). These vulnerable road users mostly do not own automobiles and the majority are from the poorer rural communities in society (Nantulya, 2003; Nantulya, et al., 2003).

The need to prevent road accidents on the road networks is increasingly becoming important. In Ghana, accident analysis systems have been put in place to identify blackspots for treatment on the highways and for roads in the urban centers. A similar system is however not available at the Department of Feeder Roads (DFR). It is against this backdrop that the DFR has identified this need for an Accident Blackspot Management System (ABMS), to help identify hazardous locations and recommend cost-effective remedial measures on selected rural roads under the jurisdiction of DFR.

1.2 Project Objectives

The **overall objective** of the project is to develop an Accident Blackspot Management System for the management of road safety work on the rural road infrastructure under the control of

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DFR through the reduction of road traffic crashes. The other project objectives cover research, capacity building, and uptake and embedment:

1. The **research objective** is to develop an appropriate model-based management system for the feeder (generally rural) road network for identifying road sections with higher road traffic crash rates than at other sections, to define the engineering causes of the crashes at those specific road sections by evaluating how the design of the road interacts with traffic to develop the accidents.
2. The **capacity building objective** is integral to the AFCAP programme requiring that the Consultant engages fully with assigned counterpart staff within the DFR so as to ensure that the knowledge acquired throughout the project is transferred and entrenched operationally within DFR. Accordingly, a minimum of five (5) DFR staff shall be trained through a "train-the trainer" programme to undertake ongoing training at DFR of additional staff on the use of the system. This would enable DFR to undertake the necessary interventions to correct design errors at hazardous sections country-wide.
3. The **uptake and embedment objective** is a fundamental target for AFCAP. The uptake and embedment of the project is based on the premise that the framework for assessing hazardous rural road sections will be adopted, integrated and expanded into normal DFR operations in every part of the country to promote the safer use of rural roads in Ghana. This will be facilitated by the five (5) DFR trainers that will be trained as part of the project.

1.3 Project Team

This project is being implemented by the Building and Road Research Institute (BRRI), of the Council for Scientific and Industrial Research (CSIR), Ghana, in partnership with Transport Research Laboratory (TRL), United Kingdom (UK).

The project team consists of 3 key personnel from the BRRI (the Team Leader, a Civil Engineer and a Computer Analyst) and two experts from TRL, UK, composed of a Reviewer (Road Safety Expert) and an IT Specialist to enable access to the iMAAP software and offer training services as backstopping technical support services for the successful implementation of the project. The project team will consult with the staff at DFR and those at Ghana Highway Authority (GHA) and Department of Urban Roads (DUR).

1.4 Comments on the Terms of Reference

The Building and Road Research Institute (BRRI), as Consultants, have thoroughly studied the Terms of Reference (TOR) and scope of works and found them to be comprehensive and appropriate in addressing the road safety management challenge at the DFR.

In as much as the objectives and expected deliverables of the TOR are good and laudable, the Consultants find that the scope of work never mentioned the need to establish strip maps for the feeder roads which are critical in defining the locations where road traffic crashes occur in terms of kilometer posts. Furthermore, the TOR mentioned selected feeder roads without providing, a list of the candidate roads so as to indicate the extent of work. These are crucial since a large number of roads would obviously affect the timescale for the deliverables. The strip map development would be put under Task No. 2 and a total of about 2,000 kilometres of feeder roads in three regions, namely Ashanti, Central and Eastern regions would be strip mapped to test the suitability of the ABMS. From literature, a 5-year most recent police recorded accident data for the ABMS would be most appropriate for low volume roads (Meuleners and Fraser,

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2008). In view of the timescale, we have made arrangements to procure a licensed accident analysis software from the Transport Research Laboratory (TRL), UK, and the latest version, web based called iMAAP cloud is recommended (see Box1).

The TRL MAAP software has been installed and used for more than a decade at the GHA and DUR and the associated challenges have been:

1. the frequent breakdown of the system due to misuse and virus attacks
2. the system is centralized at the Head Offices and is not in use in the regions
3. the non-availability of GIS maps for the highways and most urban centres

BOX1: Use of TRL MAAP in Ghana

The TRL microcomputer accident analysis package (MAAP) has been used in Ghana for the past two and half decades. It was first introduced towards the end of the 1980's under the Ghana Road Safety Project (GRSP), funded by the World Bank. MAAP was installed at the BRRRI for the management of the road traffic crash database for GRSP. This time, the software was in MS DOS.

In the 1990's when the windows version of the software was developed, it was again installed in early 2000's at the BRRRI and the staff was trained by TRL in the use of the MAAP software for road safety research and management in Ghana. The BRRRI has since used the MAAP to support the development and implementation of Ghana's road safety strategies and to identify hazardous road sections (blackspots) not only on some of the feeder roads networks but also for the highways and urban roads networks. Through these, the BRRRI has gained considerable experience in the use of the TRL MAAP.

Baguley, 2001 indicated that the TRL MAAP for windows systems have been adapted and used in over 20 developing countries including Ghana, Mauritius, Uganda, Zimbabwe, Turkey, Colombia, Jordan, Fiji, Nepal and Vietnam to successfully manage road traffic crash databases.

Currently, the TRL has upgraded the windows version to a web-based status known as iMAAP cloud (an internet-based MAAP). The iMAAP cloud is a web enabled, GIS based, commercial off the shelf, cloud ready solution that is used in managing road traffic crash databases. The software is a top of the range product which has a comprehensive traffic crash data analysis features with high storage and retrieval capabilities. The system has the capability to support stick analysis or corridor analysis to help the traffic crash investigator discover patterns which present some underlying causes.

It is user friendly and users can create, edit, save and delete queries. The system has the capacity to perform cross-tabulations and display the query results on GIS maps. The TRL has successfully applied the iMAAP cloud to implement road crash data systems in Abu Dhabi, Oman, Dubai, India, Kuwait, Qatar, UK, Europe, Malaysia and Africa.

The current direction for road traffic crash data management is the use of the internet. The effort by the DFR to use the iMAAP cloud for their accident blackspot management is thus laudable and fits into the overall plans of the NRSC, as the lead national road safety agency, to use web based road accident data management system (RADMS) in Ghana(NRSC, 2011).

These challenges would be fully addressed under the ABMS for the DFR, firstly through the use of a web based iMAAP cloud which would overcome the virus attacks. The systematic

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pursuance of the staff train-the-trainer programme would ensure the uptake and embedment of the road safety operations in every part of the country. Currently, the DFR has GIS roadmaps which would be incorporated in the iMAAP software for subsequent road traffic crash analysis.

The shortcomings of the identification of hazardous sites on some feeder roads project and some lessons-learned were that:

- i. The project focused only on roads which once were under the Ghana Highway Authority (GHA) but had been ceded to the Department of Feeder Roads (DFR) to administer. Most of these roads had been surface-dressed and so the effects of unsealed roads on crashes could not immediately be assessed.
- ii. The roads did not have strip maps and so fresh ones had to be developed which was time consuming. In future, a separate project should be prepared just to develop the strip maps for the feeder road networks.
- iii. Most of the roads did not register any crash and the few roads that recorded crashes, we found, were scattered on the lengths of the roads. Only route actions could be recommended.
- iv. The lesson-learned which should be applied to the upcoming project is that we rather concentrate initially, on only 3 key regions (eg. Ashanti, Eastern and Central regions) where we have high densities of inter-district feeder roads and connectors and are likely to get traffic crashes on the roads to test the performance of the ABMS. This will greatly save time for the project delivery.

Furthermore, the Consultant would also deal with fewer number of Regional/District Engineers in the selection of roads for the development of the Accident Blackspot Management System (ABMS).

1.5 Main Deliverables

The following are the main deliverables under the project:

- ***Inception Report*** setting out the approach and methodology for implementation of activities relating to the defined scope of work including a draft framework for an Accident Blackspot Management System (ABMS) for discussion at the first stakeholder workshop. A report is to be delivered **4 weeks** from start of the project.
- ***1st Stakeholder Workshop Report*** summarizing the views of stakeholders on the inception report which reviews the international blackspot management systems to assess their suitability for Ghana and proposing a draft framework for an ABMS system. The report shall contain stakeholder inputs on the ABMS framework before a pilot test with field data. It is to be delivered **6 weeks** from start of the project.
- ***Draft Report*** on the progress of work, achievements made and constraints and suggestions for the way forward for effective project implementation. The report shall be presented at a stakeholder workshop to discuss the final outcomes of the study and agree on the recommendations for improving on the ABMS for effective use at wider roll-out and application. The report shall be delivered **20 weeks** from start of the project.
- ***2nd Stakeholder Workshop Report*** on the proceedings and outcomes of the stakeholder inputs of the Draft report. It is to be delivered **22 weeks** from start of the project.

