BENEFIT ASSESSMENT SYSTEM

USER MANUAL

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ABSTRACT

This user manual presents a detailed description of the steps involved in using the Benefit Assessment System (BAS). The manual describes the development of the Benefit Assessment framework, Systems Architecture, and the Monitoring and Evaluation (M&E) framework. The BAS was developed based on inputs from key stakeholders that define the user requirements specifications (URS). A systems approach is used in developing the BAS where each subsystem represents a component of the benefits of conducting and implementing the results of research projects. The BAS can be visualized as a report (score) card where grades (or scores) are assigned to the various indicators in each subsystem. The system architecture describes the structure of the database and M&E website using an open source software application. The open source application for data collection, storage, and application avoids the need to pay software subscription fees, making it sustainable. The User Manual presents detailed steps to follow in installing and setting up the data collection tool on Android smartphones, PC or Tablet. The steps necessary to collect and upload data onto a cloud server, download and manipulate such data are described. Also included are descriptions of steps to access the M&E system and results of the benefits analysis. The User Manual concludes with several examples demonstrating application of the BAS to projects focusing on different research areas.

Keywords: *Benefits Assessment System Framework, Indicators, Monitoring and Evaluation System, Systems Architecture, User Requirements Specification, Sustainability.*

ACRONYMS, UNITS AND CURRENCIES

AfCAP	Africa Community Access Partnership
AsCAP	Asia Community Access Partnership
API	Application Programming Interface
ARTREF	African Road and Transport Research Forum
BAS	Benefits Assessment System
B/C	Benefit/Cost
BRRI	Building and Road Research Institute
BSC	Balanced Score Card
CB	Capacity Building
CBA	Cost Benefit Analysis
CSIR	Council for Scientific and Industrial Research
DFID	Department for International Development
DFR	Department of Feeder Roads
DUR	Department of Urban Roads
EIRR	Economic Internal Rate of Return
HDM	Highway Design and Management, software
IRF	International Road Federation
IT	Information Technology
KTC	Koforidua Training Center (under MRH)
LCM	Life Cycle Modelling
LVRR	Low Volume Rural Road
MDA	Municipal and District Assemblies
M&E	Monitoring and Evaluation
MRH	Ministry of Roads and Highways
MoT	Ministry of Transport
NPV	Net Present Value
NS	Name Server
ODK	Open Data Kit
OS	Operating System
RAI	Rural Access Index
ReCAP	Research for Community Access Partnership
R&D	Research and Development
RED	Road Economic Decision Model
RR	Rural Roads
TCS	Total Cost Savings
ToR	Terms of Reference
TRL	Transport Research Laboratories
TS	Transport Services
UAT	User Acceptance Testing
UK	United Kingdom (of Great Britain and Northern Ireland)
URS	User Requirements Specifications
VOC	Vehicle Operating Costs
VOT	Value of Time

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1   INTRODUCTION

1.1   Background

Good rural access facilitates the movement of people, goods and services which affects the livelihoods of low income households, especially in developing economies. Evidence shows there is a strong correlation between poverty and connectivity. Road access in rural areas can improve social welfare by increasing the proximity and quality of basic services, and broadening livelihood opportunities.

In order to monitor and evaluate the benefit assessment impact in rural access projects on livelihood opportunities and poverty reduction, and to measure the socio-economic benefits of improved accessibility on project beneficiaries, it is important to identify whether the project outcomes have been achieved through ex-ante and ex-post studies.

Currently, various donor funded rural access programmes and projects are being implemented, whilst other such projects are in the pipeline. There is a growing need to measure the benefit of these projects on rural livelihoods and economic growth.

To that end, Research for Community Access Partnership (ReCAP) sought to establish a Benefits Assessment System (BAS) for assessing the benefits of research investments, and a Monitoring and Evaluation (M&E) Framework for assessing ReCAP projects. Six subsystems are identified and performance indicators are categorised according to these sub-systems. A scoring system is used for the indicators, and their surrogates for each subsystem are scored according to the relative importance in defining the subsystem. ReCAP-BAS can be visualised as a report (score) card where grades (or scores) are assigned to the various indicators or groups for each subsystem.

1.2   About this Document

This document describes the ReCAP-BAS systems architecture, how to collect M&E data and upload to the M&E database using Open Data Kit (ODK) application. It also explains how to manage data and generate reports.

1.3   Purpose of this Manual

This manual is intended to be a resource to guide users on how to use the Benefits Assessment System from data collection through data management and visualization of results.

1.4   Scope of the Manual

The manual covers descriptions of the systems architecture, development of data collection template according to ODK requirements, data collection process and upload to the cloud database, and navigation of the M&E database system. The various subsystems of the BAS framework are described as well as explanation of the results generated from the BAS.

1.5   Structure of the Manual

The manual is in several parts, as described below. The first three parts present the background, BAS framework, and the system architecture. The remaining sections (parts IV and VI) describe the steps that a user needs to follow in installing the data collection tool, inputting data, and navigating the database to view data and results of the benefits analysis.

1. Part I presents an introduction to the user manual;
2. Part II describes ReCAP-BAS framework and indicators for the various subsystems;

3. Part III presents the systems architecture;
4. Part IV describes users' actions with respect to installation and use of the ODK Collect Tool;
5. Part V describes data management functionalities of the ODK system once data has been uploaded to the cloud database. It describes how to visualise data in different graphic forms and how to export data to .csv format that can be used in the M&E system;
6. Part VI describes the M&E portal and how data for the M&E database is imported for ReCAP-BAS analysis and presentation. Results and explanations are presented in this part. This part also describes other functionalities of the M&E system.
7. Annex 1 presents details of the data collection template.
8. Annex 2 presents several examples illustrating application of the BAS.

1.6   Recommendations on the Use of the Manual

In order to be proficient in the use of the system, it is recommended that users be well-versed in the basics of field data survey implementation and use of an Android device.

Users are not required to learn Microsoft (MS) Excel, develop a new data collection template nor learn or know Oracle database management in order to use the BAS system.

BAS system users' actions are limited to Parts IV and VI of this manual. In Part V, the user can visualize data that is inputted in the data collection form. The Systems Administrator executes data transfer from the database into the BAS M&E system.

1.7   Limitations of BAS

The BAS was developed to allow users to assess the benefits of the conduct and implementation of the results of research projects. Analysis of the benefits in the various categories requires data on the various core indicators for each benefit area or subsystem. A limitation of this system is data availability especially for the impact indicators. Currently, ReCAP system is not set up to maintain baseline data prior project implementation. This data limitation is can be addressed by establishing a systematic data collection protocol.

1.8   Requests for Corrections and Updates

Request for updates and suggestions for corrections should be directed to the Project Administrator of ReCAP.

2. RECAP-BAS FRAMEWORK

2.1 Overview of Benefits Assessment Framework

The BAS uses a systems approach where the benefits and impact assessment is viewed as an open system, that is composed of a number of interacting and interdependent parts, called subsystems. That is, the system is viewed as "an organised whole" made up of sub-systems integrated into a unity or orderly totality. These elements operate in an environment that it interacts with and that influences it. The BAS framework consists of six (6) sub-systems or assessment areas. The performance indicators are categorised according to these sub-systems: These subsystems are:

A. Research products and extent of use;
B. Economic indicators (benefits and costs);
C. Socio-economic;
D. Road Safety;
E. Environmental;
F. User satisfaction and value.

A schematic of the BAS is presented in Figure 1. The guiding principle in the development of the performance indicators and assessment framework is to ensure that the indicators are relevant, that they capture all types of research, that they are objective enough to highlight the benefits and weaknesses of research programs and projects, and above all, they are simple enough to be easily understood and applied.

Based on the systems approach as indicated above, the benefits assessment framework can be visualised as a report (score) card where grades (or scores) are assigned to the various indicators or groups and therefore for each subsystem. Poor performance in one area does not necessarily lead to the conclusion that the program/project is a failure. The relative merits (scores) of the various subsystems of the framework need to be considered in assessing the overall benefits of the program/project in any given time frame.

The indicators in each subsystem are weighted based on their relative importance or contribution to defining the indicator for that subsystem. The weighted scores for each subsystem are summarised in a report or score card. This is visualised as a report card but with no aggregated or cumulative score for all the subsystems. Converting all scores to a single score would lose the essence of the assessment exercise where strong and weak points would not be easily identified and documented as lessons learned to help in designing future projects. Moreover, in situations where for a given project or program some subsystems are not applicable or indicators lack sufficient data, an aggregated single overall weighted score would be misleading.

Figure 1: Schematic BAS Framework

Performance Indicators

Rating

Part A - Research Output and Usage
- Achievement of objectives
- Types of research products
- Adoption for implementation
- Extent of use

Excellent:
- Fully achieved objectives
- Products widely used

Good:
- Partially achieved objectives
- Some use of product

Fair:
- Barely achieved objectives
- Product not yet readily available

Poor:
- Objectives not met
- Product not widely used

Part B – Economic
- Cost of Research
- Agency costs (capital and operation)
- User costs (VOC, travel and transport)
- Crash cost savings

Ratio of Cost Savings to Research Funding (Benefit/Cost Ratio)

Part C – Socio-economic Impacts
- Access (Healthcare, Education, social, retail, farming, economic activities)
- Travel and transport costs
- Employment opportunities
- Women empowerment
- Social inclusion

Excellent – High positive impacts
Good – Significant impacts
Fair – Limited impacts
Poor – Insignificant positive impacts or negative impacts

Part D – Road Safety
- Accident rate
- Fatality rate
- Helmet use

Excellent – Exceeds all targets
Good – Satisfactorily meets all targets
Fair – Fails to meet some targets
Poor – Targets not met

Part E – Environmental
- Air quality/dust
- Erosion
- Drainage structures

Excellent – High positive impacts
Good – Low positive impacts
Fair – Marginal positive or negative impacts
Poor – Significant negative impacts

Part F – User Satisfaction
- Awareness
- Use
- Value

Excellent – Adequately meets users' needs
Good – Satisfactorily meets users' needs
Fair – Limited user satisfaction
Poor – Users not satisfied

Overall Rating
- Research Output and Usage
- Cost Savings
- Socio-economic
- Safety
- Environmental
- User Satisfaction

2.2   Performance Indicators

The performance indicators form the basis of the BAS. Several indicators are identified for each of the six (6) subsystems as follows.
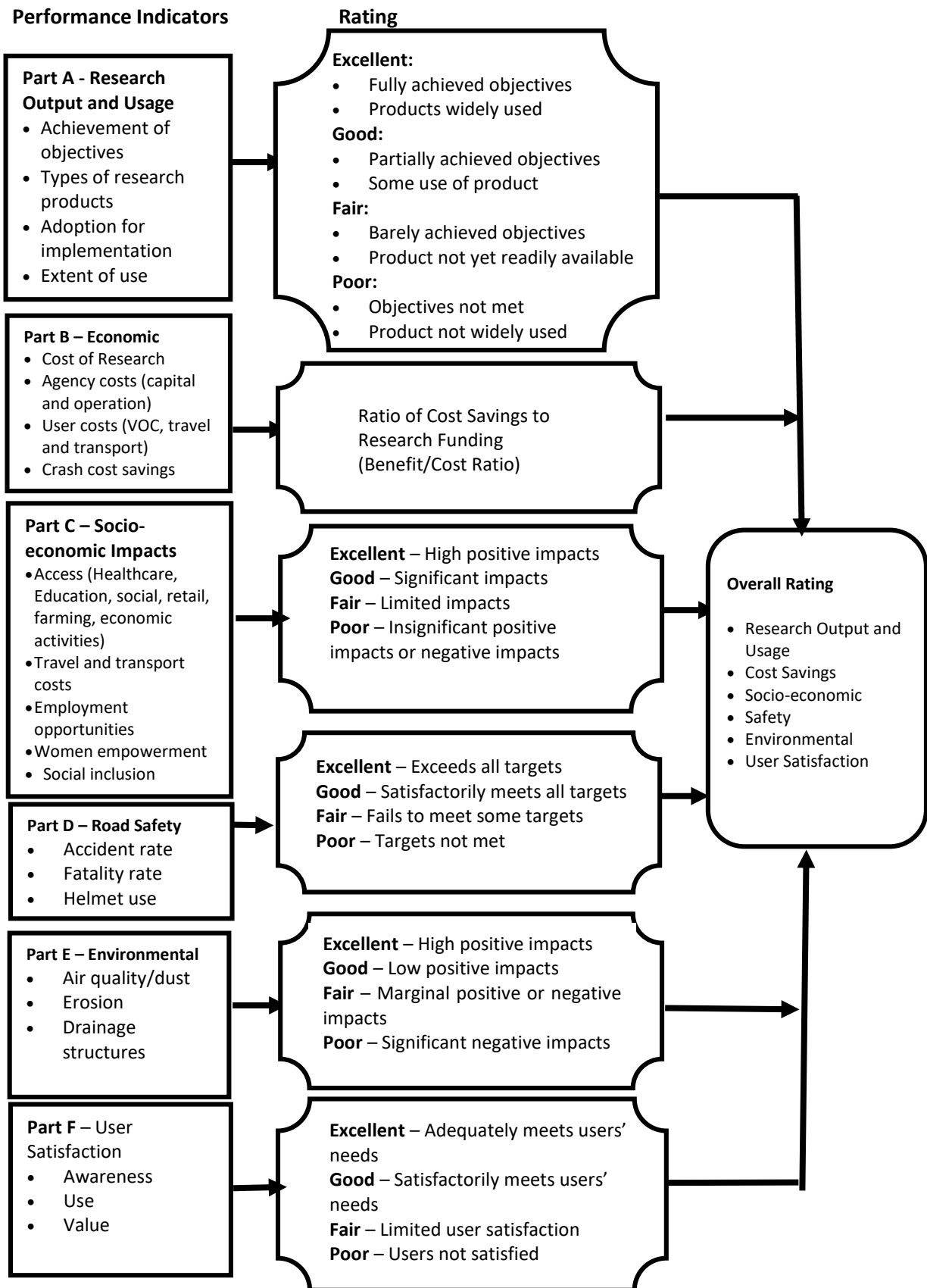
- A. Research products and extent of use indicators;
- B. Economic indicators (benefits and costs);
- C. Socio-economic indicators;
- D. Road safety indicators;
- E. Environmental indicators;
- F. User satisfaction and value indicators.

A large number of indicators have been identified in order to adequately assess the benefits from the various subsystems. It is recognised that for a given project or programme, not all indicators will be relevant and data may not be available for all the indicators. A balance between the efforts and resources required to collect useful data on one hand and the usefulness of the information on the other are considerations in selecting the key indicators. Therefore, the framework is designed with focus on **minimum core indicators** that would be sufficient to provide an indication of the benefits of each subsystem. Furthermore, the benefits assessment system is structured such that the calculation of the weighted score for each subsystem is based only on indicators for which data is available. Consequently, missing data for indicators will not affect calculation of the scores for a given subsystem. This section provides details of the indicators for each subsection.

2.2.1   Subsystem A – Research Product and Usage

This subsystem assesses the success of the research effort and extent of adoption and implementation of the outputs. Four (4) major indicators are identified with several sub-elements or surrogate measures as follows:

Data Sources
ReCAP Website
ReCAP PMU
Project reports

Achievement of Research Objectives
Indicators in this subgroup measure success in terms of achievement of the stated objectives of the research effort. Surrogate indicators of research success include:
- i.   development of research reports;
- ii.   publication of refereed papers in technical journals;
- iii.   conference presentations, working papers, workshop reports; and
- iv.   citations and/or awards.

Types of Products from Research
This indicator identifies ReCAP research focus areas in terms of the types of research and outputs generated. These include:
- i.   Specifications, Guidelines and Handbooks;
- ii.   Improved Conventional, New, and Innovative Materials;
- iii.   Advanced Technology/Equipment;
- iv.   Software tools and advanced state-of-the-art procedures (e.g., methods and techniques);
- v.   Technology Transfer Tools

Adoption for mandatory Implementation / Embedment
This indicator measures the level of embedment or the level of adoption for implementation of the research products identified by the previous metric.

Notes: For projects whose primary products are specifications, adoption by ReCAP and its partner countries, organisations like World Bank, IRF or other standards setting agencies is critical. For projects whose product is new and improved materials, commercial production of the material is a good indicator of success. Equipment and technology-based research outcomes are considered to be successful if transportation agencies use the product. Projects with software tools as outputs are successful if their software is available as a completed product or in case of agency specific software like Rural Access Index (RAI), are being used. The success of technology transfer tools is in their creation and wider use.

Extent of Use at the National and Local Levels /Uptake
This indicator assesses the level of usage or uptake of the research products at local and national levels. This metric is considered one of the key indicators of the benefits of the research effort. This is because the extent of usage of a research product or result is a true reflection of the benefits associated with the research product.

2.2.2   Subsystem B: Economic
This subsystem assesses the cost savings or benefits of implementing the research products relative to the research investment. Therefore, one of the key indicators is the investment or cost of the resources associated with the conduct of the research project. Cost saving is estimated as the difference in cost with (ex-poste) and without (do nothing or counterfactual) the use of the research product. This includes savings to the implementing agencies and road users.

B1   Investment or cost of inputs
This indicator measures investment, cost or resources used in conducting the research. Given the time value of money, the present worth of the investment should be used.

> **Data Sources**
> ReCAP website;
>
> Road agencies implementing research products

B2   Agency cost savings
These relate to the cost savings to the implementing agency (typically national and local road agencies) that use the research product. This is made up of capital and operating costs.

Capital Costs - For purposes of this analysis, capital costs are defined as costs incurred in the deployment or implementation of the research product. Where cost data is available on more than one project or application, of a research product, the average cost should be used. This includes labour, materials, and equipment costs.

Operating Costs - The cost savings in maintenance operations results from the reduction in capital expenditure (reconstruction and major rehabilitation) and recurrent (routine and periodic) expenditures. This also includes labour, materials, and equipment costs.

Training costs - These are costs incurred in training road agency staff personnel, supervisors as well as civil works contractors in the implementation of the research outputs. These costs apply only to certain research outputs where specialized training is required to ensure appropriate application. Examples include, software tools, new construction techniques, innovative and new improved materials, climate change adaptation strategies.

Total Agency Costs: The total agency costs is the sum of the annualized capital costs, the annual routine maintenance costs and the annualized major reconstruction and rehabilitation (R&R) costs. This is dependent on the type of research product or result.

B3   User cost savings
User cost savings includes vehicle operation cost savings, travel time and transport cost savings.

Vehicle Operating Cost (VOC) Savings: VOC savings measures the difference between VOC with and without research products (or do-nothing) implementation. These are average VOCs per vehicle-kilometre of road segment.

Travel time and transport savings: This indicator measures the impact of implementing research products on beneficiary communities' travel time and transport costs between given origins and destinations relating to both economic and social activities. Travel time savings can be converted to monetary values using the Value of Time (VOT) concept. The VOT varies by type of vehicle and type of trip. The average cost savings can be estimated by the reductions in travel times multiplied by the VOT and annual average traffic volume. Ideally, travel time savings should be determined from empirical studies that take into account the local variables.

> **Data Sources**
> Data on ex-ante and ex-post CBA results from Government Agencies implementing the ReCAP products;
>
> BAS users are not expected to generate VOC data from HDM or RED analyses

NOTE: Travel time savings in less developed countries can be estimated based on rural wage rates. An international study estimated rural travel time savings as 51%, 64% and 49% of the rural wage rates in Bangaldesh, Ghana, and Tanzania respectively. [1] *While this study is dated, the findings can provide useful guidelines to generate rough estimates for purposes of BAS application.*

B4- Crash Cost Savings: Assigning or translating reductions in number, rate, or density of crashes directly to implementation of research products is difficult. Furthermore, placing monetary value on human life due to fatalities is difficult. It would be necessary to make assumptions based on domain knowledge or evidence from similar products e.g., Road Safety studies.

NOTE: The most recent study on estimating the cost of road crashes in less developed countries was conducted in Ghana and based on 2004 data (Afukaar et al., 2008)[2]. The results of this study, summarized below, are dated and can only serve as a guide in estimating crash cost savings.

Per Fatal Crashes (US$)	*Per Serious Crashes (US$)*	*Per Slight Crashes (US$)*	*Per Property Damage Only Crashes (US$)*
37,476.67	*7,242.22*	*1,713.33*	*943.33*

> **Notes**
> Cost data, in particular, for certain indicators may be difficult to obtain. In such cases it is necessary to make assumptions based on domain knowledge or evidence from similar products or projects. ***It is important that any such assumptions be properly qualified and justified.*** The cost savings can be expressed per unit or project or application depending on the nature of the research product

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[1] . I.T. Transport Ltd. (2005). The value of time in least developed countries: the African studies (R8307). Final Report., DFID, I.T. Transport Ltd., Ardington, Oxfordshire, United Kingdom UK
[2] Afukaar, F.K., Agyemang, W., Debrah, E.K., and Ackaah, W. (2008). *The Socio-Economic Cost of Road Traffic Accidents in Ghana*. Journal of Building and Road Research, Ghana. Vol. 11, Dec. 2008 pp. 39-44.

2.2.3   Subsystem C: Socio-Economic

Indicators in this subsystem measure the socio-economic impacts of the implementation of the research products. These indicators are medium to long term impacts and the benefits are reflected in improved access and mobility for the beneficiaries which ultimately result in improvement of living standards. The benefits are measured in terms of changes in these indicators relative to the existing (baseline) situation prior to implementation of research results or products. Indicators in this subsystem are considered to be minimum core to sufficiently characterize the socio-economic impacts resulting from implementation of research products. These indicators include the following:

Data Sources

Road agencies implementing research products

Household sample surveys of impacted communities

#	Indicator	Description
1	Access to educational facilities	Measures people's ease of access to educational facilities e.g. a change in the number of facilities available, transport to educational facilities, and or the level of enrolment.
2	Access to health services	Measures the change in the number of facilities, transport to health facilities, and or the level of health improvement in people's health.
3	Social Inclusion	Measures extent of the project impact on all social networking activities for categories including gender and age specific, the vulnerable and minorities within the project catchment area.
4	Access to agricultural inputs and services	Measures the impact of project on accessibility of agricultural or farm inputs with project communities or districts before and after the project.
5	Access to markets, retail, farming and other economic activities	This measures the impact in terms of the change or diversification of economic activities, level of market facilities (district or regional markets) and the impact on productivity in farming activities.
6	Access to employment opportunities	Measures the impact in terms of the change in and number of employment opportunities created, such as services, manufacturing, trading etc
7	Women and Youth Benefiting (empowerment)	Measures the number or percentage change in activities engaged in by women and youth within project communities. Improvements in the lives of women and the youth overtime.
8	Travel time savings	Measures travel time between given origins and destinations relating to both economic and social activities before and after the project.
9	Transport Cost savings	Measures travel cost savings (passenger and freight costs) given the improvement on roads. It takes into account the change in the travel mode and the fares by mode.

2.2.4   Subsystem D: Road Safety

Road safety benefits are quantified by the reduction in number and severity of crashes. Three (3) levels of crash severity are used – fatal, serious, and property damage only. For the purpose of the ReCAP-BAS, three (3) levels of crash severity are used – fatal, serious/slight, and property damage only.

Road traffic crashes are usually categorised into fatal, serious, slight and property damage only. Casualties are also classified into fatality (killed), seriously injured and slightly injured. Countries have

different coverage periods for qualifying deaths as road traffic crash related. But by WHO standard, a fatality is defined as a casualty who dies within 30 days from the time of occurrence of the crash. The definition of the different crash categories also differ from one country to the other. It is advised that countries use their existing definitions for the evaluation.

Any of the indicators listed below can be used to assess the impact on Road Safety. Data on all indicators are not necessarily required to assess the Road Safety impacts of implementing the research products. The safety benefits are measured in terms of safety improvements (i.e., reductions in number and severity of crashes or improvement in helmet use) in these indicators relative to the existing situation prior to implementation of research results or products. It is recommended that crash data of between three (3) and five (5) years are used in the before and after situation analysis. The proportion of safety helmet usage can be employed as a surrogate to assess intervention in the short term. In making the short-term evaluation, a cross-sectional study of helmet use before and after implementation of the measure is required.

Weighted Crash Severity Score (WCSS)

The total weighted number of crashes on the intervention (where weight for Fatal = 5, Serious/Slight = 2, Damage only = 1). This is calculated as below:

WCSS = (No. of fatal crashes * 5) + (No. of serious/slight crashes * 2) + (No. of property damage only crashes * 1)

Data Sources

Road agencies implementing research products

Police accident database

Road Safety Authority cross-sectional survey

Crash /Fatality Density

Crash density (CD) is the number of crashes per unit length of road.
CD = (No. of fatal crashes or fatalities + No. of serious or slight crashes + No. of property damage only crashes), divided by length of road

Crash/Fatality per population

The number of crashes/fatalities per population of beneficiary communities served by the improved road segment
(F/P) = No. of Fatalities divided by the Population of community served.

Percentage of helmet use per population

The proportion of motorcycle or tricycle riders that use helmets. This indicator assumes that the use of helmets reduces fatality rates.

2.2.5   Subsystem E: Environmental

Indicators in this subsystem measure the impacts of implementation of research products or results on the environment. For example, construction can cause sediment and erosion problems and impact wetlands, streams, etc. Advances in environmentally friendly materials and their use in design is another way by which infrastructure research can impact the environment. The benefits are measured in terms of changes in these indicators relative to the existing situation prior to implementation of research results or products. The indicators in this subsystem are the following:

Air quality – Pollution (dust)

This indicator measures air quality (e.g., in terms of emissions or dust concentration) in the beneficiary communities where the research products/results have been implemented. This is measured by the percentage of population directly exposed to dust and other forms of air pollution that can be attributed to the implementation of research products or results.

> **Data Sources**
>
> Road agencies implementing research products
>
> Environmental Protection Agencies
>
> Household sample surveys

Erosion

This indicator measures square metre or linear length eroded area in the beneficiary communities where the research products/results have been implemented. It could also be measured by the percentage of population whose daily activities are affected by erosion resulting from implementation of research product or result.

Drainage Structure Failures

This indicator reflects the effects of climate change. It measures the number of drainage structures that fail due to flooding resulting from climate change. Where climate adaptation strategies are employed in the design and construction of the drainage structures, the chances of being washed away in floods and cause environmental problems are minimised.

Notes: While it is clear that implementation of some research products or results impacts the environment positively or negatively, it might be difficult to quantify in terms of monetary terms. Therefore, the environmental impacts are measured in terms of the proportion of the population affected.

Depending on the project or program, information may be available for some but not all of the indicators. Therefore, any of the indicators in this subsystem could be used to assess the impact on the environment.

2.2.6 Subsystem F: User Satisfaction and Use

Indicators in this subsystem directly assess the users' (customers') satisfaction with the research products. Users include national and local road agencies, international funding agencies, and ultimately the travelling public. The indicators used are:

Awareness of the research product,

This indicator measures whether potential users are aware of the existence of the research product or result. It is measured by the percentage of potential users that are aware of the research product.

> **Data Sources**
>
> Household sample surveys of impacted communities
>
> Focus groups in impacted communities

Use of the product

This indicator measures the percentage of potential users who are aware of the existence of the research product or result and actually use it (e.g., road agencies). This includes the use of the product resulting from implementation of research product (e.g., road users).

Value that users place on the research product

This indicator measures the percentage of potential users who are aware of implementation of the research product or result, use the facility, and place value on it relative to other products. Increased

use of a facility resulting from implementation of research products or results reflects the value road users and beneficiaries in general place on the product.

Notes: User satisfaction indicators assess the extent to which users are satisfied with the services provided by the implementation of the research products and results in improving their quality of life. The extent of use indirectly reflects the value that users (e.g., road agencies) place on the research product and may be exhibited in the extension of application to other facilities. Value is a long term indicator of user satisfaction.

While the travelling public may not be aware of the underlying research that resulted in a more durable transportation infrastructure (e.g., pavement and drainage structures) or reliable transport services, increased use or expressions of satisfaction through other means are indications of value placed associated with the result or product. Thus hidden research outcomes cannot be directly measured or captured in the benefit assessment framework.

3.0   SYSTEMS ARCHITECTURE

3.1 Introduction

A systems architecture is a formal description and representation of the basic software structure, identifying the various components or functional layers and interrelationships amongst them. It depicts how a typical software system might interact with its users, external systems, data sources, and services. The systems architecture is therefore the conceptual model based on which the system is designed and developed. This section describes the design and structure of the systems architecture and the database system of ReCAP-BAS. The purpose of the systems architecture is to show the structure and the various components or steps from the design of the data collection template/form through data collection, analysis, and presentation of BAS results.

The choice of software and approach is guided by the requirement that the benefit assessment system must be supported by an efficient, user friendly data acquisition and management system. More importantly, the system must be sustainable. As such, the BAS was developed using an open source software application where the source code is publicly accessible and anyone can modify, enhance or customize it to suit individual needs. Furthermore, an open source software facilitates updates and modifications without the need to pay licensing and updating fees. The systems architecture for ReCAP-BAS was developed based on an open-source software called Open Data Kit (ODK) Collect. It supports a wide range of question and answer types including location, audio, images, video, multiple-choice, free text, and numeric answers. This feature allows users to include project specific images as part of data entry. Some advantages of ODK Collect include:

- It replaces paper forms for data gathering;
- The data collection forms are stored in a Cloud server so that users anywhere in the world can easily access it;
- Because it operates on Android platform, users can enter data from their smartphones or Tablets or PCs with or without network connectivity;
- Being an open source software System Administrators of the ReCAP countries can configure the ReCAP-BAS application to suit their respective server environments and link it to systems that can be used for data manipulation;
- The choice of an open source software application also satisfies the sustainability requirement where no annual subscription, licensing, or updates fees are required. Therefore, the system will continue to be useful even after the ReCAP program ends.

Details of the various elements of the systems architecture are described in the following subsections of this user manual.

3.2 System Architecture

The system architecture shown in Figure 2 below consists of 6 elements or steps as follows:
1. Design the data collection form (also called XLSForm) using Microsoft Excel software. The data collection template or XLSForm has been designed and created in Microsoft Excel and in accordance with ODK guidelines;
2. The data collection form or XLSForm is then uploaded to the ReCAP cloud server – Aggregate Server;
3. When ready to collect data, a blank data collection form or XLSForm is downloaded on the data collection device (smartphone or Tablet or PC) prior to start of data collection exercise;
4. Complete the data collection form or XLSForm by inputting data into the fields or answering questions on the downloaded form;
5. Upload the completed data collection form or XLSForm to the cloud server (i.e., Aggregate Server);

6. Before manipulating or processing the data uploaded, it is necessary to first download the data from Aggregate Server and then import and store it in the MySQL database for analysis. MySQL database is a relational database supporting the Monitoring and Evaluation (M&E) system of the BAS. The user can query, visualize, and analyze the data as desired. The analysis involves converting the answers to the questions in the data collection form into scores for the various indicators for each subsystem in ReCAP-BAS. The results of the analysis can be viewed in the M&E Portal and website.

Figure 2: Systems Architecture
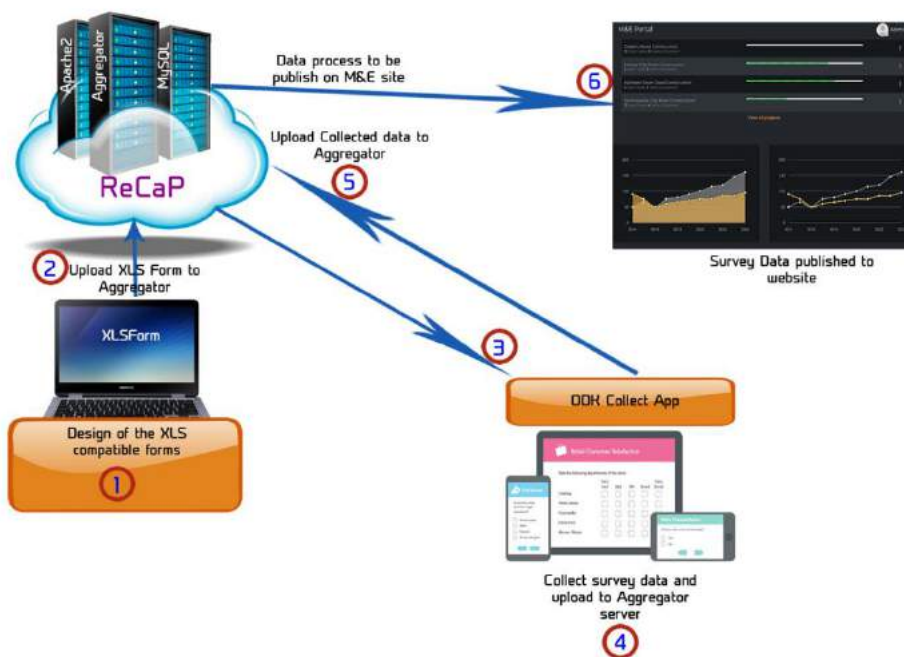
All data collected are uploaded to ReCAP cloud server, which hosts ODK Aggregate Server and a MySQL server that supports the M&E Application. The key components of the architecture are further explained in the following subsections.

3.3   Data Collection Template or XLSForm

The data collection template is created offline in MS Excel (see below). For this project, the data collection template has been created and uploaded to the Cloud Aggregate Server. The user of BAS is not expected to create new forms in order to collect data. The form is uploaded to the Aggregate server and can be accessed and downloaded to Smartphone (Android operating system) devices, or Tablet or PC. The data collection template is included as Annex 1 to this manual.

The Systems Administrator is responsible for future updates to the uploaded data collection form (XLSForm) as necessary.

> **Note**
>
> Data collection form (XLSForm has been created and uploaded to the Aggregate server.
>
> Users are not required to create new data collection templates

Figure 3: Sample of Data Collection Template

type	name	label
start	start	
end	end	
begin group	Project_details	**PROJECT HEADER**
text	interviewer_name	Interviewer's Name:
alpha_numeric	project_number	Project Number:
text	project_name	Project title Name:
select_one ReCAP_region	Name_of_ReCAP_region	ReCAP Region:
select_one ReCAP_country	Name_of_ReCAP_country	ReCAP Country:
text	agency_name	Road Authority:
text	project_location	Location of Project:
integer	Year_completed	Year of completion:
text	road_name	Name of Road:
select_one road_class	road_class	Road Class:
decimal	road_length	Length of road (km):
text	community_name	Name of Community:
integer	Community_population	Population of Community:
select_one research_type	research_type	What type of research was investment for (applied, basic etc)?
select_one research_focus_area	research_focus_area	What is the focus area of the research effort (construction material,
end group		
begin group	select_research_output	**A1-ACHIEVEMENT OF RESEARCH OBJECTIVES**
select_one level_of_achievement	stated_research_objective_achieved	Were the stated research objectives achieved?
select_one yes_or_no_research_report	research_report	Was a research report prepared?
select_one yes_or_no_peer_reviewed_publication	peer_reviewed_publication	was the research findings published in a peer reviewed journal
select_one yes_or_no_working_papers_workshops_confere	working_papers_workshops_conference_proceedings	was the research findings published in conference proceedings, or workshop or as a working paper?
select_one yes_or_no_awards_citations	awards_citations	was the research publication cited elsewhere or received awards?
end group		
begin group	select_research_products_that_apply	**A2-3-4 TYPES OF RESEARCH PRODUCTS, ADOPTION AND USE**
select_one research_product	Type_of_research_product	What are the research products?
select_one level_of_development	Level_of_development_of_research_product	What is the level of development of research product?
select_one level_of_adoption	Level_of_adoption_of_research_product	How many agencies have adopted research product?
select_one extent_of_use	Extent_of_use_of_research_products	How many agencies have implemented the research product?
end group		
begin_group	text_question_investment_cost	**B1-INVESTMENT COST OF RESEARCH PROJECT**
select_one currency	currency	What is the currency?
decimal	exchange_rate	What is the exchange rate to the US Dollar?
integer	research_investment_by_ReCAP	What is the research investment by ReCAP in GBP?
end_group		
begin_group	agency_capital_cost_of_implementing_research_proc	**B2-AGENCY_CAPITAL_COST**
integer	agency_total_capital_implementation_cost	What is the total agency capital cost of implementing research
integer	capital_cost_from_external_funding	What is the capital cost for implementing research product from ext
integer	capital_cost_from_local_funding	What is the capital cost for implementing research product from loc
integer	training_cost_of_civil_works_contractors	What is the training cost for civil works contractors?
integer	training_cost_of_road_agency_personnel_supervisors	What is the training cost for road agency personnel and supervisors
end_group		
begin_group	indicate_agency_operating_costs	**B3-AGENCY_OPERATING_COST**
decimal	annual_routine_maintenance_cost_before_implemen	What is the annual routine maintenance cost before implementing
decimal	annual_routine_maintenance_cost_after_implementa	What is the annual routine maintenance cost after implementing res
decimal	annual_major_rehabilitation_cost_before_implemen	What is the annual major rehabilitation cost before implementing re
decimal	annual_major_rehabilitation_cost_after_implementa	What is the annual major rehabilitation cost after implementing rese
end group		

4.0   HOW TO INSTALL DATA COLLECTION TOOL AND COMPLETE DATA COLLECTION TEMPLATE

4.1   Introduction

This section describes steps to install and set up ODK Collect Tool on your smartphone or PC and how to complete the data collection form that has already been created and available in the Cloud Aggregate Server.

Note

The user is not required to create a new data collection form

4.2   Installing ODK Collect Tool on Smartphone or PC

There are two ways of installing the ODK Collect Tool as follows:
A. – On an Android powered smartphone. This is easiest way to install ODK Collect Tool

1.   Go to Play Store on your Android powered smartphone

2.   Search for ODK Collect and install on your smartphone or Tablet

B.   On a PC

1.   download and install **BlueStacks** software on your computer. This is available at:

https://www.bluestacks.com/download.html?utm_campaign=aw-ded-siteextentdownloadnow-sitee-en-d-1&gclid=Cj0KCQjwvezZBRDkARIsADKQyPnhSD9GSC3Ri9av5buS72u1czCZjrXqSmunVFStT_7lT0uF--oiBzMaAgJTEALw_wcB

2.   On your PC, open BlueStacks

3.   Go to Google Play Store

4.   Search for ODK Collect and install on your PC

4.3   Setting up ODK Collect Tool

Setting up ODK Collect Tool involves a few steps as described below.

1.   To set up the ODK Data Collection tool, click on the **ODK** icon on your phone or PC

2.   Click on the 3 dots on top right corner of Main Menu image that appears (see Figure 4)

3.   Click on **"General settings"**

4.   Click on **"Server"**

5.   Click on **Type** and under **Platform**, select **Other (see Fig. 5)**

6.   Enter the following URL:

http://173.255.217.175:8080/ODKAggregate

Figure 4: Screen Shots of ODK Collect Tool
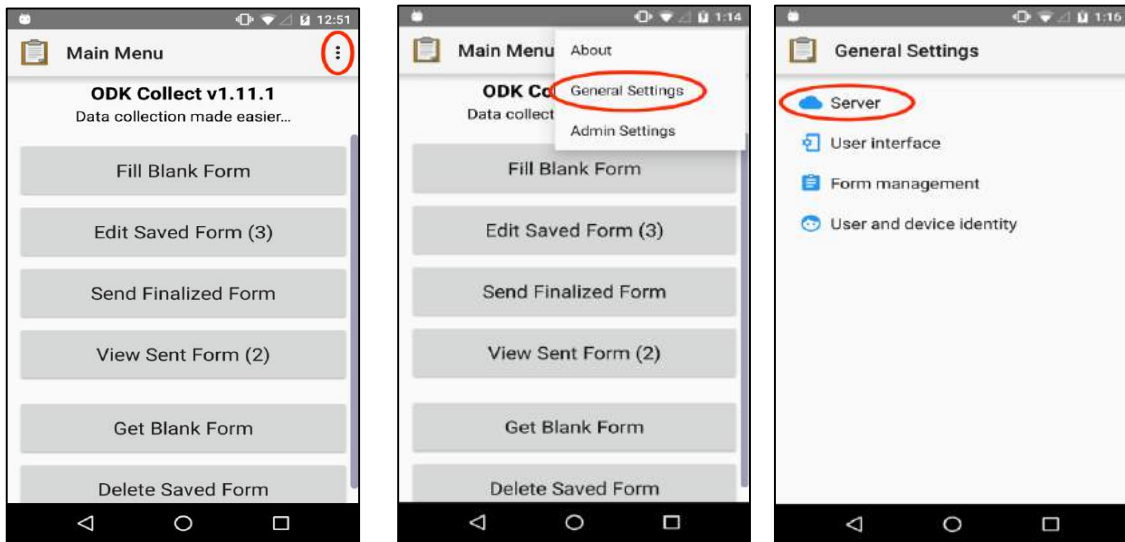
7. Username – **To be provided by Systems Administrator**

8. Password – **To be provided by Systems Administrator**

9. Under other platform Settings, enter the following exactly as shown:

   Form list path – type in the following
   /formList

   Submission path - type in the following
   /submission

10. Click **back** to take you to main menu screen.

Figure 5: Screen Shots of ODK Collect Tool Setup
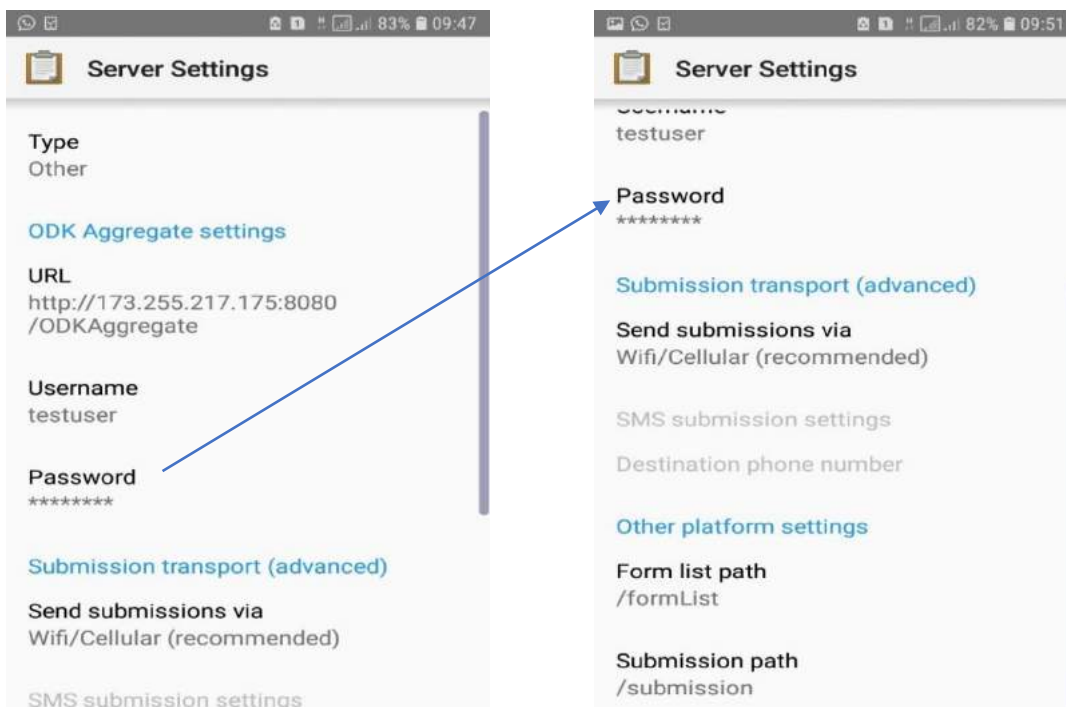
4.4   Using ODK Collect Tool

With the XLSForm (i.e., data collection template) created and uploaded to the Aggregate server in the ReCAP cloud, and the ODK Collect installed, the next step is to access the form and begin to collect data. The steps are outlined below:

- **CAUTION**
  It is recognized that data on certain indicators may be difficult to obtain. In such cases, it is necessary to make assumptions based on domain knowledge or evidence from similar products or projects. It is important that any such assumptions be properly qualified and justified.

1. On your Smartphone or PC click on ODK Collect to open **Main Menu**
2. Click on **'Get Blank Form'**
3. Select the data collection form that has been created and uploaded to the server (e.g., Combined_Subsystems). Then click on **"Get Selected"** at the bottom right of screen (see Figure 6).