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- **User Manual and Training Course notes** would be prepared for the training of trainers sessions for selected DFR staff. They are to be delivered **24 weeks** from start of the project.
- **Final Report** that incorporates the outcomes of the stakeholder workshop and other comments. The report shall include agreed recommendations for improving the ABMS made at the stakeholder workshop. The report is to be delivered **28 weeks** from start of the project.

1.6 Scope of Work for Task No. 1

The detailed scope of work for **Task No.1** includes a review of international blackspot management systems to assess their suitability for Ghana as part of the inception phase. The **Task No.1** includes:

- Inception report with detailed project methodology; and
- First stakeholder workshop to discuss the methodology and agree on the way forward. A Stakeholder Workshop report shall be produced.

1.7 Report Structure

The report covers four major chapters in total. The first chapter presents the general background to the project, highlighting the project objectives and main deliverables. Chapter two reviews international blackspot management systems and recommends a suitable framework for adoption in Ghana, while chapter three provides the strategic approach and methodology to tackling the accident blackspot project. The plan for successful implementation of the project has been highlighted in chapter four and references identified from the literature searches have also been provided.

2.0 REVIEW OF INTERNATIONAL ACCIDENT BLACKSPOT MANAGEMENT SYSTEMS

This chapter reviews the international accident blackspot management practices in order to ascertain what is being done elsewhere that Ghana can learn from. The method for the review depended largely on relevant published papers highlighting accident blackspot management systems in selected high income countries and some low- and middle-income countries.

2.1 Definition of hazardous road section

Literature has described hazardous road sections variously as "high risk accident locations", "hot spots", "accident blackspots", "sites with a promise" or "accident-prone locations" (Persaud&Hauer, 1984; Persaud, 1986; Maher & Mountain, 1988; Hauer, 1996; Geurts& Wets, 2003; Cheng & Washington, 2005;Elvik, 2008;Agarwal, Patil&Mehtar, 2013).

Hazardous road sections have been defined as locations on the roadway noted for a high incidence of traffic crashes. It is generally taken to be a site that has an abnormally high number of traffic crashes. In this report, hazardous road section has been used interchangeably with accident blackspot.

2.2 Accident Blackspot Management System Framework

Road Traffic Crashes (RTCs) are the fundamental measure of traffic safety. Generally, any accident blackspot management system requires an institutional framework, a system for technical road accident data management, and funding for road safety improvements.

Bliss and Breen (2009) posited that a successful road safety management system includes three interrelated elements with integrated activities and links between them. The three elements are: institutional management functions, interventions and results.

The institutional management functions require that there are key governmental agencies in charge of road safety in the country, and that they have road safety programmes. An institutional framework is there to support, champion and ensure continuity of road safety activities. At the national level, a lead agency is needed to champion road safety coordination and advise government on policy formulation for road safety. At the local level, there is a road safety unit or organization to implement all programs pertaining to road safety.

The interventions require that a technical road accident data management system is in place to ensure systematic accident data collection activities, data storage, analysis and reporting to guide effective mitigations to road safety needs. Crash and casualty reduction would then be achieved from implementing the blackspot programs and activities.

Bener, et al (2003) reported that one strategy for better road safety management is to have not only technical measures in place but also institutional measures. These are related to road safety organizations with better organizational structures, financing, research, and development of staff education and training.

The next section highlights the methodology for the review of accident blackspot management system and it is as follows:

- i. review of international practices
- ii. review of existing practices in Ghana and lessons learnt
- iii. propose a new framework for Ghana.

2.3 Review of international practices

To reach a practical accident blackspot management system framework for Ghana, we reviewed relevant international practices in similar areas. This section draws heavily on road safety management practices in Europe, United States of America (in some States), Australia and some developing countries (including examples from the Gulf States and India), reported by Elvik 2007; Meuleners and Fraser, 2008; Khan et al, 2004; Luoma and Sivak, 2012; and Vigneswari and Minachi, 2013 and these have briefly been summarized below.

2.3.1 Key road safety organizations: All the countries reviewed have national focal agencies/organizations as well as local road organizations responsible for road safety management. They also have national research institutes which carry out specialized road safety research.

2.3.2 Road traffic crash recording: The Police, as the enforcement authority, universally have the responsibility for the collection of road traffic crash details at the scene of a crash. Whereas, in the high income countries police attended to injury and severe property damage only crashes, in the developing countries all crashes (injury and non-injury road crashes) are required to be reported to the police for investigations. In most countries, notes are taken in the field by Police Officers, which are then transferred onto coded paper forms once back at the police station. Pen and paper is still the most commonly used medium for recording road traffic crash data in the field, but there is a trend toward using electronic personal digital assistants (PDAs) in some HICs.

2.3.3 Crash location referencing: Several different types of information to help locate the crash are used in most forms. These include, the street name, highway number, intersection name, or kilometre post information. Some states of the USA, Sweden, Australia and UK use global (geographical) positioning system as a tool to reference an accident.

2.3.4 Data storage, data linkages, analysis and reporting: Traffic crash data entry and storage in the countries reviewed is exclusively done using computers by the Police. Most of the countries have linked the crash database to GIS mapping platforms. This facility permits staff to plot crash data on digital maps and enables in-depth GIS-based spatial analysis such as corridor analysis, grid analysis and cluster analysis for accident blackspot identification. Web-based road traffic crash analysis software has recently been developed by the TRL, and this type of system is increasingly being used in most developing countries for road traffic accident management. There is also a general requirement in countries to produce standard sets of traffic crash statistical reports on a periodic basis (monthly/annually).

2.3.5 Funding of road improvement schemes: Allocation of funds for blackspot improvement schemes was fully available in some countries and very restricted in others.

Furthermore, the work done in recent years by Risk Solutions (2012) for the Republic of Ireland which reviewed the accident data management practices taking account of the presence of key road safety organizations, the mode of accident data collection and analysis, and funding of road improvement schemes in six European Countries as a benchmark for international practice exemplified in Germany, Hungary, The Netherlands, Norway, Sweden and the United Kingdom have also been summarized and presented in Table 1. These countries were selected because they represented a selection of the best performing countries in Europe.

Table 1: Road Traffic Crash Data Management Practices in Six European Countries

Country	Who is responsible for road safety and any key organizations?	Who is responsible for accident data collection?	What data is collected?	In what form is data collected?	What is done with the data?	Funding of road improvement schemes
Germany	i).The Federal Min. of Transp., Building Urban Development (BMVBS); Federal States(Lander) and Local Authorities. ii).The Federal Highway Research Institute (BAST)	The Police	Accidents involving personal injury and severe property damage only (PDO) accidents. ii). GIDAS (German in-depth accident study) carry out specialist in-depth accident investigations.	The data is by electronic means. Most states have at-site electronic data collection.	DeSTATIS - The Federal Statistics Office generates national accident statistics report. ii). For Safety Research	Federal Gov't allocates funds for road safety programs
Hungary	i).The Coordination Centre for Transport Dev't (CCTD) ii).Hungary Transport Research Institute	The Police	Injury accidents	i). In paper form. ii). Planned to use smart phone for e-data collection	i). For accident statistics ii). GIS linkage iii). Research	Some funds are allocated for road improvement

Adapted from Risks Solutions (2012)

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Table 1 cont'd

The Netherlands	i). The Min. of Transport, Public Works and Water Management ii). Rijkswaterstaat iii). SWOV&TNO	The Police	Injury road accidents	i). Until 2011, data collection was in paper form ii). Now all injury accidents on Rich Text Format files	i). Statistical reporting ii).GIS linkage and linkage to vehicle database ii) Research	Broad State subsidy for road safety schemes
Norway	i). Min. of Transport and Communication ii). Norwegian Public Road Authority (NPRA)	i). The Police ii). Specialist fatal accident investigation teams	i) Injury road accidents ii). detailed risk factors for each fatal accident since 2005	In paper form	i). Statistics reports ii). GIS linkage iii).Research	Comes from the Counties
Sweden	Swedish Transport Administration(STA) (Trafikverket)	i).The Police ii) STA carries out fatal accident investigations	i).Injury road accidents ii)Detailed investigations for fatal accidents	On paper or on a personal digital assistant (PDA) before uploading to database.	i).Statistics report ii). GIS linkage	Restricted funding by the Government
United Kingdom	i). Department for Transport (DfT) ii).Highways Agency iii). Local Authorities iv).Research Inst: Transport Research Lab (TRL)& Transport Safety Res. Centre(TSRC)	i).The Police using the form STATS19. ii).Specialists detailed road accident investigation by TRL and TSRC.	Injury and severe property damage only accidents using STATS19.	i).In paper form using STATS19. ii). Project called CRASH plans to use IT based system for injury accidents	i).Statistics report. ii).linkage to vehicle & driver database iii). Research	Restricted funding on a reactive basis following an incident

2.3.6 Some observable conclusions from the study: It could be observed and concluded from Table 1 that all the six best performing countries in Europe have national focal agencies responsible for road safety management in their respective countries. There were either established research institutes or specialist road accident investigation teams to support the work of the lead agencies which coordinated the road safety activities. The police service is found to be central in the primary collection of road accident data. Most of them, however, use paper based forms for field data collection.