Figure 6: Screen Shots of Getting Data Collection
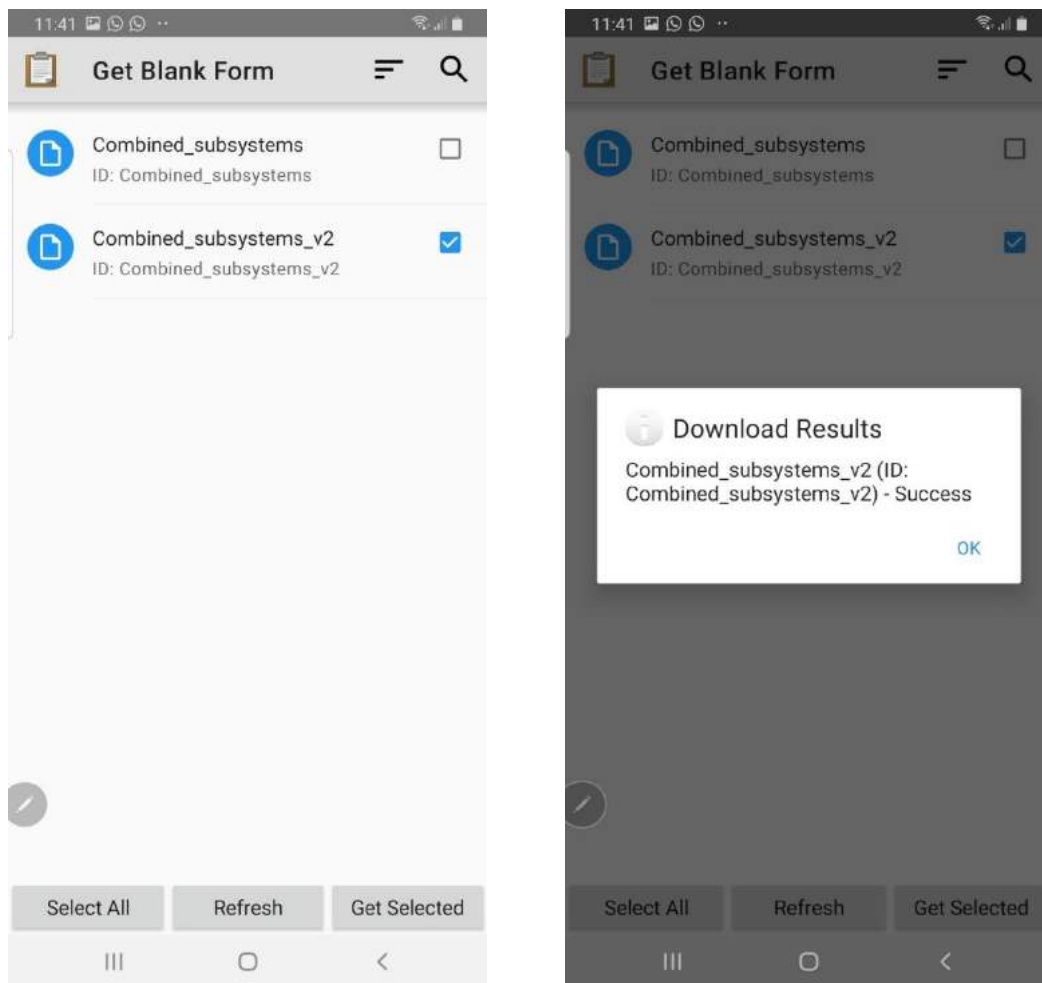
4. After the Blank form has been downloaded onto your phone or PC, the screen to the right in Figure 6 appears confirming successful download of data collection form. Click **OK** to back to the Main Menu

5. On the **Main Menu** page, Click on **'Fill Blank Forms'**

6. The screen shows all the subsections of the data collection form that has been created (Figure 7).

7. Click each section in turn and input the data either by typing the required information or selecting the appropriate answer from a list of options.

<div align="center">

Figure 7: Screen Shots of Data Collection

</div>
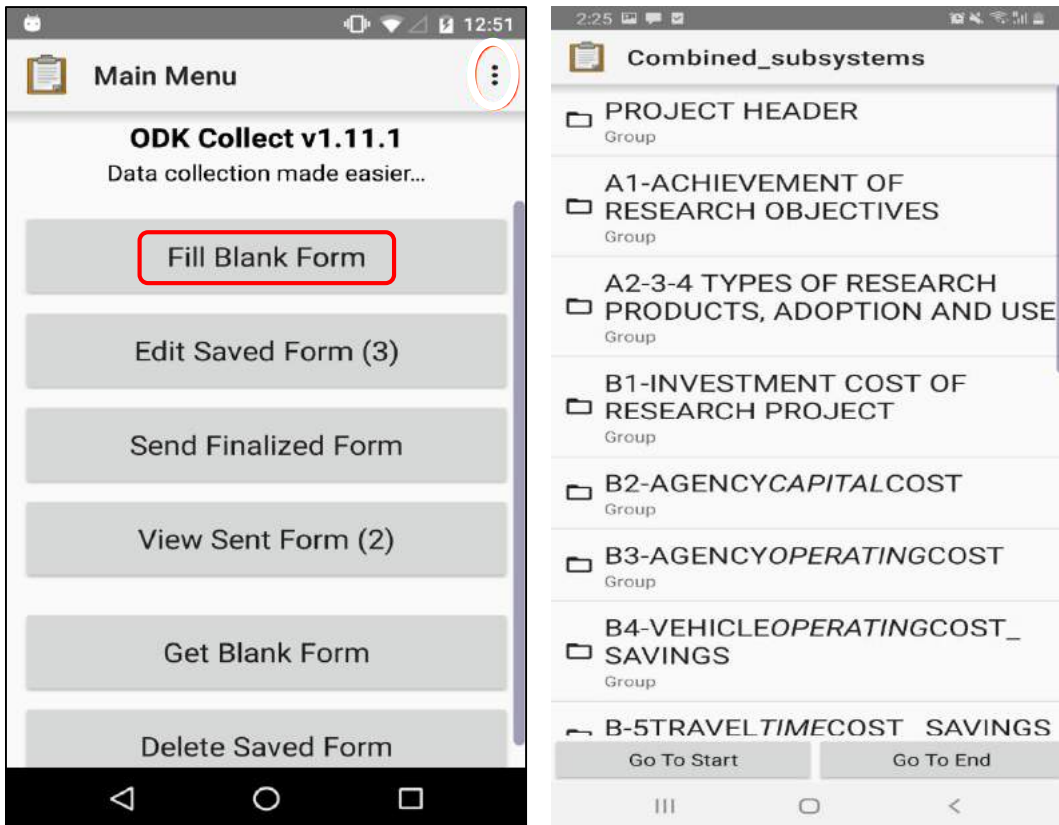
For example, when you click on section PROJECT HEADER, all questions under that section will pop up as shown in the screenshot in Figure 8 (left side).

Click on each question and provide the required data. If the question requires you to type in the information, then you do so as shown in the screenshot in Figure 8 (right side). When done click on downward pointing at the top right corner of the screen to go to the next question in the section.

Figure 8: Screen Shots Data Entry for Questions Requiring Typing
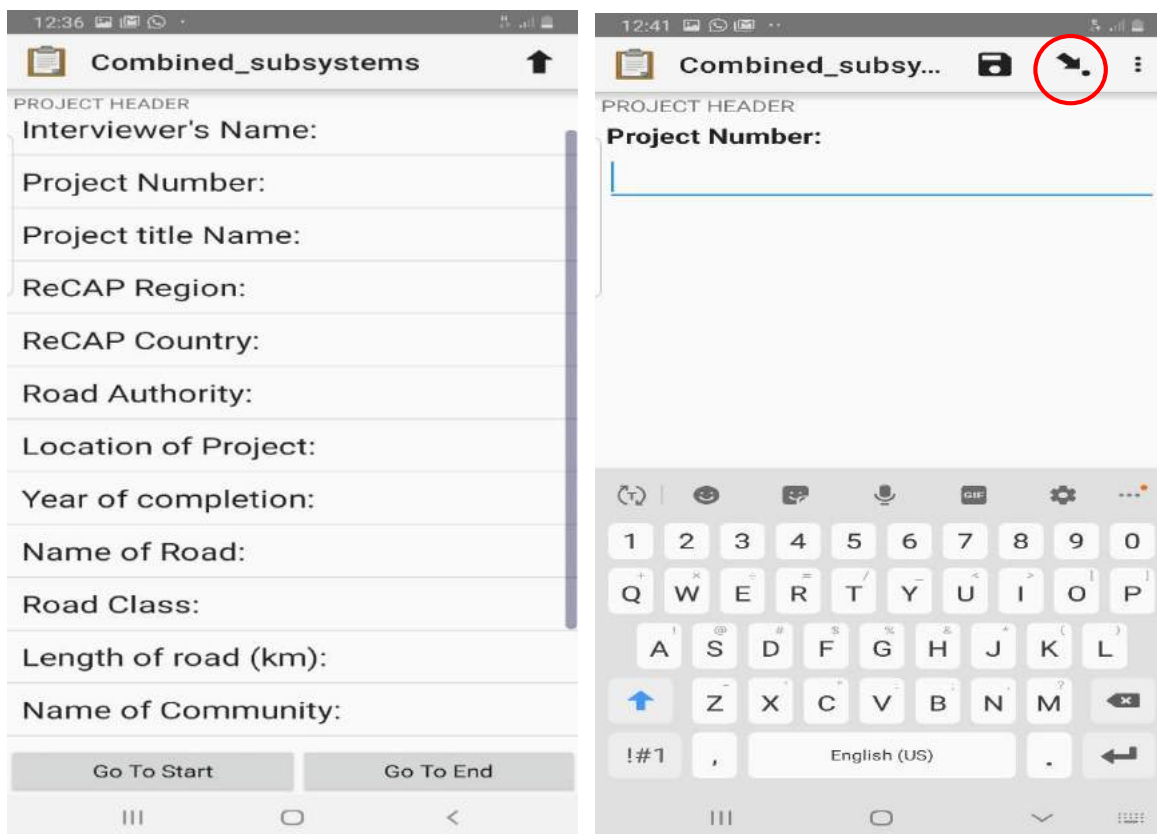
If the question has options to select from, click on the question to display the list of options to select from. Select the appropriate answer using the radio buttons then click on downward pointing at the top right corner of the screen to go to the next question in that section (see Figure 9).

After completing all questions in the section, click on upward pointing arrow. This takes you back to the list of sections as shown in Figure 7 (right side)

8. When all the data fields are completed, click on **'Go to end'** (Figure 9) and save completed file
9. On the Main Menu, click on **"Edit Saved Form"** to make changes to saved file, if necessary. If not changes are required, go to the next step.
10. When all edits are completed, upload the completed file to the Aggregate Server by clicking **'Send Finalized Form'** on the Main Menu.
11. Select the file to be uploaded by ticking the appropriate file (Figure 10).
12. On the same screen, click on **Send Selected** (at the bottom of Figure 10 left side)
13. When the file is successfully uploaded, a confirmation appears (Figure 10, right side).
14. Clicking ok completes the data entry and upload process.

Figure 9: Screen Shots of Data Entry for Questions with Options
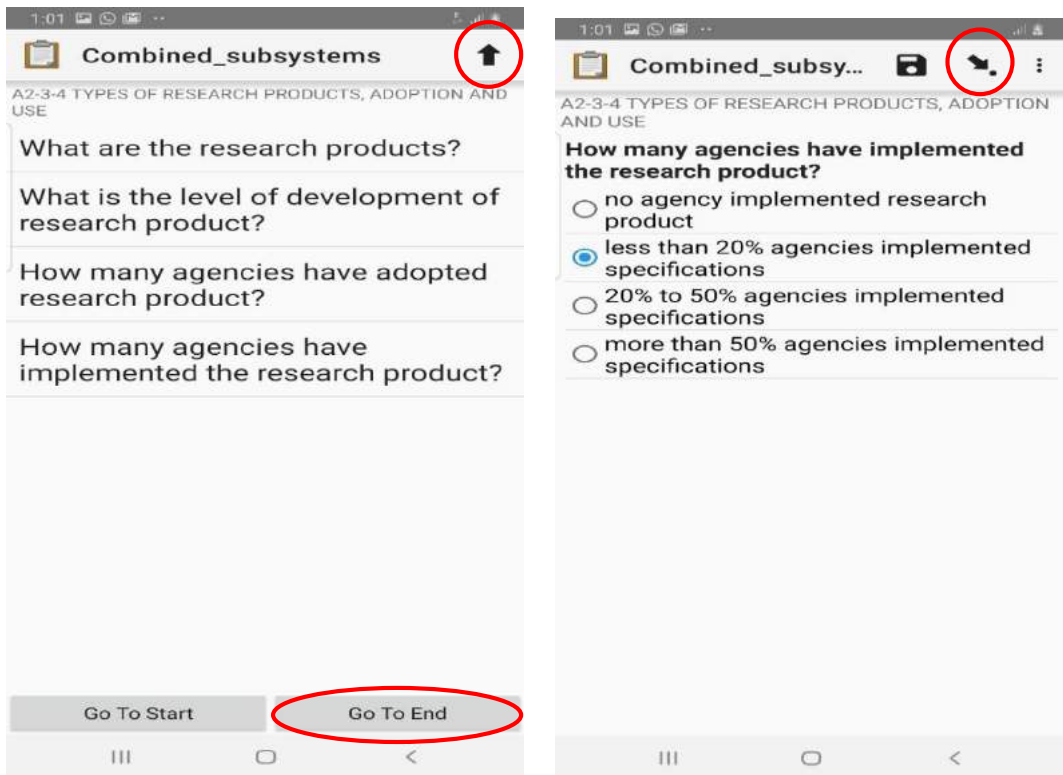
Figure 10: Screen Shots of Data Submission and Confirmation
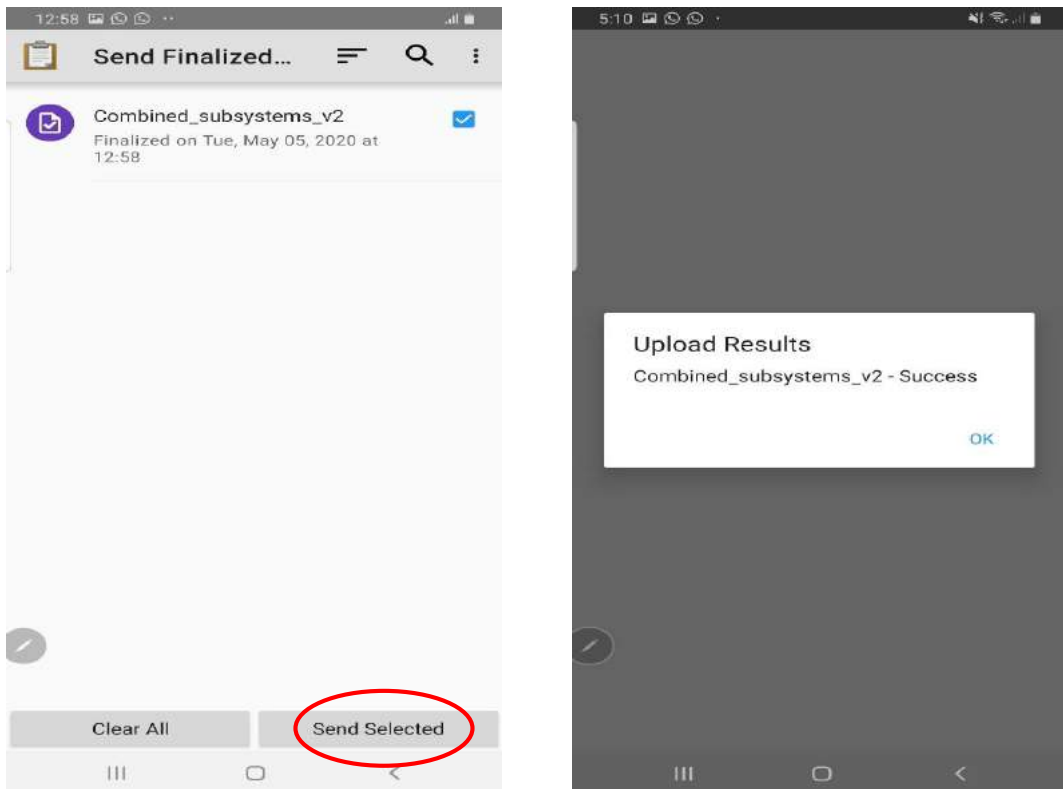
5.0   DATA MANAGEMENT FROM CLOUD DATABASE

The user completes the data collection form and uploads the data to the cloud Aggregate server. This data can be viewed by the user by logging into the Aggregate Server website (See section5.2.1).

Project data available in the Aggregate Server needs to be exported from the Aggregate server in .cvs format and imported into this M&E system. We recommend that the System Administrator performs these actions (See sections 5.3 and 6.4.)

5.1   Introduction

Once you have completed the data collection template with ODK Collect and uploaded it into the cloud database, you can then view and manage your data using ODK Aggregate, if desired.

Note
Systems Administrator provides the usernames and passwords that are country specific.

Users can only view data for their respective countries

5.2   Viewing Form Submissions

The following are the steps to view data that has been uploaded to the server

1. Go to the Aggregate Database at
   https://agg.recapbas.com:8080/ODKAggregate/multimode_login.html

   (You have to put in your username and password provided by the Systems Administrator) Once logged in, the list of completed data collection forms that have been uploaded to the ODK Aggregate server will be displayed

Figure 11: Access to ODK Aggregate Server

2. Click on the **Submissions** tab and select the desired **Form** from the drop-down menu that you wish to view.
3. Click on the "**View Submissions**" button next to the form.
4. Select the Form that you want to view
5. Click **Visualize** and it will take you to another page where you will see **Type** (Types of visualization you desire; e.g.: Pie or Bar Chat)

6. Click on the **Column to visualize** and select the question you want to visualize
7. Select the type of chart by clicking **Pie It** or **Bar It**

Figure 12: Screen Shot of Form Uploaded to Aggregate Server
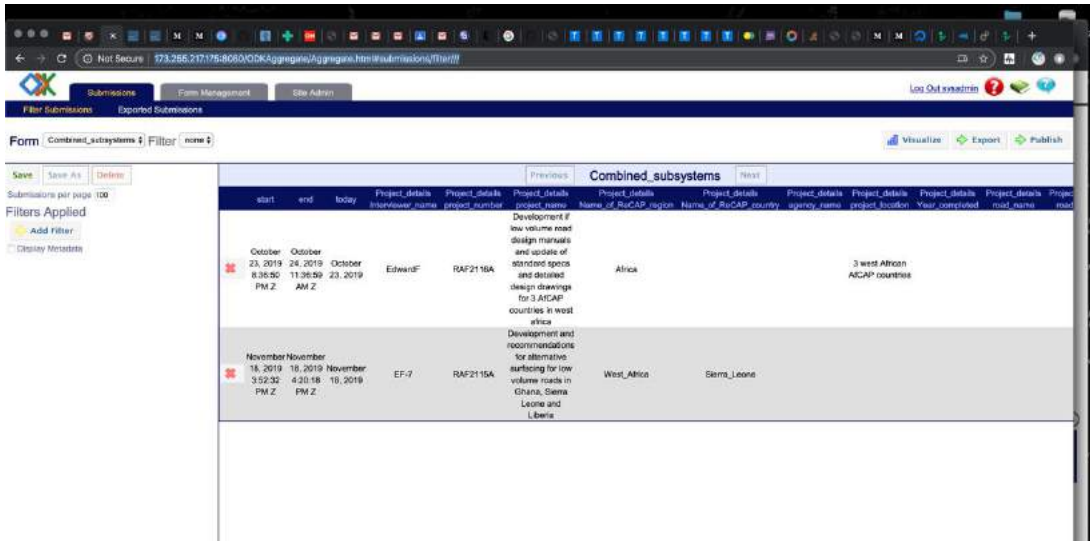
Figure 13: Screen Shot of Sample of Visualization
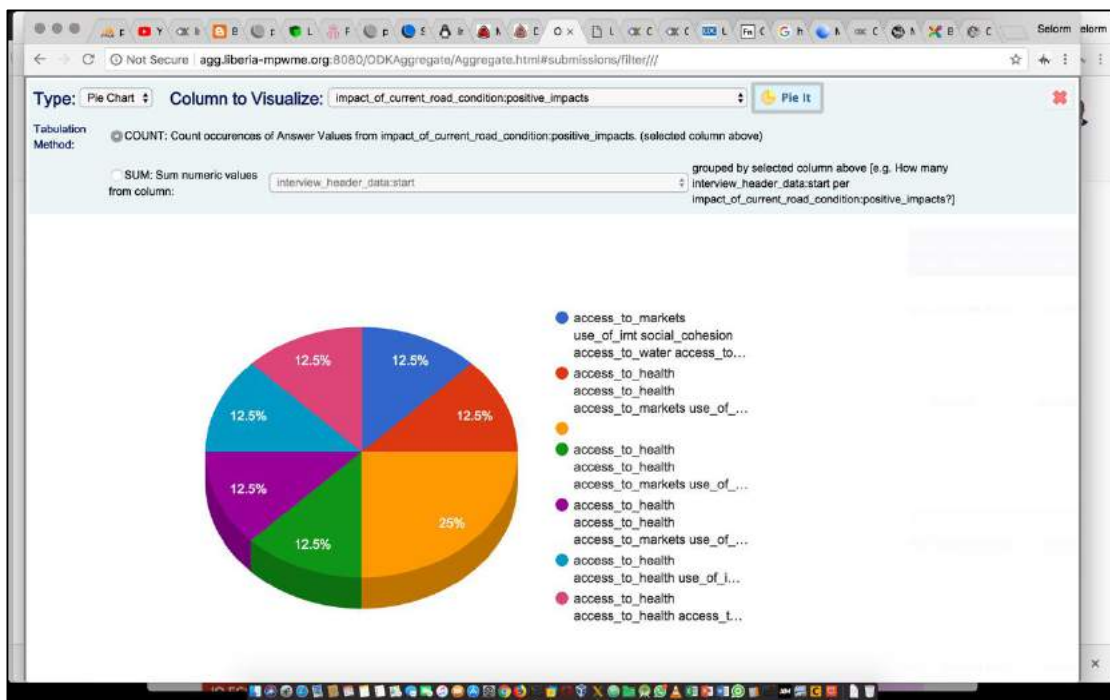
5.3 Exporting Data from ODK Aggregate as CSV

In order to use the uploaded data in the BAS analysis, export data as .csv file from ODK Aggregate server.

1. Click **"Export"**

2. Select **CSV** and click **Export**
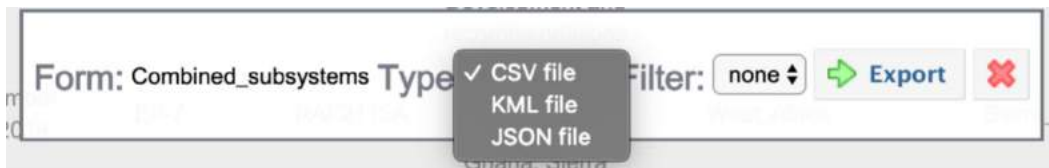
This takes you to the dataset page where you will see the dataset that you have just exported in .csv format.

Caution: Do not click on the dataset to open it, this is because it will break any link that you have with a media file if you just open it without importing it.

6.0   MONITORING AND EVALUATION (M&E) PORTAL

6.1   Introduction

This section describes the steps to access the Monitoring and Evaluation (M&E) portal where the BAS results can be viewed. To access the M&E portal, go to the ReCAP Projects website and click on the M&E Portal tab: http://app.recapbas.com/me/index.php. This takes you to the login page.

6.2   M&E Login Page

Enter the username and password are provided by the Systems Administrator.
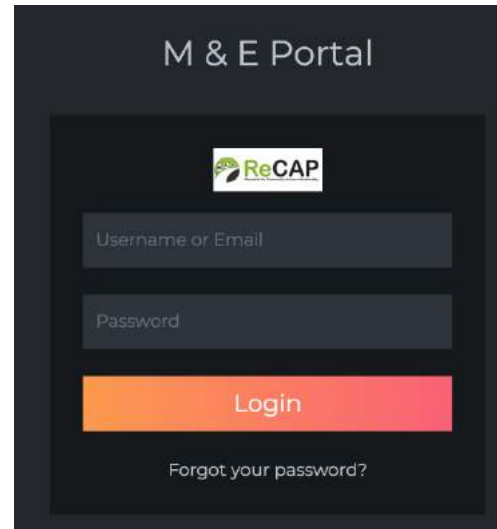
6.3   M&E Portal Menu

When your login is successful, you will see the dashboard which gives you an overview of Projects with information uploaded into the database.

6.4   Importing Data from ODK Aggregate into BAS for analysis

The exported .CSV file from the ODK Aggregate server in the section 5.3 is now imported into the ReCAP-BAS subsystem table for BAS analysis using the following steps.

1. After login to the M&E Portal http://app.recapbas.com/me/upload.php, from the dashboard, click on **projects.** It takes you to another screen (see below). This page shows the list of projects for which data has been uploaded to Aggregate Server.

2. Click on **Load Project from csv**
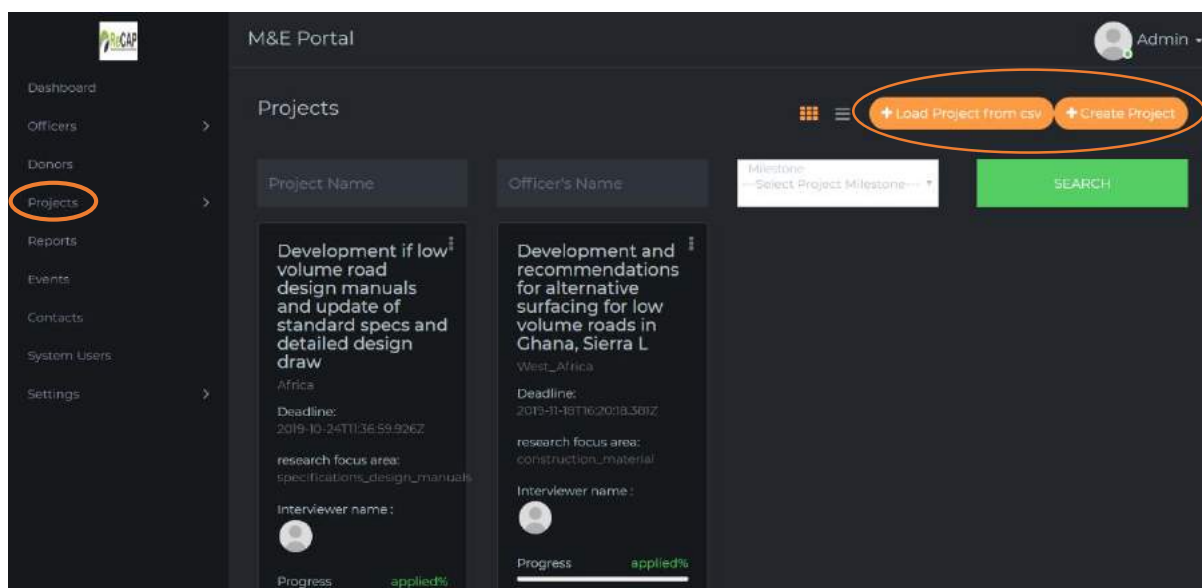
3. Click on **choose file** then and select your exported CSV file •

4. click on **Import** and to populate the BAS subsystem tables
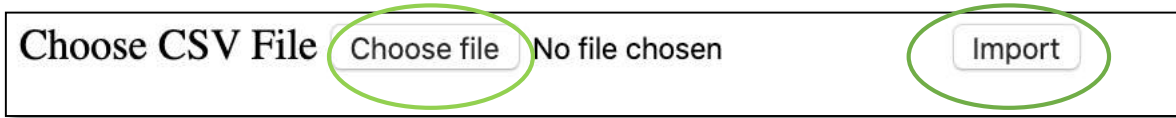
6.5   BAS Projects and Results

1. To view the benefits analyses results click on **Dashboard** – the project identity numbers and titles will be displayed

2. Click on the **Project ID** for the project of interest

3. The next screen displays the scores for each indicator for each subsystem as well as the overall or summary scores for that project.
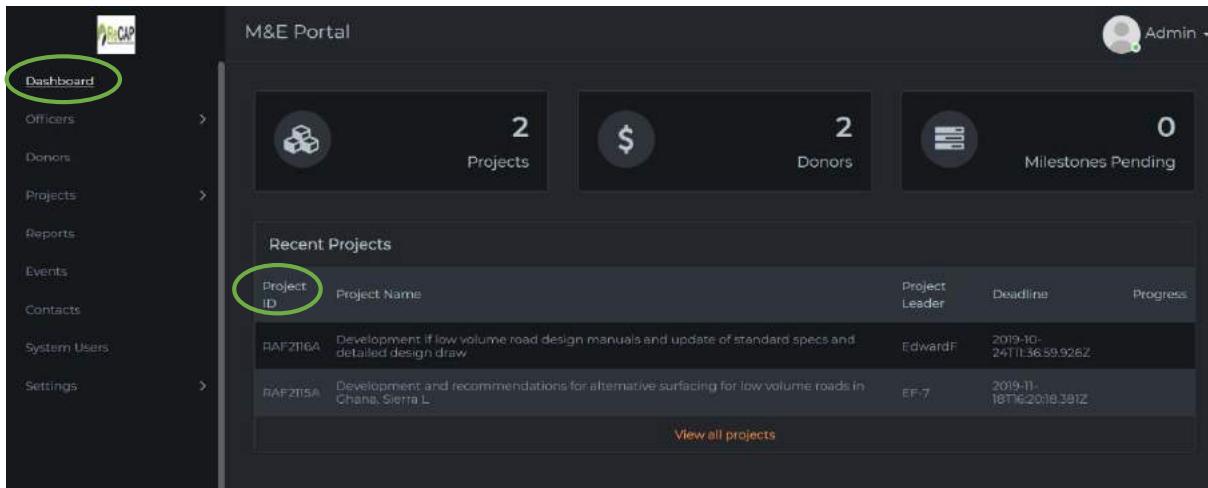
The screen shots below show the benefit analyses results/scores for the 6 subsystems sequentially for A through F and a summary explanation of the scores for all subsystems.

Notes:

- Subsystem A has 4 parts and subsystem B has 3 parts (or Tables)

- The scores are calculated based on responses to the questions in the data collection form. These are the numerical values associated with the responses. Explanations of the scorings are shown in the text boxes associated with each subsystem output.

Subsystem A: Research Output and Use

A-1: Achievement of Research Objectives

Performance Measure	Performance Measure value	Score
Level of achievement	3	15
Research report	1	4
Peer reviewed publication	0	0
Working papers workshops conference proceedings	0	0
Awards citations	0	0
Awards citations	0	0
Total		19
Maximum Score		25
Percentage Score		76.00

A1- achievement of research objectives
The primary measure of success is if the research achieved its stated objectives. A scale from zero to three is provided with zero representing unmet objectives and 3 representing fully met objectives.

Stated objective of program/project (weight =5):
        0 = not achieved
        1 = barely achieved
        2 = partially achieved
        3 = fully achieved

Additional measures of research success are given weights ranging from 4 to 1 with a binary value 1 (or 0) representing if a measure was met or not.
    i.   publishing of research reports (weight =4)
    ii.   publishing a technical paper in a refereed journal (weight =3)
    iii.   publishing in workshops, conferences (weight =2)
    iv.   citations and/or awards for technical publications (weight =1).

A-2: Types of Products from Research

Perforamnce indicator	Performance value	Score	Maximum score	Percentage Score
guidelines_handbooks_monographs	3	15	15	100.00

A-3: Adoption for Implementation/ Embedment

Perforamnce indicator	Performance value	Score	Maximum score	Percentage Score
guidelines_handbooks_monographs	3	15	15	100.00

Table A-4: Extent of Use/ Uptake

Perforamnce indicator	Performance value	Score	Maximum score	Percentage Score
guidelines_handbooks_monographs	3	15	15	100.00

A2- Identifies Research Product and Level of Development
    Weighting factor =5
    0 = not developed
    1 = initial stages of development
    2 = partially developed
    3 = fully developed

A3 and A4: Research Output Embedment and Uptake
- **None** – no national or local road agencies, institutions or other agencies adopt/use the research (0 points)
- **Few** – less than 20% of the expected national road and local agencies, institutions and others adopt/use the research product (1 point)
- **Several** – 20% to 50% of the potential national and local agencies, institutions and others adopt/use the research product (2 points)
- **Widespread** – more than 50% of national and local agencies, institutions and others adopt/use the research product (3 points).

Overall Score for Part A

Performance indicator	Relative Weight	Metric Score	Weighted Score
A.1. Achievement of research objectives	10%	76	7.6%
A.2. Types of Products from Research	15%	100	15%
A.3. Adoption for Implementation	30%	100	30%
A.4. Extent of Use/ Number of Users of Research Product	45%	100	45%
Total	100	376	97.6%

Relative weights depict relative importance of sub-indicators and were determined through nominal techniques and Delphi approach

Subsystem B: Economic

B-1: Agency Cost Savings
Research_investment: 422575

Benefit Areas	Cost with use	Cost without use	Differential
agency_total_capital_cost_for_implementing_research_product_external_funding	0	0	0
cost_of_training_of_road_agency_personnel_supervisors	1690	1690	0
cost_of_training_of_civil_works_contractors	2535	2535	
annual_routine_maintenance_cost	29580	29580	0
Average Rehabilitation cost	0	0	0
Total	33805	33805	0
Percentage change			0%

B-2: User Costs

Benefit Areas	Cost with use	Cost without use	Differential
Vehicle Operating Cost	206	271	65
Travel and transportation cost	45	30	-15
Average crash cost			
Total	251	301	50
Percentage change			16.61%

B-3: Overall Cost Savings

Indicator	Cost With Use of Research Product	Cost Withot Use of Research Product
AGENCY COSTS	33805	33805
USER COSTS t	251	301
Total Cost	34056	34106
Total Cost Savings	50	50
Ratio of Total Cost Savings over Research Funding (TCS/I)	0.0001183	0.0001183

Table B1 – Research Investment and Agency costs and investment
Table B2 – User costs
Table B3 – Summary of agency and user costs savings

Investment and Cost Savings
Cost savings/research investment ratio represents the magnitude of benefits generated by implementing the results of the research project. This ratio is not a true benefit-cost ratio or return on investment because all the benefits and costs are not included in the calculation.

Subsystem C   Socio-Economic

Table C-1: Socio-Economic Subsystem

Indicator	Before	Before score	After	After score	Difference	Maximum score
Access to educational facilities before	2	10	4	20	10	25
Access to health facilities	2	10	3	15	5	25
Social inclusion	1	5	3	15	10	25
Access to agric inputs and services	2	10	3	15	5	25
Access to markets, retail, farming and economic activities	4	20	2	10	-10	25
Employment opportunities	2	10	3	15	5	25
Women benefiting	2	10	3	15	-10	25
Youth benefiting	2	10	3	15	5	25
Travel time savings	0	0	0	0	0	25
Transport cost savings	0	0	0	0	0	25
Total	17	85	24	120	20	250
Total Maximum Score						250
Percentage Score		34%		48%	8%	

> ### *Socio-Economic Impacts*
>
> - **Very low** – no noticeable change (1 point)
> - **Low** – less than 20% of improvement due to implementation of research products (2 points)
> - **Medium**– 20% to 50% of improvement due to implementation of research products (3 points)
> - **High** –50% -75%of improvement due to implementation of research products (4 points).
> - **Very High** –greater than 75% improvement due to implementation of research products (5 points).

Subsystem D: Road Safety

D-1: Safety Subsystem

Performance Indicator	Before	Before_score	After	After_Score	Difference	Maximum score
Number of crashes	0	0	0	0	0	25
Number of fatalities	0	0	0	0	0	25
Crash density (crashes/kilometre)	0	0	0	0	0	25
Number of serious crashes	0	0	0	0	0	25
Number of minor crashes	0	0	0	0	0	25
Number of safety helmet use	1	5	3	15	5	25
Total	1	5	3	15	5	150
Percentage Score		3.3333333333333335%		10%	3.3333333333333335%	

> **Road Safety Impacts**
>
> - **Very low** – no noticeable improvement in road safety (1 point)
> - **Low** – less than 5% improvement in road safety (2 points)
> - **Medium** – 5-10% improvement in road safety (3 points)
> - **High** –10% to 20% improvement in road safety (4 points).
> - **Very High** – more than 20% improvement in road safety (5 points).

Subsystem E: Environmental Impacts

E-1: Environmental Subsystem

Environmental Indicators	Environmental Indicators Value	Score	Maximum Score
Improvement in Air Quality or Emissions Reduction or dust control	0	0	25
Erosion	0	0	25
Drainage structure protection	0	0	25
Total	0	0	
Maximum Score Total			75
Percentage Score			0.00%

> **Environmental Impacts**
>
> - **Very low** – high negative – more than 20% of population negatively impacted (1 point)
> - **Low** – less than 20% of population negatively impacted (2 points)
> - **Neutral** – no noticeable positive or negative impact (3 points)
> - **Medium** – less than 20% of population positively impacted (4 points).
> - **High** – more than 20% of population positively impacted (5 points).

Subsystem F: User Satisfaction

F-1: User Satisfaction

Performance Indicator	Performance Indicator Value	Score	Maximum Score
Awareness of research product	3	15	25
Use of research product	3	15	25
Value of research product	4	20	25
Total	34	50	
Maximum Score Total			75
Percentage Score			66.67%

> ### *User Satisfaction*
>
> - **Very low** –no noticeable impact (1 point)
> - **Low** – less than 20% of population satisfied (2 points)
> - **Neutral** – 20-50% of users satisfied and value implementation or research product (3 points)
> - **Medium** – 50-75% of users satisfied and value implementation or research product (4 points)
> - **High** – more than 75% of users satisfied and value implementation or research product (5 points).

Overall Scorecard

Rating Scale

Depending on the score for each subsystem, the interpretations are different. The rating scheme is presented in Table 1 below and screenshot with graphical comparison of the scores for each subsystem are also shown below.

Table 1. Rating Scale of BAS Outputs

Score	Rating	Research Output and Usage	Economic	Socio-Economic	Road Safety	Environmental	User Satisfaction
Score > 75%	Excellent	The research fully achieved its objectives, has developed products/outputs that are readily available and adopted by national agencies. These products/outputs are widely used by local and national agencies, and other institutions.	Total Cost Savings/Research Investment ratio	Excellent: Implementation of research product or result has significantly positive socio-economic effects	Implementation of research product or result has significantly improved road safety by reduced crashes and fatalities	High positive environmental impacts	Meets users' needs/expectations adequately
60% < Score ≤ 75%	Good	The research partially achieved its objectives, has partially developed products that are available and adopted by national agencies. Several local and national agencies, and other institutions use these products		Implementation of research product or result has some positive socio-economic effects.	Implementation of research product or result has improved road safety by reduced crashes and fatalities to some measurable extent	Low positive environmental impacts	Meets users' needs/expectations satisfactorily
45 < Score ≤ 60%	Fair	The research barely achieved its objectives, has developed products that are in the early stages of availability and adoption by national agencies. Few local and national agencies, and other institutions use these products.		Implementation of research product or result has marginal positive socio-economic effects.	Implementation of research product or result has marginal effects on road safety.	Marginal positive or negative environmental impacts	Limited users' satisfaction
Score < 45%	Poor	The research did not quite achieve its intended objectives, has not developed products that are available and adopted by national agencies. Few or no local and national agencies, or other institutions use these products.		Poor: Implementation of research product or result has no significant positive socio-economic effects.	Implementation of research product or result has no significant effect on road safety.	Significant negative environmental impacts	Users not satisfied with research product
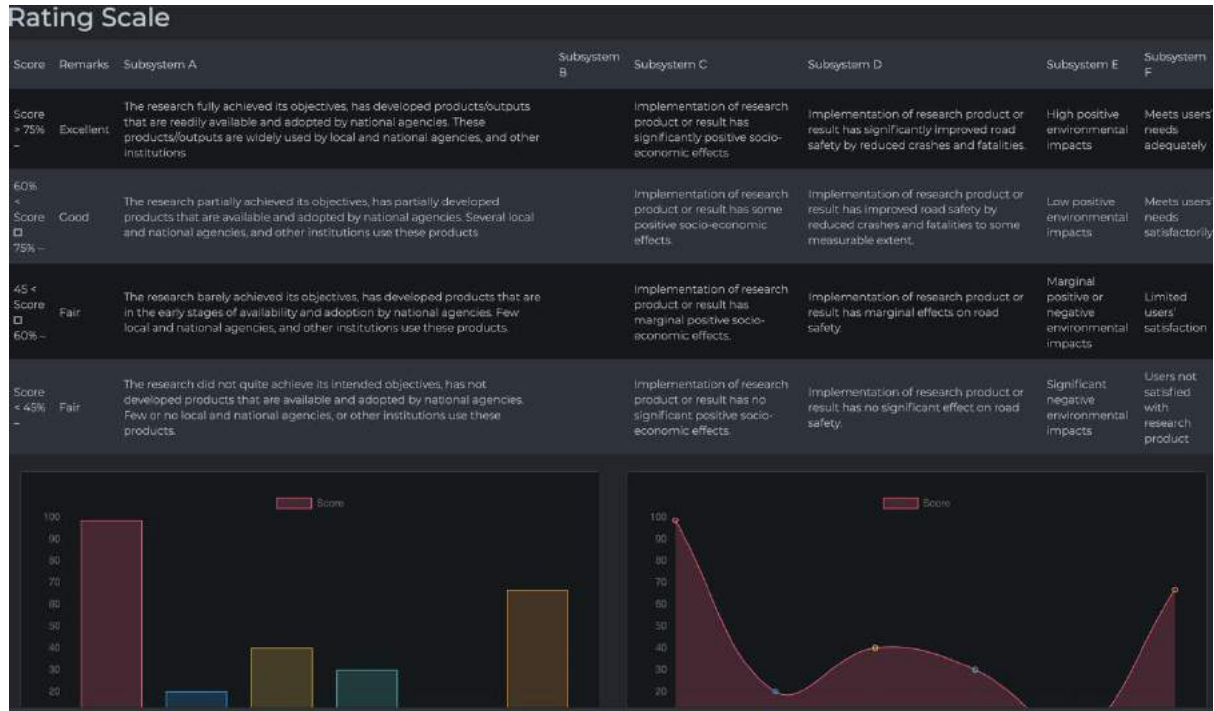
6.6   Printing Analysis Results

By clicking on the Print icon on top of the subsystem tables, you can either print or save the results from the subsystem tables as pdf or select a printer to print everything.

6.7 Illustrative Examples

To illustrate and further explain application of the BAS, seven (7) worked examples are presented in Annex 2 of this report. These examples represent different research types or focus areas and demonstrate the systems' flexibility to report benefit scores for subsystems with varying degrees of data availability. Six of the examples relate to specific ReCAP projects with different levels of data availability. The seventh example is hypothetical and it is included to demonstrate a situation where the research project produces more than one outcome and where data is available for all key indicators for each subsystem. The examples also illustrate the calculation of the benefit scores using the BAS framework.

7. CONCLUDING REMARKS

This project identifies performances measures and developed a framework to assess the benefits of research funded ReCAP. The guiding principle in the development of the performance indicators and assessment framework is to ensure that the measures are relevant, that they capture all types of research activities, objective enough to highlight the benefits and weaknesses of research projects and or programs and above all simple enough to be understood and applied by all potential users.

The final output of the benefits assessment framework is visualized as a report or score card where scores are assigned to the various components. Poor performance in one area does not necessarily lead to the conclusion that the project or program is a failure. The relative merits of the various components of the framework need to be considered in assessing the overall benefits of the program in any given year.

In applying the framework to new and potential projects it is recommended that assumptions and educated guesses of the data required be made and justified accordingly. It is recommended that the results of the assessment be updated as new data becomes available.

FREQUENTLY ASKED QUESTIONS (FAQ)

1)   How do I install ODK?
Open 'Play Store'. Search for 'ODK', select 'ODK Collect' from the drop-down list. Click the 'INSTALL' button.