Apart from Germany and Hungary which use electronic means, Sweden, Norway, and the Netherlands still use the paper forms. All the countries concentrate efforts in collecting only injury accidents and only Germany further collect non-injury data for severe accidents involving material damage.

The road traffic data acquired is used in generating and disseminating national accident statistical reports. The accident data is also used for research. Linking the accident data to a GIS platform was a norm for all the countries. In the UK, the data has also been linked to the vehicle and driver registration data. A similar situation is found in the Netherlands where the accident data has been linked to vehicle registration database and medical records. Funding, though restrictive in, for example, UK and Sweden, was generally allocated by the respective governments for road improvement schemes.

This means that for an accident blackspot management system to succeed there should be provision which interlinks institutional arrangements with effective accident data collection and analysis, research and reporting, and then funding for road schemes to improve road safety.

2.4 Review of existing accident blackspot management system in Ghana

2.4.1 The Lead Agency and Organizations responsible for blackspot programs

In Ghana, the National Road Safety Commission (NRSC) is the lead agency for road safety management and has the overall responsibility to coordinate road safety activities at the national level. The NRSC, as the lead agency, has developed a vision for road safety and a recent strategic plan (NRSC, 2011) to guide its activities. The Commission works in close collaboration with the national road agencies, namely Ghana Highway Authority (GHA), Department of Urban Roads (DUR) and the Department of Feeder Roads (DFR); the Motor Traffic and Transport Department (MTTD) of the Ghana Police Service and a national research institute; the Building and Road Research Institute (BRRI) of the Council for Scientific and Industrial Research (CSIR), Ghana, in the area of accident blackspot management.

2.4.2 Road traffic crash data collection process in Ghana

Organization responsible for road traffic crash data collection: The collection of primary road traffic crash data is the sole responsibility of the Traffic Police; the Motor Traffic and Transport Department of the Ghana Police Service. All road traffic crashes, whether “injury” or “property damage only” crashes, are required by law to be reported and investigated by the MTTD.

Traffic crash data recording: Road traffic crashes are currently recorded at the scene of the crash by the Police using a paper based system. At the scene, the Police Officer secures the road and collects data which is largely written long hand. The Police Officer captures as much information as possible at the scene and draws sketches of the crash scene and takes statements from witnesses. The data collected contains information on the vehicles involved,

the road characteristics, persons involved and general information on the weather, date and prevailing traffic control.

Traffic crash location referencing: There appears to be no formal system for location referencing. The crash location is usually described in words, in general terms with road name and nearby landmarks being noted. Strip maps, which are schematic line diagram representation of the road features and kilometre posts, have therefore been prepared by BRR I for the major highway networks for blackspot location referencing. This system though potentially effective has been acknowledged as a fundamental deficiency in accident records in Ghana since better systems exist. An improved method capturing Global Positioning System (GPS) coordinates, to accurately geo-reference the location using standard map easting and northing coordinates is required. The Police Officers would have to be trained to use their hand held mobile devices to establish the GPS coordinates. For this study, the BRR I staff would use mobile GPS devices to establish the GPS location coordinates for the crashes.

Data storage and linkage to GIS database: Once all paper forms are completed by the investigating Police Officer, dockets are then prepared mainly for prosecution purposes. No formal computerized database is kept by the Police but summary accident data results are prepared manually and sent monthly to the Police Head Quarters. The BRR I, annually visits all the police stations to transfer the accident information from the dockets onto a standard accident reporting form (ARF) for coding, keying into the computer for storage, processing and reporting as shown in Fig. 1.

Currently, the computerized accident database at the BRR I has been linked to a Geographical Information System (GIS) platform, but not to a vehicle registration database since a digitized system is not in place at the DVLA.

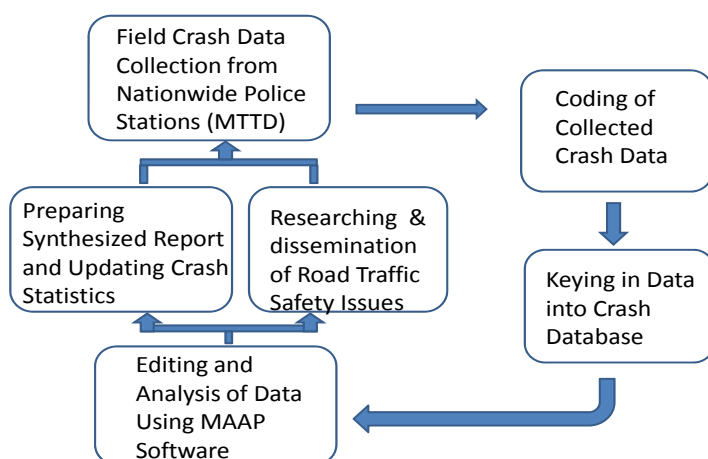


Figure 1: Flow Chart Showing Crash Data Management at BRR I

Traffic crash data analysis, reporting and research: Since there is no road traffic crash accident database at the Police MTTD, no rigorous analysis and reporting is carried out. Only limited compilation of general statistics is done by the Traffic Police to indicate the total number of traffic crashes for a period, the number of deaths and injuries, and vehicles involved. Detailed

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analysis is carried out by the Building and Road Research Institute with the help of MAAP (windows version 5) developed by the TRL and results are reported in the form of annual accident statistics for the NRSC. The data is further used for research by the BRRI, academia and other private consulting firms.

The blackspot database of the GHA and DUR have been integrated into the MAAP and the DFR's iMAAP database system would contain all the road traffic crash databases for the road agencies.

2.4.3 Funding of accident blackspot improvement schemes

Responsibility for blackspot improvements on the road networks rests with the respective road agencies. Due to paucity of funds there is no continuous, systematic blackspot improvement programmes being pursued at the various road agencies. Funding is generally very limited for road improvement schemes but may sometimes be available through other road projects or they can be allocated following an incident. For blackspot improvement programs and activities to be sustainably carried out, adequate, dependable funds should be made available by the Government of Ghana (GoG).

2.4.4 Lessons Learnt

The review of international accident blackspot management practices and review of the existing accident blackspot management system in Ghana indicate that for an accident blackspot management to succeed there should be a system which interlinks institutional arrangements with effective accident data collection and analysis, research and reporting, as well as funding for implementing road accident blackspot programs and evidence based activities developed to improve road safety.

The institutional measures require that there is an organization committed to ensuring the successful implementation of accident blackspot programs through systematic road traffic crash data collection, referencing and analysis of the data to produce reports. Clearly, in Ghana, the single most important item of road traffic crash data which needs to be improved is the precise determination of crash location. The strip maps with their kilometre post reference locations should be enhanced with GPS coordinates, geo-referencing eastings and northings for incorporation into the GIS-based road network map currently available at the DFR.

The accident data management has the requirement to rely heavily on the use of electronic platforms with their software for efficient storage and analysis of the data. In line with the capacity building objective of the project, the DFR staff would have to be trained to use the web-based accident analysis software called iMAAP (an internet-based traffic crash analysis and storage system) developed by the TRL, UK.

The TRL MAAP system was selected because its performance in Ghana has been excellent. It has been used to manage road traffic crash database for over two decades and it is still in use. It is user friendly, robust and has been able to withstand the tropical environmental conditions. The web based facility would make it possible to access and apply the iMAAP at different geo-spatial locations.

2.5 Proposed ABMS framework for DFR, Ghana

The review of the local situation and practices across other HICs and developing countries has contributed significantly in highlighting an acceptable accident blackspot management system for the Department of Feeder Roads, Ghana. The proposed ABMS framework must have the following interrelated components:

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- i. A committed road safety unit (RSU) within the DFR with motivated staff, working in close collaboration with the NRSC, to champion accident blackspot programmes and activities. Accident blackspot management must become integral to the operations of the DFR and must be firmly rooted as a regular institutional activity.
- ii. A well-functioning accident data management system for the RSU, for accident data collection, analysis and reporting. The proposed access to the iMAAP system at the DFR becomes essential to the successful implementation of an accident blackspot programme and for research. It does, however, require training of the RSU staff at DFR.
- iii. Adequate funding to implement, on a long term basis, an accident blackspot improvement programme to reduce the incidence of road traffic crashes on the feeder road networks. The proposed ABMS is illustrated in Fig.2.

The benefits of a vibrant road safety unit within the DFR, to champion accident blackspot programmes and activities are enormous, ensuring continuous and sustainable road safety improvement on the feeder roads networks in Ghana.

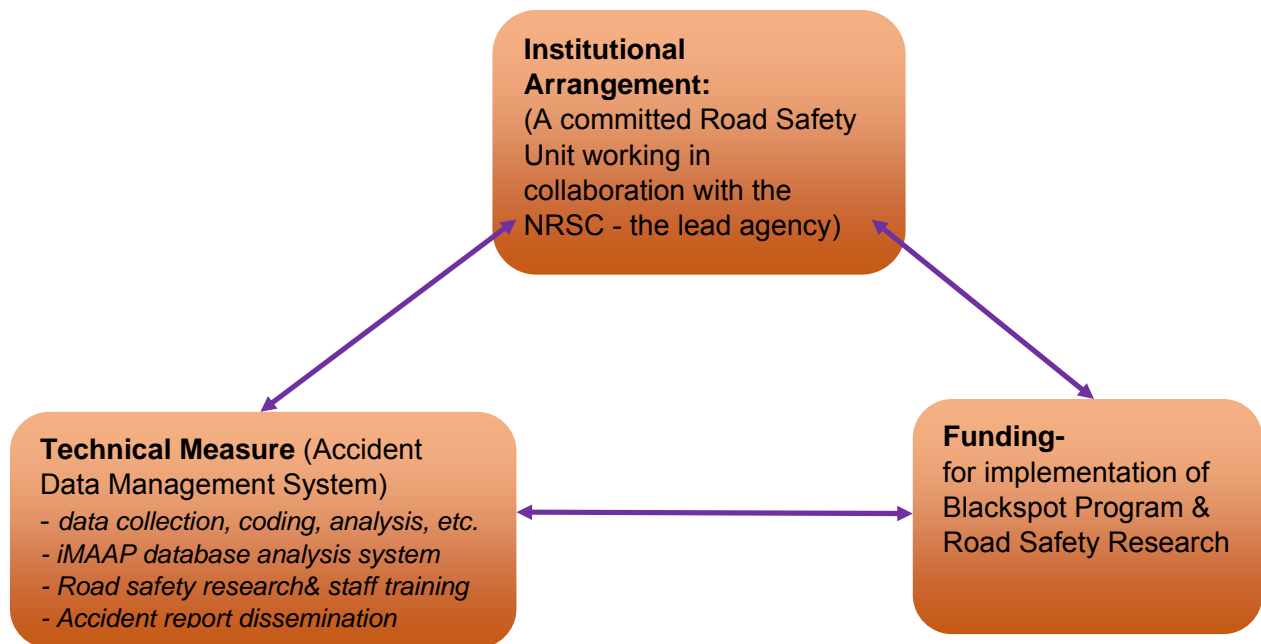


Figure 2: A Simplified Accident Blackspots Management System Framework for DFR, Ghana

3.0 STRATEGIC APPROACH AND METHODOLOGY

3.1 Proposed Framework for Accident Blackspot Management

This chapter presents detailed activities to be carried out to fulfill **Task Nos. 2-10** and then **Task Nos. 11-14** under the scope of work. It sets out a framework, as shown in Fig. 3, for the management of the accident blackspots project at DFR highlighting activities and Task Numbers at the various stages of the assignment.

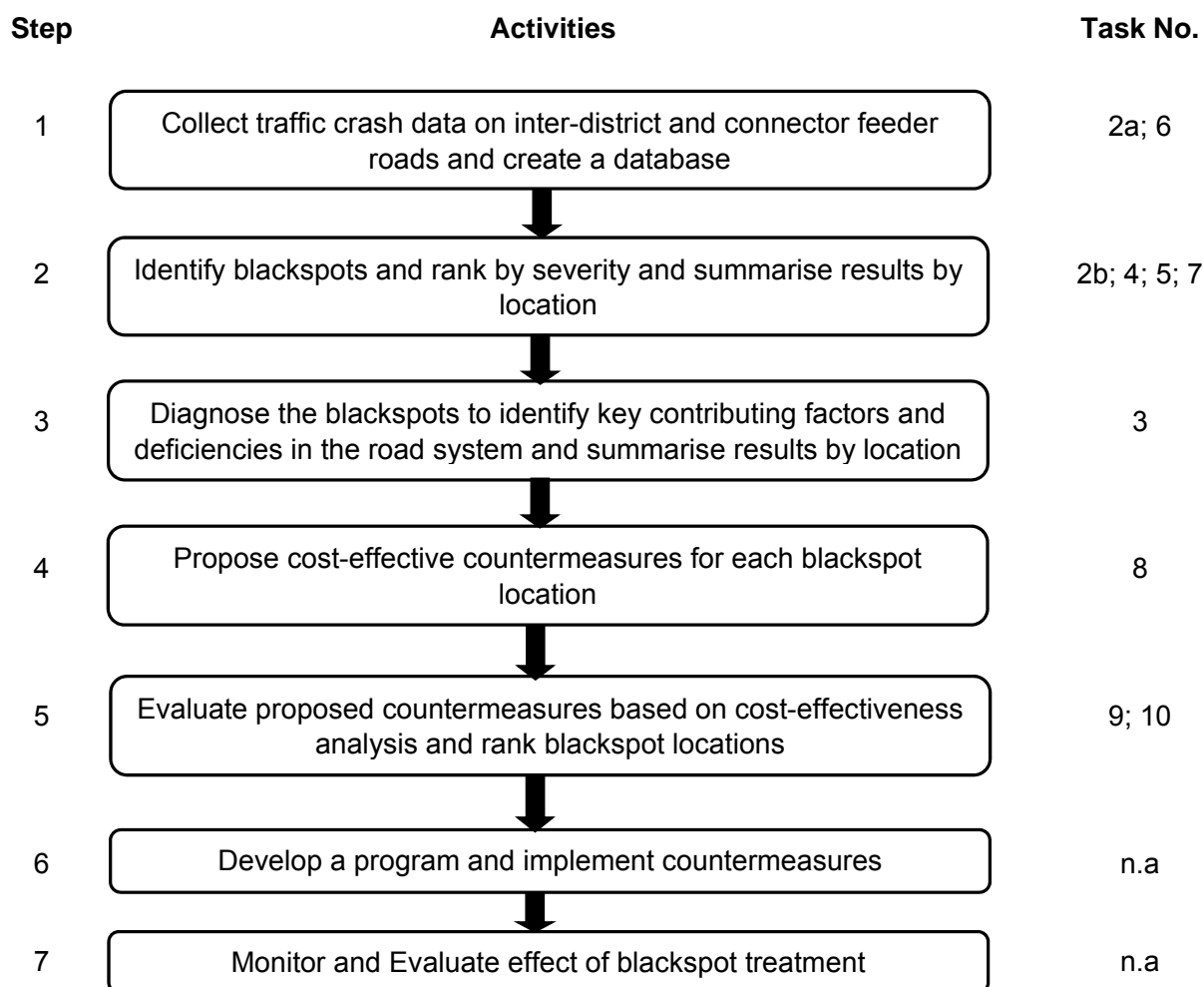


Figure 3: Proposed Framework for Accident Blackspot Management for DFR, Ghana
Adapted from Sorensen (2007).

For this project, only steps 1 – 5 fall under the scope of works and have been described further in the next sections.

3.2 Road Traffic Crash Data Collection and Development of Crash Database

3.2.1 Field Traffic Crash Data Collection

In order to test the robustness and functionality of the proposed framework as prescribed under Task No. 11, road traffic crash data collection would be undertaken in only three (3) regions, namely Ashanti region, Central region and Eastern region, where the traffic levels and accident occurrences are generally high.