2)   Can I download data from ODK without internet connectivity?
Yes, but you should also install ODK briefcase.

3)   Can I go ahead with my data collection when offline?
Yes, once you have downloaded your form to the mobile device, ODK can collect and queue the data. Once back online, you can transfer your data to the server

4)   Does ODK auto save my work?
Yes, the system auto saves first on your local device and after upload to the server. On the server, it does auto save too.

5)   Is there a way to retrieve my data after the app has abruptly closed or I ran out of battery?
If the user just re-launches ODK Collect and re-opens the form that they were filling out, ODK Collect will open the save point file it made for that form.

6)   Where do I get the username and password in order to access the ODK Aggregate server from Collect?
Contact the ReCAP-BAS Systems Administrator.

7)   Where do I get extra support on ODK Collect?
For support on how to use ODK and coordinated assessments, please visit
https://forum.opendatakit.org/c/support

8)   Do I need all the data for a particular subsystem before the assessment will be done?
No. Just upload the data which is available to you. No assessment will be done for the indicator(s) which data is unavailable. This will not affect the evaluation of the subsystem in anyway.

9)   Will I have results for all subsystems in any particular project?
No. Some subsystems may not apply or data may be missing or unavailable in certain projects.

10)   Where can I find the aggregated or cumulative score for all the subsystems?
There is no aggregated or cumulative score for all the subsystems. Converting all scores to a single score would lose the essence of the assessment exercise where strong and weak points would not be easily identified and documented as lessons learned to help in designing future projects.

ANNEX 1: DATA COLLECTION TEMPLATE

type	name	label
type	name	label
start	start	
end	end	
begin group	Project_details	**PROJECT HEADER**
text	interviewer_name	Interviewer's Name:
alpha_numeric	project_number	Project Number:
text	project_name	Project title Name:
select_one ReCAP_region	Name_of_ReCAP_region	ReCAP Region:
select_one ReCAP_country	Name_of_ReCAP_country	ReCAP Country:
text	agency_name	Road Authority:
text	project_location	Location of Project:
integer	Year_completed	Year of completion:
text	road_name	Name of Road:
select_one road_class	road_class	Road Class:
decimal	road_length	Length of road (km):
text	community_name	Names of Communities:
integer	community_population	Population of Communities:
end group		
begin group	select_research_output	**A1-ACHIEVEMENT OF RESEARCH OBJECTIVES**
level_of_achievement	stated_research_objective_achieved	Were the stated research objectives achieved?
select_one yes_or_no_research_report	research_report	Was a research report prepared?
yes_or_no_peer_reviewed_publi	peer_reviewed_publication	was the research findings published in a peer reviewed journal?
select_one yes_or_no_working_papers_workshops_conference_proceedings	working_papers_workshops_conference_pr	was the research findings published in conference proceedings, or workshop report or as a working paper?
select_one yes_or_no_awards_cit	awards_citations	was the research publication cited anywhere or received awards?
end group		
begin group	select_research_products_that_apply	**A2-3-4 TYPES OF RESEARCH PRODUCTS, ADOPTION AND USE**
select_one research_type	Research_type	What is the type of research?
select_one research_focus_area	Research_focus_area	What is the research focus area?
select_multiple research_product	Research_product	What are the research products?
select_one level_of_development	Level_of_development_of_research_produc	What is the level of development of research product?
select_one level_of_adoption	Level_of_adoption_of_research_product	How many agencies have adopted research product?
select_one extent_of_use	Extent_of_use_of_research_products	How many agencies have implemented the research product?
end group		

begin group	Investment_cost	**B1-INVESTMENT COST OF RESEARCH PROJECT**
select_one currency	currency	What is the currency?
decimal	exchange_rate	What is the current exchange rate to the US Dollar?
decimal	research_investment_by_ReCAP	What is the research investment by ReCAP in GBP?
end group		
begin group	agency_capital_cost_of_implementing_r	**B2-AGENCY_CAPITAL_COST**
decimal	agency_total_capital_implementation_c	What is the total agency capital cost of implementing research product?
decimal	capital_cost_from_external_funding	What is the capital cost for implementing research product from external funding?
decimal	capital_cost_from_local_funding	What is the capital cost for implementing research product from local funding?
decimal	training_cost_of_civil_works_contractors	What is the training cost for civil works contractors to implement research product?
decimal	training_cost_of_road_agency_personne	What is the training cost for road agency personnel and supervisors to implement research product?
end group		
begin group	indicate_agency_operating_costs	**B3-AGENCY_OPERATING_COST**
decimal	annual_routine_maintenance_cost_befo	What was the average annual routine maintenance cost before implementing research product?
decimal	annual_routine_maintenance_cost_after	What is the average annual routine maintenance cost after implementing research product?
decimal	annual_major_rehabilitation_cost_befor	What was the average annual major rehabilitation cost before implementing research product?
decimal	annual_major_rehabilitation_cost_after_	What is the average annual major rehabilitation cost after implementing research product?
end group		
begin group	User_cost_savings	**B4 USER_COST_SAVINGS**
decimal	average_VOC_before_implementation_o	What was the average VOC per kilometer before implementation of research product?
decimal	average_VOC_after_implementation_of_	What is the average VOC per kilometer after implementation of research product?
decimal	travel_time_cost_before_implementatio	What was the average travel time cost before implementation of research product?
decimal	travel_time_cost_savings_after_impleme	What is the average travel time cost after implementation of research product?
decimal	transportation_cost_before_implementa	What was the average transportation cost before implementation of research product?
decimal	transportation_cost_after_implementati	What is the average transportation cost after implementation of research product?
decimal	crash_cost_before_implementation_of_r	What was the average crash cost before implementation of research product?
decimal	crash_cost_after_implementation_of_res	What is the average crash cost after implementation of research product?
end group		

begin group	transport_services	**C1-SOCIO-ECONOMIC -TRIP DETAILS**
text	passenger_trip_origin	What is the usual starting point of trips on this route?
text	passenger_trip_destination	What is the usual destination point of trips on this route?
select_one yes_or_no	yes_or_no	Is the project road the main route to your destination?
select_one distance	distance	What is the approximate distance from origin to destination near, far or very far?
select_one purpose_destination_	purpose_destination_visit_before	What was the primary purpose of travel to this destination before project implementation?
select_one purpose_destination_	purpose_destination_visit_after	What is the primary purpose of travel to this destination after project implementation?
select_one frequency_destination	frequency_destination_visit_before	On average, how often did people travel to visit this destination before project implementation?
select_one frequency_destination	frequency_destination_visit_after	On average, how often do people travel to visit this destination before project implementation?
end group		
begin group	mode_of_transport_to_destination	**C2- TRANSPORT MODES AND FARES**
integer	num_modes_transport_passenger	How many modes of transport are available for travel to your destination?
select_one common_mode_of_tra	common_mode_of_transport_before	What was the most common of transport before project implementation?
select_one common_mode_of_tra	common_mode_of_transport_after	What is the most common of transport after project implementation?
select_one waiting_time_for_tran	waiting_time_for_transport_before	Approximately, what was average waiting time for transport before project implementation?
select_one waiting_time_for_tran	waiting_time_for_transport_after	Approximately, what is average waiting time for transport after project implementation?
decimal	fare_paid_before	What was average transport fare for a one-way trip before project implementation?
decimal	fare_paid_after	What is average transport fare for a one-way trip after project implementation?
select_one travel_time_before	travel_time_before	What was the average travel time to travel to your destination before project implementation?
select_one travel_time_after	travel_time_after	What is the average travel time to travel to your destination after project implementation?
end group		
begin group	impact_of_implementing_research_prod	**C3-SOCIO-ECONOMIC IMPACTS OF IMPLEMENTING RESEARCH PRODUCT**
select_one access_to_educationa	access_to_educational_facilities_before	What was the impact of the baseline condition on access to educational facilities before project in
select_one access_to_educationa	access_to_educational_facilities_after	What is the impact on access to educational facilities after project implementation?
select_one access_to_health_faci	access_to_health_facitlities_before	What was the impact of the baseline condition on access to health facilities before project implen
select_one access_to_health_faci	access_to_health_facitlities_after	What is the impact on access to health facilities after project implementation?
select_one access_for_social_incl	access_for_social_inclusion_before	What was the impact of the baseline condition on access to social inclusion and networking activi
select_one access_for_social_incl	access_for_social_inclusion_after	What is the impact on access to social inclusion and networking activities after tproject implemer
select_one access_to_agriculture_	access_to_agriculture_inputs_and_servic	What was the impact of the baseline condition on access to agriculture inputs, services and faciliti
select_one access_to_agriculture_	access_to_agriculture_inputs_and_servic	What is the impact on access to agriculture inputs, services and facilities after project implementa
select_one access_to_markets_re	access_to_markets_retail_economic_acti	What was the impact of the baseline condition on access to markets, retail and economic activitie
select_one access_to_markets_re	access_to_markets_retail_economic_acti	What is the impact on access to markets, retail and economic activities after project implementat
select_one access_to_employmen	access_to_employment_opportunities_b	What was the impact of the baseline condition on access to employment opportunities before pro
select_one access_to_employmen	access_to_employment_opportunities_a	What is the impact on access to employment opportunities after project implementation?
select_one women_benefiting_be	women_benefiting_before	What was the impact of the baseline condition on women empowerment before project impleme
select_one women_benefiting_af	women_benefiting_after	What is the impact on women empowerment after project implementation?
select_one youth_benefiting_befd	youth_benefiting_before	What was the impact of the baseline condition on youth empowerment before project implement
select_one youth_benefiting_afte	youth_benefiting_after	What is the impact on youth empowerment after project implementation?
end group		

begin group	injury_severity_level	**D1-SAFETY - CASUALITIES BY SEVERITY**
integer	traffic_volume	Annual Average Daily Traffic (AADT)
integer	fatality_before	What was the number of fatalities before project implementation?
integer	fatality_after	What is the number of fatalities after project implementation?
integer	serious_injury_before	What was the number of Seriously Injured Casualties before project implementation?
integer	serious_injury_after	What is the number of Seriously Injured Casualties after project implementation?
integer	slight_injury_before	What was the number of Slightly Injured Casualties before project implementation?
integer	slight_injury_after	What is the number of Slightly Injured Casualties after project implementation?
end group		
begin group	crash_severity_level	**D2- CRASHES BY SERVERITY**
integer	fatal_before	What was the number of Fatal Crashes before project implementation?
integer	fatal_after	What is the number of Fatal Crashes after project implementation?
integer	serious_crash_before	What was the number of Serious Crashes before project implementation?
integer	serious_crash_after	What is the number of Serious Crashes after project implementation?
integer	minor_crash_before	What was number of minor of Minor Crashes before project implementation?
integer	minor_crash_after	What is number of minor of Minor Crashes after project implementation?
integer	property_damage_only_before	What was the number of Property Damage Only (PDO) crashes before project implementation?
integer	property_damage_only_after	What is the number of Property Damage Only (PDO) crashes after project implementation?
end group		
begin group	impact_of_implementing_research_prod	**D3-SAFETY IMPACTS OF IMPLEMENTING RESEARCH PRODUCT**
select_one crashes	number_of_crashes_before	What was the impact on number of crashes/accidents before project implementation?
select_one crashes	number_of_crashes_after	What is the impact on number of crashes/accidents after project implementation?
select_one crash_density	crash_density_before	What was the impact on number of crashes/accidents per kilometer before project implementatic
select_one crash_density	crash_density_after	What is the impact on number of crashes/accidents per kilometer after project implementation?
select_one fatalities	number_of_fatalities_before	What was the impact on number of fatalities before project implementation?
select_one fatalities	number_of_fatalities_after	What is the impact on number of fatalities after project implementation?
select_one serious_crashes	number_of_serious_crashes_before	What was the impact on number of serious crashes before project implementation?
select_one serious_crashes	number_of_serious_crashes_after	What is the impact on number of serious crashes after project implementation?
select_one minor_crashes	number_of_minor_crashes_before	What was the impact on number of minor crashes before project implementation?
select_one minor_crashes	number_of_minor_crashes_after	What is the impact on number of minor crashes after project implementation?
end group		
begin group	safety_helmet_use	**D4 - CRASH HELMET USE BY MOTORCYCLE RIDERS**
select_one safety_helmet_users	safety_helmet_user_before	What was the approximate number of motorcycle riders use helmets before training?
select_one safety_helmet_users	safety_helmet_use_after	What is the approximate number of motorcycle riders use helmets after training?
select_one safety_training_sessio	safety_training_and_sensitization	How many safety training and sensitization campaigns were conducted during implementation of
select_one safety_training_partici	Safety_training_participants	What is average number of participants in each training session?
end group		

begin_group	select_environmental_impacts_that_apply	**E1-ENVIRONMENTAL IMPACTS**
select_one population_affected	air_quality_emissions_and_dust	what proportion of the population is affected by environmental of implementation of research products in terms of air quality (tail pipe emissions and dust)?
select_one area_eroded	soil_erosion	what proportion of population is affected by erosion due to implementation of research products?
select_one drainage_structures_fa	drainge_structure_failures	How many drainage structures failed due to flooding, lanslides, construction trucks?
end group		
begin group	select_user_satisfaction_value_that_app	**F1-USER SATISFACTION**
select_one users_aware	awareness_of_research_product	What percentage of potential users are aware ofikplementation of the research product?
select_one beneficiaries_using_fa	use_of_research_product	What percentage of beneficiaries actually use the facility after implementation of research product (traffic volume)?
select_one users_value	value_of_research_product	What value do users or beneficiaries place on the use of the research product?
end group		

ANNEX 2. EXAMPLES OF BAS APPLICATION

The examples presented herein are intended to illustrate the application BAS for different research types and the systems' flexibility to report benefit scores for subsystems with varying degrees of data availability. Seven examples are presented, six of which relate to specific ReCAP projects.

EXAMPLE 1 – GHA2065B PROJECT NARRATIVE

GHA2065B: Alternative surfacing for steep hill sections in Ghana - Phase 1 (2016-2017). The study aimed at identifying, defining and demonstrating appropriate surfacing options as alternatives to the current gravel wearing courses on the steep hill sections of feeder roads in Ghana.

The results of the research are being implemented on a 5.10km rural road connecting Akwasiho and Twenedurase in the Eastern Region of Ghana. The road is being rehabilitated with bitumen surfacing under the Ghana Ministry of Roads and Highways with the Department of Feeder Roads as the implementing agency. At the time of the site visit, the project was on hold due to funding limitations.

In an effort to collect data to help demonstrate application of BAS, the project team conducted on site surveys on 19th December, 2019 at Akwasiho. Focus Group Discussion (FGD) and a household questionnaire were used to gather socio-economic data. The FGD was conducted with opinion leaders and some community members of Akwasiho while the household interviews were conducted with five (5) randomly selected households within the community. Both tools were used to ascertain the impacts and assess the respondents' perspectives of the before and after situations of the Akwasiho – Twenedurase road project.

The following are explanations of judgments to support the assumptions where data on indicators are not available. These are presented by subsystems as follows.

A. As noted above, the project was successfully completed where a final project report was submitted. No technical paper was published in a peer reviewed journal; working papers or conference papers were presented but no citations recorded.

   The research product was Guidelines for the alternative surfacing for steep hills of low volume rural roads. The Guidelines were fully developed and being a single country research project, full embedment or adoption for implementation was assumed. Similarly, full uptake or implementation was expected.

B. Insufficient cost data on before and after implementation of research results and the implications are not available at the time of benefits assessment.

C. Expert judgment and limited socio-economic data collected during the project site visit as described above were used.

D. Based on expert knowledge, implementation of the research product is not expected to have any noticeable impacts on road safety. Therefore, this subsystem was not analysed.

E. By virtue of the nature of the research product, it was assumed that some negative environmental impacts would result in the medium to long term. This could be in terms of erosion and damage to drainage structures due the steep slopes

F. Data collected during site visits provided users' perspectives on satisfaction with the final outcome when project is completed.

Table 1A-1. Achievement of Research Objectives

Performance Indicator	Weight (5 = critical, 0 = not achieved)	Level of Achievement				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = not	1 = barely	2 = partially	3 = fully		
Stated objective of program/project	5				3	15	15
Additional Indicators		Level of Achievement					
		0 = No		1 = Yes		--	--
Project report	4			1		4	4
Papers published in peer reviewed Journals	3	0				0	3
Working papers, conferences, workshops	2			1		2	2
Awards or Citations for Product	1	0				0	1
Total						21	25
Score - (total score / max score)							84%

Table 1A-2. Types of Products from Research

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Development				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = not developed	1 = initial stages	2 = partially developed	3 = fully developed		
Specifications (Design, construction, inspection, testing, maintenance etc.)	5						15
	0						0
Guidelines/Handbooks (including tables, charts, monographs)	5				3	15	15
	0						0
Improved Conventional and New Innovative Materials	5						15
	0						0
Advanced Technology and New Equipment (construction, inspection or testing)	5						15
	0						0
Software Tools (design, analysis, management, testing, inspection, etc.)	5						15
	0						0
Advanced state-of-the-art procedures (e.g., methods, techniques)	5						15
	0						0
Technology Transfer (websites, workshops, clearinghouses)	5						15
	0						0
Total						15	15
Score -- (total score / max score)							100%

Table 1A-3. Adoption for Implementation/ Embedment

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Adoption				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = No	1 = few	2= several	3 = fully		
Specifications (including Design, construction, inspection, testing, maintenance)	5	Have the specifications been adopted as National Specifications?					15
	0						0
Guidelines/Handbooks (including tables, charts, monographs, etc.)	5	Do National and local road agencies or similar organizations and institutions adopt the guidelines/handbooks?			3	15	15
	0						0
Improved Conventional and New Innovative Materials	5	Are the materials developed available commercially?					15
	0						
Advanced Technology and New Equipment (including construction, inspection or testing)	5	Are the technologies and equipment in regular use by transportation agencies (excluding pilot projects)?					15
	0						
Software Tools (for design, analysis, inspection, testing or management)	5	Is the software available, installed, tested and in use by agencies?					15
	0						
Technology Transfer Applications (including websites, clearinghouses, workshops, etc.)	5	Have technology transfer applications been created and implemented?					15
	0						
Total						15	15
Score - (total score / max score)							100%

Table 1A-4. Extent of Use/ Uptake

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Extent of Use by Local and National Road Agencies and Institutions				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = none	1 = few	2 = several	3 = widespread		
Specifications (including Design, construction, inspection, testing, maintenance)	5	Number of agencies using the specifications					15
	0						0
Guidelines/Handbooks (including tables, charts, monographs)	5	Number of agencies that recommend or use of the guidelines, handbooks etc.			3	15	15
	0						0
	5	Number of agencies with reported applications of the materials					15

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Extent of Use by Local and National Road Agencies and Institutions				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = none	1 = few	2 = several	3 = widespread		
Improved Conventional and New Innovative Materials							
	0						0
Advanced Technology and New Equipment (including construction, inspection or testing)	5	Number of agencies who have procured the equipment or the technology					15
	0						0
Software Tools (for design, analysis, inspection, testing or management)	5	Number of agencies with users of software[4]					15
	0						0
Technology Transfer (including websites, clearinghouses, workshops etc.)	5	Number of agencies requesting additional information or attending workshops or related training courses					15
	0						0
Total						15	15
Score (total score / max score)							100%

Table 1A-5. Overall Score for Part A

Performance Indicator	Relative Weight (w)	Metric Score (s)	Weighted Score (w*s)
A.1. Achievement of research objectives	10%	84	8.4
A.2. Types of Products from Research	15%	100	15
A.3. Adoption for Implementation	30%	100	30
A.4. Extent of Use/ Number of Users of Research Product	45%	100	45
Total	100%		98.4
Score (%)			98.4%

Table 1B-1. Agency Cost Savings

Research Program/Project	
Investment Cost/Research Investment (*I*)	GBP565,825

Capital Costs			
Agency Cost Indicator	Applicability (Yes = 1; No=0)	Cost With implementation of Research Product	Without implementation of Research Product
– Capital cost (design, construction materials, labour, equipment, etc)		198,000	
– Training cost for agency personnel and supervisors			
– Training cost for civil contractors			
Total Implementation Cost (1)			

Operating Costs				
Routine Maintenance Cost Major Rehabilitation & Reconstruction Costs				
Operating Cost Indicator	Applicability (Yes = 1; No=0)	Cost With implementation of Research Product	Without implementation of Research Product	Differential
Average Maintenance Costs (labour, equipment, materials etc)	1			
Average Rehabilitation and Reconstruction cost (labour, equipment, materials, etc)	0			
Total Operating Costs = (2)				
Total Agency Costs (3) = (1)+(2)				
Percent change (%)				

Table 1B-2. User Costs

User Cost Savings (If project produces user benefits)				
		Annual Costs		
User Cost Indicator	**Applicability (Yes = 1; No=0)**	**Cost With implementation of Research Product**	**Without implementation of Research Product**	**Differential**
Average Vehicle Operating Cost (VOC)				
Average travel time and transportation costs				
Average crash costs				
Total User Costs (4)				
Percent change (%)				

Table 1B-3. Overall Cost Savings

Ratio of Cost Savings to Research Finds Calculations		
Indicator	**Cost With Use of Research Product**	**Cost Without Use of Research Product**
AGENCY COSTS *Table B-1 (3)*		
USER COSTS *Table B-2 (4)*		
Total COSTS (5) = *(3)+(4)*		
Total Cost Savings $TCS = (5)_{with} - (5)_{without}$		
Ratio of Total Cost Savings over Research Funding *(TCS/I)*		

Table 1C-1. Socio-Economic Subsystem

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1= very low	2 = low	3 = medium	4 = high	5 = very high		
Access to educational facilities	5				4		20	25
	0							
Access to health facilities	5				4		20	25
	0							
Social Inclusion	5					5	25	25
	0							
Access to agric inputs and services	5				4		20	25
	0							
Access to markets, retail, farming and economic activities	5				4		20	25
	0							
Employment	5			3			15	25
	0							
Women benefiting	5			3			15	25
	0							
Youth benefiting	5			3			15	25
	0							
Travel time savings	5					5	25	25
	0							
Transport cost savings	5				4		20	25
	0						0	
Total							195	250
Score - (total score / max score)								78%

Table 1D-1. Road Safety Subsystem

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1 = very low	2 = low	3 = medium	4 = high	5 = very high		
Number of crashes	5							25
	0							0
Number of fatalities	5							25
Crash density (crashes/km)	5							25
	0							0
Number of serious crashes	5							25
	0							0
Number of minor crashes	5							25
	0							
Number safety helmet use	5							25
	0							
Total								
Score – (total score / max score)								

Table 1E-1. Environmental Subsystem

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Impact					Score (level * weight)	Max Score Possible = (max level *weight)
		1 = high negative impact	2 = low negative	3 = no noticeable	4 = low positive	5 = high positive		
Air Quality or Emissions Reduction or dust control	5							25
	0						0	0
Erosion	5		2				10	25
	0							0
Drainage structure protection	5		2				10	25
	0							0
Total							20	50
Score - (total score / max score)								40%

Table 1F-1. User Satisfaction

Performance Indicator	Weight (5 = critical, 0 = not applicable)	Level of Satisfaction 1 = very low; 5 = very high					Score (level * weight)	Maximum Score Possible (max level * weight)
		1	2	3	4	5		
Awareness of research product					4		20	25
Use of research product						5	25	25
Value of research product						5	25	25
Total							70	75
Score - (total score / max score)								93.3%

Overall Scorecard

Subsystem	Description	Score (%)	Remarks
A	Research Output And Usage	98.4%	The research fully achieved its objectives, has developed products/outputs that are readily available and adopted by national agencies. These products/outputs are widely used by local and national agencies, and other institutions.
B	Economic /Cost Savings	N/A	Data not available
C	Socio-Economic	78%	Implementation of research product or result has significantly positive socio-economic effects.
D	Road Safety	N/A	Data not available
E	Environmental	40%	Significant negative environmental impacts
F	User Satisfaction	93.3%	Meets users' needs/expectations adequately

EXAMPLE 2 – RAF2115A PROJECT NARRATIVE

RAF2115A: Development and Recommendations for alternative surfacings for low volume roads in Ghana, Sierra Leone and Liberia (2017-2018).