The BRRRI would raise two teams to collect the primary traffic crash data from the police at the various stations of the Motor Traffic and Transport Department in the three candidate regions to cover the latest five (5) year period from 2011 to 2015 inclusive. Through the counterpart Engineer at DFR's Head Office, the various Regional Directors and District Engineers would be consulted and directly involved in the identification of the various routes and crash locations.

Strip maps would be developed for only the routes on which road traffic crashes had occurred and such other interlinked routes. The strip maps would provide details on the route names, route numbers (route ID), kilometer post/chainage, region and road side features such as fuel stations, schools, settlements, etc. In addition, the more precise coordinates of the crash spots would be captured by our team using hand held GPS.

The information on the road traffic crashes and from the strip maps would be transferred onto standard Accident Reporting Forms (ARFs) for coding and then later keyed into the computers for storage, retrieval and analysis. Existing road traffic crash records at BRRRI would also be utilized.

3.2.2 Development of Road Traffic Crash Database

An iMAAP cloud (an internet-based microcomputer accident analysis package) developed by TRL, would be used for the management of the road traffic crash database at the DFR. This shall facilitate a seamless operation of the MAAP system in Ghana, allowing existing data to be transferred easily onto the new iMAAP for use. We have therefore made arrangements to procure a license to access the iMAAP system from TRL, which shall be setup by an IT Specialist from TRL, to be available to five users through dedicated computers for the project.

Since the crash reporting forms vary from country to country, the iMAAP software would be customized to reflect the local road traffic crash characteristics needs. The customization and initial training of BRRRI/DFR staff would be done by the IT Specialist from TRL, UK during his first trip to Ghana in the 12th week from 22nd August, 2016.

The iMAAP, functioning as a database, has the capabilities to store a large amount of data and to perform diverse detailed road traffic crash analyses. This project would therefore utilize these in-built features of the software. Generally iMAAP can perform analysis of traffic crash patterns, an area or at junction level and can be integrated into a GIS database platform for spatial analysis using road maps.

The DFR has a road map having ArcView shape file format which would be integrated into the iMAAP web-based platform for use. However, where practicable the open street platform would be employed.

3.3 Identification and Ranking of Blackspots

Stage 2 of the proposed framework for the accident blackspots management (Fig. 3) deals with the identification and ranking of the blackspots for further detailed analysis in stage 3.

3.3.1 The Blackspot Identification Process

The general purpose of blackspot identification is to identify high accident frequency locations on a road network to improve road safety (Nguyen, et al, 2014). At the identification stage, the object is to select sites that have a good chance of being in need of remedial action which also may be treated in a cost-effective way.

The notion of blackspot identification is for road administration professionals to recognize road sites that are deficient either because of how they were constructed incorrectly or the design is inappropriate or because the engineered elements have deteriorated while in use (Hauer, 1996).

An accurate identification of blackspots prevents the waste of resources that may result if such locations are less accurately identified. Sorensen (2007) recommended that blackspot management should be **traffic crash-based**. Road traffic crashes are still considered as the best indicator of blackspots.

Blackspot Identification Criteria

i. Length of Years of Crashes: One basic criterion for blackspot identification is the length of years of crashes to be used. Elvik, 2008 indicated that the suitable period of data for identifying hazardous road locations is between 3 to 5 years. A period of 3 years is, however, frequently used.

Research by Cheng and Washington (2005) suggests that the gain in accuracy of identification obtained by using a period longer than 3 years is marginal and declines rapidly as the length of the period is increased. There is in most cases little point in using a period of more than 5 years.

Longer periods may be used if crash occurrence is low generally. Meuleners and Fraser (2008) indicated that an aggregated crash data for a period of five (5) years provides statistical reliability and should be adopted particularly for low volume roads where traffic interactions are low resulting in low level of crashes.

In this study, a period of 5 years has been chosen to ensure that there are sufficient crash data to improve statistical reliability for the analysis.

ii. Method to use - simple vs. complex models: There is a wide range of methodologies available for use to identify blackspots. They range from simple models based on traffic crash counts to advanced statistical models based on estimates. Any identification criterion therefore specifies the method being used, either the simple non-model approach based on "crash number" and "crash frequency" (crash per kilometre) method or the complex statistical model-based approach using the Empirical Bayes method.

According to Meuleners and Fraser (2008), majority of countries the world over, use the simple non-model based blackspot identification methods, the most common being 'crash number' and 'crash frequency' as shown in Table 2. Some countries including Canada, Texas in USA, Austria and the UK (England) use the 'crash rate' method (i.e. crashes per vehicle kilometre).

Only three countries used the statistical model-based methods to identify blackspots including 'categorical analysis' in Kentucky, USA, the Poisson statistical method in Denmark and the Empirical Bayes approach in Portugal.

Table 1: Accident Blackspot Identification Methods and Criteria in Some HICs Around the World

Country	Identification Principle	Method	Minimum Crash Criteria	Reference
Australia	<ul style="list-style-type: none"> • Specific (SA and VIC) • Non-model based 	<ul style="list-style-type: none"> • Crash type • Crash number • Crash frequency 	For local rural road: <ul style="list-style-type: none"> • < 3km: 3 crashes over 5 years • ≥ 3km: Average of 1 crash per km over 5 years 	Meuleners, L. and Fraser, M. (2008).
Canada	Combined principles <ul style="list-style-type: none"> • Specific • Non-model based 	<ul style="list-style-type: none"> • Crash type • Crash rate 	Not available	Meuleners, L. and Fraser, M. (2008)
USA (Kentucky)	Combined principles <ul style="list-style-type: none"> • Non-model based • Model based 	<ul style="list-style-type: none"> • Crash number 	Urban: 14 crashes over 3 years Rural: 5 crashes over 3 years	Meuleners, L. and Fraser, M. (2008)
		<ul style="list-style-type: none"> • Category analysis 	Critical factor >1	
USA (Colorado)	Combined principles <ul style="list-style-type: none"> • Non-model based • Model based 	<ul style="list-style-type: none"> • Crash number 	7 PDO or casualty crashes or 3 fatal crashes over 3 years	Meuleners, L. and Fraser, M. (2008)
		<ul style="list-style-type: none"> • Traditional approach 	<ul style="list-style-type: none"> • Weighted hazard index ≥0 • Binomial probability of ≥90% 	
USA (Texas)	Combined principles <ul style="list-style-type: none"> • Specific • Non-model based 	<ul style="list-style-type: none"> • Crash type • Crash theme • Crash rate 	Not available	Meuleners, L. and Fraser, M. (2008)
New Zealand	<ul style="list-style-type: none"> • Non-model based 	<ul style="list-style-type: none"> • Crash number 	Determined by Road Controlling Authority. LTNZ recommends 3-5 crashes over 5 years	Meuleners, L. and Fraser, M. (2008); Land Transport New Zealand (2004)
Austria	Combined principles <ul style="list-style-type: none"> • Specific • Non-model based 	<ul style="list-style-type: none"> • Crash type • Crash theme • Crash rate 	Not Available	Meuleners, L. and Fraser, M. (2008); Sorenson (2007)
Belgium	<ul style="list-style-type: none"> • Non-model based 	<ul style="list-style-type: none"> • Crash number 	3 or more casualty crashes over 3 years per intersection or 100m road segment	Meuleners, L. and Fraser, M. (2008); Geurts (2006); Leelakajonjit et al (2014)
Denmark	Combined principles <ul style="list-style-type: none"> • Model based • Non-model based 	<ul style="list-style-type: none"> • Traditional approach (Poison) 		Meuleners, L. and Fraser, M. (2008); Sorenson (2007); Leelakajonjit et al (2014)
		<ul style="list-style-type: none"> • Crash number 	4 crashes over 5 years	

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Germany	<ul style="list-style-type: none"> • Combined • Specific 	<ul style="list-style-type: none"> • Crash theme 	<p>Recommended criteria:</p> <ul style="list-style-type: none"> • 5 similar crashes at a location in the past year 	Meuleners, L. and Fraser, M. (2008); Sorenson (2007); Leelakajonjit et al (2014)
	<ul style="list-style-type: none"> • Non-model based 	<ul style="list-style-type: none"> • Crash number 	<ul style="list-style-type: none"> • 3 fatal or serious injury crashes in the past 5 years or • 5 injury crashes over the past 3 years 	
Portugal	<ul style="list-style-type: none"> • Combined • Model based 	<ul style="list-style-type: none"> • Modern approach (Empirical Bayes) 		Meuleners, L. and Fraser, M. (2008).
	<ul style="list-style-type: none"> • Non-model based 	<ul style="list-style-type: none"> • Crash number 	Not available	
UK (Scotland)	<ul style="list-style-type: none"> • Non-model based 	<ul style="list-style-type: none"> • Crash number 	<ul style="list-style-type: none"> • 3 casualty crashes over 3 years in a 100m radius 	Meuleners, L. and Fraser, M. (2008).
UK (England)	<ul style="list-style-type: none"> • Combined • Specific • Non-model based 	<ul style="list-style-type: none"> • Crash type • Crash number • Crash rate 	<ul style="list-style-type: none"> • Determined by local authorities 	Meuleners, L. and Fraser, M. (2008).
Sweden	No longer conducts blackspot programs			Meuleners, L. and Fraser, M. (2008).
Norway	<ul style="list-style-type: none"> • Non-model based (followed by a model based ranking) 	<ul style="list-style-type: none"> • Crash number 	<ul style="list-style-type: none"> • 4 injury crashes within 100 metres for 5 years 	Meuleners, L. and Fraser, M. (2008).
Netherlands	<ul style="list-style-type: none"> • Non-model based 	<ul style="list-style-type: none"> • Crash number 	Determined by provincial road administrators	Meuleners, L. and Fraser, M. (2008).

Though the non-model based methods for blackspots identification are simple to use, there are disadvantages associated with their use. They tend to detect more sites with higher traffic volumes (Geurts, et al, 2006) and do not take into account systematic and random variation, potentially producing high numbers of false positives and false negatives (Sorensen, 2007; Cheng and Washington, 2005). However, the strength of these non-model based methods is that they are easy to use and understand.

The model-based methods especially the Empirical Bayes though are considered the state-of-the-art approach for blackspot identification, however, their weakness is that they require comprehensive data collection for crashes which are connected to road and traffic data. The use of this approach may be currently unrealistic for the Department of Feeder Roads since the needed historical traffic data and linkages are not available currently to permit the statistical modeling needed (such as Accident Predictive Model development or Safety Performance Functions).

The non-model based method of blackspot identification is recommended to be employed for this DFR study.

iii. Number of Crashes Criterion: The identification of blackspots is based on the available traffic crash records. In a study by Sorensen and Pedersen (2007), the blackspot identification criteria used were that road sections must have crash frequency equal to or higher than 0.5 crash per year per kilometre. In Western Australia, the crash criteria for short road sections (< 3km) and for road length (\geq 3km) are 3 crashes over 5 years and average of one (1) crash per km over 5 years respectively. Or the top 10% of sites which have a demonstrable higher crash rate than other roads in a region.

The crash criteria, based on the number of crashes for the given length of years, are used as a cut-off point to set the stage for the ranking and further analysis of the accidents. For this study, a minimum of 5 crashes in 5 years is adopted for the blackspot identification but this may be varied once analysis is undertaken.

3.3.2 Ranking of Accident Blackspots by Severity

In spite of the fact that most road safety policies concern the number and severity of injuries, the identification of blackspots is still based on the number of crashes.

Sorensen (2007) recommended that crash severity should not be included at the identification stage but rather be applied to the crashes of the identified blackspots in order to prioritize them for more detailed analysis. Here, it is recommended that severity is included by a weighting principle where fatal crashes and crashes with more severe injuries are weighted more than crashes with minor injuries and crashes with only property damage. The idea is that blackspot sites with severe crashes deserve prior attention, in line with the road safety policy which seeks to prevent the most serious crashes. Better economic returns may be achieved at the locations with more severe casualties and crashes occurring making them a higher priority. Elvik (2008) proposed that a hazardous road location should focus on identifying sites at which fatal and serious injury crashes are over-represented.

Tamburri and Smith (1970) introduced the notion of the safety index and suggested the use of costs weight for crash severity. They suggested weights of 9.5 for fatal crash, 3 for injury crash and 1 for property damage only (PDO). Sorensen (2007) added that though different weights for different categories of crash severity have been used variously in different countries, the easiest way to determine the weight is to base it on cost of injuries. The weights are calculated with basis in the socio-economic cost of injuries, which is the average cost of crashes or injured road

users of different severity. However, the use of very high relative weights for fatal crashes should be avoided (Ogden, 1996; Persaud, et al, 1997). On the contrary, weights for fatal crashes and other crashes with serious injuries should not be too small, because then the whole idea of weighting would be wasted.

In Belgium, to determine the most 'dangerous' traffic crash sites, first each site where in the last three years, three or more crashes have occurred is selected. Then a site is considered to be dangerous when its priority value (P), calculated using the following formula, equals 15 or more.

$$P = X + 3(Y) + 5(Z), \text{ where}$$

X = total number of light injuries

Y = total number of serious injuries

Z = total number of fatal injuries

The study proposes to adopt this procedure based on the number of crashes and their severities but would have to be agreed upon at the stakeholder workshop.

Our strategy for ranking of the accident blackspots would be to use a combination of crash frequency and weightings assigned to crash severity levels. A weighting of 5 points would be for a fatal crash, 3 points for a serious (hospitalized) crash and 1 point for a minor or damage only crash. In this way, the most serious crash locations involving more fatalities and serious injuries would be ranked ahead of less serious crash locations for the appropriate analysis and treatment. The weighting scores would, however, be discussed further with the Road Authorities and other stakeholders during the first stakeholder workshop. Some sensitivity analysis would also be done with real local data and identified blackspots.

3.4 Accident Blackspots Analysis and Diagnosis

The main object of accident blackspot analysis and diagnosis is to carry out detailed crash analysis so as to identify patterns in crash features which relate to associated risk factors (why the crashes occurred and why they became serious) for the various hazardous road sites.

The philosophy underlying the analysis is that frequent road traffic crash situations and circumstances indicate problems and similar crashes will probably occur again if nothing is done.

The detailed traffic crash analysis and diagnosis would be based on:

- i. Stick diagram analysis,
- ii. Collision diagram analysis, and
- iii. Road inspections

3.4.1 Stick Diagram Analysis

The iMAAP software would be used in carrying out the stick diagram analysis for the top 20 worst blackspots for the three proposed regions, namely Ashanti region, Central region and Eastern region. The stick diagram shall be used to carry out in-depth analysis for crashes at each identified separate blackspot to define what the problems are and the key contributory factors, indicating among others the following:

- Crash type

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- Crash severity
- Total number of crashes and casualties
- Traffic crash location indicating route number and kilometre- post
- Crash by time of day, week and year
- Crash circumstances, weather, lighting, visibility, etc.
- Total number of crashes and casualties within each severity type
- Road user classes injured
- Vehicles involved

The stick columns can be sorted and this can help staff identify common features in crashes from sites which relate to the same cause which may be treated.

The information obtained would be summarized into tables and graphs.

3.4.2 Collision Diagram Analysis

A collision diagram is the graphic representation that displays all the registered crashes at the concerned blackspot sites. It gives overview of what traffic crash situations that are frequent and over-represented at the hazardous road location. An over-representation of a given crash pattern can indicate that there is a safety problem with a common cause which may be treated by engineering improvement (or potentially enforcement measures or education).

3.4.3 Road Inspections

The in-office analyses would be supplemented by road inspections. This is important to identify problems that do not appear from the accident analyses such as inappropriate road user behavior or interactions at the location which may be due to the road layout or maintenance issues. A checklist for road safety inspection would be used. This can also identify infrastructure issues at the site which may be resulting in the excess crash occurrence.

3.5 Proposed Cost-Effective Countermeasures to treat the Blackspots

The accident blackspot treatment stage follows the detailed accident analysis stage. This stage offers proposals for the minimization or elimination of the accidents at the hazardous sites, based on the accident patterns established during the thorough accident investigation stage and identification of common risk factors contributing to the crash patterns (Elvik, 2006). Simple low-cost or cost-effective remedial measures are then prescribed to treat the accident blackspots taking account of the observed problems/accident patterns and the related deficiencies in the road location for each blackspot.

The proposed cost-effective countermeasures for each hazardous road location would be selected based on their potential to improve the safety of the identified location.

3.6 Evaluation of countermeasures and Prioritization of Sites for Treatments

3.6.1 Evaluation of proposed countermeasures for blackspots treatment

It is expected that the proposed countermeasures for the treatment of the blackspots when implemented would reduce the crashes both in number and severity. The evaluation of the countermeasures requires the estimation of the expected costs and benefits of the proposed safety measures. The benefits are the expected savings to be made by the reduction in the number and severity of traffic crashes derived from the proposed countermeasures. The expected costs for implementing the safety measures include the capital and maintenance costs

for the first five (5) years to get at least the return of the full project cost for the proposed interventions.