The following are explanations of judgments to support the assumptions where data on indicators are not available. These are presented by subsystems as follows.

A. The project was successfully completed where a final project report was submitted and accepted; no technical paper was published in a peer reviewed journal; working papers or conference papers were presented but no citations recorded.

   The research product was Guidelines for alternative surfacings of low volume rural roads. This product was fully developed and being a regional research project for only three countries, full embedment or adoption for implement was assumed. Similarly, all three countries were assumed to uptake the research product (i.e. full uptake).

B. Insufficient cost data on before and after implementation of research results and the implications are not available at the time of benefits assessment.

C. With regards to socio-economic impacts, no before and after data are available. The potential impacts resulting from implementation of the specific research products are estimated based on expert judgment for the different indicators.

D. For road safety, based on expert knowledge, improvements in road surface conditions would not have significant (low to medium) impacts on road safety indicators

E. Improvements in road surface conditions were assumed to have no noticeable negative impacts on the environmental indicators.

F. No data on user satisfaction of implementation of the research product was available. However, the nature of research product and data obtained from site visits for GHA2065A, guided the estimates used in analysing the benefits in the user satisfaction subsystem.

Table 2A-1. Achievement of Research Objectives

Performance Indicator	Weight (5 = critical, 0 = not achieved)	Level of Achievement				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = not	1 = barely	2 = partially	3 = fully		
Stated objective of program/project	5				3	15	15
Additional Measures		**Level of Achievement**					
		0 = No		**1 = Yes**		**--**	**--**
Project report	4			1		4	4
Papers published in peer reviewed Journals	3	0				0	3
Working papers, conferences, workshops	2	0		1		2	2
Awards or Citations for Product	1	0				0	1
Total						21	25
Score - (total score / max score)							84%

Table 2A-2. Types of Products from Research

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Development				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = not developed	1 = initial stages	2 = partially developed	3 = fully developed		
Specifications (Design, construction, inspection, testing, maintenance etc.)	5						15
	0						0
Guidelines/Handbooks (including tables, charts, monographs)	5				3	15	15
	0						0
Improved Conventional and New Innovative Materials	5						15
	0						0
Advanced Technology and New Equipment (construction, inspection or testing)	5						15
	0						0
Software Tools (design, analysis, management, testing, inspection, etc.)	5						15
	0						0
Advanced state-of-the-art procedures (e.g., methods, techniques)	5						15
	0						0
Technology Transfer (websites, workshops, clearinghouses)	5						15
	0						0
Total						15	15
Score -- (total score / max score)							100%

Table 2A-3. Adoption for Implementation/ Embedment

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Adoption				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = No	1 = few	2= several	3 = fully		
Specifications (including Design, construction, inspection, testing, maintenance)	5	Have the specifications been adopted as National Specifications?					15
	0						0
Guidelines/Handbooks (including tables, charts, monographs, etc.)	5	Do National and local road agencies or similar organizations and institutions adopt the guidelines/handbooks?			3	15	15
	0						0
Improved Conventional and New Innovative Materials	5	Are the materials developed available commercially?					15
	0						

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Adoption				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = No	1 = few	2= several	3 = fully		
Advanced Technology and New Equipment (including construction, inspection or testing)	5	Are the technologies and equipment in regular use by transportation agencies (excluding pilot projects)?					15
	0						
Software Tools (for design, analysis, inspection, testing or management)	5	Is the software available, installed, tested and in use by agencies?					15
	0						
Technology Transfer Applications (including websites, clearinghouses, workshops, etc.)	5	Have technology transfer applications been created and implemented?					15
	0						
Total						15	15
Score - (total score / max score)							100%

Table 2A-4. Extent of Use/ Uptake

Performance Measures	Weight (5 = critical, 0 = Not Applicable)	Extent of Use by Local and National Road Agencies and Institutions				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = none	1 = few	2 = several	3 = widespread		
Specifications (including Design, construction, inspection, testing, maintenance)	5	Number of agencies using the specifications					15
	0						0
Guidelines/Handbooks (including tables, charts, monographs)	5	Number of agencies that recommend or use of the guidelines, handbooks etc.			3	15	15
	0						0
Improved Conventional and New Innovative Materials	5	Number of agencies with reported applications of the materials					15
	0						0
Advanced Technology and New Equipment (including construction, inspection or testing)	5	Number of agencies who have procured the equipment or the technology					15
	0						0
Software Tools (for design, analysis, inspection, testing or management)	5	Number of agencies with users of software[4]					15
	0						0
Technology Transfer (including websites, clearinghouses, workshops etc.)	5	Number of agencies requesting additional information or attending workshops or related training courses					15
	0						0
Total						15	15
Score (total score / max score)							100%

Table 2A-5. Overall Score for Part A

Performance Indicator	Relative Weight (w)	Metric Score (s)	Weighted Score (w*s)
A.1. Achievement of research objectives	10%	84	8.4
A.2. Types of Products from Research	15%	100	15
A.3. Adoption for Implementation	30%	100	30
A.4. Extent of Use/ Number of Users of Research Product	45%	100	45
Total	100%		98.4
Score (%)			98.4%

Table 2B-1. Agency Cost Savings

Research Program/Project	
Investment Cost/Research Investment *(I)*	GBP235462

Capital Costs			
Agency Cost Indicator	Applicability (Yes = 1; No=0)	Cost With implementation of Research Product	Without implementation of Research Product
– Capital cost (design, construction materials, labour, equipment, etc)			
– Training cost for agency personnel and supervisors		941	
– Training cost for civil contractors		1,413	
Total Implementation Cost (1)		2,354	

Operating Costs				
Routine Maintenance Cost Major Rehabilitation & Reconstruction Costs				
Operating Cost Indicator	Applicability (Yes = 1; No=0)	Cost With implementation of Research Product	Without implementation of Research Product	Differential
Average Maintenance Costs (labour, equipment, materials etc)	1	16,482		
Average Rehabilitation and Reconstruction cost (labour, equipment, materials, etc)	0	0		
Total Operating Costs = (2)	1	18,836		
Total Agency Costs (3) = (1)+(2)		18,836		
Percent change (%)				

Table 2B-2. User Costs

User Cost Indicator	Applicability (Yes = 1; No=0)	Annual Costs		Differential
		Cost With implementation of Research Product	Without implementation of Research Product	
Average Vehicle Operating Cost (VOC)		206		
Average travel time and transportation costs		45		
Average crash costs				
Total User Costs (4)		251		
Percent change (%)				

Table 2B-3. Overall Cost Savings

Ratio of Cost Savings to Research Finds Calculations		
Indicator	Cost With Use of Research Product	Cost Without Use of Research Product
AGENCY COSTS *Table B-1 (3)*	18,836	
USER COSTS *Table B-2 (4)*	251	
Total COSTS (5) = *(3)+(4)*	19,807	
Total Cost Savings $TCS = (5)_{without} - (5)_{with}$		
Ratio of Total Cost Savings over Research Funding *(TCS/I)*		

Table 2C-1. Socio-Economic Subsystem

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1= very low	2 = low	3 = medium	4 = high	5 = very high		
Access to educational facilities	5				4		20	25
	0							
Access to health facilities	5		2				10	25
	0							
Social Inclusion	5		2				10	25
	0							
Access to agric inputs and services	5		2				10	25
	0							
Access to markets, retail, farming and economic activities	5			3			15	25
	0							

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1= very low	2 = low	3 = medium	4 = high	5 = very high		
Employment	5			3			15	25
	0							
Women benefiting	5			3			15	25
	0							
Youth benefiting	5			3			15	25
	0							
Travel time savings	5				4		20	25
	0							
Transport cost savings	5				4		20	25
	0						0	
Total							150	250
Score - (total score / max score)								60%

Table 2D-1. Road Safety Subsystem

Performance Indicators	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1 = very low	2 = low	3 = medium	4 = high	5 = very high		
Number of crashes	5		2				10	25
	0							0
Number of fatalities	5		2				10	25
Crash density (crashes/km)	5			3			15	25
	0							0
Number of serious crashes	5			3			15	25
	0							0
Number of minor crashes	5			3			15	25
	0							
Proportion of safety helmet use	5			3			15	25
	0							
Total							80	150
Score – (total score / max score								53.3%

Table 2E-1. Environmental Subsystem

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Impact					Score (level * weight)	Max Score Possible = (max level *weight)
		1 = high negative impact	2 = low negative	3 = no noticeable	4 = low positive	5 = high positive		
Air Quality or Emissions Reduction or dust control	5			3			15	25
	0							0
Erosion	5			3			15	25
	0							0
Drainage structure protection	5			3			15	25
	0						0	0
Total							45	75
Score - (total score / max score)								60%

Table 2F-1. User Satisfaction

Performance Indicator	Weight (5 = critical, 0 = not applicable)	Level of Satisfaction 1 = very low; 5 = very high					Score (level * weight)	Maximum Score Possible (max level * weight)
		1	2	3	4	5		
Awareness of research product			2				10	25
Use of research product					4		20	25
Value of research product					4		20	25
Total							50	75
Score - (total score / max score)								66.7%

Overall Scorecard

Subsystem	Description	Score (%)	Remarks
A	Research Output And Usage	98.4%	The research fully achieved its objectives, has developed products/outputs that are readily available and adopted by national agencies. These products/outputs are widely used by local and national agencies, and other institutions.
B	Economic /Cost Savings	N/A	Insufficient data available
C	Socio-Economic	60%	Implementation of research product or result has some positive socio-economic effects.
D	Road Safety	53.3%	Implementation of research product or result has marginal effects on road safety.
E	Environmental	60%	Low positive environmental impacts
F	User Satisfaction	66.7%	Meets users' needs/expectations satisfactorily

EXAMPLE 3 – RAF2116A PROJECT NARRATIVE

RAF2116A: Development of Low Volume Road Design Manuals and update of standard specifications and detailed drawings for three AfCAP member countries in West Africa (2017-2019).

The overall objective of the project is to prepare manuals for low volume rural roads in Ghana, Sierra Leone and Liberia based on a review, adaption and expansion of previous AfCAP LVR manuals and local manuals that are available in these countries

The following are explanations of judgments to support the assumptions where data on indicators are not available. These are presented by subsystems as follows.

A. The project was successfully completed where a final project report was submitted and accepted; no technical paper was published in a peer reviewed journal; working papers or conference papers were presented but no citations recorded.

   The research product was Design Manual. This product was fully developed and being a regional research project, full embedment or adoption for implementation was assumed. Similarly, full uptake of the research product was assumed.

B. Insufficient cost data on before and after implementation of research results and the implications are not available at the time of benefits assessment.

C. With regards to socio-economic impacts, no before and after data are available. The potential impacts resulting from implementation of the specific research products were estimated to be neutral for some of the core indicators based on expert judgment.

D. Based on expert knowledge, implementation of design manuals is not expected to have significant direct impact on road safety indicators.

E. Given the research focus area, implementation of research product was assumed to have no noticeable negative impact on the environmental indicators.

F. No data on implementation of the research product was available. However, the nature of research product and data obtained from site visits for GHA2065A, guided the estimates used in analysing the benefits in the user satisfaction subsystem.

Table 3A-1. Achievement of Research Objectives

Performance Indicator	Weight (5 = critical, 0 = not achieved)	Level of Achievement				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = not	1 = barely	2 = partially	3 = fully		
Stated objective of program/project	5				3	15	15
Additional Indcators		**Level of Achievement**				--	--
		0 = No		**1 = Yes**			
Project report	4			1		4	4
Papers published in peer reviewed Journals	3	0				0	3
Working papers, conferences, workshops	2	0				0	2
Awards or Citations for Product	1	0				0	1
Total						19	25
Score - (total score / max score)							76%

Table 3A-2. Types of Products from Research

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Development				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = not developed	1 = initial stages	2 = partially developed	3 = fully developed		
Specifications (Design, construction, inspection, testing, maintenance etc.)	5						15
	0						0
Guidelines/Handbooks (including tables, charts, monographs)	5				3	15	15
	0						0
Improved Conventional and New Innovative Materials	5						15
	0						0
Advanced Technology and New Equipment (construction, inspection or testing)	5						15
	0						0
Software Tools (design, analysis, management, testing, inspection, etc.)	5						15
	0						0
Advanced state-of-the-art procedures (e.g., methods, techniques)	5						15
	0						0
Technology Transfer (websites, workshops, clearinghouses)	5						15
	0						0
Total						15	15
Score -- (total score / max score)							100%

Table 3A-3. Adoption for Implementation/ Embedment

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Adoption				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = No	1 = few	2= several	3 = fully		
Specifications (including Design, construction, inspection, testing, maintenance)	5	Have the specifications been adopted as National Specifications?					15
	0						0
Guidelines/Handbooks (including tables, charts, monographs, etc.)	5	Do National and local road agencies or similar organizations and institutions adopt the guidelines/handbooks?			3	15	15
	0						0
Improved Conventional and New Innovative Materials	5	Are the materials developed available commercially?					15
	0						
Advanced Technology and New Equipment (including construction, inspection or testing)	5	Are the technologies and equipment in regular use by transportation agencies (excluding pilot projects)?					15
	0						
Software Tools (for design, analysis, inspection, testing or management)	5	Is the software available, installed, tested and in use by agencies?					15
	0						
Technology Transfer Applications (including websites, clearinghouses, workshops, etc.)	5	Have technology transfer applications been created and implemented?					15
	0						
Total						15	15
Score - (total score / max score)							100%

Table 3A-4. Extent of Use/ Uptake

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Extent of Use by Local and National Road Agencies and Institutions				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = none	1 = few	2 = several	3 = widespread		
Specifications (including Design, construction, inspection, testing, maintenance)	5	Number of agencies using the specifications					15
	0						0
Guidelines/Handbooks (including tables, charts, monographs)	5	Number of agencies that recommend or use of the guidelines, handbooks etc.			3	15	15
	0						0
Improved Conventional and New Innovative Materials	5	Number of agencies with reported applications of the materials					15
	0						0

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Extent of Use by Local and National Road Agencies and Institutions				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = none	1 = few	2 = several	3 = widespread		
Advanced Technology and New Equipment (including construction, inspection or testing)	5	Number of agencies who have procured the equipment or the technology					15
	0						0
Software Tools (for design, analysis, inspection, testing or management)	5	Number of agencies with users of software[4]					15
	0						0
Technology Transfer (including websites, clearinghouses, workshops etc.)	5	Number of agencies requesting additional information or attending workshops or related training courses					15
	0						0
Total						15	15
Score (total score / max score)							100%

Table 3A-5. Overall Score for Part A

Performance Indicator	Relative Weight (w)	Metric Score (s)	Weighted Score (w*s)
A.1. Achievement of research objectives	10%	76	7.6
A.2. Types of Products from Research	15%	100	15
A.3. Adoption for Implementation	30%	100	30
A.4. Extent of Use/ Number of Users of Research Product	45%	100	45
Total	100%		97.6
Score (%)			97.6%

Table 3B-1. Agency Cost Savings

Research Program/Project	
Investment Cost/Research Investment *(I)*	GBP422,575

Capital Costs			
Agency Cost Indicator	Applicability (Yes = 1; No=0)	Cost With implementation of Research Product	Without implementation of Research Product
– Capital cost (design, construction materials, labour, equipment, etc)		0	0
– Training cost for agency personnel and supervisors		1,690	
– Training cost for civil contractors		2,535	
Total Implementation Cost (1)		4,225	

Operating Costs				
Routine Maintenance Cost, Major Rehabilitation & Reconstruction Costs				
Operating Cost Indicator	Applicability (Yes = 1; No=0)	Cost With implementation of Research Product	Without implementation of Research Product	Differential
Average Maintenance Costs (labour, equipment, materials etc)	1	29,580		
Average Rehabilitation and Reconstruction cost (labour, equipment, materials, etc)	0	0		
Total Operating Costs = (2)	1	29,580		
Total Agency Costs (3) = (1)+(2)		33,805		
Percent change (%)				

Table 3B-2. User Costs

User Cost Savings (If project produces user benefits)				
		Annual Costs		
User Cost Indicator	**Applicability (Yes = 1; No=0)**	**Cost With implementation of Research Product**	**Without implementation of Research Product**	**Differential**
Average Vehicle Operating Cost (VOC)		206		
Average travel time and transportation costs		45		
Average crash costs				
Total User Costs (4)		251		
Percent change (%)				

Table 3B-3. Overall Cost Savings

Ratio of Cost Savings to Research Finds Calculations		
Indicator	**Cost With Use of Research Product**	**Cost Without Use of Research Product**
AGENCY COSTS *Table B-1 (3)*	33,805	
USER COSTS *Table B-2 (4)*	251	
Total COSTS (5) = *(3)+(4)*	34,056	
Total Cost Savings $TCS = (5)_{without} - (5)_{with}$		
Ratio of Total Cost Savings over Research Funding *(TCS/I)*		

Table 3C-1. Socio-Economic Subsystem

Performance Indicators	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1= very low	2 = low	3 = medium	4 = high	5 = very high		
Access to educational facilities	5				4		20	25
	0							
Access to health facilities	5			3			15	25
	0							
Social Inclusion	5			3			15	25
	0							
Access to agric inputs and services	5			3			15	
	0							
Access to markets, retail, farming and economic activities	5			3			15	25
	0							
Employment	5			3			15	25
	0							
Women benefiting	5			3			15	25
	0							
Youth benefiting	5			3			15	25
	0							
Travel time savings	5							25
	0							
Transport cost savings	5							25
	0						0	
Total							125	200
Score - (total score / max score)								62.5%

Table 3D-1. Road Safety Subsystem

Performance Indicators	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1 = very low	2 = low	3 = medium	4 = high	5 = very high		
Number of crashes	5							25
	0							0
Number of fatalities	5							
	0							
	5	1					5	25

Performance Indicators	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1 = very low	2 = low	3 = medium	4 = high	5 = very high		
Crash density (crashes/km)	0							0
Number of serious crashes	5	1					5	25
	0							0
Number of minor crashes	5							25
	0							
Proportion of safety helmet use	5							
	0						0	
Total							10	50
Score – (total score / max score								20%

Table 3E-1. Environmental Subsystem

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Impact					Score (level * weight)	Max Score Possible = (max level *weight)
		1 = high negative impact	2 = low negative	3 = no noticeable	4 = low positive	5 = high positive		
Air Quality or Emissions Reduction or dust control	5		2				10	25
	0							0
Erosion	5			3			15	25
	0							0
Drainage structure protection	5			3			15	25
	0						0	0
Total							40	75
Score - (total score / max score)								53.3%

Table 3F-1. User Satisfaction

Performance Indicator	Weight (5 = critical, 0 = not applicable)	Level of Satisfaction 1 = very low; 5 = very high					Score (level * weight)	Maximum Score Possible (max level * weight)
		1	2	3	4	5		
Awareness of research product		1					5	25
Use of research product			2				10	25
Value of research product				3			15	25
Total							30	75
Score - (total score / max score)								40%

Overall Scorecard

Subsys tem	Description	Score (%)	Remarks
A	Research Output And Usage	97.6%	The research fully achieved its objectives, has developed products/outputs that are readily available and adopted by national agencies. These products/outputs are widely used by local and national agencies, and other institutions.
B	Economic /Cost Savings	N/A	Insufficient data available
C	Socio-Economic	62.5%	Implementation of research product or result has some positive socio-economic effects.
D	Road Safety	20%	Implementation of research product or result has no significant effect on road safety
E	Environmental	53.3%	Marginal positive or negative environmental impacts
F	User Satisfaction	40%	Users not satisfied with research product

EXAMPLE 4 – TAN2044H PROJECT NARRATIVE

TAN2044H: Impacts and Implications of gender mainstreaming in the rural transport sector in Tanzania with particular reference to women with multi-dimensional vulnerabilities. (2016-2017).
The aim of this research is to assess whether gender mainstreaming in rural transport has had a transformative effect on women facing multiple forms of discrimination and exclusion

The following are explanations of judgments to support the assumptions where data on indicators are not available. These are presented by subsystems as follows.

A. The project was successfully completed where a final project report was submitted and accepted; no technical paper was published in a peer reviewed journal; no working papers or conference papers were presented but no citations recorded.