Multiplying the expected number of crashes to be prevented by the crash prevention value would produce the benefits expected as a result of implementing the safety measures. The costs of physical implementation of treatment options are then compared to the expected savings to be derived from the anticipated crash reductions to calculate the first year rate of return.

The first year rate of return (FYRR) is computed as follows:

$$\text{FYRR} = \frac{\text{expected savings gained from proposed countermeasures}}{\text{estimated total implementation costs}}$$

3.6.2 Prioritization of blackspots for treatment

Restricted funding for blackspot improvement programs puts a limit to the number of sites that may be treated at a given time period. Therefore, it is necessary to prioritize between sites and safety measures in order to utilize the limited funds as effectively as possible.

Prioritization of the identified blackspots for treatment would be based on their expected First Year Rate of Return (FYRR). This is an economic indicator that is simple to use. The higher the FYRR, the better the option. In all, 20 sites would be ranked for the three regions, in the order of their FYRRs.

The advantage in using the FYRR is that the physical costs of proposed interventions can readily be computed in monetary terms for comparison. The only draw-back is sometimes the expected savings to be derived from anticipated crash reductions can be difficult to estimate due to a lack of evaluation evidence. We shall rely heavily on current international best practices.

A simple computer programme would be developed as a prioritization tool based on the FYRR for ranking of the hazardous road locations for treatment.

The stage 6 of the framework brings to completion the assignments to be carried out for **Task Nos. 2 - 10** under the scope of work.

3.7 Testing the framework with a sample database of crashes by location

The whole essence of the project is to develop a framework for an accident blackspot management system at the DFR which will aid in the identification and ranking of blackspots for cost-effective interventions. We shall test the framework with a sample database of traffic crashes on inter-district and connector feeder roads by location.

Road traffic crash data collected from the various police stations, would be cleaned, coded and keyed into the iMAAP software which would be accessible at DFR for further analysis to establish the blackspots on the inter-district and connector feeder roads.

This shall fulfill **Task No. 11** under the scope of work.

3.8 Draft final report and a second stakeholder workshop

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The project activities would culminate into a Draft Report on the progress of work, achievements made and constraints and suggestions for the way forward for effective project implementation/rollout. The report shall be submitted together with the ABMS, database and its initial user guidelines for review, first by the Road Safety Expert at the TRL, UK, in line with the partnership forged between the BRRI and TRL for the successful implementation of the project where the latter is providing a backstopping technical support service; and then reviewed by the DFR and the AfCAP Project Management Unit (PMU). This Draft final report shall be submitted **20 weeks** from start of the project.

The Consultants shall conduct a second stakeholder workshop to present the Draft Report in fulfillment of **Task No.12** under the scope of work. This stakeholder workshop shall discuss the final outcomes of the study and agree on the recommendations for improving upon the ABMS for effective use by the DFR staff. The consultants shall prepare a stakeholder workshop 2 report on the proceedings and outcomes of the stakeholder inputs on the draft report which shall be submitted **22 weeks** from start of the project.

3.9 Training of trainers and mentorship

We shall develop capacity for accident blackspot assessment and improvement within DFR through a “train-the-trainer” programme. A minimum of five (5) DFR staff will be trained to give them capacity for giving ongoing training on the use of the system. A user manual on the accident blackspot management system and guidelines notes for the training shall be prepared for use during the training-of-trainers session. The training would be offered jointly by the BRRI in partnership with the TRL, represented by the IT Specialist to fulfill **Task No.13** of the project. The manuals and training guideline notes would be prepared by the IT Specialist and would be ready **24 weeks** from start of the project. The training course for the DFR staff would commence in the **25th week**(November 21, 2016) from the start of the project.

The BRRI would be available, even after the project ends, to provide the needed technical assistance and mentorship to DFR staff to ensure that accident blackspot management is entrenched within the DFR.

3.10 Final reporting

A Final Project Report shall be prepared which shall contain the outcomes of the stakeholder workshop and other comments. The report shall include agreed recommendations for improving the Accident Blackspots Management System (ABMS) made at the stakeholder workshop. This report would be completed in fulfillment of **Task No. 14** of the project. It shall be submitted for review first to the Road Safety Expert from TRL, UK, as part of the backstopping technical support services to be offered by the TRL on the project, before submission to the DFR and the AfCAP PMU by the Team Leader, **28 weeks** from start of the project.

4.0 ACTIVITIES FOR SUCCESSFUL IMPLEMENTATION OF THE PROJECT

4.1 At the Inception phase

4.1.1 Kick start meeting

A kick-start meeting was held on 6th June, 2016 at the Conference Room of the Department of Feeder Roads Head Office in Accra. The meeting started at 9:45 am. It was attended by the Project Team from BRRRI and the management of DFR as well as the AfCAP Regional Manager. The AfCAP Regional Manager provided an overview of the ReCAP programme in Africa and the inclusion of Ghana as a partner country. The Project Team Leader made a power-point presentation of the proposed approach for execution of the accident blackspot project highlighting the various tasks to be accomplished to fulfill the project objectives, including the desktop activities required at the inception phase. He mentioned about BRRRI's partnership with the Transport Research Laboratory to provide backstopping technical support services for the successful implementation of the project and reiterated the consultative stakeholder workshops to be held under the project and the training sessions for selected DFR staff. Accordingly, the Team Leader mentioned the need for the Department to have an office accommodation ready for the project and counterpart staff that the BRRRI would be working with at the Head Office.

The DFR Representatives were then introduced to the Project Team by the Chief Director, Development, who chaired the meeting.

The meeting started at 9:45am and closed at 11:00am.

The meeting was attended by:

1	Dr. K. OsafoAmpadu	Chief Engineer, Development
2	Dr. Paulina Agyekum	West Africa Regional Manager, AfCAP
3	Ing. Francis KwakuAfukaar	Project Team Leader, BRRRI
4	Ing. William Agyemang	Project Engineer, BRRRI
5	Simon Ntramah	Technical Officer, BRRRI
6	Martin KwasihMensa	DFR
7	KwabenaAfrifa	DFR
8	Castro ElormNyoagbe	DFR
9	Mawusi Joseph Adekponya	DFR
10	K.N. Akosah-Koduah	DFR
11	Nathan N. Odjao	DFR
12	Dr. Patrick AmoahBekoe	DFR
13	Lanquaye Wellington	DFR
14	R.O. Otoo	DFR
15	Herbert Korantent	DFR

Discussion Points of the Meeting

The following were discussed at the meeting:

- It was mentioned that the aim of the project was to develop a framework for the compilation of database and management of hazardous (blackspots) on feeder road

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sections. This would focus on both sealed and unsealed sections of feeder roads particularly inter-district and connector roads.

- The consultant proposed to use the iMAAP software developed by the TRL, UK, for the compilation of the accident database for the project instead of developing a brand new Accident Blackspot Management System (ABMS) for use.
- The BRRl was partnering the TRL, UK, on the project. The TRL would provide backstopping technical support services on the project and to provide access to their iMAAP software and train staff of DFR and BRRl on the use of the software.
- It was requested of DFR to make available three dedicated laptops and two desktop computers, with the necessary internet connectivity, for providing access to iMAAP software by an I.T. Expert from TRL (UK).
- A key part of the project was capacity building and that the BRRl/TRL will work with assigned counterpart staff from DFR as well as organize a train-the-trainer workshop for about five (5) DFR staff.
- The Team Leader mentioned that the current road names of the DFR were too long and would have to be recoded into the iMAAP software but the DFR team suggested that it would be rather good to hook their GIS-based road map onto the iMAAP software for use in identifying accident locations.
- The Consultant proposed to initially focus on only three important accident prone regions, namely the Ashanti, Central and Eastern Regions, due to time constraint. This, the AFCAP Representative said she was not sure of any such arrangement and would confirm that later.
- A question was raised on the option of launching the iMAAP onto the DFR's server since the iMAAP was internet-based. The Project team noted this for further discussion with the IT Specialist for consideration.
- A question was also raised on who Cardno Emerging Market (UK) Ltd was and this was clarified by the West Africa Regional Manager, AFCAP, that Cardno were the fund managers of ReCAP.

4.1.2 Literature searches

We carried out desktop studies to review international blackspot management systems to assess their suitability for Ghana as part of the inception phase.

4.2 The involvement of TRL on the project

As part of the implementation plan, the BRRl has partnered TRL to bring onto the project international best-practice experience to supplement the local knowledge of BRRl. The TRL's role and contribution could broadly be divided into two, as follows:

- I. to provide backstopping technical support services, and
- II. to travel down to Ghana to provide access to iMAAP software and offer training on the project

A. Provision of Backstopping technical support services

The TRL shall provide technical expertise to review all the technical reports including the inception report, draft report and the final report. The international expert's input would be critical in so far as quality performance needs must be met on the project.

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To this end, the Client (Cardno Emerging Markets (UK) Ltd) has approved of one Road Safety Expert, knowledgeable in blackspot management practices to critique and supply useful suggestions to the reports which would be drafted at any stage by the Team Leader. The Expert's services would be required for the Inception Report, three (3) man-days; the Draft Report, three (3) man-days and the Final Report, two (2) man-days.

B. International trips to Ghana to work on project

The IT Specialist would be required to travel down to Accra to provide access to iMAAP software, customize it and transfer existing data and GIS road maps; and also train the BRR/DFR staff in the use of the software. Two separate international trips would be required of the IT Specialist. The first trip shall last for four (4) days and would be from August 22 - 25, 2016 in the 12th week from start of the project. The TRL personnel shall have an itinerary as follows:

- Day 1 – Courtesy call on the Technical Adviser/DFR Management and iMAAP Software deployment
- Day 2 – Customisation of iMAAP software to meet the local accident data input format
- Day 3 – Transfer of existing accident data and GIS maps onto iMAAP and training of BRR/DFR staff.
- Day 4 - Training of BRR/DFR staff on new iMAAP and departure to UK.

The second international trip to Ghana by the IT Specialist would take place at the beginning of week 25 from November 21 - 24, 2016. The purpose of this visit is for the expert to assist in the train-the-trainers workshop. Here, 5 of the DFR staff shall be trained on the use of the iMAAP software in the identification of accident blackspots and other applications of the software. This second international trip would last for 4 working days, after which the expert shall return to the UK.

The itinerary of the TRL expert is as follows:

- Day 1 – Courtesy call on the Technical Adviser/DFR Management and start of training workshop
- Day 2 – Training workshop
- Day 3 – Training workshop
- Day 4 – Training workshop and departure of expert to the UK.

So in all, the TRL expert staff would be engaged for a total of 16 man-days to partner the BRR on the successful execution of the project in Ghana.

4.3 The implementation activities and schedules

4.3.1 Proposed tasks necessary to achieve the project objectives

1. Literature review of international blackspots management systems to assess their suitability for Ghana.
2. Stakeholders' consultative workshops to discuss the methodology and agree on the way forward. A framework for the ABMS.
3. Selection of candidate feeder roads for the assignment.
4. Development of strip maps to establish kilometer posts/chainage
5. Accident data collection from the various police stations and coding of data.

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6. Procurement of 5 user licenses for the accident analysis software (iMAAP) from TRL, UK.
7. Accident data keying-in using the software and running the database to identify blackspots
8. Carry out detailed Stick Diagram Analysis to help diagnose and categorize accident blackspots and establish contributory factors
9. Rank accident blackspots by accident severity
10. Provide cost-effective and appropriate counter – measures and prioritize blackspots based on their First Year Rate of Return results
11. Submit a Draft Report providing User guidelines for discussion at workshop
12. Conduct a stakeholder workshop to discuss outcomes of study and agree on the recommendations
13. Develop user manuals and training course notes and train DFR Staff on effective use of the system
14. Submit Final Report

4.3.2 Inputs and Outputs

Inputs

- Desktop review of international Blackspots Management Systems
- Consultative stakeholder workshops
- Road reconnaissance surveys by driving on the roads for strip mapping, establish chainages / kilometer posts and road features and also using GPS.
- Latest 5-year police reported crash data for the selected roads
- Site visits
- Training the trainer

Outputs

- A framework for a suitable ABMS
- Strip Maps developed
- Accident database with all the attributes available
- List of accident blackspots ranked by severity
- Proposed cost – effective counter measures based on the observed problems and deficiencies for each blackspot.
- Prioritization tool based on cost and anticipated benefits of the improvements related to accident prevention
- A well trained DFR Staff to manage the accident database. Capacity built at the DFR to use the ABMS.
- A set of reports and manuals including
 - Inception Report
 - Workshops Reports
 - Draft Report
 - User Manuals
 - Final report

4.3.3 Work Plan

Figure 4: Revised Work Plan

No.	ACTIVITY	ACTIVITY DURATION (WEEKS)																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
MOBILIZATION																													
1	Kick Start Meeting with DFR	★																											
2	Desk Study and reporting																												
3	Stakeholder Consultations																												
DATA COLLECTION / ANALYSIS																													
4	Collection of police reported crash data																												
5	Coding and Entry of Police RTC Data																												
6	In-depth analysis of crashes																												
7	Selection of candidate feeder roads																												
8	Development of strip maps																												
9	Blackspot Identification / Remedial measures																												
REPORTS / WORKSHOPS / TRAINING																													
9	Inception Report																												
10	Stakeholder Workshop 1																												
11	Draft Report																												
12	Stakeholder Workshop 2																												
13	Final user manual / Trainers guidelines																												
14	Train - the - trainers																												
15	Final Report																												

4.3.4 Risks

- The selection of the candidate inter-district and connector feeder roads if not done promptly could affect the timetable.
- The availability and co-operation of regional engineers in taking round the consultants on the selected feeder roads for detailed strip mapping and geometric information if not forthcoming could affect project implementation
- The accident analysis software package being procured from TRL, UK, can be delayed
- Unannounced national power outages and load shedding are affecting computer based assignments, forcing the consultants to work sometimes late into the night to bring progress on course.

4.4 Milestones and Deliverables

Table 2: List of Milestones and Deliverables

Milestones	Timing Schedule (weeks)
Inception report	4(8)
1 st workshop report	6(9)
Draft report	20
2 nd workshop report	22
Final user manual and trainers guidelines notes	24
Training the trainers sessions	26
Final report	28

There has been a slip with the submission of the reviewed Inception report and conduct of the first stakeholder workshop but this would not affect the rest of the target dates. The project is still on track.

4.5 Approach to Managing the Project

4.5.1 Quality Control

Quality control is about preventing and avoiding poor quality outputs by ensuring that all project inputs meet the desired quality standards. Quality control management is a continuous process that starts and ends with the project. It starts with the managers of the project being quality-minded. To this end, the Team Leader will ensure that each team member thinks and acts to promote quality at every stage of the project. The Team Leader will have overall responsibility for the execution of the project. He would check all the project outputs and services ensuring that they meet the intended objectives and expectations of the project and that they have value to the stakeholders, especially DFR. Input data from field such as police reported crash data and data for the strip maps would be checked for quality and cleaned before incorporating them in the database for the blackspot analysis.

The Consultants shall hold regular brainstorming sessions to check whether the project objectives and expectations of the stakeholders, especially management of DFR, are being met. The TRL iMAAP software to be procured for the Accident Blackspot Management System (ABMS) would be customized to meet the local accident data input format. We shall check the

various input processes early for quality to ensure the quality of project deliverables, as only sound processes lead to good output solutions.

4.5.2 Monitoring and Evaluation

Monitoring and Evaluation (M&E) of a project is required for an effective governance of the project. It offers the needed transparency from inception through to the close of the project. The consultants shall therefore keep internal records to track progress of project activities, processes and output indicators. Reports prepared on the project implementation would be shared with the Project Management Unit (PMU) of AfCAP, the Standing Steering Committee managing AfCAP 2 and DFR. We shall report on the progress and findings in the work, aimed at providing all the key stakeholders with early detailed information on the progress or delay of the ongoing activities.

The consultants would monitor and evaluate the project in close consultation with the stakeholders. We shall engage the key stakeholders right from the start of the project at the kick-off meeting through to the final close down of the project. We shall ensure accountability to the key stakeholders by providing timely and useful information for effective decision making on the progress of work. Assignments being carried out by other team members would be monitored on daily and on week by week basis to ensure that there are no serious slippages.

All relevant comments raised during the planned workshops would be incorporated in our reports and such comments would be utilized to improve the overall objective of the project.

The purpose of the M & E is to ascertain if the desired outputs and planned schedules have been reached or not so that a quick action can be taken to correct the deficiencies as quickly as possible. High risk levels would be flagged to the AfCAP Regional Technical Manager, West Africa for redress.

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