The research product was Guidelines for Gender Mainstreaming. This product was fully developed and being a country specific research project, full embedment and uptake were assumed.

B. Insufficient cost data on before and after implementation of research results and the implications are not available at the time of benefits assessment.

C. Based on expert judgment, the socio-economic impacts resulting from implementation of the specific research product are assumed to be medium to high depending on the indicator. For example, social inclusion and women empowerment are expected to be high, whereas access to education and other facilities are not expected to be affected.

D. Given the nature of the research product and based on expert knowledge, implementation of research products is not expected to have any direct impact on road safety indicators.

E. Implementation of research products is assumed to have no environmental impacts.

F. No data on implementation of the research product was available. However, the nature of research product and data obtained from site visits for GHA2065A, guided the estimates used in analysing the benefits in the user satisfaction subsystem.

Table 4A-1. Achievement of Research Objectives

Performance Indicator	Weight (5 = critical, 0 = not achieved)	Level of Achievement				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = not	1 = barely	2 = partially	3 = fully		
Stated objective of program/project	5				3	15	15
Additional Indicators		**Level of Achievement**					
		0 = No		**1 = Yes**		**--**	**--**
Project report	4			1		4	4
Papers published in peer reviewed Journals	3	0				0	3
Working papers, conferences, workshops	2	0				0	2
Awards or Citations for Product	1	0				0	1
Total						19	25
Score - (total score / max score)							76%

Table 4A-2. Types of Products from Research

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Development				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = not developed	1 = initial stages	2 = partially developed	3 = fully developed		
Specifications (Design, construction, inspection, testing, maintenance etc.)	5						15
	0						0
Guidelines/Handbooks (including tables, charts, monographs)	5				3	15	15
	0						0
Improved Conventional and New Innovative Materials	5						15
	0						0
Advanced Technology and New Equipment (construction, inspection or testing)	5						15
	0						0
Software Tools (design, analysis, management, testing, inspection, etc.)	5						15
	0						0
Advanced state-of-the-art procedures (e.g., methods, techniques)	5						15
	0						0
Technology Transfer (websites, workshops, clearinghouses)	5						15
	0						0
Total						15	15
Score -- (total score / max score)							100%

Table 4A-3. Adoption for Implementation/ Embedment

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Adoption				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = No	1 = few	2= several	3 = fully		
Specifications (including Design, construction, inspection, testing, maintenance)	5	Have the specifications been adopted as National Specifications?					15
	0						0
Guidelines/Handbooks (including tables, charts, monographs, etc.)	5	Do National and local road agencies or similar organizations and institutions adopt the guidelines/handbooks?			3	15	15
	0						0
Improved Conventional and New Innovative Materials	5	Are the materials developed available commercially?					15
	0						
Advanced Technology and New Equipment (including	5	Are the technologies and equipment in regular use by transportation agencies (excluding pilot projects)?					15

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Adoption				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = No	1 = few	2= several	3 = fully		
construction, inspection or testing)							
	0						
Software Tools (for design, analysis, inspection, testing or management)	5	Is the software available, installed, tested and in use by agencies?					15
	0						
Technology Transfer Applications (including websites, clearinghouses, workshops, etc.)	5	Have technology transfer applications been created and implemented?					15
	0						
Total						15	15
Score - (total score / max score)							100%

Table 4A-4. Extent of Use/ Uptake

Performance Indicators	Weight (5 = critical, 0 = Not Applicable)	Extent of Use by Local and National Road Agencies and Institutions				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = none	1 = few	2 = several	3 = widespread		
Specifications (including Design, construction, inspection, testing, maintenance)	5	Number of agencies using the specifications					15
	0						0
Guidelines/Handbooks (including tables, charts, monographs)	5	Number of agencies that recommend or use of the guidelines, handbooks etc.			3	15	15
	0						0
Improved Conventional and New Innovative Materials	5	Number of agencies with reported applications of the materials					15
	0						0
Advanced Technology and New Equipment (including construction, inspection or testing)	5	Number of agencies who have procured the equipment or the technology					15
	0						0
Software Tools (for design, analysis, inspection, testing or management)	5	Number of agencies with users of software[4]					15
	0						0
Technology Transfer (including websites, clearinghouses, workshops etc.)	5	Number of agencies requesting additional information or attending workshops or related training courses					15
	0						0
Total						15	15
Score (total score / max score)							100%

Table 4A-5. Overall Score for Part A

Performance Indicator	Relative Weight (w)	Metric Score (s)	Weighted Score (w*s)
A.1. Achievement of research objectives	10%	76	7.6
A.2. Types of Products from Research	15%	100	15
A.3. Adoption for Implementation	30%	100	30
A.4. Extent of Use/ Number of Users of Research Product	45%	100	45
Total	100%		97.6
Score (%)			97.6%

Table 4B-1. Agency Cost Savings

Research Program/Project			
Investment Cost/Research Investment *(I)*		GBP49,822	
Capital Costs			
Agency Cost Indicator	**Applicability (Yes = 1; No=0)**	**Cost With implementation of Research Product**	**Without implementation of Research Product**
– Capital cost (design, construction materials, labour, equipment, etc)			
– Training cost for agency personnel and supervisors			
– Training cost for civil contractors			
Total Implementation Cost (1)			

Operating Costs				
Routine Maintenance Cost		**Major Rehabilitation & Reconstruction Costs**		
Operating Cost Indicator	**Applicability (Yes = 1; No=0)**	**Cost With implementation of Research Product**	**Without implementation of Research Product**	**Differential**
Average Maintenance Costs (labour, equipment, materials etc)	1	5,480		
Average Rehabilitation and Reconstruction cost (labour, equipment, materials, etc)	0	0		
Total Operating Costs = (2)	1			
Total Agency Costs (3) = (1)+(2)		5,480		
Percent change (%)				

Table 4B-2. User Costs

| User Cost Indicator | Applicability (Yes = 1; No=0) | Annual Costs | | Differential |
		Cost With implementation of Research Product	Without implementation of Research Product	
Average Vehicle Operating Cost (VOC)				
Average travel time and transportation costs				
Average crash costs				
Total User Costs (4)				
Percent change (%)				

Table 4B-3. Overall Cost Savings

Ratio of Cost Savings to Research Finds Calculations		
Indicator	Cost With Use of Research Product	Cost Without Use of Research Product
AGENCY COSTS *Table B-1 (3)*	5,480	
USER COSTS *Table B-2 (4)*	0	
Total COSTS (5) = *(3)+(4)*	5,480	
Total Cost Savings $TCS = (5)_{without} - (5)_{with}$		
Ratio of Total Cost Savings over Research Funding *(TCS/I)*		

Table 4C-1. Socio-Economic Subsystem

| Performance Indicators | Weight (5 = critical, 0 = Not Applicable) | Degree of Impact | | | | | Score (level * weight) | Maximum Score Possible (max level * weight) |
		1= very low	2 = low	3 = medium	4 = high	5 = very high		
Access to educational facilities	5							25
	0							
Access to health facilities	5							25
	0							
Social Inclusion	5				4		20	25
	0							
Access to agric inputs and services	5			3			15	25
	0							
Access to markets, retail, farming and economic activities	5			3			15	25
	0							

Performance Indicators	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1= very low	2 = low	3 = medium	4 = high	5 = very high		
Employment	5				4		20	25
	0							
Women benefiting	5				4		20	25
	0							
Youth benefiting	5			3			15	25
	0							
Travel time savings	5			3			15	25
	0							
Transport cost savings	5			3			15	25
	0						0	
Total							135	200
Score - (total score / max score)								67.5%

Table 4D-1. Road Safety Subsystem

Performance Indicators	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1 = very low	2 = low	3 = medium	4 = high	5 = very high		
Number of crashes	5							25
	0							0
Number of fatalities	5							
	0							
Crash density (crashes/km)	5							25
	0							0
Number of serious crashes	5							25
	0							0
Number of minor crashes	5							25
	0							
Proportion of safety helmet use	5							
	0							
Total								
Score – (total score / max score								

Table 4E-1. Environmental Subsystem

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Impact					Score (level * weight)	Max Score Possible = (max level *weight)
		1 = high negative impact	2 = low negative	3 = no noticeable	4 = low positive	5 = high positive		
Air Quality or Emissions Reduction or dust control	5							25
	0							0
Erosion	5							25
	0							0
Drainage structure protection	5							25
	0							0
Total								
Score - (total score / max score)								

Table 4F-1. User Satisfaction

Performance Indicator	Weight (5 = critical, 0 = not applicable)	Level of Satisfaction 1 = very low; 5 = very high					Score (level * weight)	Maximum Score Possible (max level * weight)
		1	2	3	4	5		
Awareness of research product				3			15	25
Use of research product				3			15	25
Value of research product					4		20	25
Total							50	75
Score - (total score / max score)								66.7%

Overall Scorecard

Subsystem	Description	Score (%)	Remarks
A	Research Output And Usage	97.6%	The research fully achieved its objectives, has developed products/outputs that are readily available and adopted by national agencies. These products/outputs are widely used by local and national agencies, and other institutions.
B	Economic /Cost Savings	N/A	Insufficient data available
C	Socio-Economic	67.5%	Implementation of research product or result has some positive socio-economic effects.
D	Road Safety	N/A	Not Applicable
E	Environmental	N/A	Not Applicable
F	User Satisfaction	66.7%	Meets users' needs satisfactorily

EXAMPLE 5 – RAF2114A PROJECT NARRATIVE

RAF2114A: Enhancing understanding on safe motorcycle and three-wheeler use for rural transport and the implications for appropriate training and regulatory frameworks (2017-2019).

The overall aim of the project was to improve knowledge and understanding concerning effective ways of enabling rural people to benefit from the safe use of motorcycles and three-wheelers, with an emphasis on rural motorcycle taxis, rider training, appropriate regulatory frameworks and realistic enforcement methods.

The following are explanations of judgments to support the assumptions where data on indicators are not available. These are presented by subsystems as follows.

A. The project was successfully completed where a final project report was submitted and accepted; no technical paper was published in a peer reviewed journal; no working papers or conference papers were presented but no citations recorded.

   The research product was a set of Guidelines for motorcycle safety and the product was fully developed. However, being a regional research project, it was assumed that several road agencies in the region adopted (embedded) the product for implementation. Similarly, it was assumed that several road agencies actually implemented the product.

B. Insufficient cost data on before and after implementation of research results and the implications are not available at the time of benefits assessment.

C. With regards to socio-economic impacts, no before and after data are available. Based on expert knowledge it was assumed the potential impacts resulting from implementation of the specific research product will range from low to medium depending on the specific indicator.

D. Based on expert knowledge and the objectives of the research project, implementation of research products is expected to have low to high direct impact on road safety depending on the indicator.

E. Implementation of research products is assumed to have no environmental impacts.

F. No data on implementation of the research product was available. However, the nature of research product and data obtained from site visits for GHA2065A, guided the estimates used in analysing the benefits in the user satisfaction subsystem.

Table 5A-1. Achievement of Research Objectives

Performance Indicator	Weight (5 = critical, 0 = not achieved)	Level of Achievement				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = not	1 = barely	2 = partially	3 = fully		
Stated objective of program/project	5				3	15	15
Additional Indicators		Level of Achievement					
		0 = No		1 = Yes		--	--
Project report	4			1		4	4
Papers published in peer reviewed Journals	3	0				0	3
Working papers, conferences, workshops	2	0				0	2
Awards or Citations for Product	1	0				0	1
Total						19	25
Score - (total score / max score)							76%

Table 5A-2. Types of Products from Research

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Development				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = not developed	1 = initial stages	2 = partially developed	3 = fully developed		
Specifications (Design, construction, inspection, testing, maintenance etc.)	5						15
	0						0
Guidelines/Handbooks (including tables, charts, monographs)	5				3	15	15
	0						0
Improved Conventional and New Innovative Materials	5						15
	0						0
Advanced Technology and New Equipment (construction, inspection or testing)	5						15
	0						0
Software Tools (design, analysis, management, testing, inspection, etc.)	5						15
	0						0
Advanced state-of-the-art procedures (e.g., methods, techniques)	5						15
	0						0
Technology Transfer (websites, workshops, clearinghouses)	5						15
	0						0
Total						15	15
Score -- (total score / max score)							100%

Table 5A-3. Adoption for Implementation/ Embedment

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Adoption				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = No	1 = few	2= several	3 = fully		
Specifications (including Design, construction, inspection, testing, maintenance)	5	Have the specifications been adopted as National Specifications?					15
	0						0
Guidelines/Handbooks (including tables, charts, monographs, etc.)	5	Do National and local road agencies or similar organizations and institutions adopt the guidelines/handbooks?		2		10	15
	0						0
Improved Conventional and New Innovative Materials	5	Are the materials developed available commercially?					15
	0						
Advanced Technology and New Equipment (including construction, inspection or testing)	5	Are the technologies and equipment in regular use by transportation agencies (excluding pilot projects)?					15
	0						
Software Tools (for design, analysis, inspection, testing or management)	5	Is the software available, installed, tested and in use by agencies?					15
	0						
Technology Transfer Applications (including websites, clearinghouses, workshops, etc.)	5	Have technology transfer applications been created and implemented?					15
	0						
Total						10	15
Score - (total score / max score)							66.7%

Table 5A-4. Extent of Use/ Uptake

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Extent of Use by Local and National Road Agencies and Institutions				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = none	1 = few	2 = several	3 = widespread		
Specifications (including Design, construction, inspection, testing, maintenance)	5	Number of agencies using the specifications					15
	0						0
Guidelines/Handbooks (including tables, charts, monographs)	5	Number of agencies that recommend or use of the guidelines, handbooks etc.		2		10	15
	0						0
Improved Conventional and New Innovative Materials	5	Number of agencies with reported applications of the materials					15
	0						0

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Extent of Use by Local and National Road Agencies and Institutions				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = none	1 = few	2 = several	3 = widespread		
Advanced Technology and New Equipment (including construction, inspection or testing)	5	Number of agencies who have procured the equipment or the technology					15
	0						0
Software Tools (for design, analysis, inspection, testing or management)	5	Number of agencies with users of software[4]					15
	0						0
Technology Transfer (including websites, clearinghouses, workshops etc.)	5	Number of agencies requesting additional information or attending workshops or related training courses					15
	0						0
Total						10	15
Score (total score / max score)							66.7%

Table 5A-5. Overall Score for Part A

Performance Indicator	Relative Weight (w)	Metric Score (s)	Weighted Score (w*s)
A.1. Achievement of research objectives	10%	76	7.6
A.2. Types of Products from Research	15%	100	15
A.3. Adoption for Implementation	30%	66.7	20.01
A.4. Extent of Use/ Number of Users of Research Product	45%	66.7	30
Total	100%		72.6
Score (%)			72.6%

Table 5B-1. Agency Cost Savings

Research Program/Project			
Investment Cost/Research Investment *(I)*		GBP351,890	
Capital Costs			
Agency Cost Indicator	**Applicability (Yes = 1; No=0)**	**Cost With implementation of Research Product**	**Without implementation of Research Product**
– Capital cost (design, construction materials, labour, equipment, etc)			
– Training cost for agency personnel and supervisors		1408	
– Training cost for civil contractors		2,111	
Total Implementation Cost (1)		3,519	

Operating Costs				
Routine Maintenance Cost Major Rehabilitation & Reconstruction Costs				
Operating Cost Indicator	Applicability (Yes = 1; No=0)	Cost With implementation of Research Product	Without implementation of Research Product	Differential
Average Maintenance Costs (labour, equipment, materials etc)	1	24,632		
Average Rehabilitation and Reconstruction cost (labour, equipment, materials, etc)	0			
Total Operating Costs = (2)	1			
Total Agency Costs (3) = (1)+(2)		28,151		
Percent change (%)				

Table 5B-2. User Costs

User Cost Savings (If project produces user benefits)				
User Cost Indicator	**Applicability (Yes = 1; No=0)**	Annual Costs		**Differential**
		Cost With implementation of Research Product	**Without implementation of Research Product**	
Average Vehicle Operating Cost (VOC)				
Average travel time and transportation costs				
Average crash costs				
Total User Costs (4)				
Percent change (%)				

Table 5B-3. Overall Cost Savings

Ratio of Cost Savings to Research Finds Calculations		
Indicator	**Cost With Use of Research Product**	**Cost Without Use of Research Product**
AGENCY COSTS *Table B-1 (3)*	28,151	
USER COSTS *Table B-2 (4)*	2.468	
Total COSTS (5) = *(3)+(4)*	28,154	
Total Cost Savings $TCS = (5)_{without} - (5)_{with}$		
Ratio of Total Cost Savings over Research Funding *(TCS/I)*		

Table 5C-1. Socio-Economic Subsystem

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1= very low	2 = low	3 = medium	4 = high	5 = very high		
Access to educational facilities	5		2				10	25
	0							
Access to health facilities	5		2				10	25
	0							
Social Inclusion	5		2				10	25
	0							
Access to agric inputs and services	5			3			15	25
	0							
Access to markets, retail, farming and economic activities	5			3			15	25
	0							
Employment	5		2				10	25
	0							
Women benefiting	5		2				10	25
	0							
Youth benefiting	5		2				10	25
	0							
Travel time savings	5			3			15	25
	0							
Transport cost savings	5			3			15	25
	0						0	
Total							120	250
Score - (total score / max score)								48%

Table 5D-1. Road Safety Subsystem

Performance Indicators	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1 = very low	2 = low	3 = medium	4 = high	5 = very high		
Number of crashes	5			3			15	25
	0							0
Number of fatalities	5			3			15	25
	0							
Crash density (crashes/km)	5		2				10	25
	0							0
Number of serious crashes	5			3			15	25
	0							0
Number of minor crashes	5			3			15	25
	0							
Proportion of safety helmet use	5					4	20	25
	0							
Total							**90**	**150**
Score – (total score / max score)								**60%**

Table 5E-1. Environmental Subsystem

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Impact					Score (level * weight)	Max Score Possible = (max level *weight)
		1 = high negative impact	2 = low negative	3 = no noticeable	4 = low positive	5 = high positive		
Air Quality or Emissions Reduction or dust control	5							25
	0							0
Erosion	5							25
	0							0
Drainage structure protection	5							25
	0							0
Total								
Score - (total score / max score)								

Table 5F-1. User Satisfaction

Performance Indicator	Weight (5 = critical, 0 = not applicable)	Level of Satisfaction 1 = very low; 5 = very high					Score (level * weight)	Maximum Score Possible (max level * weight)
		1	2	3	4	5		
Awareness of research product			2				10	25
Use of research product			2				10	25
Value of research product			2				10	25
Total							30	75
Score - (total score / max score)								40%

Overall Scorecard

Subsystem	Description	Score (%)	Remarks
A	Research Output And Usage	72.6%	The research partially achieved its objectives, has partially developed products that are available and adopted by national agencies. Several local and national agencies, and other institutions use these products.
B	Economic /Cost Savings	N/A	Insufficient data available
C	Socio-Economic	48%	Implementation of research product or result has marginal positive socio-economic effects
D	Road Safety	60%	Implementation of research product or result has marginal effects on road safety.
E	Environmental	N/A	Not applicable
F	User Satisfaction	40%	Users not satisfied with research product

EXAMPLE 6 - GEN2014C -PROJECT NARRATIVE

GEN2014C - Climate Adaptation: Risk Management and Resilience Optimisation for Vulnerable Road Access in Africa – Phase 1. Engineering Adaptation Guidelines (2016-2017).

The fundamental research objective is to identify, characterise and demonstrate appropriate engineering and non-engineering adaptation procedures that may be implemented to strengthen the long-term resilience of rural access. The project developed "*Climate Adaptation Handbook"* to assist in the development of a climate-resilient road network that reaches fully into and between rural communities.

The following are explanations of judgments to support the assumptions where data on indicators are not available. These are presented by subsystems as follows.

A. The project was successfully completed where a final project report was submitted and accepted; a technical paper was published in a peer reviewed journal; working papers or conference papers were presented but no citations recorded.

   The research product was a Climate Adaptation Handbook to assist in the development of a climate-resilient road network. This product was fully developed and assumed to be adopted for implementation by most road agencies. It is also assumed most road agencies have actually implemented the research product.

B. Insufficient cost data on before and after implementation of research results and the implications are not available at the time of benefits assessment.

C. With regards to socio-economic impacts, the potential impacts resulting from implementation of the specific research product are estimated based on expert judgment for the various indicators. The impacts are assumed to be low to medium depending on the indicator.

D. Based on expert knowledge and the research focus area, the direct road safety impacts of implementing the research product is assumed be minimal.

E. Based on the research focus area, implementation of the research product is assumed to have high positive environmental impacts.

F. No data on user satisfaction of implementation of the research product was available. No assumptions offered.

Table 6A-1. Achievement of Research Objectives

Performance Indicator	Weight (5 = critical, 0 = not achieved)	Level of Achievement				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = not	1 = barely	2 = partially	3 = fully		
Stated objective of program/project	5				3	15	15
Additional Indicators		**Level of Achievement**					
		0 = No		**1 = Yes**		--	--
Project report	4			1		4	4
Papers published in peer reviewed Journals	3			1		3	3
Working papers, conferences, workshops	2			1		2	2
Awards or Citations for Product	1	0				0	1
Total						24	25
Score (total score / max score)							96%

Table 6A-2. Types of Products from Research

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Development				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = not developed	1 = initial stages	2 = partially developed	3 = fully developed		
Specifications (Design, construction, inspection, testing, maintenance etc.)	5						15
	0						0
Guidelines/Handbooks (including tables, charts, monographs)	5				3	15	15
	0						0
Improved Conventional and New Innovative Materials	5						15
	0						0
Advanced Technology and New Equipment (construction, inspection or testing)	5						15
	0						0
Software Tools (design, analysis, management, testing, inspection, etc.)	5						15
	0						0
Advanced state-of-the-art procedures (e.g., methods, techniques)	5						15
	0						0
Technology Transfer (websites, workshops, clearinghouses)	5						15
	0						0
Total						15	15
Score -- (total score / max score)							100%

Table 6A-3. Adoption for Implementation/ Embedment

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Adoption				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = No	1 = few	2= several	3 = fully		
Specifications (including Design, construction, inspection, testing, maintenance)	5	Have the specifications been adopted as National Specifications?					15
	0						0
Guidelines/Handbooks (including tables, charts, monographs, etc.)	5	Do National and local road agencies or similar organizations and institutions adopt the guidelines/handbooks?			3	15	15
	0						0
Improved Conventional and New Innovative Materials	5	Are the materials developed available commercially?					15
	0						
Advanced Technology and New Equipment (including construction, inspection or testing)	5	Are the technologies and equipment in regular use by transportation agencies (excluding pilot projects)?					15
	0						
Software Tools (for design, analysis, inspection, testing or management)	5	Is the software available, installed, tested and in use by agencies?					15
	0						
Technology Transfer Applications (including websites, clearinghouses, workshops, etc.)	5	Have technology transfer applications been created and implemented?	1				15
	0						
Total						15	15
Score - (total score / max score)							100%

Table 6A-4. Extent of Use/ Uptake

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Extent of Use by Local and National Road Agencies and Institutions				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = none	1 = few	2 = several	3 = widespread		
Specifications (including Design, construction, inspection, testing, maintenance)	5	Number of agencies using the specifications					15
	0						0
Guidelines/Handbooks (including tables, charts, monographs)	5	Number of agencies that recommend or use of the guidelines, handbooks etc.		2		10	15
	0						0
Improved Conventional and New Innovative Materials	5	Number of agencies with reported applications of the materials					15
	0						0

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Extent of Use by Local and National Road Agencies and Institutions				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = none	1 = few	2 = several	3 = widespread		
Advanced Technology and New Equipment (including construction, inspection or testing)	5	Number of agencies who have procured the equipment or the technology					15
	0						0
Software Tools (for design, analysis, inspection, testing or management)	5	Number of agencies with users of software[4]					15
	0						0
Technology Transfer (including websites, clearinghouses, workshops etc.)	5	Number of agencies requesting additional information or attending workshops or related training courses					15
	0						0
Total						10	15
Score (total score / max score)							66.7%

Table 6A-5. Overall Score for Part A

Performance Indicator	Relative Weight (w)	Score (s)	Weighted Score (w*s)
A.1. Achievement of research objectives	10%	76	7.6
A.2. Types of Products from Research	15%	100	15
A.3. Adoption for Implementation	30%	100	30
A.4. Extent of Use/ Number of Users of Research Product	45%	66.7	30.02
Total Score	100%		82.62
Score (%)			83%

Table 6B-1. Agency Cost Savings

Research Program/Project	
Investment Cost/Research Investment *(I)*	GBP277,260

Capital Costs			
Agency Cost Indicator	**Applicability (Yes = 1; No=0)**	**Cost With implementation of Research Product**	**Without implementation of Research Product**
– Capital cost (design, construction materials, labour, equipment, etc)			
– Training cost for agency personnel and supervisors			
– Training cost for civil contractors			
Total Implementation Cost (1)			

Operating Costs					
Routine Maintenance Cost Major Rehabilitation & Reconstruction Costs					
Operating Cost Indicator	Applicability (Yes = 1; No=0)	Cost With implementation of Research Product	Without implementation of Research Product	Differential	
Average Maintenance Costs (labour, equipment, materials etc)					
Average Rehabilitation and Reconstruction cost (labour, equipment, materials, etc)					
Total Operating Costs = (2)					
Total Agency Costs (3) = (1)+(2)					
Percent change (%)					

Table 6B-2. User Costs

User Cost Savings (If project produces user benefits)				
User Cost Indicator	**Applicability (Yes = 1; No=0)**	**Annual Costs**		**Differential**
		Cost With implementation of Research Product	Without implementation of Research Product	
Average Vehicle Operating Cost (VOC)				
Average travel time and transportation costs				
Average crash costs				
Total User Costs (4)				
Percent change (%)				

Table 6B-3. Overall Cost Savings

Ratio of Cost Savings to Research Finds Calculations		
Indicator	**Cost With Use of Research Product**	**Cost Without Use of Research Product**
AGENCY COSTS *Table B-1 (3)*		
USER COSTS *Table B-2 (4)*		
Total COSTS (5) = *(3)+(4)*		
Total Cost Savings $TCS = (5)_{with} - (5)_{without}$		
Ratio of Total Cost Savings over Research Funding *(TCS/I)*		

Table 6C-1. Socio-Economic Subsystem

Performance Indicators	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1= very low	2 = low	3 = medium	4 = high	5 = very high		
Access to educational facilities	5		2				10	25
	0							
Access to health facilities	5		2				10	25
	0							
Social Inclusion	5		2				10	25
	0							
Access to agric inputs and services	5			3			15	25
	0							
Access to markets, retail, farming and economic activities	5			3			15	25
	0							
Employment	5		2				10	25
	0							
Women benefiting	5		2				10	25
	0							
Youth benefiting	5		2				10	25
	0							
Travel time savings	5							25
	0							
Transport cost savings	5							25
	0						0	
Total							90	200
Score - (total score / max score)								45%

Table 6D-1. Road Safety Subsystem

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1 = very low	2 = low	3 = medium	4 = high	5 = very high		
Number of crashes	5							25
	0							0
Number of fatalities								
Crash density (crashes/km)	5	1					5	25
	0							0
Number of serious crashes	5	1					5	25
	0							0
Number of minor crashes	5							25
	0							
Proportion of safety helmet use	5							
	0						0	
Total							10	50
Score – (total score / max score								20%

Table 6E-1. Environmental Subsystem

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Impact					Score (level * weight)	Max Score Possible = (max level *weight)
		1 = high negative impact	2 = low negative	3 = no noticeable	4 = low positive	5 = high positive		
Air Quality or Emissions Reduction or dust control	5				4		20	25
	0							0
Erosion	5					5	25	25
	0							0
Drainage structure failures	5					5	25	25
	0						0	0
Total							70	75
Score - (total score / max score)								93.3%

Table 6F-1. User Satisfaction

Performance Indicator	Weight (5 = critical, 0 = not applicable)	Level of Satisfaction 1 = very low; 5 = very high					Score (level * weight)	Maximum Score Possible (max level * weight)
		1	2	3	4	5		
Awareness of research product								25
Use of research product								25
Value of research product								25
Total								
Score - (total score / max score)								

Overall Scorecard

Subsystem	Description	Score (%)	Remarks
A	Research Output And Usage	83%	The research fully achieved its objectives, has developed products/outputs that are readily available and adopted by national agencies. These products/outputs are widely used by local and national agencies, and other institutions.
B	Economic /Cost Savings	N/A	Data not available
C	Socio-Economic	45%	Implementation of research product or result has marginal positive socio-economic effects.
D	Road Safety	N/A	Not applicable
E	Environmental	93.3%	High positive environmental impacts
F	User Satisfaction	N/A	Data not available

EXAMPLE 7 -   HYPOTHETICAL PROJECT NARRATIVE

This is an example of the application of the BAS using a hypothetical project with the primary objective to develop improved highway pavement construction materials additive to reduce rutting in rural gravel road pavements. The project was also required to develop the outline/structure for a website for effective dissemination of the project findings to users.

The following are explanations of the assumptions for data for the indicators for which data is not available. These are presented by subsystems.

A. The project was successfully completed where a final project report was submitted and accepted; a technical paper was assumed to have been published in a peer reviewed journal; working papers or conference papers were presented but no citations recorded.

A. The research products were (a) Improved or innovative materials to reduce rutting on gravel roads and (b) technology transfer (website for effective dissemination of the project findings). Product (a) was fully developed and assumed to be adopted for implementation by most road agencies. However, it is assumed several (not all) road agencies have actually implemented the research product. Product (b) on the other hand, was partially developed at the time of benefit assessment, few road agencies have adopted it for implementation and few have actually implemented it.

B. Based on experience and expert knowledge, some cost data were assumed for purposes of this analysis to illustrate the computations of benefits in the economic subsystem.

C. Expert knowledge was used to estimate the impacts of this project implementation on the various indicators in the socio-economic subsystem. The impacts are assumed to be low to medium depending on the indicator.

D. Based on expert knowledge, implementation of the research products are assumed to have very low impacts on road safety indicators.

E. The use of improved road construction materials is assumed to have noticeable positive impacts of environmental impact indicators.

F. It is assumed that the users derive benefits when products are implemented – e.g., smoother rides, reduced VOCs. As such, it is assumed that users will derive some satisfaction with the implementation of the research product.

Table 7A-1. Achievement of Research Objectives

Performance Indicator	Weight (5 = critical, 0 = not achieved)	Level of Achievement				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = not	1 = barely	2 = partially	3 = fully		
Stated objective of program/project	5				3	15	15
Additional Indicators		**Level of Achievement**					
		0 = No		**1 = Yes**		**--**	**--**
Project report	4			1		4	4
Papers published in peer reviewed Journals	3			1		3	3
Working papers, conferences, workshops	2	0		1		2	2
Awards or Citations for Product	1	0				0	1
Total						24	25
Score - (total score / max score)							96%

Table 7A-2. Types of Products from Research

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Development				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = not developed	1 = initial stages	2 = partially developed	3 = fully developed		
Specifications (Design, construction, inspection, testing, maintenance etc.)	5						15
	0						0
Guidelines/Handbooks (including tables, charts, monographs)	5						15
	0						0
Improved Conventional and New Innovative Materials	5				3	15	15
	0						0
Advanced Technology and New Equipment (construction, inspection or testing)	5						15
	0						0
Software Tools (design, analysis, management, testing, inspection, etc.)	5						15
	0						0
Advanced state-of-the-art procedures (e.g., methods, techniques)	5						15
	0						0
Technology Transfer (websites, workshops, clearinghouses)	5		2			10	15
	0						0
Total						25	30
Score -- (total score / max score)							83.3%

Table 7A-3. Adoption for Implementation/ Embedment

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Adoption				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = No	1 = few	2= several	3 = fully		
Specifications (including Design, construction, inspection, testing, maintenance)	5	Have the specifications been adopted as National Specifications?					15
	0						0
Guidelines/Handbooks (including tables, charts, monographs, etc.)	5	Do National and local road agencies or similar organizations and institutions adopt the guidelines/handbooks?					15
	0						0
Improved Conventional and New Innovative Materials	5	Are the materials developed available commercially?			3	15	15
	0						
Advanced Technology and New Equipment (including construction, inspection or testing)	5	Are the technologies and equipment in regular use by transportation agencies (excluding pilot projects)? •					15
	0						
Software Tools (for design, analysis, inspection, testing or management)	5	Is the software available, installed, tested and in use by agencies?					15
	0						
Technology Transfer Applications (including websites, clearinghouses, workshops, etc.)	5	Have technology transfer applications been created and implemented?	1			5	15
	0						
Total						20	30
Score - (total score / max score)							66.7%

Table 7A-4. Extent of Use/ Uptake

Performance Indicators	Weight (5 = critical, 0 = Not Applicable)	Extent of Use by Local and National Road Agencies and Institutions				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = none	1 = few	2 = several	3 = widespread		
Specifications (including Design, construction, inspection, testing, maintenance)	5	Number of agencies using the specifications					15
	0						0
Guidelines/Handbooks (including tables, charts, monographs)	5	Number of agencies that recommend or use of the guidelines, handbooks etc.					15
	0						0
	5	Number of agencies with reported applications of the materials				10	15

Performance Indicators	Weight (5 = critical, 0 = Not Applicable)	Extent of Use by Local and National Road Agencies and Institutions				Score (level * weight)	Maximum Score Possible (max level * weight)
		0 = none	1 = few	2 = several	3 = widespread		
Improved Conventional and New Innovative Materials				2			
	0						0
Advanced Technology and New Equipment (including construction, inspection or testing)	5	Number of agencies who have procured the equipment or the technology					15
	0						0
Software Tools (for design, analysis, inspection, testing or management)	5	Number of agencies with users of software[4]					15
	0						0
Technology Transfer (including websites, clearinghouses, workshops etc.)	5	Number of agencies requesting additional information or attending workshops or related training courses				5	15
			1				
	0						0
Total						15	30
Score (total score / max score)							50%

Table 7A-5. Overall Score for Part A

Performance Indicator	Relative Weight (w)	Metric Score (s)	Weighted Score (w*s)
A.1. Achievement of research objectives	10%	96	9.6
A.2. Types of Products from Research	15%	83.3	12.5
A.3. Adoption for Implementation	30%	66.7	20.01
A.4. Extent of Use/ Number of Users of Research Product	45%	50	22.5
Total	100%		64.6
Score (%)			64.6%

Table 7B-1. Agency Cost Savings

Research Program/Project			
Investment Cost/Research Investment *(I)*		GBP350,000	
Capital Costs			
Agency Cost Indicator	**Applicability (Yes = 1; No=0)**	**Cost With implementation of Research Product**	**Without implementation of Research Product**
– Capital cost (design, construction materials, labour, equipment, etc)		200,000	300,000
– Training cost for agency personnel and supervisors		10,000	0
– Training cost for civil contractors		15,000	0
Total Implementation Cost (1)		225,000	300,000
Operating Costs			
Routine Maintenance Cost Major Rehabilitation & Reconstruction Costs			

Operating Cost Indicator	**Applicability (Yes = 1; No=0)**	**Cost With implementation of Research Product**	**Without implementation of Research Product**	**Differential**
Average Maintenance Costs (labour, equipment, materials etc)		50,000	100,000	50,000
Average Rehabilitation and Reconstruction cost (labour, equipment, materials, etc)				
Total Operating Costs = (2)		50,000	100,000	50,000
Total Agency Costs (3) = (1)+(2)		275,000	400,000	
Percent change (%)				31.25%

Table 7B-2. User Costs

User Cost Savings (If project produces user benefits)				
		Annual Costs		
User Cost Indicator	**Applicability (Yes = 1; No=0)**	**Cost With implementation of Research Product**	**Without implementation of Research Product**	**Differential**
Average Vehicle Operating Cost (VOC)		125	400	275
Average travel time and transportation costs		100	200	100
Average crash costs				
Total User Costs (4)		225	600	375
Percent change (%)				62.5%

Table 7B-3. Overall Cost Savings

Ratio of Cost Savings to Research Finds Calculations		
Indicator	Cost With Use of Research Product	Cost Without Use of Research Product
AGENCY COSTS *Table B-1 (3)*	275,000	400,000
USER COSTS *Table B-2 (4)*	225	600
Total COSTS (5) = *(3)+(4)*	275,225	500,600
Total Cost Savings $TCS = (5)_{without} - (5)_{with}$		225,375
Ratio of Total Cost Savings over Research Funding *(TCS/I)*		64.4%

Table 7C-1. Socio-Economic Subsystem

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1= very low	2 = low	3 = medium	4 = high	5 = very high		
Access to educational facilities	5		2				10	25
	0							
Access to health facilities	5		2				10	25
	0							
Social Inclusion	5		2				10	25
	0							
Access to agric inputs and services	5			3			15	25
	0							
Access to markets, retail, farming and economic activities	5			3			15	25
	0							
Employment	5				4		20	25
	0							
Women benefiting	5		2				10	25
	0							
Youth benefiting	5		2				10	25
	0							
Travel time savings	5					5	25	25
	0							
Transport cost savings	5					5	25	25
	0						0	
Total							150	250
Score - (total score / max score)								60%

Table 7D-1. Road Safety Subsystem

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Degree of Impact					Score (level * weight)	Maximum Score Possible (max level * weight)
		1 = very low	2 = low	3 = medium	4 = high	5 = very high		
Number of crashes	5							25
	0							0
Number of fatalities								
Crash density (crashes/km)	5	1					5	25
	0							0
Number of serious crashes	5	1					5	25
	0							0
Number of minor crashes	5							25
	0							
Proportion of safety helmet use	5							
	0						0	
Total							10	50
Score – (total score / max score								20%

Table 7E-1. Environmental Subsystem

Performance Indicator	Weight (5 = critical, 0 = Not Applicable)	Level of Impact					Score (level * weight)	Max Score Possible = (max level *weight)
		1 = high negative impact	2 = low negative	3 = no noticeable	4 = low positive	5 = high positive		
Air Quality or Emissions Reduction or dust control	5			3			15	25
	0							0
Erosion	5				4		20	25
	0							0
Drainage structure protection	5							25
	0						0	0
Total							35	50
Score - (total score / max score)								70%

Table 7F-1. User Satisfaction

Performance Indicator	Weight (5 = critical, 0 = not applicable)	Level of Satisfaction 1 = very low; 5 = very high					Score (level * weight)	Maximum Score Possible (max level * weight)
		1	2	3	4	5		
Awareness of research product				3			15	25
Use of research product					4		20	25
Value of research product				3			15	25
Total							50	75
Score - (total score / max score)								66.7%

Overall Scorecard

Subsystem	Description	Score (%)	Remarks
A	Research Output And Usage	68%	The research barely achieved its objectives, has developed products that are in the early stages of availability and adoption by road agencies. Few local and national agencies, and other institutions use these products.
B	Economic /Cost Savings	64.4%	Unit research investment of generates approximates 64% cost savings (agency, operations, and user cost)
C	Socio-Economic	60%	Implementation of research product or result has marginal positive socio-economic effects
D	Road Safety	20%	Implementation of research product or result has no significant effect on road safety
E	Environmental	70%	Low positive environmental impacts
F	User Satisfaction	66.7%	Limited users' satisfaction with research product implementation

SUMMARY RESULTS OF EXAMPLES

This section presents a summary of results of seven (7) examples analysed using the BAS. The first example presents an ongoing project implementing a research product. Data on impacts were collected through field studies conducted by the project team. The objective was to ascertain the impacts and perspectives of the before and after situation of the project.

Cost data on the implementation of the research products were not readily available. However, in an attempt to demonstrate the use of BAS for subsystem B- Economic, a hypothetical example is included. The results are summarized in the Table 2.

The examples demonstrate the applicability of the benefits assessment framework to different research focus areas. These examples also illustrate flexibility of BAS in assessing benefits of research investments in different contexts. The results also demonstrate the rationale for not reporting an aggregated single score for all the subsystems.

Table 2. Summary of Results

	Project ID	Result	Rating	Description
A. Research Output and Usage				
Ex-1	GHA2065B	98.4%	*Excellent*	The research fully achieved its objectives, has developed products/outputs that are readily available and adopted by national agencies. These products/outputs are widely used by local and national agencies, and other institutions.
Ex-2	RAF2114A	98.4%	*Excellent*	
Ex-3	RAF2116A	97.6%	*Excellent*	
Ex-4	TAN2014H	97.6%	*Excellent*	
Ex-5	RAF2114A	72.6	*Good*	The research partially achieved its objectives, has partially developed products that are available and adopted by national agencies. Several local and national agencies, and other institutions use these products.
Ex-6	GEN2014C	83%%	*Excellent*	The research fully achieved its objectives, has developed products/outputs that are readily available and adopted by national agencies. These products/outputs are widely used by local and national agencies, and other institutions.
Ex-7	Hypothetical	73%	*Good*	The research partially achieved its objectives, has partially developed products that are available and adopted by national agencies. Several local and national agencies, and other institutions use these products.
B. Economic				
Ex-1	GHA2065B	N/A	N/A	N/A
Ex-2	RAF2114A	N/A	N/A	N/A
Ex-3	RAF2116A	N/A	N/A	N/A
Ex-4	TAN2014H	N/A	N/A	N/A
Ex-5	RAF2114A	N/A	N/A	N/A
Ex-6	GEN2014C	N/A	N/A	N/A
Ex-7	Hypothetical	0.644	N/A	Total Cost Savings/Research Investment Ratio is 0.644
C: Socio-Economic				
Ex-1	GHA2065B	78%	Excellent	Implementation of research product or result has significant positive socio-economic effects
Ex-2	RAF2114A	60%	Good	Implementation of research product or result has some positive socio-economic effects.
Ex-3	RAF2116A	62.5%	Good	Implementation of research product or result has some positive socio-economic effects.
Ex-4	TAN2014H	67.5%	Excellent	Implementation of research product or result has significant positive socio-economic effects
Ex-5	RAF2114A	48%	Excellent	Implementation of research product or result has significant positive socio-economic effects
Ex-6	GEN2014C	45%	Good	Implementation of research product or result has some positive socio-economic effects.
Ex-7	Hypothetical	60%	Fair	Implementation of research product or result has marginal positive socio-economic effects.

	Project ID	Result	Rating	Description
D: Road Safety				
Ex-1	GHA2065B	*N/A*	*N/A*	*N/A*
Ex-2	RAF2114A	*53.3%*	*Fair*	Implementation of research product or result has marginal effects on road safety.
Ex-3	RAF2116A	*20%*	*Poor*	Implementation of research product or result has no significant effect on road safety
Ex-4	TAN2014H	*N/A*	*N/A*	*N/A*
Ex-5	RAF2114A	*60%*	*Good*	Implementation of research product or result has improved road safety by reduced crashes and fatalities to some measurable extent
Ex-6	GEN2014C	*N/A*	*N/A*	*N/A*
Ex-7	Hypothetical	*20%*	*Poor*	Implementation of research product or result has no significant effect on road safety
E: Environmental				
Ex-1	GHA2065B	*40%*	*Poor*	Significant negative environmental impacts
Ex-2	RAF2114A	*60%*	*Good*	Low positive environmental impacts
Ex-3	RAF2116A	*53.3%*	*Fair*	Marginal positive or negative environmental impacts
Ex-4	TAN2014H	*N/A*	*N/A*	*N/A*
Ex-5	RAF2114A	*N/A*	*N/A*	*N/A*
Ex-6	GEN2014C	*93.3%*	*Excellent*	High positive environmental impacts
Ex-7	Hypothetical	*70%*	*Good*	Low positive environmental impacts
F: User Satisfaction				
Ex-1	GHA2065B	93.3%	*Excellent*	Meets users' needs/expectations adequately
Ex-2	RAF2114A	66.7%	*Good*	Meets users' needs/expectations satisfactorily
Ex-3	RAF2116A	40%	*Poor*	Users not satisfied with research product
Ex-4	TAN2014H	66.7%	*Good*	Meets users' needs/expectations satisfactorily
Ex-5	RAF2114A	40%	*Poor*	Users not satisfied with research product
Ex-6	GEN2014C	N/A	*N/A*	N/A
Ex-7	Hypothetical	66.7%	*Good*	Meets users' needs/expectations satisfactorily